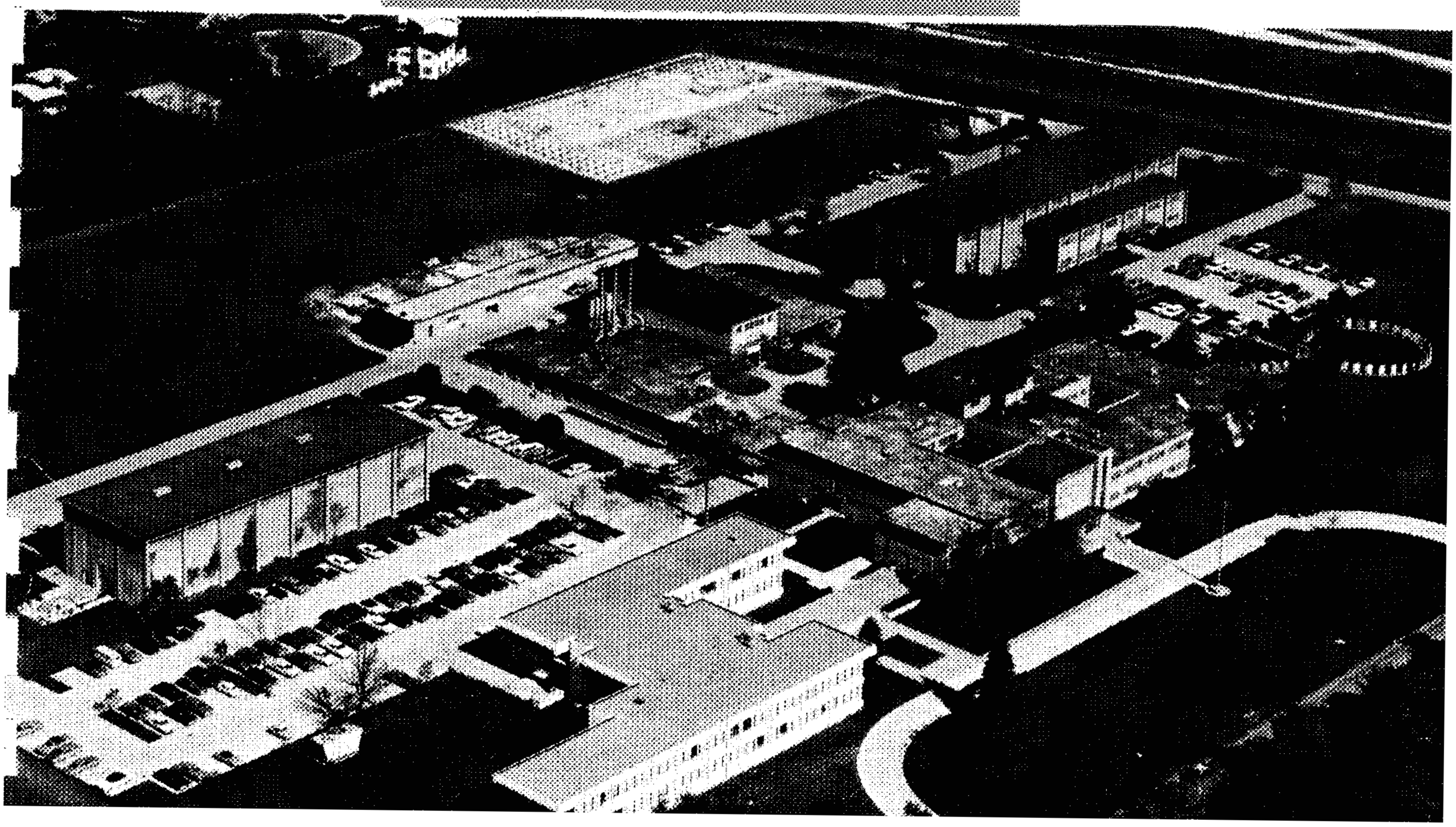
ORNL/Sub/79-42539/4

construction technology laboratories

a Division of the PORTLAND CEMENT ASSOCIATION



ORNL/SUB/79-42539/4

CALIBRATED HOT BOX TEST RESULTS
DATA MANUAL - VOLUME I

Final Report

by

M. G. Van Geem

Report Prepared by

CONSTRUCTION TECHNOLOGY LABORATORIES
A Division of the Portland Cement Association
5420 Old Orchard Road
Skokie, Illinois 60077

Prepared for
Building Thermal Envelope Systems and Materials Program
OAK RIDGE NATIONAL LABORATORIES
Oak Ridge, Tennessee 37830
Operated by
MARTIN MARIETTA ENERGY SYSTEMS INC.
for the
U.S. DEPARTMENT OF ENERGY
Under Subcontract No.
DE-AC05-84OR21400

November 1984

Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road, Springfield, Virginia 22161
NTIS price codes--Printed Copy: A15 Microfiche A01

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

<u>CALIBRATED HOT BOX TEST RESULTS</u>

<u>DATA MANUAL - VOLUME I</u>

by

M. G. Van Geem*

ABSTRACT

This manual summarizes results from 15 wall assemblies tested under steady-state and dynamic temperature conditions in the calibrated hot box facility at Construction Technology Laboratories, a Division of the Portland Cement Association.

The calibrated hot box provides data on the heat transmission characteristics of full-size wall assemblies under steady-state and dynamic temperature conditions. Steady-state tests are used to obtain average heat transmission coefficients. Dynamic tests provide data on thermal performance under controlled conditions that simulate actual temperature changes in building envelopes. Calibrated hot box tests are performed generally following procedures described in ASTM Designation: C976, "Thermal Performance of Building Assemblies by Means of a Calibrated Hot Box."

This manual summarizes test results of six concrete masonry walls, two masonry cavity walls, three concrete walls, three wood frame walls, and a brick veneer-wood frame wall. A description of wall geometry and material properties is given for each specimen. The manual presents steady-state, transient, and dynamic (periodic) test results in tabular form, in figures, and in summary tables. Heat transfer characteristics of different

*Research Engineer, Construction Methods Department, Construction Technology Laboratories, a Division of the Portland Cement Association, 5420 Old Orchard Road, Skokie, Illinois 60077

wall assemblies can be compared by using figures and summary tables for each wall. Data presented in numerical form can be used to validate models or analyze results.

CALIBRATED HOT BOX TEST RESULTS

DATA MANUAL - VOLUME I

by

M. G. Van Geem*

INTRODUCTION

The calibrated hot box provides data on heat transmission characteristics of full-size wall assemblies under steady-state and dynamic temperature conditions. Heat transmission characteristics of walls must be determined to evaluate thermal performance of building envelopes.

The 1981 ASHRAE Handbook of Fundamentals[1]** summarizes steady-state properties of five commonly used types of wall construction. Thermal and physical properties of building materials used in wall construction are also listed.

There is a need for a document to summarize data from tests on wall assemblies under dynamic temperature conditions. Massive materials, such as concrete and masonry, store and release heat energy under changing temperature conditions. Only dynamic tests can be used to determine heat storage characteristics of building components.

This manual summarizes results of 15 wall assemblies tested under steady-state and dynamic temperature conditions in the calibrated hot box facility at Construction Technology Laboratories (CTL), a division of the Portland Cement Association. Wall descriptions and test dates are listed

*Research Engineer, Construction Methods Department, Construction Technology Laboratories, a Division of the Portland Cement Association, 5420 Old Orchard Road, Skokie, Illinois 60077

**Superscript numbers in parenthesis refer to references listed at the end of the descriptive portion of the manual.

in Table 1. Steady-state tests are used to obtain average heat transmission coefficients. Dynamic tests provide data on thermal performance under controlled conditions that simulate actual temperature changes in building envelopes.

Dynamic test data are applicable only for the temperature cycles used during testing. Although cycles used for tests summarized in this report do not cover a wide range of temperature conditions, test results illustrate the significance of dynamic testing.

Test results for six additional walls will be covered in a future report entitled, "Calibrated Hot Box Test Results Data Manual - Volume II."(2) Wall descriptions for Volume II are listed in Table 2.

CALIBRATED HOT BOX TEST FACILITY

Tests were conducted in the calibrated hot box facility shown in Figs. 1 and 2. Tests were performed generally following procedures described in ASTM Designation: C976, "Standard Test Method for Thermal Performance of Building Assemblies by Means of a Calibrated Hot Box,"(3) approved in 1983. The fifteen walls described in this manual were tested before the standard was approved.

Description

The following is a brief description of the calibrated hot box. Details are available in Reference 4. The facility consists of two highly insulated chambers as shown in Fig. 2. Walls, ceiling, and floors of each chamber are insulated with foamed urethane sheets to obtain a nominal thickness of 12 in. (305 mm). During tests, the chambers are clamped tightly against an insulated frame that surrounds the test wall. Air in

TABLE 1 - CALIBRATED HOT BOX TEST DATES

Wall Designation	Wall Description	Date of Calibrated Hot Box Tests
M1	8-in. (203-mm) Medium Weight Concrete Block	December 1978 - January 1979
M2	8-in. (203-mm) Medium Weight Concrete Block with Insulation in Cores	January-February 1979
M5	8-in. (203-mm) Normal Weight Concrete Block with Reflective Insulation	February-April 1980
M6	8-in. (203-mm) Lightweight Concrete Block with Insulation on Inside Surface	January-February 1981
M7	6-in. (152-mm) Lightweight Concrete Block with Insulation on Inside Surface	April-June 1981
M8	8-in. (203-mm) Normal Weight Concrete Block with Insulation on Inside Surface	March-April 1981
M3	10-in. (254-mm) Block-Brick Cavity Wall	March-April 1979
M4	10-in. (254-mm) Block-Brick Cavity Wall with Insulation in Cavity	April 1979
C1	8-in. (203-mm) Normal Weight Concrete	October-December 1981
C2	8-in. (203-mm) Structural Lightweight Concrete	December 1981 - February 1982
C3	8-in. (203-mm) Low Density Concrete	February-March 1982
F3	2x4-in. (51x102-mm) Wood Frame with R-11 Fiberglass Insulation and Cedar Siding	February-March 1979
F4	2x4-in. (51x102-mm) Wood Frame with R-11 Fiberglass Insulation and Cedar Siding	November 1979 - January 1980
F5	2x4-in. (51x102-mm) Wood Frame with R-11 Fiberglass Insulation and Hardboard Siding	December 1980 - January 1981
V1	10-in. (254-mm) Brick Veneer	May-June 1979

TABLE 2 - DESCRIPTIONS OF WALLS SUMMARIZED IN THE "CALIBRATED HOT BOX TEST RESULTS DATA MANUAL - VOLUME II"

Wall Designation	Wall Description
S1	1-3/8-in. (35-mm) Fiberglass Board
S2	4-in. (102-mm) Polystyrene Beadboard
M9	12-in. (305-mm) Block-Brick Cavity Wall
M10	12-in. (305-mm) Block-Brick Cavity Wall with Insulation in Cavity
F1	2x4-in. (51x102-mm) Wood Frame with R-13 Fiberglass Insulation and Aluminum Siding
F2	2x6-in. (51x152-mm) Wood Frame with R-19 Fiberglass Insulation and Aluminum Siding

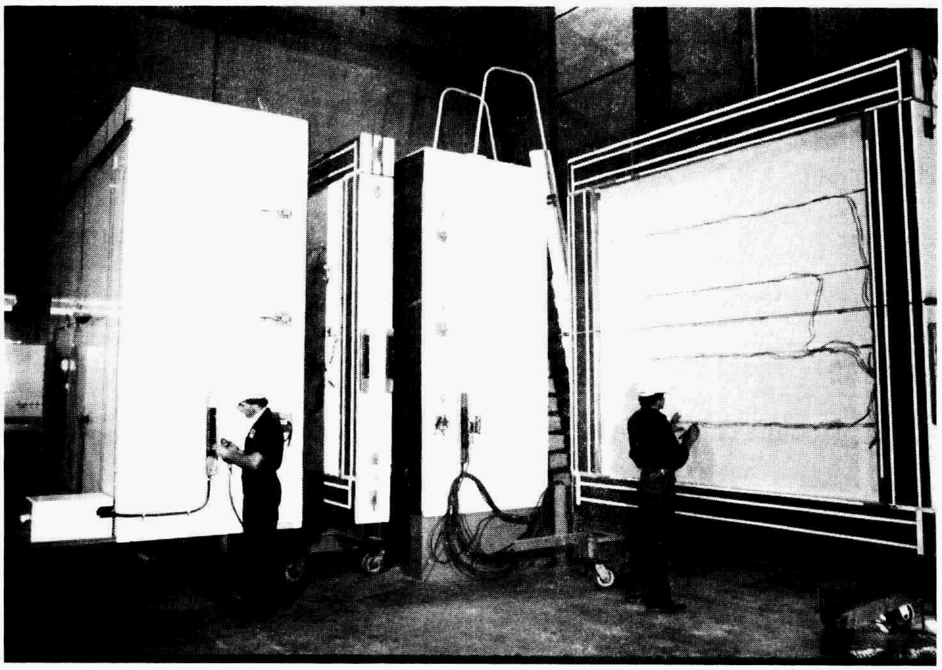


Fig. 1 Calibrated Hot Box Test Facility

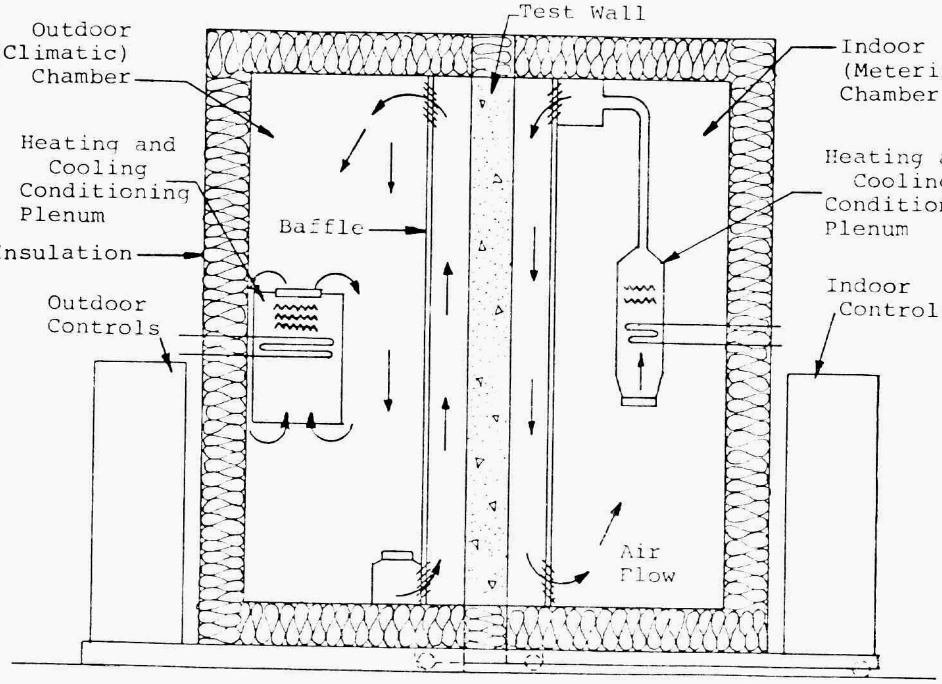


Fig. 2 Schematic of Calibrated Hot Box

each chamber is conditioned by heating and cooling equipment to obtain desired temperatures on each side of the test wall.

The outdoor (climatic) chamber can be held at a constant temperature or cycled between -15 and 130°F (-26 and 54°C). Temperature cycles can be programmed to obtain the desired time-temperature relationship. The indoor (metering) chamber, which simulates an indoor environment, can be maintained at a constant room temperature between 65 and 80°F (18 and 27°C).

The facility was designed to accommodate walls with thermal resistance values ranging from 1.5 to 20 $hr{\cdot}ft^2{\cdot}°F/Btu$ (0.26 to 3.52 $K{\cdot}m^2/W$).

Basic Instrumentation

Instrumentation was greater on some walls than on others. Those items common to all wall tests are referred to as basic instrumentation. Supplementary instrumentation was used in selected wall tests. Generally, wall tests done later in the program have more instrumentation.

Instrumentation was designed to monitor temperatures inside and outside the indoor chamber, air and surface temperatures on both sides of the test wall, and heating energy input to the indoor chamber. Additional measurements monitor indoor cooling system performance. Basically, the instrumentation provides a means of monitoring the energy required to maintain constant temperature in the indoor chamber while temperatures in the outdoor chamber are varied. This energy, when corrected for thermal losses, provides a measure of heat flow through the test wall.

Thermocouples corresponding to ASTM Designation: E230, "Standard Temperature-Electromotive Force (EMF) Tables for Thermocouples,"[3] Type T, were used to measure temperatures. There were 16 thermocouples in the air space of each chamber and 16 on each face of the test wall. Thermocouples were uniformly distributed on a 20-in. (508-mm) square grid over the wall area.

Surface thermocouples were securely attached to the wall over a length of approximately 3 in. (76 mm). Tape that covered sensors mounted on surfaces of painted walls was painted the same color as the test wall surfaces. Thermocouples in air were located approximately 3 in. (76 mm) from the face of the test wall.

Laboratory and interior surface temperatures of the indoor chamber sides were measured. These temperatures provided data for evaluating heat transfer between the chamber and the laboratory. Temperature data were supplemented with heat flux transducer measurements.

A watt-hour transducer was used to measure cumulative electrical energy input to the indoor chamber.

Measurements were monitored with a programmable digital data acquisition system capable of sampling and recording up to 124 independent channels of data in less than one minute. The data acquisition system is interfaced with a microcomputer that is programmed to reduce and store data.

For tests performed prior to October 1979, all data channels were scanned at one, two, or four hour intervals. For tests performed after October 1979, thermocouple channels were scanned every two minutes. Average temperature and supplementary data were obtained from average readings for one or two hours. The cumulative watt-hour transducer output was scanned every one or two hours.

Supplementary Instrumentation

Supplementary thermocouples were used to measure temperatures at selected locations. For the three concrete walls, C1, C2, and C3, 16 thermocouples were embedded approximately at midthickness of the test wall. These internal thermocouples were uniformly distributed over the same 20-in. (508-mm) grid as surface and air thermocouples.

Heat flux transducers were applied to seven wall specimens. Walls C1, C2, and C3 had heat flux transducers applied to the indoor and outdoor wall surfaces. Heat flux transducers were applied to the indoor surfaces of Walls M6, M7, M8, and F5. For the masonry walls, the apparatus was applied at a furring strip used to attach insulation and between furring strips. Transducers were applied at a wood stud and between wood studs for Wall F5.

A digital humidity and temperature measurement system was used to measure relative humidity and temperature in air streams on each side of most test specimens. Probes were located in the air streams approximately at the specimen mid-point.

Air flow rates in each chamber were measured with air flow meters located approximately at the wall geometric center. Each flow rate meter was mounted perpendicular to the air flow. Data from air flow meters were monitored periodically and were not part of the automated data acquisition apparatus. Air flow rates in each chamber for all wall tests were approximately 20 ft/min. (0.1 m/s).

Calibration Procedure

Procedures for calibration and determination of indoor chamber cooling energy were modified November 1981 to increase accuracy of test results.

Methods used for the time periods before and after November 1981 are described in the following sections.

Heat flow through a test wall is determined from measurements of the amount of energy input to the indoor chamber to maintain a constant temperature. The measured energy input must be adjusted for heat losses. Figure 3 shows sources of heat losses and gains by the indoor chamber where:

Q_w = heat transfer through test wall

Q_c = heat removed by indoor chamber cooling

Q_h = heat supplied by indoor electrical resistance heaters

Q_{fan} = heat supplied by indoor circulation fan

Q_ℓ = heat loss/gain from laboratory

Q_f = heat loss/gain from flanking path around specimen

Since net energy into the control volume of the indoor chamber equals zero, heat transfer through the test wall can be expressed by the following energy balance equation:

$$Q_w = Q_c - Q_h - Q_{fan} - Q_\ell - Q_f \qquad (1)$$

The need for cooling in the indoor chamber results from requirements for dynamic tests. In cases where outdoor temperatures exceed indoor temperatures, cooling capacity is required to maintain indoor temperature control.

Indoor chamber cooling equipment operates continuously and is designed to remove heat at a constant rate. Control of indoor chamber temperature is obtained by varying the amount of input heat required to balance the amount of heat removed by the refrigeration system, the amount of heat that flows through the test specimen, and the amount of heat lost to laboratory space.

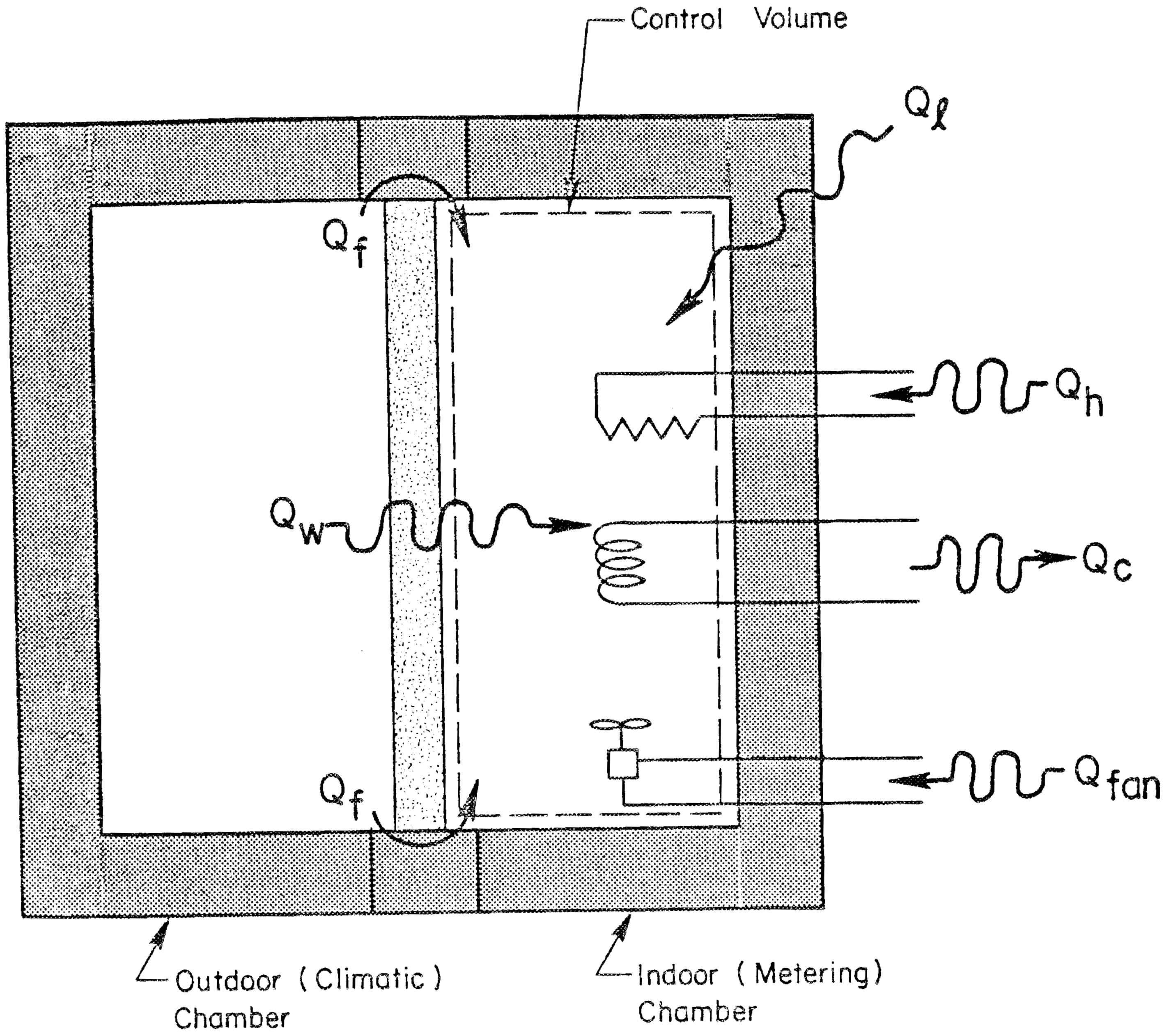


Fig. 3 Indoor (Metering) Chamber Energy Balance

The following are brief descriptions of calibration procedures. Details are available in Reference 5 and individual wall reports.

Calibration Prior to November 1981

Correction for indoor cooling and laboratory losses was accomplished by performing base calibration tests immediately before and after each steady-state and dynamic test. Base calibration tests were steady-state tests with indoor and outdoor chamber temperatures held at approximately 73°F (23°C). These tests provided a measure of "base calibration" energy, $Q_c - Q_\ell$, for the system.

Heat losses to laboratory space were minimized by keeping indoor chamber air temperature near laboratory temperature. In addition, losses were accounted for since the base calibration test was run at essentially the same indoor chamber and laboratory temperature as that for the steady-state or dynamic test being evaluated.

A watt-hour transducer was used to measure heat supplied to the indoor chamber by heaters and a fan, $Q_h + Q_{fan}$.

Flanking losses, Q_f, were neglected. Tests performed on a fiberglass board wall with a known R-value approximately the same as that of test specimens showed that neglecting flanking losses did not adversely affect test results.

Calibration After November 1981

Steady-state calibrated hot box tests of two "standard" calibration specimens were used to refine calculations of heat removed by indoor chamber cooling, Q_c, and flanking losses, Q_f. The first calibration Specimen, S1, has a relatively low thermal resistance of 5.7 hr•ft^2•°F/Btu

(1.0 $m^2 \cdot °K/W$). It consists of 1.375-in. (34.9-mm) thick fiberglass and was specially fabricated to insure uniformity.

The second calibration wall, S2, has a relatively high thermal resistance of 17.3 $hr \cdot ft^2 \cdot °F/Btu$ (3.0 $m^2 \cdot °K/W$). Material for Specimen S2 was selected as part of the ASTM Committee C16 Hot Box Round Robin program. It consists of expanded polystyrene board that is specially produced and cut to insure uniformity. Board faces are coated to provide surfaces suitable for attachment of instrumentation.

Heat removed by indoor chamber cooling, Q_c, was calculated from refrigerant enthalpy and mass flow rate, assuming an ideal basic vapor compression refrigeration cycle. Results from steady-state calibrated hot box tests on the two "standard" calibration specimens were used to adjust for inefficiencies in the actual refrigeration cycle.

Losses from the indoor chamber to the laboratory, Q_ℓ, were calculated from thermal properties of component materials making up walls and ceilings of the indoor chamber and temperature conditions on the inner and outer surfaces of the indoor chamber. Heat flux transducers mounted on the inside surface of the indoor chamber were used to check calculations. Indoor chamber air and laboratory air temperatures were generally maintained at the same nominal value, 72°F (22°C), to minimize laboratory losses. Thus, the value of Q_ℓ is small relative to other terms of the energy balance equation.

A watt-hour transducer was used to measure heat supplied to the indoor chamber by heaters and a fan, $Q_h + Q_{fan}$.

Heat loss or gain from flanking around the test specimen, Q_f, was determined from steady-state tests of the "standard" calibration walls. Since thermal conductance of each standard calibration wall is known,

Q_w for a given steady-state test can be calculated using the following equation:

$$Q_w = A \cdot C \cdot (t_2 - t_1) \tag{2}$$

where:

Q_w = heat transfer through test wall, Btu/hr (W•hr/hr)

A = area of wall surface normal to heat flow, ft^2 (m^2)

C = average thermal conductance, Btu/hr•ft^2•°F (W/m^2•K)

t_2 = average temperature of outside wall surface, °F (C)

t_1 = average temperature of inside wall surface, °F (C)

Thus, Q_f was determined from Eq. (1) using calculated values of Q_w, Q_c, and Q_ℓ, and measured values of Q_h and Q_{fan}.

For both standard calibration walls, values of Q_f were observed to follow the relationship:

$$Q_f = 0.235\ (t_2 - t_1) \tag{3}$$

where:

Q_f = heat loss or gain from flanking around test specimen, W•hr/hr

t_2 = average temperature of outside wall surface, °F

t_1 = average temperature of inside wall surface, °F

Since Q_f is the residual from Eq. (1), it may include other undetermined losses from the indoor chamber.[5]

USE OF MANUAL

In the section "Test Data", beginning on page 39 of this manual, results for each wall are presented in tabular form, in figures, and in summary tables. Heat transfer characteristics of different wall assemblies can be easily compared by using figures and summary tables for each wall. Data presented in numerical form can be used to validate models or analyze results.

Each table or figure designation in the "Test Data" section identifies the wall tested and the type of data presented. Designation formats are

XX-Y

where

XX = wall tested

Y = table or figure type as described in Table 3 on the following page.

For example, Table M1-4 summarizes steady-state test results for Wall M1.

If data for a particular table or figure type were not available for a given wall assembly, that table or figure was omitted. However, the numbering system applied to other tables or figures remains as listed in Table 3. For example, Tables XX-5 and XX-6 on transient tests are not included for all wall assemblies.

Data of different wall assemblies are easily comparable because table formats are consistent throughout the manual. Table formats were not altered when data were not available or headings were not applicable. In these cases, columns and rows were left blank, not deleted. For example, the t_3 column of Table M1-7(a) is blank because internal wall temperatures were not measured for Wall M1.

Contents of individual sections, tables, and figures are described in the following paragraphs.

Description, Reference, and Wall Composition

The first sheet of data for each wall assembly contains a brief wall description, the reference report, and details of wall composition.

TABLE 3 - TABLE AND FIGURE DESCRIPTIONS

Table or Figure No.	Description
Table XX-1*	Physical Properties of Wall at Time of Test
Table XX-2	Material Properties
Table XX-3	Design Heat Transmission Coefficients
Table XX-4	Steady-State Test Results
Table XX-5	Transient Test Results
Table XX-6	Summary of Transient Test Results
Table XX-7	Dynamic Test Results (Periodic) for NBS Test Cycle
Tables XX-8 thru XX-11	Dynamic Test Results (Periodic) for Test Cycles Other Than the NBS Cycle
Table XX-12	Summary of Dynamic Test Results (Periodic), Thermal Lag
Table XX-13	Summary of Dynamic Test Results (Periodic), Reduction in Amplitude
Table XX-14	Summary of Dynamic Test Results (Periodic), Energy Requirements
Figure XX-1	Transient Test Results
Figure XX-2	Dynamic Test Results (Periodic) for NBS Test Cycle
Figures XX-3 thru XX-6	Dynamic Test Results (Periodic) for Test Cycles Other Than the NBS Cycle

* Characters in the "XX" position are wall designations.

Calibrated hot box test results for each assembly were originally published in the report listed as a reference.

In the section labeled "Composition," an isometric sketch illustrates wall construction, and materials used for construction. Paints and wall coatings used on wall surfaces are omitted from descriptions. This information is available in individual wall reports.

Physical Properties of Wall (Table XX-1)

Table XX-1 in the section for each wall assembly lists physical properties of the test specimen at the time of calibrated hot box tests. Measured unit weight of the wall is listed in weight per unit area. Average thickness and wall area are measured dimensions of the calibrated hot box test specimen. Measured wall moisture content is listed for masonry and concrete walls.

Material Properties (Table XX-2)

Walls were constructed using materials listed in the "Composition" section on the first sheet of data for each wall assembly. When additional data are available on the properties of any construction material, the additional data are listed in Table XX-2 of the section for each wall assembly. In the case where more than one Material Properties Table may exist for a given wall, Tables are designated XX-2(a), XX-2(b), etc.

Design Heat Transmission Coefficients (Table XX-3)

Design values of overall resistance and transmittance are shown in Table XX-3 of the section for each wall assembly. These were calculated in accordance with procedures established by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers.[1]

Surface resistances were taken as 0.68 hr•ft^2•°F/Btu (0.12 K•m^2/W) for inside and 0.17 hr•ft^2•°F/Btu (0.03 K•m^2/W) for outside. These values are commonly used in design and are considered to represent still air on the indoor wall surface and an air flow of 15 mph (24 km/hr) on the outdoor wall surface.

Resistances for construction materials were taken from the 1981 ASHRAE Handbook of Fundamentals[(1)] or other similar listings of thermal properties. Resistances used in this table were not measured.

Steady-State Test Results (Table XX-4)

Steady-state tests were conducted by maintaining constant indoor and outdoor chamber temperatures. Results were calculated from data collected when specimen temperatures reach equilibrium and the rate of heat flow through the test wall was constant.

Results of steady-state tests are summarized in Table XX-4 of the section for each wall assembly. For tests performed prior to October 1979, results are averages of data collected at one, two, or four hour intervals. Results are averages of data collected at two hour intervals for tests performed in the period from November 1979 through April 1980. For tests performed after April 1980, results are hourly averages of sixteen consecutive hours of data.

The first column of Table XX-4 lists the mean wall temperature, t_m, during each steady-state test. Mean wall temperature is determined from the average of the indoor and outdoor wall surface temperatures.

The second column shows wall heat flux determined from each calibrated hot box test.

The third and fourth columns list overall thermal resistance and transmittance coefficients calculated using measured values of heat flux and the design surface resistance coefficients given in Table XX-3. Design heat transmission coefficients, from Table XX-3, are shown in the last row of Table XX-4 for comparison.

Outdoor air, outdoor surface, indoor air, and indoor surface temperatures are average readings of 16 thermocouples placed in the uniform grid described in the "Basic Instrumentation" section of this manual. For the three concrete walls, C1, C2, and C3, internal temperatures are the average readings of 16 thermocouples embedded in the concrete approximately at midthickness.

Average measured relative humidities for the indoor and outdoor chambers are listed. Relative humidity within the two chambers is not controlled by Construction Technology Laboratories' (CTL's) calibrated hot box. However, relative humidity has been measured for most tests performed since October 1979.

Maximum and minimum laboratory air temperatures obtained during each steady-state test are also listed in Table XX-4. The laboratory acts as a guard for the indoor chamber for tests conducted in CTL's calibrated hot box. Therefore, maintaining a small temperature differential between the laboratory air temperature and the indoor chamber air temperature minimizes heat loss to and from the indoor chamber. For example, the steady-state test performed on Wall C1 at a mean wall temperature of 37°F (3°C), had heat loss from the indoor chamber to the laboratory, Q_{ℓ}, equal to 0.5% of the total heat flow through the wall, Q_w.

Transient Test Results (Fig. XX-1, Tables XX-5 and XX-6)

Time required for a wall to reach a steady-state condition can be determined from transient tests. This time is affected by both thermal resistance and heat storage capacity of the test wall.

Results of a transient test are determined from data collected in the period of time between two steady-state tests. After a wall is in a steady-state condition, denoted time 0, the outdoor chamber temperature setting is changed. The transient test continues until the wall reaches an equilibrium for the new outdoor chamber air temperature. The rate of heat flow through a test specimen is determined from hourly averages of data. Transient tests were performed on Walls C1, C2, and C3 only.

Figure XX-1 in the sections for Walls C1, C2, and C3 illustrates measured temperatures, temperature differentials, and heat flux through the wall for a transient test. Tables XX-5(a) and XX-5(b), respectively, list measured temperatures and heat flux in U.S. units and SI units. Values are shown as a function of time.

Table 4 lists brief descriptions of symbols used in test data figures and tables. Symbols are described more thoroughly in the "Dynamic Test Results" section of this report.

Table XX-6 for each wall assembly lists time required to reach 99.5, 95, and 90% of the final steady-state heat flux achieved during a transient test. Results show steady-state predictions underestimate the amount of time required for massive walls to reach steady-state conditions.

Dynamic Test Results

Dynamic tests are a means of evaluating thermal response under controlled conditions that simulate temperature changes actually encountered

TABLE 4 - ABBREVIATIONS

q_{hfm} = heat flux measured by heat flow meter mounted on indoor wall surface

q'_{hfm} = heat flux measured by heat flow meter mounted on outdoor wall surface

q''_{hfm} = heat flux measured by heat flow meter mounted on indoor surface of a nonhomogeneous wall, at a stud or furring strip

q'''_{hfm} = heat flux measured by heat flow meter mounted on indoor surface of a nonhomogeneous wall, between studs or furring strips

q_{rf} = heat flux calculated using a Response Factor Program

q_{ss} = heat flux predicted from steady-state analysis

q_w = heat flux measured by calibrated hot box

t_i = indoor chamber air temperature

t_1 = wall surface temperature, indoor side

t_3 = internal wall temperature at approximate midthickness

t_2 = wall surface temperature, outdoor side

t_o = outdoor chamber air temperature

t_m = average of wall surface temperatures on indoor and outdoor side in building envelopes. Response of walls to temperature changes is a function of both thermal resistance and heat storage capacity.

Dynamic tests were conducted by maintaining calibrated hot box indoor air temperature constant while outdoor air temperatures were cycled over a predetermined time versus temperature relationship. The rate of heat flow through a test specimen was determined from hourly averages of data.

One 24-hour (diurnal) temperature cycle, denoted the NBS test cycle, was applied to every wall tested in the calibrated hot box. This cycle was based on a simulated sol-air* cycle used by the National Bureau of Standards in their evaluation of dynamic thermal performance of an experimental masonry building.(6) It represents a large variation in outdoor temperature over a 24-hour period. The mean outdoor temperature of the cycle was approximately equal to the mean indoor temperature. The use of this cycle permits the comparison of results with those from other wall assemblies.

Additional sol-air diurnal temperature cycles were performed on most test specimens. A description of dynamic temperature cycles and corresponding test walls is given in Table 5. Additional information on test cycles is available in individual wall reports.

For all tests, dynamic cycles were repeated until conditions of equilibrium were obtained. Equilibrium conditions were evaluated by consistency of applied temperatures and measured energy response. Each test required approximately four to six days for completion. After equilibrium

---

*Sol-air temperature is that temperature of outdoor air that, in the absence of all radiation exchanges, would give the same rate of heat entry into the surface as would exist with the actual combination of incident solar radiation, radiant energy exchange, and convective heat exchange with outdoor air.(1)

TABLE 5 - CALIBRATED HOT BOX DYNAMIC TEMPERATURE CYCLES

Test Cycle Designation	Walls Tested Using Cycle	Cycle Description
NBS	All Walls	Used by NBS in evaluation of dynamic thermal performance of an experimental masonry building.[6] See text.
Orlando January	M5,F4	Average sol-air temperature conditions for Orlando, Florida in January.
Orlando January Modified	M5,F4	Similar to the Orlando January cycle but with warmer simulated nighttime temperatures.
Orlando April	M5,F4	Average sol-air temperature conditions for Orlando, Florida in April.
Orlando August	M5,F4	Average sol-air temperature conditions for Orlando, Florida in August.
Phoenix January	M6,M7,M8,F5	Average 30-year sol-air temperature conditions for Phoenix and Tucson, Arizona on January 21.
Phoenix April	M6,M7,M8,F5	Average 30-year sol-air temperature conditions for Phoenix and Tucson, Arizona on April 21.
Phoenix August	M6,M7,M8,F5	Average 30-year sol-air temperature conditions for Phoenix and Tucson, Arizona on August 21.
NBS+10	C1,C2,C3	Similar to NBS cycle, but outdoor temperatures increased by 10°F (6°C).
NBS-10	C1,C2,C3	Similar to NBS cycle, but outdoor temperatures decreased by 10°F (6°C).

conditions were reached, tests were generally continued for a period of three days. Results are based on average readings for at least three consecutive 24-hour cycles, unless otherwise noted.

Hourly Test Data (Figures XX-2 thru XX-6, Tables XX-7 thru XX-11)

Measured temperatures, temperature differentials, and heat flux for the NBS test cycle are illustrated in Fig. XX-2 and listed in Table XX-7 of the section for each wall assembly. Figures XX-3 through XX-6 and Tables XX-8 through XX-11 give results from other test cycles, when available.

Brief descriptions of symbols used in figures and tables are listed in Table 4. Symbols are described in detail in the following paragraphs. Tables denoted XX-Y(a) and XX-Y(b) list results in U.S. and SI units, respectively.

<u>Measured Temperatures</u>. Outdoor air (t_o), outdoor surface (t_2), indoor air (t_i), and indoor surface (t_1), temperatures are average readings of 16 thermocouples placed in the uniform grid described in the "Basic Instrumentation" section of this manual. For the three concrete walls, C1, C2, and C3, internal temperatures (t_3), are the average readings of 16 thermocouples embedded in the concrete approximately at midthickness. Values are listed in Tables XX-7 through XX-11 and illustrated in the portion of Figs. XX-2 through XX-6 denoted (a).

<u>Temperature Differentials</u>. Air-to-air (t_o-t_i), surface-to-surface (t_2-t_1), and surface-to-air (t_o-t_2,t_1-t_i) temperature differentials are illustrated in the portion of Figs. XX-2 through XX-6 denoted (b).

Heat Flux. Measured and calculated heat flux values are listed in Tables XX-7 through XX-11 and illustrated in the portion of Figs. XX-2 through XX-6 denoted (c). Heat flux is positive when heat flows from the outdoor chamber to the indoor chamber.

Heat flux determined from calibrated hot box tests is denoted q_w.

Heat flux measurements were also determined using 4x4-in. (102x102-mm) heat flow meters. Measurements from heat flow meters located on indoor and outdoor wall surfaces were denoted q_{hfm} and q'_{hfm}, respectively. Measurements for heat flow meters located on the indoor surface of nonhomogeneous walls were denoted q''_{hfm} if the meter was located at a stud or furring strip, and q'''_{hfm} if the meter was located between studs or furring strips. Heat flow meter data were calibrated using results of steady-state calibrated hot box tests for the given wall. Heat flow meters were not used on all wall assemblies.

Values of heat flux calculated using a response factor program are denoted q_{rf}. These values were supplied by Ken Childs of Oak Ridge National Laboratories. Values were calculated using a Response Factor Program developed at the National Bureau of Standards. Indoor and outdoor chamber air temperatures from calibrated hot box tests were used as input to the Response Factor Program.

Heat flux predicted by steady-state analysis is denoted q_{ss}. Values were calculated on an hourly basis from wall surface temperatures using the following equation:

$$q_{ss} = (t_2 - t_1)/R \qquad (4)$$

where:

q_{ss} = heat flux through test wall predicted by steady-state analysis, Btu/hr•ft^2 (W/m^2)

R = average thermal resistance, hr•ft^2•°F/Btu (m^2•K/W)

t_2 = average temperature of outdoor wall surface

t_1 = average temperature of indoor wall surface

Wall resistances are derived from steady-state calibrated hot box test results. Measured wall resistance is equal to the total resistance, R_T, listed in Table XX-4 for each wall assembly, minus the sum of the design air film resistance, 0.85 hr•ft^2•°F/Btu (0.15 K•m^2/W).

Tables XX-7 through XX-11 also footnote the calibrated hot box indoor and outdoor chamber relative humidities, and maximum and minimum laboratory air temperatures measured during tests.

Thermal Lag (Table XX-12)

Thermal lag is a measure of the response of both indoor surface temperatures and heat flow to fluctuations in outdoor air temperature. Lag is related to the ratio of the wall's ability to store energy to its ability to conduct energy.

For each dynamic test cycle, Table XX-12 lists values of thermal lag determined from measured calibrated hot box test results, measured heat flow meter readings, and response factor calculations. Calibrated hot box thermal lag is quantified by two methods. In one measure, denoted t_o vs t_1, lag was calculated as the time required for the maximum or minimum indoor surface temperature to be reached after the maximum or minimum outdoor air temperature was attained. In the second measure, denoted q_{ss} vs q_w, lag was calculated as the time required for the maximum or minimum heat flow rate, q_w, to be reached after the maximum or minimum heat flow rate based on steady-state predictions, q_{ss}, was attained. This is illustrated in Fig. 4. Both measures give similar results. The second

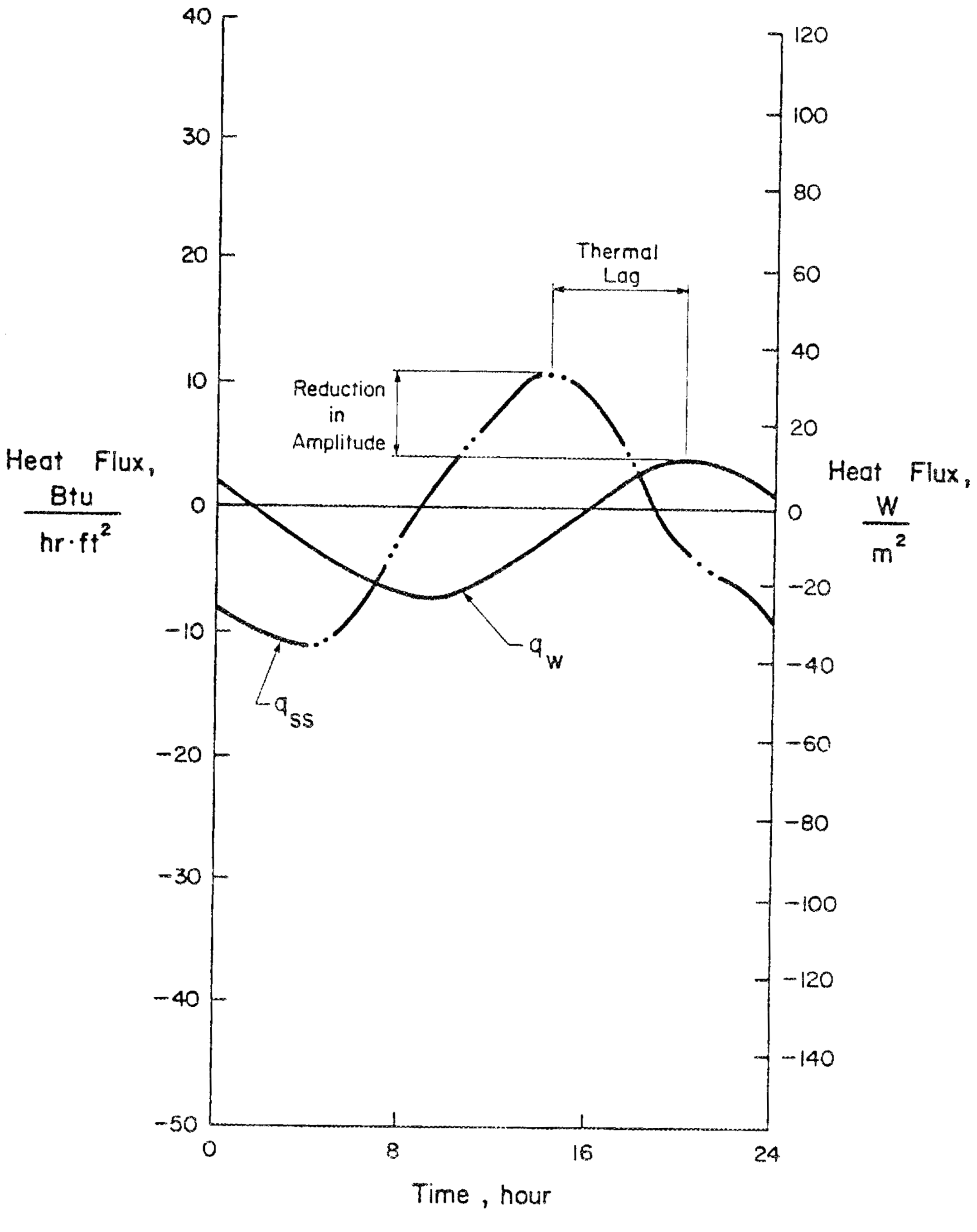


Fig. 4 Definition of Thermal Lag and Reduction in Amplitude

measure was used to determine thermal lag for heat flow meter data and response factor calculations.

The time constant for each wall assembly is also listed in Table XX-12 for each wall assembly. A time constant is a theoretical value of heat flow delay calculated from the conductivity, specific heat, density, and thickness for each layer of building material in a wall system.

If the difference in temperature across a wall is changed abruptly from the steady-state condition, as in a step change, then the heat flow through the wall will equal 63.2% of the next steady-state equilibrium heat flow after a time period equal to the time constant.(7)

The following equation was used to calculate time constants:(7)

$$t_c = \frac{a_k}{\pi^2}\left(\sum_{n=1}^{N}(g_n X_n)\right)^2 \tag{5}$$

where:

t_c = characteristic time constant of building component, hr (s)

g_n = $(a_n/a_k)^{1/2}$, conversion constant adjusting thickness of layer to make material uniform throughout wall

a_n = $r_n c_n d_n$, reciprocal of diffusivity of n-th layer, hr/ft^2 (s/m^2)

a_k = a_n at layer k chosen for normalization

r_n = resistivity of n-th layer, or reciprocal of conductivity of n-th layer, hr•ft•°F/Btu (m•K/W)

c_n = specific heat of n-th layer, Btu/lb•°F (J/kg•K)

d_n = density of n-th layer, lb/ft^3 (kg/m^3)

X_n = thickness of n-th layer, ft (m)

When available, measured thermal properties listed in Table XX-2 in the section for each wall assembly were used to calculate time constants.

Properties from the 1981 ASHRAE Handbook of Fundamentals[1] were used when measured values were not available.

Details on the derivation, calculation, and significance of time constants are available in Reference 7.

Reduction in Amplitude (Table XX-13)

Table XX-13 in the section for each wall assembly lists reduction in amplitude values for each dynamic temperature cycle. Percent reduction in amplitude is defined as the percent reduction in peak heat flow when compared to peak heat flow predicted by steady-state analysis. Values for percent reduction in amplitude were calculated using the following equation:

$$A = [1-(q' - \bar{q})/(q'_{ss} - \bar{q}_{ss})]\cdot 100 \qquad (6)$$

where:

A = percent reduction in amplitude

q' = maximum or minimum heat flow through wall

$\bar{q}$ = mean heat flow through wall

q'_{ss} = maximum or minimum heat flow through wall predicted by steady-state analysis

$\bar{q}_{ss}$ = mean heat flow through wall predicted by steady-state analysis

Reduction in amplitude is illustrated in Fig. 4 of this section.

Actual maximum heat flow through a wall is important in determining the peak energy load for a building envelope. If peak heat flows are reduced, peak energy demands will decrease. Storage capacity as well as thermal transmittance of each wall in a building envelope influences peak energy requirements.

Amplitudes for heat flow meter data, q_{hfm}, are generally not the same as those for measured heat flow, q_w. On a nonhomogeneous wall, amplitudes differ due to location and limitations of heat flow meters. Amplitudes also differ because of the physical effect of a heat flow meter mounted on a wall. A wall's thermal properties are altered at the location of a heat flow meter. Heat flow meter calibration using steady-state results does not correct for dynamic effects of the meter location.

Energy Requirements (Table XX-14)

Results of dynamic tests were also compared using measures of energy expended in maintaining constant indoor temperature while outdoor temperatures were varied. Energy expended is a measure of heat flow through the test wall.

It should be noted that comparison of measured energy values for the test walls is limited to specimens and dynamic cycles evaluated in this program. Results are for diurnal test cycles and should not be arbitrarily assumed to represent annual heating and cooling loads. In addition, results are for individual opaque wall assemblies. As such, they are representative of only one component of the building envelope.

Two parameters were derived as measures of energy expended, or heat flow through test walls, during dynamic cycles. These are illustrated in Fig. 5. The curve marked "q_w" is a measure of heat flow through the test wall. Results were corrected for heat extracted by indoor cooling, for heat transfer to laboratory space, and flanking losses.

Areas within "loops" of the measured energy curves were used to provide an indication of total energy expended. These areas are denoted as

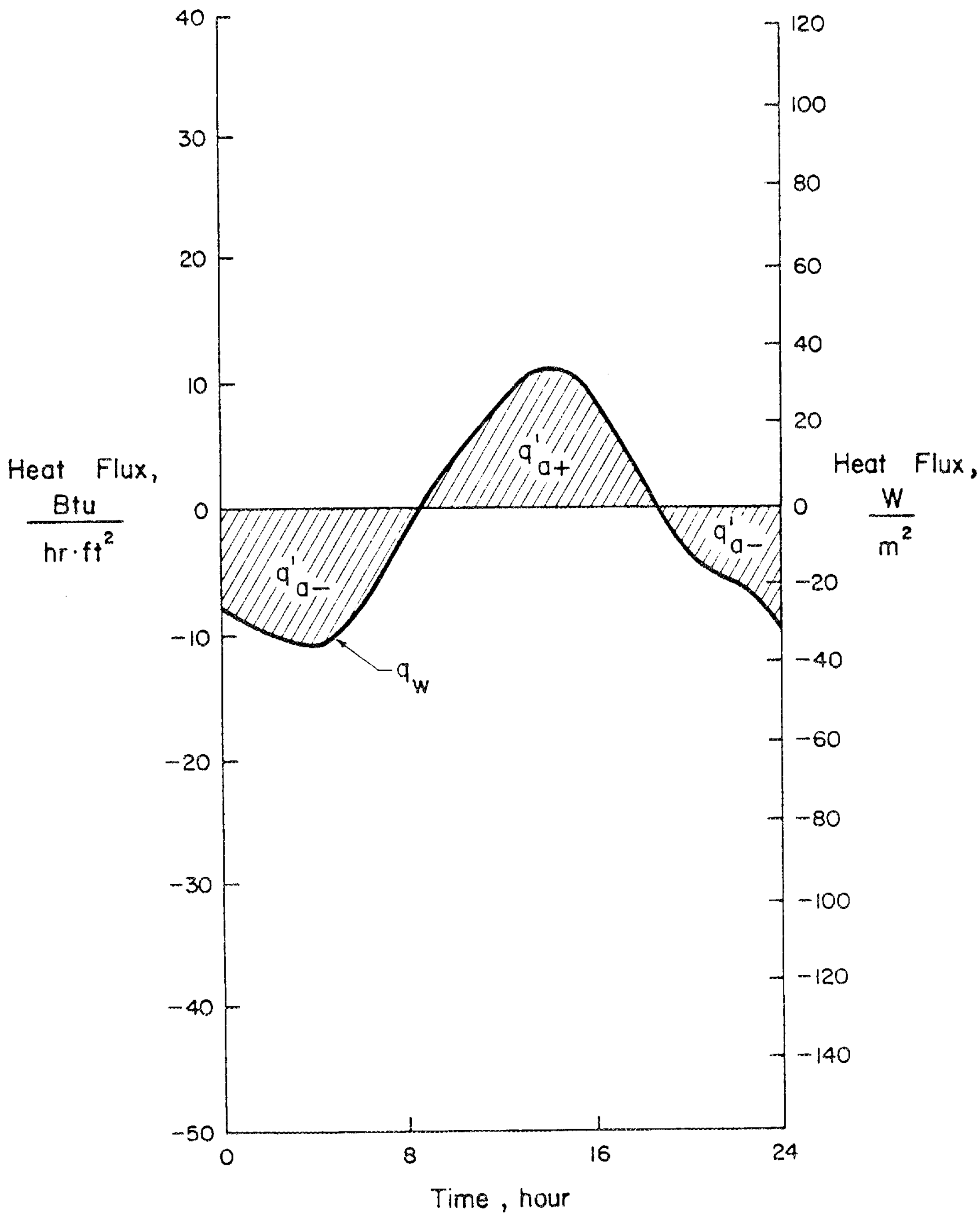


Fig. 5 Definition of Measured Energy

q'_{a+} and q'_{a-} in Fig. 5. The sum of the absolute values of positive and negative areas is taken to represent total energy over a 24-hr period. This value is denoted as a q_w^T in Table XX-14 for each wall assembly.

A similar procedure is used to calculate total energy over a 24-hr period for measured heat flow meter data, response factor calculations, and predictions based on steady-state analysis. These are also denoted by the superscript "T" in Table XX-14 for each wall assembly.

"Total Energy Comparisons" list measured energy and response factor calculations as a percentage of predicted energy based on steady-state analysis.

Net energy for a 24-hr periodic cycle is equal to the sum of hourly measured rates of heat flow. These values can be found by totaling values of "q" from columns of Tables XX-7 through XX-11. Net energy values are denoted by the superscript "N" in Table XX-14.

"Net Energy Comparisons" list measured energy and response factor calculations as a percentage of predicted energy based on steady-state analysis. Measured calibrated hot box net energy and net energy based on response factor calculations theoretically should be equal to net energy based on steady-state predictions. Differences between net energy measured using the calibrated hot box and net energy based on steady-state predictions may be attributed to inaccuracies in calibration procedures. These procedures are described in the "Calibration Procedures" section of the manual.

When the first set of calibrated hot box tests were performed in 1978, CTL maintained the only hot box in North America with the capability to perform tests under dynamic temperature conditions. Since procedures for reducing data from dynamic calibrated hot boxes with indoor chamber cooling have not been defined in industry standards, CTL has continually refined analysis procedures and added equipment to increase accuracy of test results.

Tests Performed on Wall Assemblies

Steady-state, transient, and dynamic tests performed on each wall assembly are listed in Table 6. Transient tests were not performed on all specimens.

TABLE 6 - STEADY-STATE, TRANSIENT, AND DYNAMIC TESTS PERFORMED ON EACH WALL ASSEMBLY

Wall Designation	Wall Description	Steady-State	Transient		Dynamic
		Wall Mean Temperature, °F (°C)	Wall Mean Temperature, °F (°C)		Test Cycle Designation
			@ Test Start	@ Test End	
M1	8-in. (203-mm) Medium Weight Concrete Block	55 (13) 84 (29)	--	--	NBS
M2	8-in. (203-mm) Medium Weight Concrete Block with Insulation in Cores	98 (37) 84 (29) 55 (13) 33 (1)	--	--	NBS
M5	8-in. (203-mm) Normal Weight Concrete Block with Reflective Insulation	35 (2) 100 (38)	--	--	NBS Orlando January Orlando Jan. Mod. Orlando April Orlando August
M6	8-in. (203-mm) Lightweight Concrete Block with Insulation on Inside Surface	102 (39) 38 (3)	--	--	NBS Phoenix January Phoenix April Phoenix August
M7	6-in. (152-mm) Lightweight Concrete Block with Insulation on Inside Surface	102 (39) 38 (3)	--	--	NBS Phoenix January Phoenix April Phoenix August

TABLE 6 - (Continued)

Wall Designation	Wall Description	Steady-State	Transient		Dynamic
		Wall Mean Temperature, °F (°C)	Wall Mean Temperature, °F (°C)		Test Cycle Designation
			@ Test Start	@ Test End	
M8	8-in. (203-mm) Normal Weight Concrete Block with Insulation on Inside Surface	102 (39) 39 (4)	--	--	NBS Phoenix January Phoenix April Phoenix August
M3	10-in. (254-mm) Block-Brick Cavity Wall	97 (36) 83 (28) 56 (13) 36 (12)	--	--	NBS
M4	10-in. (254-mm) Block-Brick Cavity Wall with Insulation in Cavity	98 (37) 84 (27) 55 (13) 33 (1)	--	--	NBS
C1	8-in. (203-mm) Normal Weight Concrete	37 (3) 55 (13) 101 (38)	73(23)	37(3)	NBS NBS+10 NBS-10
C2	8-in. (203-mm) Structural Lightweight Concrete	34 (1) 52 (11) 88 (31) 99 (37)	73(23)	34(1)	NBS NBS+10 NBS-10

TABLE 6 - (Continued)

Wall Designation	Wall Description	Steady-State	Transient		Dynamic
		Wall Mean Temperature, °F (°C)	Wall Mean Temperature, °F (°C)		Test Cycle Designation
			@ Test Start	@ Test End	
C3	8-in. (203-mm) Low Density Concrete	53 (11) 89 (32) 100 (38)	73(23)	31(-1)	NBS NBS+10 NBS-10
F3	2x4-in. (51x102-mm) Wood Frame with R-11 Fiberglass Insulation and Cedar Siding	98 (37) 84 (29) 55 (13) 33 (0)	--	--	NBS
F4	2x4-in. (51x102-mm) Wood Frame with R-11 Fiberglass Insulation and Cedar Siding	34 (1) 54 (12) 100 (38)	--	--	NBS Orlando January Orlando Jan. Mod. Orlando April Orlando August
F5	2x4-in. (51x102-mm) Wood Frame with R-11 Fiberglass Insulation and Hardboard Siding	102 (39) 38 (3)	--	--	NBS Phoenix January Phoenix April Phoenix August
V1	10-in. (254-mm) Brick Veneer	99 (37) 84 (29) 55 (13) 33 (0)	--	--	NBS

ACKNOWLEDGMENTS

This manual was prepared as part of a project sponsored jointly by the U.S. Department of Energy, Office of Buildings Energy Research and Development, and the Portland Cement Association. The work is under subcontract ORNL/SUB-42539 with Oak Ridge National Laboratory (ORNL). It is part of the National Program Plan for Building Thermal Envelope Systems and Materials.

The work was performed in the Engineering and Resource Development Division of the Construction Technology Laboratories (CTL), a Division of the Portland Cement Association, under the direction of Dr. W. G. Corley, Executive Director, and Mr. D. W. Musser, Director of the Construction Methods Department.

Mr. Ken Childs, ORNL, performed response factor analysis for Walls C1, F3, and V1.

The following people assisted with data reduction and compilation of tables:

Mr. B. J. Fedt, Expert Instrumentation Technician, Structural Experimental Section

Mr. P. P. Hordorwich, Senior Technician, Construction Methods Department

Mr. T. L. Weinmann, Senior Project Assistant, Structural Experimental Section

Mr. J. Furco, formerly Senior Structural Engineer, Structural Evaluation Section

Mr. J. A. Chavez, Lab Technician, Construction Methods Department

Mr. J. T. Julien, Structural Engineer, Structural Experimental Section

Mr. S. C. Larson, Assistant Construction Engineer, Construction Methods Department

Mr. R. K. Reichenbach drafted the figures.

Dr. A. E. Fiorato, Director, Concrete Materials Research Department, provided helpful comments and suggestions on the manual contents and organization.

Mrs. E. Ringquist provided editorial assistance in preparation of the manual. The manual was typed by personnel of the Portland Cement Association's Word Processing Department.

REFERENCES

1. ASHRAE Handbook of Fundamentals, American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc., Atlanta, 1981.

2. Van Geem, M. G., "Calibrated Hot Box Test Results Data Manual - Volume II," Construction Technology Laboratories, Portland Cement Association, Skokie, to be published.

3. 1983 Annual Book of ASTM Standards, American Society for Testing and Materials, Philadelphia, 1983.

4. Fiorato, A. E., "Laboratory Tests of Thermal Performance of Exterior Walls," Proceedings of the ASHRAE/DOE-ORNL Conference on Thermal Performance of the Exterior Envelopes of Buildings, Orlando, Florida, Dec. 1979, ASHRAE SP28, New York, 1981, pp. 221-236.

5. Van Geem, M. G. and Fiorato, A. E., "Calibration and Test Procedures for the Calibrated Hot Box Method of Evaluating Thermal Performance," to be published, Construction Technology Laboratories, Portland Cement Association, Skokie.

6. Peavy, B. A., Powell, F. J., and Burch, D. M., "Dynamic Thermal Performance of an Experimental Masonry Building," Building Science Series 45, U.S. Department of Commerce, National Bureau of Standards, Washington, D.C., 1973.

7. Flanders, S. N., "Time Constraints on Measuring Building R-Values," CRREL Report 80-15, United States Army, Corps of Engineers, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire, 1980, 30 pages.

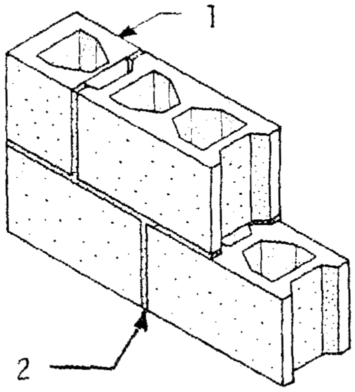
TEST DATA

WALL M1: 8-IN. (203-MM) MEDIUM WEIGHT CONCRETE BLOCK

DESCRIPTION: Medium weight 8-in. (203-mm) hollow core concrete block wall.

REFERENCE: Fiorato, A. E. and Cruz, C. R., "Thermal Performance of Masonry Walls," Research and Development Bulletin RD071, Portland Cement Association, Skokie, 1980, 17 pages.

COMPOSITION:



1. 8x8x16-in. (203x203x406-mm) Medium Weight Hollow Core Concrete Block - 2 cores per block

2. Type M Mortar: one part portland cement, one-quarter part lime, and three parts masonry sand by volume

TABLE M1-1 - PHYSICAL PROPERTIES OF WALL AT TIME OF TEST

Property	Measured Value
Unit Weight, psf (kg/m^2)	40.1 (196)
Average Thickness, in. (mm)	7.6 (193)
Area, ft^2 (m^2)	72.64 (6.75)
Moisture Content,* % by ovendry weight	0.6

*Measured on masonry, including mortar joints, after test.

TABLE M1-2 - MATERIAL PROPERTIES, MEDIUM WEIGHT CONCRETE BLOCK

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Standard Dimensions, in. (mm)	--	--	--	7-5/8x7-5/8x15-5/8 (194x194x397)
Measured Dimensions, in. (mm)	ASTM C140	--	--	--
Percent Solid Volume	--	--	--	49
Ovendry Unit Weight, pcf (kg/m^3)	--	--	--	115 (1842)
Moisture Content, % ovendry weight	ASTM C140	--	--	0.8
Absorption, % ovendry weight	ASTM C140	--	--	10.1

TABLE M1-3 - DESIGN HEAT TRANSMISSION COEFFICIENTS

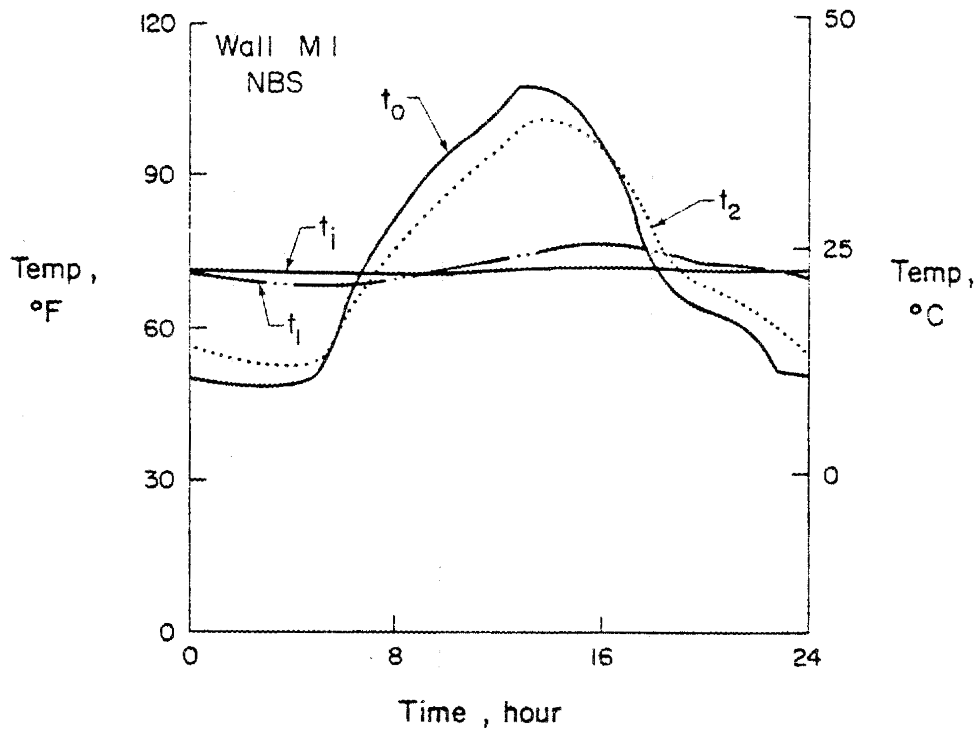
Component	R, Thermal Resistance
	$hr \cdot ft^2 \cdot °F/Btu$ ($m^2 \cdot K/W$)
1. Outside Air Film	0.17 (0.03)
2. 8x8x16-in. (203x203x406-mm) Hollow Core Block	1.52* (0.27)
3. Inside Air Film	0.68 (0.12)
Total R	2.37 (0.42)
Total U	0.42 (2.38)

*Source: Tables of U-Values for Concrete Masonry Walls, NCMA-TEK 67, National Concrete Masonry Association, McLean, Virginia, 1975.

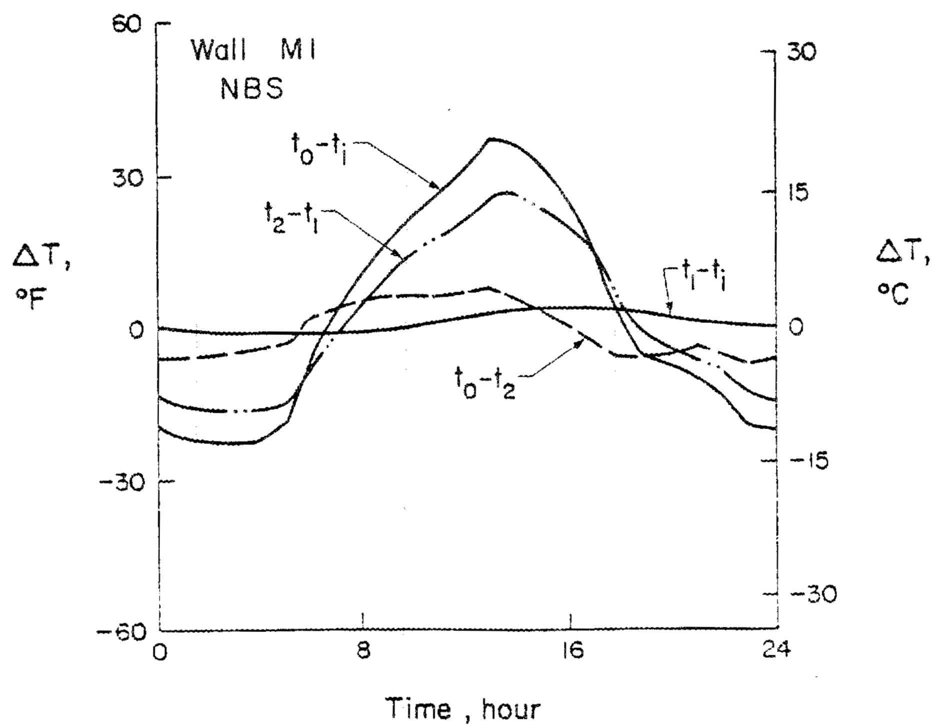
TABLE M1-4 - STEADY-STATE TEST RESULTS

Nominal Test Condition	q Heat Flux, Btu/hr·ft² (W/m²)	R_T, hr·ft²·°F/Btu (m²·K/W)	U, Btu/hr·ft²·°F (W/m²·K)	Measured Temperatures, °F (°C)					Relative Humidity**		Laboratory Air Temperature	
				t_o Outdoor Air	t_2 Outdoor Surface	t_3* Internal	t_1 Indoor Surface	t_i Indoor Air	Indoor Chamber, %	Outdoor Chamber, %	Max. °F (°C)	Min. °F (°C)
t_m = 55°F (13°C)	-14.0 (-44.3)	2.65 (0.47)	0.38 (2.14)	36 (2)	42 (6)	-	67 (19)	70 (21)	-	-	71 (22)	69 (21)
t_m = 84°F (29°C)	7.80 (24.6)	2.93 (0.52)	0.34 (1.94)	95 (35)	92 (33)	-	76 (24)	73 (23)	-	-	73 (23)	71 (22)
Design Values	-	2.37 (0.42)	0.42 (2.38)	-	-	-	-	-	-	-	-	-

*Internal thermocouples were not used for this wall assembly.
**Relative humidity was not measured for this wall assembly.

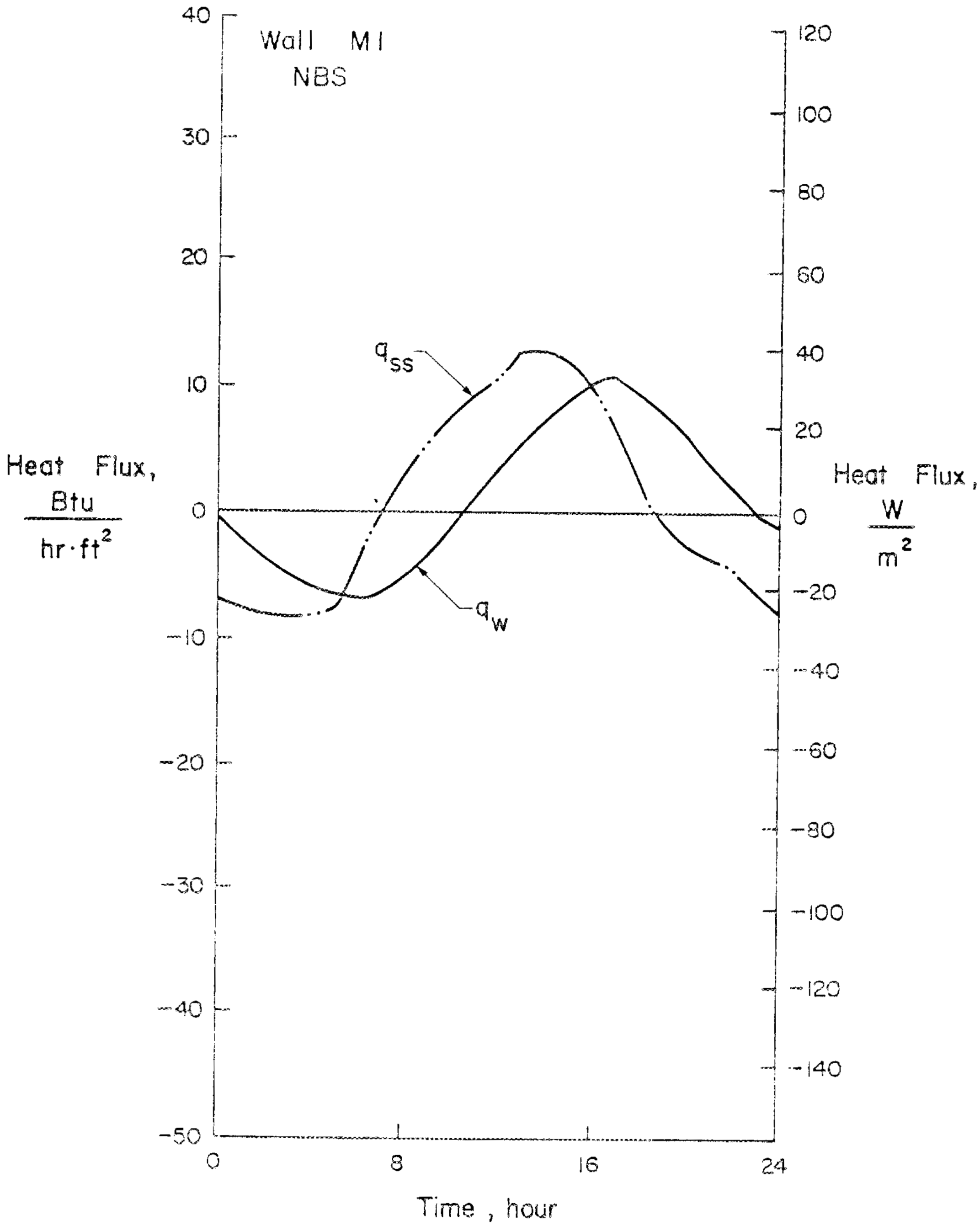


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M1-2 Wall M1 Dynamic Test Results for NBS Test Cycle



(c) Heat Flux

Fig. M1-2 Wall M1 Dynamic Test Results for NBS Test Cycle

TABLE M1-7(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1	48.7	54.6		70.3	71.1	-2.77				-8.14
2	47.8	53.4		69.8	71.0	-4.20				-8.54
3	47.6	52.7		69.4	70.9	-5.53				-8.67
4	48.0	52.6		69.0	70.4	-6.28				-8.50
5	51.1	53.8		68.8	70.5	-6.81				-7.79
6	66.2	63.0		68.8	70.5	-7.12				-2.97
7	74.1	69.7		69.2	70.4	-6.61				0.26
8	81.9	76.3		70.1	70.9	-5.28				3.24
9	89.0	82.5		71.0	71.1	-3.34				5.98
10	94.8	87.9		72.0	71.2	-1.25				8.28
11	98.3	91.7		73.1	71.6	1.30				9.71
12	103.0	95.8		73.9	71.7	3.40				11.35
13	109.5	101.2		74.7	71.7	5.72				13.74
14	108.0	102.2		75.7	72.2	7.91				13.77
15*	104.4	100.6		76.2	72.3	9.35				12.65
16*	97.8	96.8		76.5	72.2	10.78				10.55
17	87.8	90.3		76.5	72.6	11.16				7.21
18	74.7	80.8		76.0	72.7	10.37				2.49
19	66.6	73.3		75.0	71.8	8.93				-0.85
20	63.5	69.2		73.8	71.4	6.91				-2.43
21	62.3	66.8		73.0	71.8	4.32				-3.22
22	59.0	64.2		72.2	71.4	2.07				-4.16
23	51.3	58.4		71.5	71.1	0.55				-6.82
24	50.1	56.3		70.9	71.3	-1.10				-7.62
Mean	74.4	74.8		72.4	71.4	1.35				1.23

*Data are 2-day averages, not 3-day averages, of test results.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

Calibrated Hot Box Relative Humidity:
Indoor Chamber - Not measured for this wall assembly
Outdoor Chamber - Not measured for this wall assembly

Laboratory Air Temperature:
Max. - 72°F (22°C)
Min. - 70°F (21°C)

TABLE M1-7(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1	9.3	12.6		21.2	21.7	-8.14				-25.68
2	8.8	11.9		21.0	21.7	-13.24				-26.93
3	8.7	11.5		20.8	21.6	-17.44				-27.35
4	8.9	11.5		20.5	21.4	-19.81				-26.81
5	10.6	12.1		20.5	21.4	-21.49				-24.58
6	19.0	17.2		20.4	21.4	-22.47				-9.38
7	23.4	21.0		20.7	21.4	-20.84				0.82
8	27.7	24.6		21.2	21.6	-16.65				10.23
9	31.7	28.1		21.7	21.7	-10.52				18.86
10	34.9	31.1		22.2	21.8	-3.95				26.11
11	36.8	33.2		22.8	22.0	4.10				30.63
12	39.5	35.4		23.3	22.1	10.72				35.78
13	43.0	38.4		23.7	22.1	18.03				43.34
14	42.2	39.0		24.3	22.3	24.94				43.44
15*	40.2	38.1		24.6	22.4	29.49				39.90
16*	36.5	36.0		24.7	22.3	34.01				33.26
17	31.0	32.4		24.7	22.6	35.22				22.73
18	23.7	27.1		24.4	22.6	32.70				7.85
19	19.2	23.0		23.9	22.1	28.16				-2.67
20	17.5	20.7		23.3	21.9	21.78				-7.66
21	16.8	19.4		22.8	22.1	13.63				-10.15
22	15.0	17.9		22.3	21.9	6.52				-13.12
23	10.7	14.7		21.9	21.7	1.73				-21.50
24	10.1	13.5		21.6	21.8	-3.46				-24.02
Mean	23.6	23.8		22.4	21.9	4.27				3.88

*Data are 2-day averages, not 3-day averages, of test results.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

TABLE M1-12 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), THERMAL LAG

Test Cycle	Thermal Lag, hrs											Calc. Time Constant, hrs
	Measured								Calculated			
	Calibrated Hot Box					Heat Flow Meter*			Response Factor**			
	t_o vs t_1		q_{ss} vs q_w		Avg.	q_{ss} vs q_{hfm}		Avg.	q_{ss} vs q_{rf}		Avg.	
	@ Max.	@ Min.	@ Max.	@ Min.		@ Max.	@ Min.		@ Max.	@ Min.		
NBS	3.5	2.5	3	3	3	-	-	-	-	-	-	0.9

*Heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

TABLE M1-13 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), REDUCTION IN AMPLITUDE

Test Cycle	Measured, %						Calculated, %		
	Calibrated Hot Box			Heat Flow Meter*			Response Factor**		
	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.
NBS	22	14	18	-	-	-	-	-	-

*Heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

TABLE M1-14 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), ENERGY REQUIREMENTS

Test Cycle	Total Energy, Btu/ft^2 (W·hr/m^2)				Total Energy Comparisons, %			Net Energy, Btu/ft^2 (W·hr/m^2)				Net Energy Comparisons, %		
	Measured		Calculated					Measured		Calculated				
	q_w^T	q_{hfm}^T *	q_{rf}^T **	q_{ss}^T	$\frac{q_w^T}{q_{ss}^T}$	$\frac{q_{hfm}^T}{q_{ss}^T}$	$\frac{q_{rf}^T}{q_{ss}^T}$	q_w^N	q_{hfm}^N *	q_{rf}^N **	q_{ss}^N	$\frac{q_w^N}{q_{ss}^N}$	$\frac{q_{hfm}^N}{q_{ss}^N}$	$\frac{q_{rf}^N}{q_{ss}^N}$
NBS	133.1 (420)			168.9 (533)	79			32.5 (102.5)			29.5 (93.1)	110		

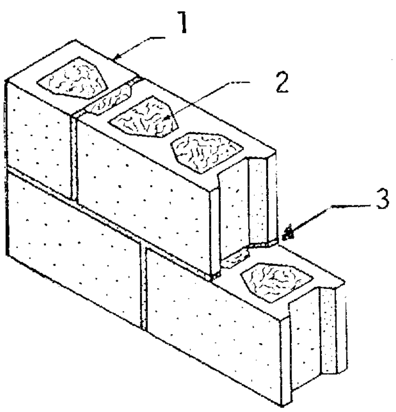
*Heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

WALL M2: 8-IN. (203-MM) MEDIUM WEIGHT CONCRETE BLOCK WITH INSULATION IN CORES

DESCRIPTION: Medium weight 8-in. (203-mm) hollow core concrete block wall with loose-fill insulation in cores.

REFERENCE: Fiorato, A. E. and Cruz, C. R., "Thermal Performance of Masonry Walls," Research and Development Bulletin RD071, Portland Cement Association, Skokie, 1980, 17 pages.

COMPOSITION:



1. 8x8x16-in. (203x203x406-mm) Medium Weight Hollow Core Concrete Block - 2 cores per block
2. Silicone-Treated Perlite Insulation Loose unit weight of 6.1 pcf (97.7 kg/m^3)
3. Type M Mortar: one part portland cement, one-quarter part lime, and three parts masonry sand by volume

TABLE M2-1 - PHYSICAL PROPERTIES OF WALL AT TIME OF TEST

Property	Measured Value
Unit Weight, psf (kg/m^2)	40.9 (200)
Average Thickness, in. (mm)	7.6 (193)
Area, ft^2 (m^2)	72.64 (6.75)
Moisture Content,* % by ovendry weight	0.6

*Measured on masonry, including mortar joints, after test.

TABLE M2-2 - MATERIAL PROPERTIES, MEDIUM WEIGHT CONCRETE BLOCK

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Standard Dimensions, in. (mm)	--	--	--	7-5/8x7-5/8x15-5/8 (194x194x397)
Measured Dimensions, in. (mm)	ASTM C140	--	--	--
Percent Solid Volume	--	--	--	49
Ovendry Unit Weight, pcf (kg/m^3)	--	--	--	115 (1842)
Moisture Content, % ovendry weight	ASTM C140	--	--	0.8
Absorption, % ovendry weight	ASTM C140	--	--	10.1

TABLE M2-3 - DESIGN HEAT TRANSMISSION COEFFICIENTS

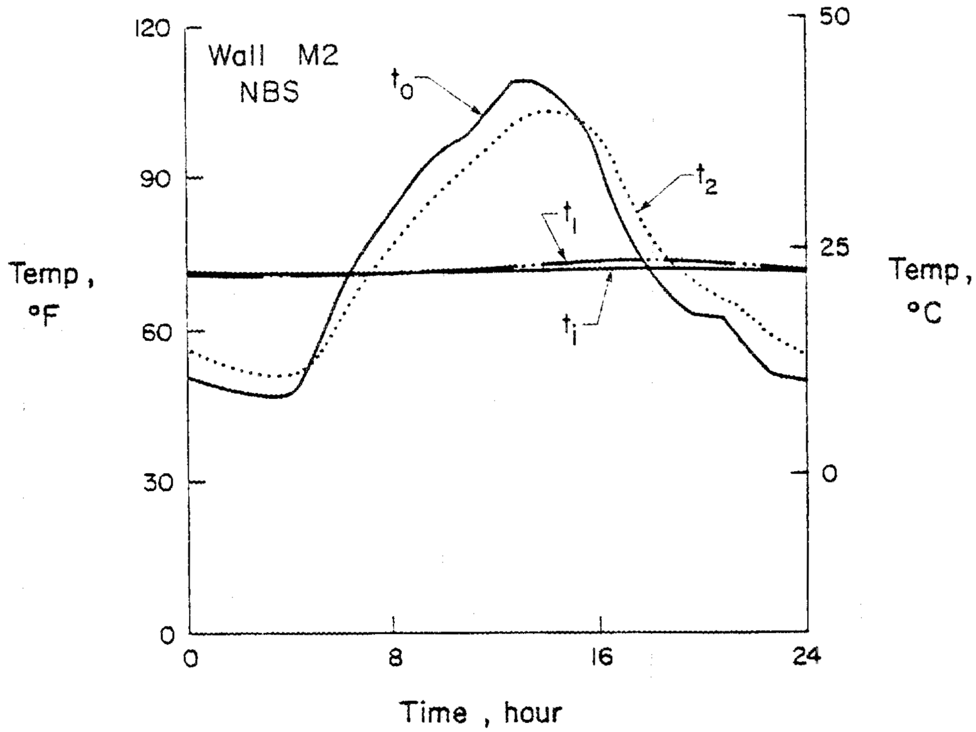
Component	R, Thermal Resistance
	$hr \cdot ft^2 \cdot °F/Btu$ ($m^2 \cdot K/W$)
1. Outside Air Film	0.17 (0.03)
2. 8x8x16-in. (203x203x406-mm) Hollow Core Block with Perlite Loose Fill Insulation	4.00* (0.70)
3. Inside Air Film	0.68 (0.12)
Total R	4.85 (0.85)
Total U	0.21 (1.18)

*Source: Tables of U-Values for Concrete Masonry Walls, NCMA-TEK 67, National Concrete Masonry Association, McLean, Virginia, 1975.

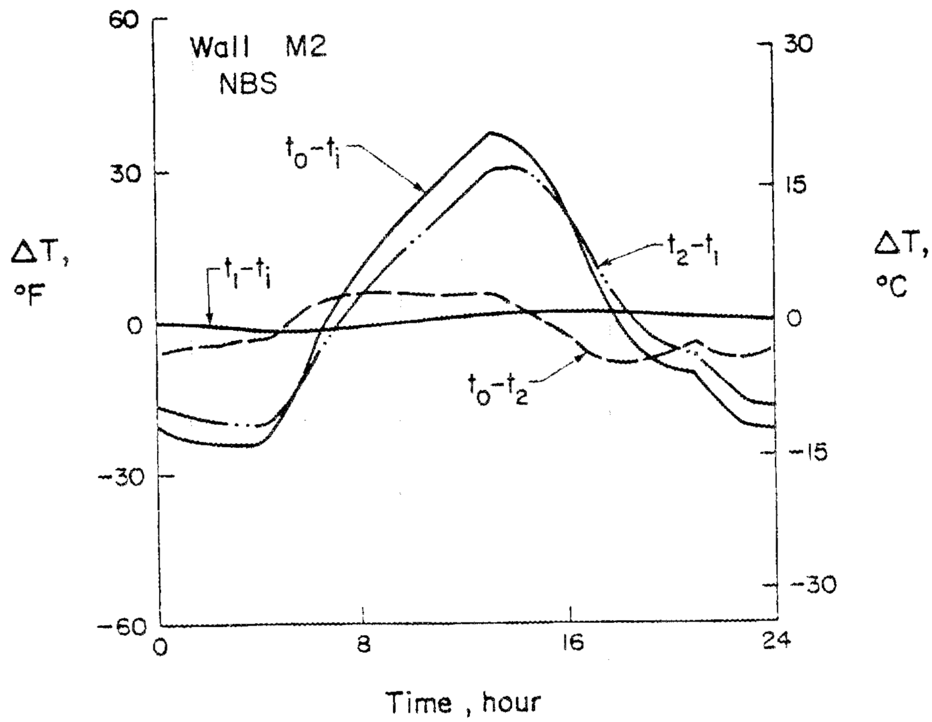
TABLE M2-4 - STEADY-STATE TEST RESULTS

Nominal Test Condition	q Heat Flux, Btu/hr·ft² (W/m²)	R_T, hr·ft²·°F/Btu (m²·K/W)	U, Btu/hr·ft²·°F (W/m²·K)	Measured Temperatures, °F (°C)					Relative Humidity**		Laboratory Air Temperature	
				t_o Outdoor Air	t_2 Outdoor Surface	t_3* Internal	t_1 Indoor Surface	t_i Indoor Air	Indoor Chamber, %	Outdoor Chamber, %	Max. °F (°C)	Min. °F (°C)
t_m = 98°F (37°C)	12.9 (40.6)	4.24 (0.75)	0.24 (1.34)	123 (51)	120 (49)	-	76 (24)	72 (22)	-	-	73 (23)	73 (23)
t_m = 84°F (29°C)	4.7 (14.9)	4.99 (0.88)	0.20 (1.14)	95 (35)	94 (34)	-	74 (23)	72 (22)	-	-	71 (22)	70 (21)
t_m = 55°F (13°C)	-8.2 (-25.9)	4.35 (0.77)	0.23 (1.30)	37 (3)	41 (5)	-	69 (21)	71 (22)	-	-	69 (21)	67 (19)
t_m = 33°F (1°C)	-17.6 (-55.5)	4.54 (0.80)	0.22 (1.25)	-6 (-21)	1 (-17)	-	66 (19)	70 (21)	-	-	70 (21)	69 (21)
Design Values	-	4.85 (0.85)	0.21 (1.18)	-	-	-	-	-	-	-	-	-

*Internal thermocouples were not used for this wall assembly.
**Relative humidity was not measured for this wall assembly.

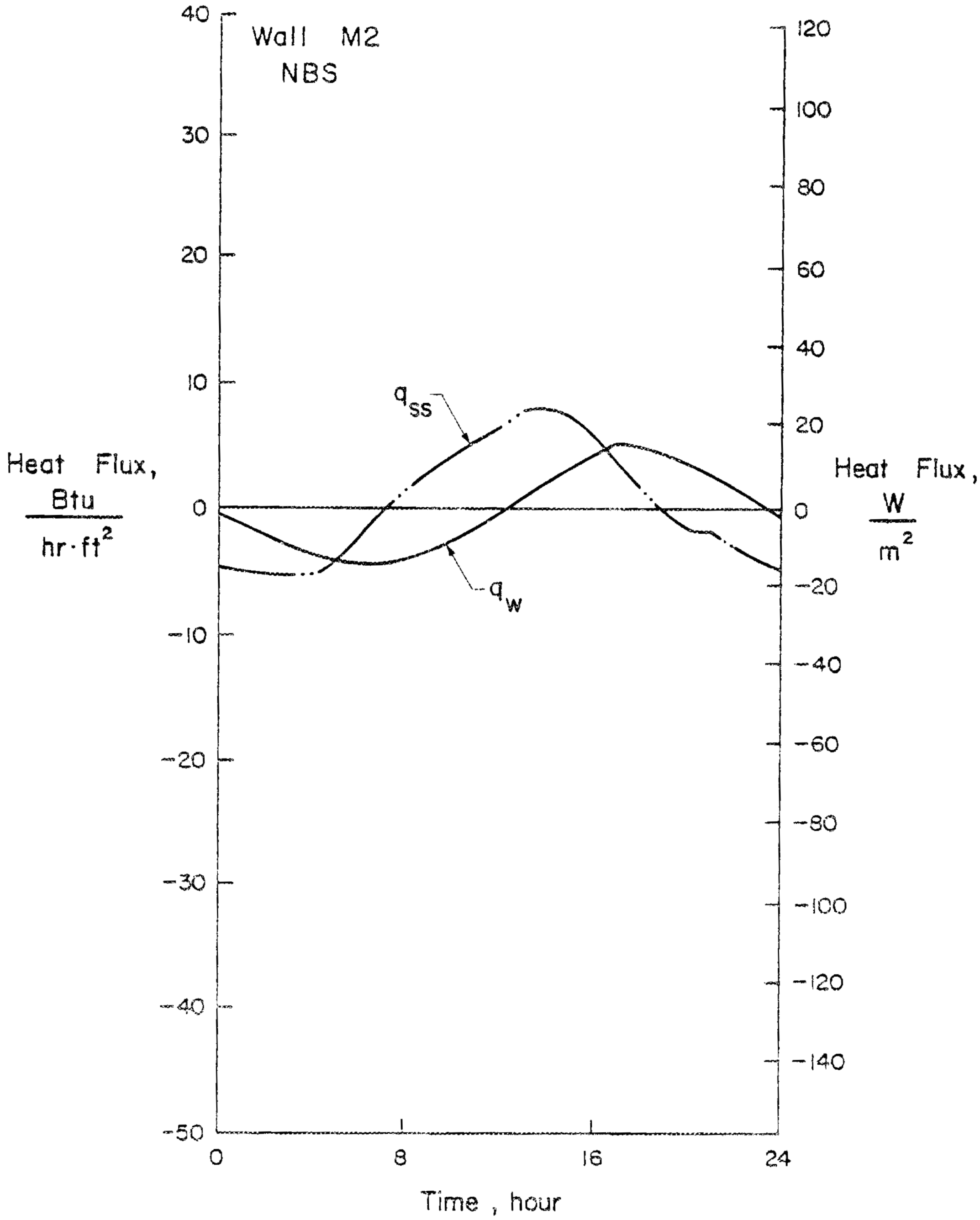


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M2-2 Wall M2 Dynamic Test Results for NBS Test Cycle



(c) Heat Flux

Fig. M2-2 Wall M2 Dynamic Test Results for NBS Test Cycle

TABLE M2-7(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q'_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1	48.3	53.1		71.6	71.5	-1.38				-5.00
2	47.1	51.7		71.3	71.4	-2.29				-5.30
3	47.5	51.3		71.1	71.6	-2.96				-5.35
4	47.5	50.9		70.8	71.5	-3.74				-5.37
5	55.4	54.8		70.6	70.9	-4.34				-4.27
6	68.4	63.9		70.5	71.0	-4.59				-1.78
7	76.0	70.8		70.8	71.6	-4.45				0.02
8	84.0	77.9		71.0	71.5	-4.03				1.85
9	91.1	84.4		71.3	71.4	-3.32				3.53
10*	95.7	89.5		71.8	71.5	-2.28				4.77
11*	99.1	93.6		72.3	71.3	-1.32				5.75
12*	105.0	98.5		72.9	72.0	0.05				6.92
13*	110.3	103.7		73.4	72.3	1.50				8.16
14*	108.3	104.5		73.7	71.6	2.40				8.33
15*	103.8	102.5		74.1	72.0	3.43				7.67
16*	95.6	97.5		74.6	72.7	4.65				6.20
17*	82.8	88.8		74.7	72.2	5.28				3.82
18	72.2	79.9		74.5	72.1	5.10				1.46
19	65.8	72.9		74.2	72.0	4.87				-0.36
20	63.2	68.9		73.8	71.9	4.17				-1.33
21	62.0	66.5		73.3	72.0	2.98				-1.85
22	56.2	62.2		72.9	72.0	1.86				-2.88
23	50.9	57.2		72.5	71.7	0.70				-4.13
24	49.6	55.0		72.0	71.3	-0.49				-4.60
Mean	74.4	75.0		72.5	71.7	0.08				0.68

*Data are 2-day averages, not 3-day averages, of test results.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

Calibrated Hot Box Relative Humidity:
Indoor Chamber - Not measured for this wall assembly
Outdoor Chamber - Not measured for this wall assembly

Laboratory Air Temperature:
Max. - 73°F (23°C)
Min. - 69°F (21°C)

TABLE M2-7(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m²			Calculated Heat Flux, W/m²	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q'_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1	9.1	11.7		22.0	21.9	-4.35				-15.75
2	8.4	10.9		21.8	21.9	-7.21				-16.71
3	8.6	10.7		21.7	22.0	-9.34				-16.88
4	8.6	10.5		21.6	21.9	-11.81				-16.94
5	13.0	12.7		21.4	21.6	-13.68				-13.45
6	20.2	17.7		21.4	21.7	-14.47				-5.61
7	24.5	21.6		21.5	22.0	-14.03				0.05
8	28.9	25.5		21.7	22.0	-13.26				5.85
9	32.8	29.1		21.9	21.9	-11.19				11.13
10*	35.4	31.9		22.1	21.9	-7.19				15.04
11*	37.3	34.2		22.4	21.9	-4.15				18.14
12*	40.6	36.9		22.7	22.2	0.15				21.81
13*	43.5	39.8		23.0	22.4	4.74				25.74
14*	42.4	40.3		23.2	22.2	7.56				26.27
15*	39.9	39.2		23.4	22.2	10.82				24.19
16*	35.3	36.4		23.6	22.6	14.67				19.57
17*	28.2	31.6		23.7	22.4	16.67				12.03
18	22.3	26.6		23.6	22.3	16.10				4.59
19	18.8	22.7		23.5	22.2	15.36				-1.14
20	17.3	20.5		23.2	22.2	13.14				-4.18
21	16.7	19.1		22.9	22.2	9.39				-5.82
22	13.5	16.8		22.7	22.2	5.88				-9.09
23	10.5	14.0		22.5	22.0	2.22				-13.02
24	9.8	12.8		22.2	21.9	-1.53				-14.51
Mean	23.6	23.9		22.5	22.1	0.24				2.14

*Data are 2-day averages, not 3-day averages, of test results.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

TABLE M2-12 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), THERMAL LAG

Test Cycle	Thermal Lag, hrs											Calc. Time Constant, hrs
	Measured								Calculated			
	Calibrated Hot Box					Heat Flow Meter*			Response Factor**			
	t_o vs t_1		q_{ss} vs q_w		Avg.	q_{ss} vs q_{hfm}		Avg.	q_{ss} vs q_{rf}		Avg.	
	@ Max.	@ Min.	@ Max.	@ Min.		@ Max.	@ Min.		@ Max.	@ Min.		
NBS	4	4	3	2.5	3.5	-	-	-	-	-	-	3.1

*Heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

TABLE M2-13 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), REDUCTION IN AMPLITUDE

Test Cycle	Measured, %						Calculated, %		
	Calibrated Hot Box			Heat Flow Meter*			Response Factor**		
	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.
NBS	32	23	28	-	-	-	-	-	-

*Heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

TABLE M2-14 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), ENERGY REQUIREMENTS

Test Cycle	Total Energy, Btu/ft^2 (W·hr/m^2)				Total Energy Comparisons, %			Net Energy, Btu/ft^2 (W·hr/m^2)				Net Energy Comparisons, %		
	Measured		Calculated					Measured		Calculated				
	q_w^T	q_{hfm}^T *	q_{rf}^T **	q_{ss}^T	$\frac{q_w^T}{q_{ss}^T}$	$\frac{q_{hfm}^T}{q_{ss}^T}$	$\frac{q_{rf}^T}{q_{ss}^T}$	q_w^N	q_{hfm}^N *	q_{rf}^N **	q_{ss}^N	$\frac{q_w^N}{q_{ss}^N}$	$\frac{q_{hfm}^N}{q_{ss}^N}$	$\frac{q_{rf}^N}{q_{ss}^N}$
NBS	72.2 (227.7)			100.7 (317.7)	72			1.8 (5.7)			16.3 (51.3)	11		

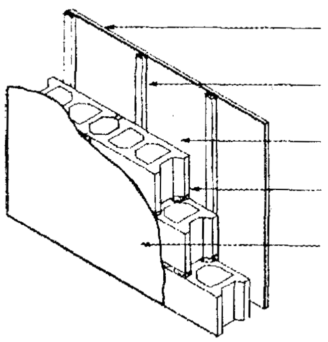
*Heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

WALL M5: 8-IN. (203-MM) NORMAL WEIGHT CONCRETE BLOCK WITH REFLECTIVE INSULATION

DESCRIPTION: 8-in. (203-mm) concrete block wall with stucco on exterior surface and gypsum wallboard secured to furring strips on interior surface.

REFERENCE: Fiorato, A. E., "Heat Transfer Characteristics of Walls Under Dynamic Temperature Conditions," Research and Development Bulletin RD075, Portland Cement Association, Skokie, 1981, 20 pages.

COMPOSITION:



1. 1/2-in. (13-mm) Stucco
2. 8x8x16-in. (203x203x406-mm) Normal Weight Hollow Core Concrete Block - 2 cores per block
3. 3/4-in.x1-1/2-in. (19x38-mm) Furring Strips at 17-in. (432-mm) center-to-center
4. 3/4-in. (19-mm) reflective air space
5. 1/2-in. (13-mm) foil-backed gypsum wallboard

Note: A bond beam was cast in the top course of block. See referenced report for details.

TABLE M5-1 - PHYSICAL PROPERTIES OF WALL AT TIME OF TEST

Property	Measured Value
Unit Weight, psf (kg/m^2)	48.2 (235)
Nominal Thickness, in. (mm)	9.375 (238)
Nominal Area, ft^2 (m^2)	73.94 (6.87)
Moisture Content,* % by ovendry weight	0.8%

*Measured on masonry, including mortar joints, after test.

TABLE M5-2(a) - MATERIAL PROPERTIES, NORMAL WEIGHT CONCRETE SPLITTER BLOCK*

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Standard Dimensions, in. (mm)	--	--	--	7-5/8x7-5/8x15-5/8 (194x194x397)
Measured Dimensions, in. (mm)	ASTM C140	--	--	7.63x7.64x15.63 (194x194x397)
Percent Solid Volume	--	--	--	55
Ovendry Unit Weight, pcf (kg/m^3)	--	--	--	124 (1987)
Moisture Content, % ovendry weight	ASTM C140	--	--	1.4
Absorption, % ovendry weight	ASTM C140	--	--	7.5

*Wall was constructed using stretcher and splitter block.

TABLE M5-2(b) - MATERIAL PROPERTIES, NORMAL WEIGHT CONCRETE STRETCHER BLOCK*

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Standard Dimensions, in. (mm)	--	--	--	7-5/8x7-5/8x15-5/8 (194x194x397)
Measured Dimensions, in. (mm)	ASTM C140	--	--	7.63x7.63x15.60 (194x194x396)
Percent Solid Volume	--	--	--	49
Ovendry Unit Weight, pcf (kg/m^3)	--	--	--	126 (2010)
Moisture Content, % ovendry weight	ASTM C140	--	--	1.5
Absorption, % ovendry weight	ASTM C140	--	--	7.3

*Wall was constructed using stretcher and splitter block.

TABLE M5-2(c) - MATERIAL PROPERTIES, MORTAR*

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Compressive Strength,** psi (MPa)	--	air dry	--	1760 (12)
Unit Weight, pcf (kg/m^3)	--	air dry	--	112 (1794)

*One part masonry cement to three parts masonry sand by volume.
**Measured on 2-in. (51-mm) cubes moist cured for 14 days and then air dried for 263 days.

TABLE M5-3(a) - DESIGN HEAT TRANSMISSION COEFFICIENTS OF WALL EXCLUSIVE OF BOND BEAM

Component	R, Thermal Resistance	
	Between Furring, $hr \cdot ft^2 \cdot °F/Btu$ $(m^2 \cdot K/W)$	At Furring, $hr \cdot ft^2 \cdot °F/Btu$ $(m^2 \cdot K/W)$
1. Outside Air Film	0.17 (0.03)	0.17 (0.03)
2. 1/2-in. (13-mm) Stucco	0.10* (0.02)	0.10 (0.02)
3. 8x8x16-in. (203x203x406-mm) Hollow Core Block	1.04* (0.18)	1.04 (0.18)
4. 3/4x1-1/2-in. (19x38-mm) Furring Strips	--	0.94* (0.17)
5. 3/4-in. (19-mm) Reflective Air Space	3.46* (0.61)	--
6. 1/2-in. (13-mm) Foil-backed Gypsum Wallboard	0.45* (0.08)	0.45 (0.08)
7. Inside Air Film	0.68 (0.12)	0.68 (0.12)
Total R	5.90 (1.04)	3.38 (0.60)
Total U	0.17 (0.96)	0.30 (1.68)

*Source: ASHRAE Handbook of Fundamentals, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., New York, 1977, Chapter 22.

Adjust for Furring (14.3%), Exclusive of Bond Beam:

$$U = 0.857\ (0.169) + 0.143\ (0.296)$$
$$= 0.187\ Btu/hr \cdot ft^2 \cdot °F\ (1.06\ W/m^2 \cdot K)$$

Adjust for Bond Beam (7.8%):

$$U = 0.922\ (0.187) + 0.078\ (0.195)$$
$$= 0.19\ Btu/hr \cdot ft^2 \cdot °F\ (1.07\ W/m^2 \cdot K)$$
$$R = 1/U = 5.33\ hr \cdot ft^2 \cdot °F/Btu\ (0.94\ K \cdot m^2/W)$$

TABLE M5-3(b) - DESIGN HEAT TRANSMISSION COEFFICIENTS AT BOND BEAM

Component	R, Thermal Resistance	
	Between Furring, $hr \cdot ft^2 \cdot °F/Btu$ ($m^2 \cdot K/W$)	At Furring, $hr \cdot ft^2 \cdot °F/Btu$ ($m^2 \cdot K/W$)
1. Outside Air Film	0.17 (0.03)	0.17 (0.03)
2. 1/2-in. (13-mm) Stucco	0.10* (0.02)	0.10 (0.02)
3. 8x8x16-in. (203x203x406-mm) Block with Concrete in Cores	0.84* (0.15)	0.84 (0.15)
4. 3/4x1-1/2-in. (19x38-mm) Furring Strips	--	0.94* (0.17)
5. 3/4-in. (19-mm) Reflective Air Space	3.46* (0.61)	--
6. 1/2-in. (13-mm) Foil-backed Gypsum Wallboard	0.45* (0.08)	0.45 (0.08)
7. Inside Air Film	0.68 (0.12)	0.68 (0.12)
Total R	5.70 (1.00)	3.18 (0.56)
Total U	0.18 (1.00)	0.31 (1.79)

*Source: ASHRAE Handbook of Fundamentals, American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc., New York, 1977, Chapter 22.

Adjust for Furring (14.3%) at Bond Beam:

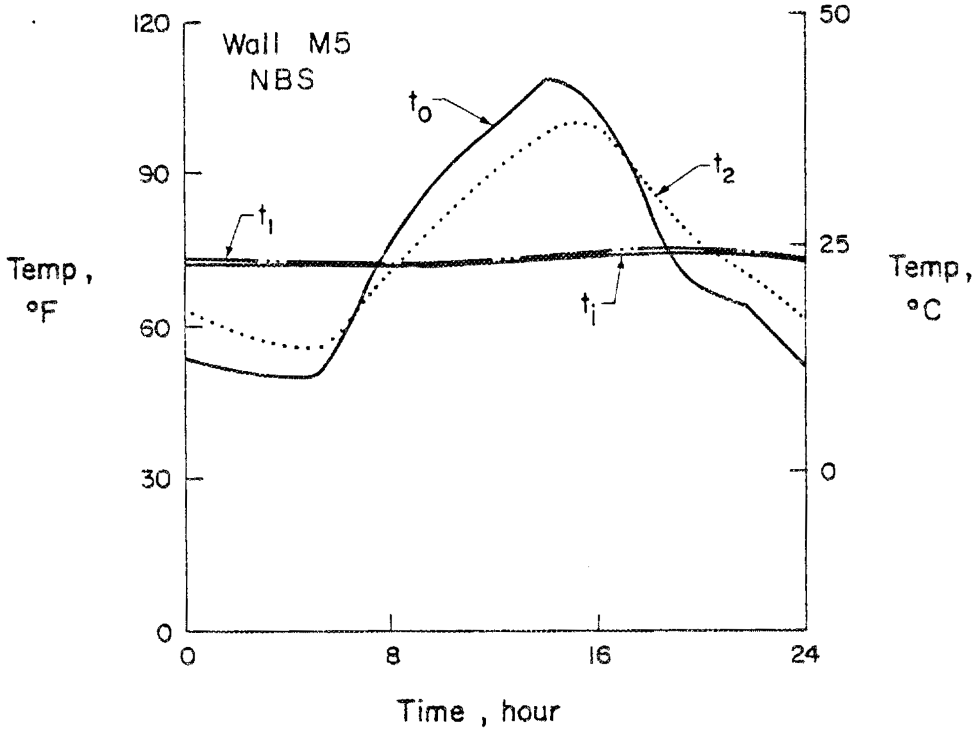
$$U = 0.857\ (0.175) + 0.143\ (0.314)$$

$$= 0.195\ Btu/hr \cdot ft^2 \cdot °F\ (1.11\ W/m^2 \cdot K)$$

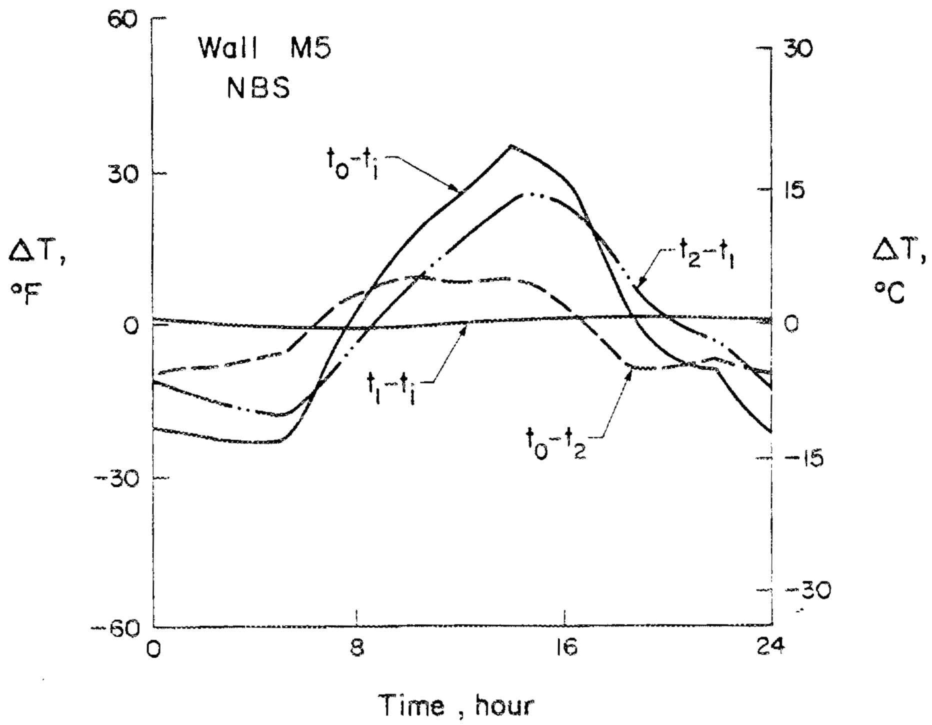
TABLE M5-4 - STEADY-STATE TEST RESULTS

Nominal Test Condition	q Heat Flux, Btu/hr·ft^2 (W/m^2)	R_T, hr·ft^2·°F/Btu (m^2·K/W)	U, Btu/hr·ft^2·°F (W/m^2·K)	Measured Temperatures, °F (°C)					Relative Humidity		Laboratory Air Temperature	
				t_o Outdoor Air	t_2 Outdoor Surface	t_3* Internal	t_1 Indoor Surface	t_i Indoor Air	Indoor Chamber, %	Outdoor Chamber, %	Max. °F (°C)	Min. °F (°C)
t_m = 35°F (2°C)	-13.14 (-41.5)	5.76 (1.01)	0.17 (0.99)	-4 (-20)	3 (-16)	-	68 (20)	73 (23)	20	13	74 (23)	70 (21)
t_m = 100°F (38°C)	9.39 (29.6)	5.54 (0.98)	0.18 (1.03)	125 (52)	122 (50)	-	78 (26)	74 (23)	25	25	69 (21)	65 (18)
Design Values	--	5.33 (0.94)	0.19 (1.07)	-	-	-	-	-	-	-	-	-

*Internal thermocouples were not used for this wall assembly.

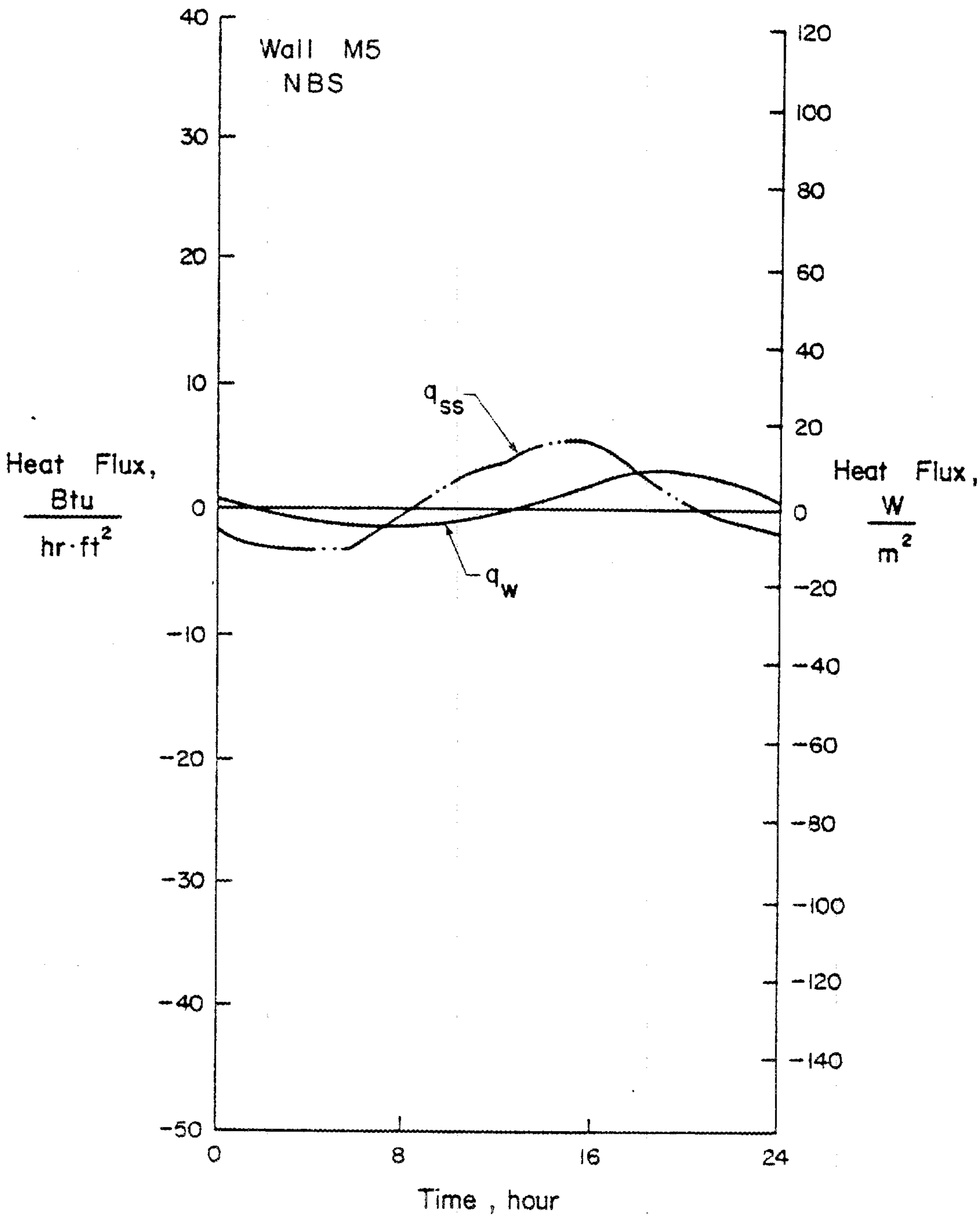


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M5-2 Wall M5 Dynamic Test Results for NBS Test Cycle



(c) Heat Flux

Fig. M5-2 Wall M5 Dynamic Test Results for NBS Test Cycle

TABLE M5-7(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft²			Calculated Heat Flux, Btu/hr·ft²	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}* HFM @ Indoor Surf.	q'_{hfm}* HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
1	52.4	60.9		74.2	73.8	0.22				-2.77
2	51.0	59.0		74.0	73.8	-0.13				-3.13
3	50.1	57.4		73.7	73.7	-0.63				-3.40
4	50.1	56.5		73.5	73.7	-1.23				-3.54
5	50.0	55.8		73.4	73.7	-1.56				-3.66
6	57.7	58.4		73.2	73.6	-1.70				-3.08
7	69.3	65.1		73.1	73.6	-1.96				-1.67
8	76.8	70.7		73.1	73.6	-1.88				-0.50
9	84.2	76.4		73.2	73.6	-1.71				0.67
10	90.8	82.0		73.4	73.6	-1.63				1.81
11	95.7	86.7		73.6	73.7	-1.12				2.76
12	99.0	90.4		73.9	73.7	-0.48				3.48
13	104.8	95.0		74.2	73.8	0.08				4.39
14	109.2	99.4		74.4	73.8	0.51				5.28
15	107.3	100.6		74.8	73.9	1.13				5.46
16	103.6	99.6		75.1	74.0	1.72				5.18
17	96.1	96.2		75.3	74.0	2.05				4.41
18	84.5	89.8		75.5	74.1	2.48				3.03
19	73.7	82.4		75.5	74.0	2.45				1.45
20	68.0	77.0		75.4	74.1	2.40				0.34
21	65.7	73.7		75.2	74.0	2.22				-0.31
22	64.5	71.5		75.0	74.0	1.75				-0.71
23	58.5	67.6		74.7	73.9	1.32				-1.48
24	53.6	63.3		74.5	73.9	0.89				-2.34
Mean	75.7	76.5		74.2	73.8	0.22				0.48

*Internal thermocouples and heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

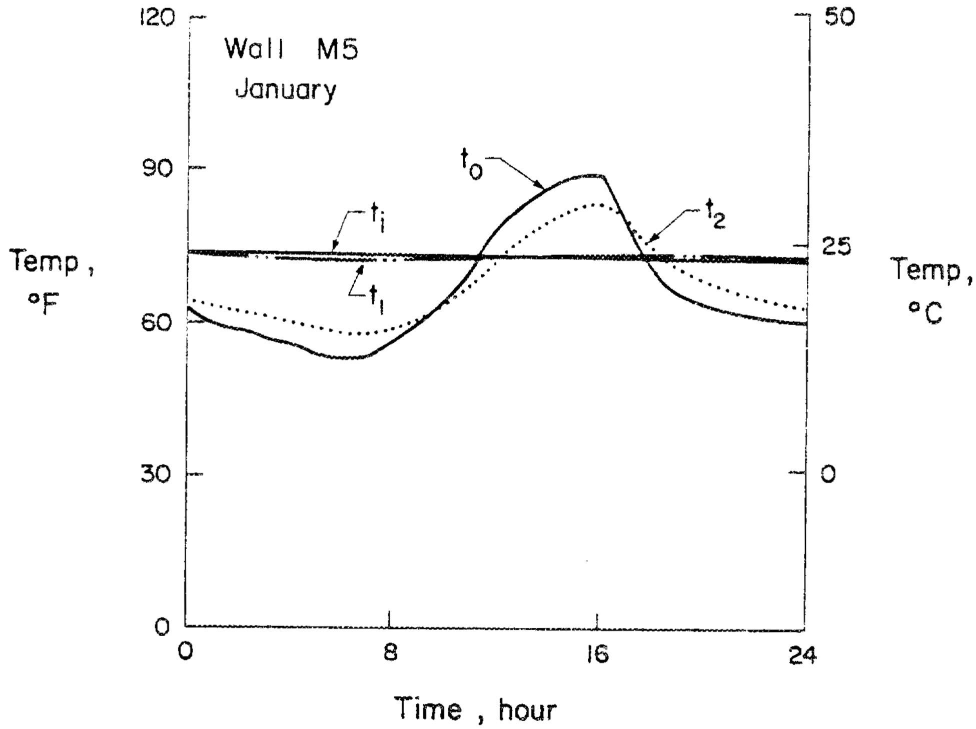
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 19%
Outdoor Chamber - 19%

Laboratory Air Temperature:
Max. - 76°F (24°C)
Min. - 70°F (21°C)

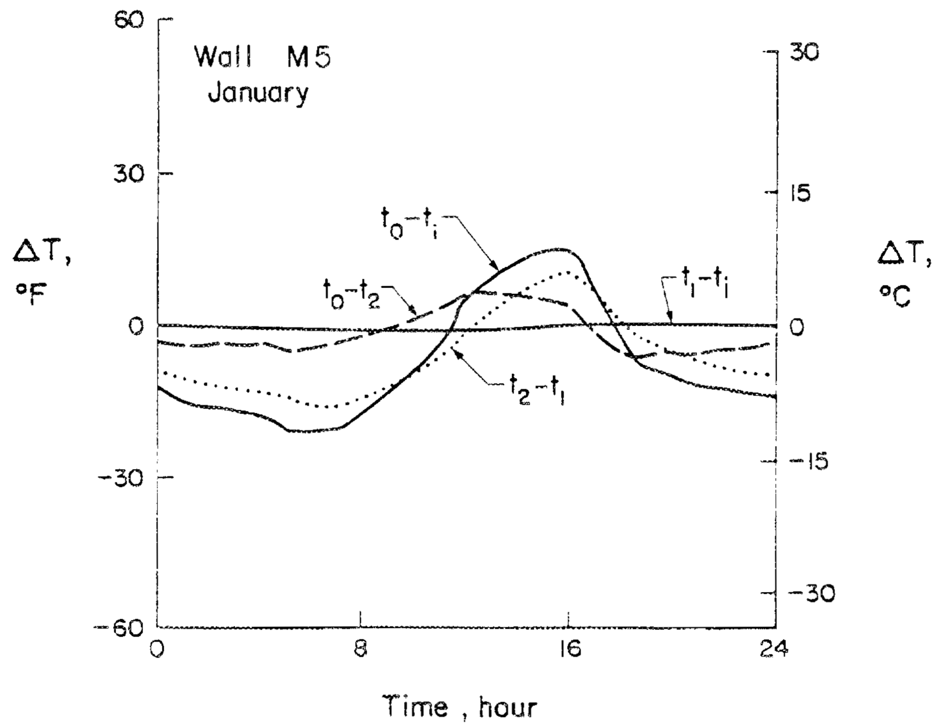
TABLE M5-7(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}* HFM @ Indoor Surf.	q'_{hfm}* HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
1	11.3	16.1		23.5	23.2	0.68				-8.76
2	10.6	15.0		23.3	23.2	-0.42				-9.87
3	10.1	14.1		23.2	23.2	-2.00				-10.72
4	10.0	13.6		23.1	23.2	-3.87				-11.17
5	10.0	13.2		23.0	23.1	-4.91				-11.56
6	14.2	14.7		22.9	23.1	-5.38				-9.73
7	20.7	18.4		22.8	23.1	-6.18				-5.27
8	24.9	21.5		22.8	23.1	-5.92				-1.58
9	29.0	24.7		22.9	23.1	-5.41				2.12
10	32.7	27.8		23.0	23.1	-5.15				5.70
11	35.4	30.4		23.1	23.1	-3.52				8.70
12	37.2	32.4		23.3	23.2	-1.51				10.97
13	40.4	35.0		23.4	23.2	0.26				13.85
14	42.9	37.5		23.6	23.2	1.61				16.67
15	41.8	38.1		23.8	23.2	3.57				17.21
16	39.8	37.6		23.9	23.3	5.44				16.34
17	35.6	35.7		24.1	23.3	6.48				13.92
18	29.1	32.1		24.1	23.4	7.81				9.57
19	23.2	28.0		24.1	23.4	7.73				4.58
20	20.0	25.0		24.1	23.4	7.56				1.06
21	18.7	23.2		24.0	23.3	7.00				-0.99
22	18.1	22.0		23.9	23.3	5.52				-2.25
23	14.7	19.8		23.7	23.3	4.18				-4.68
24	12.0	17.4		23.6	23.3	2.79				-7.38
Mean	24.3	24.7		23.5	23.2	0.68				1.53

*Internal thermocouples and heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

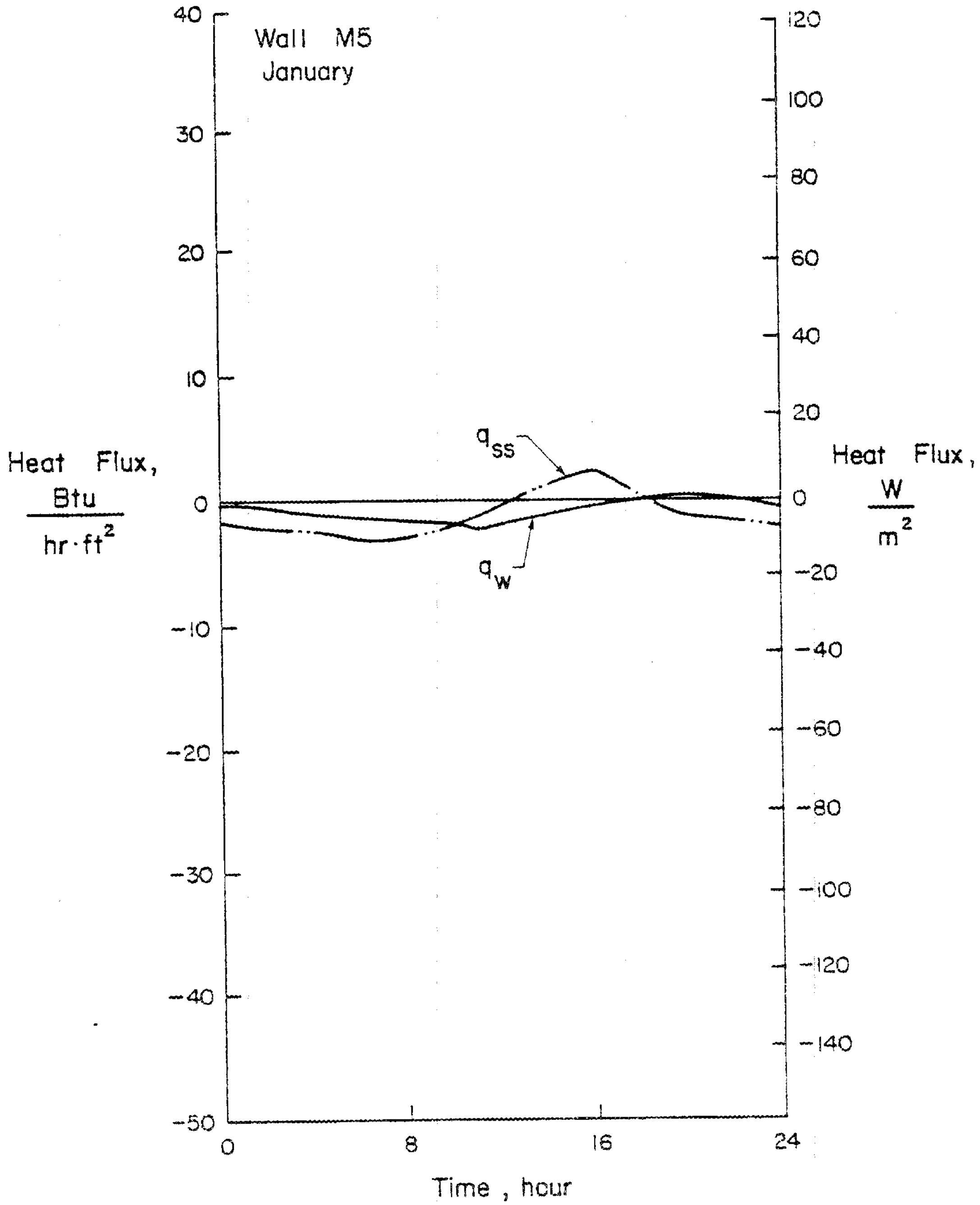


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M5-3 Wall M5 Dynamic Test Results for Orlando January Test Cycle



(c) Heat Flux

Fig. M5-3 Wall M5 Dynamic Test Results for Orlando January Test Cycle

TABLE M5-8(a) - DYNAMIC TEST RESULTS (PERIODIC), ORLANDO JANUARY TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}* HFM @ Indoor Surf.	q'_{hfm}* HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
1	58.4	62.9		73.6	73.6	-0.68				-2.23
2	58.2	62.0		73.5	73.6	-0.84				-2.40
3	56.4	60.8		73.4	73.5	-1.08				-2.63
4	55.9	59.9		73.3	73.5	-1.25				-2.79
5	53.4	58.4		73.2	73.5	-1.56				-3.08
6	53.0	57.3		73.1	73.5	-1.65				-3.29
7	53.4	57.1		73.0	73.5	-1.70				-3.31
8	56.4	58.1		72.9	73.4	-1.87				-3.08
9	59.8	60.1		72.9	73.4	-1.76				-2.67
10	64.9	63.0		72.8	73.4	-1.81				-2.05
11	70.2	66.7		72.9	73.4	-2.13				-1.30
12	79.3	72.4		73.0	73.4	-1.90				-0.13
13	83.4	76.7		73.1	73.5	-1.53				0.75
14	87.6	80.4		73.3	73.6	-1.16				1.49
15	88.8	83.1		73.6	73.6	-0.75				2.00
16	88.9	84.2		73.8	73.7	-0.28				2.19
17	81.6	81.9		74.0	73.7	-0.33				1.66
18	71.7	76.2		74.2	73.7	-0.04				0.42
19	65.7	71.6		74.2	73.7	0.33				-0.54
20	64.5	69.4		74.2	73.7	0.33				-1.00
21	62.4	67.5		74.1	73.7	0.18				-1.38
22	62.0	66.3		74.0	73.7	0.08				-1.61
23	60.2	64.9		73.8	73.6	-0.15				-1.86
24	60.2	64.1		73.7	73.6	-0.45				-2.00
Mean	66.5	67.7		73.5	73.6	-0.92				-1.20

*Internal thermocouples and heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

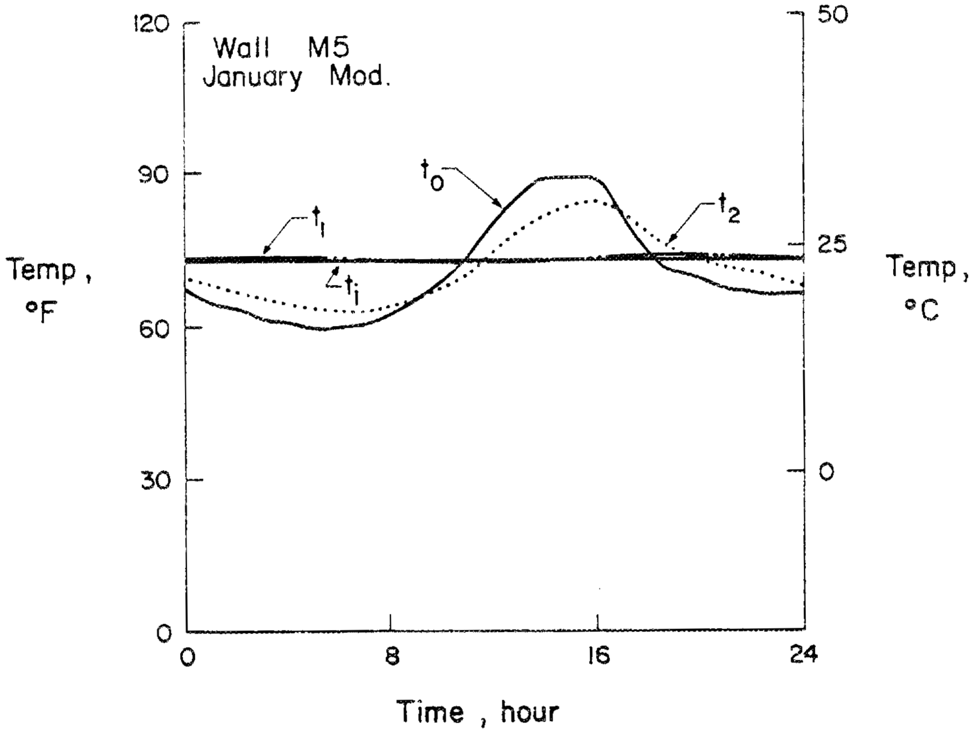
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 18%
Outdoor Chamber - 19%

Laboratory Air Temperature:
Max. - 73°F (23°C)
Min. - 67°F (19°C)

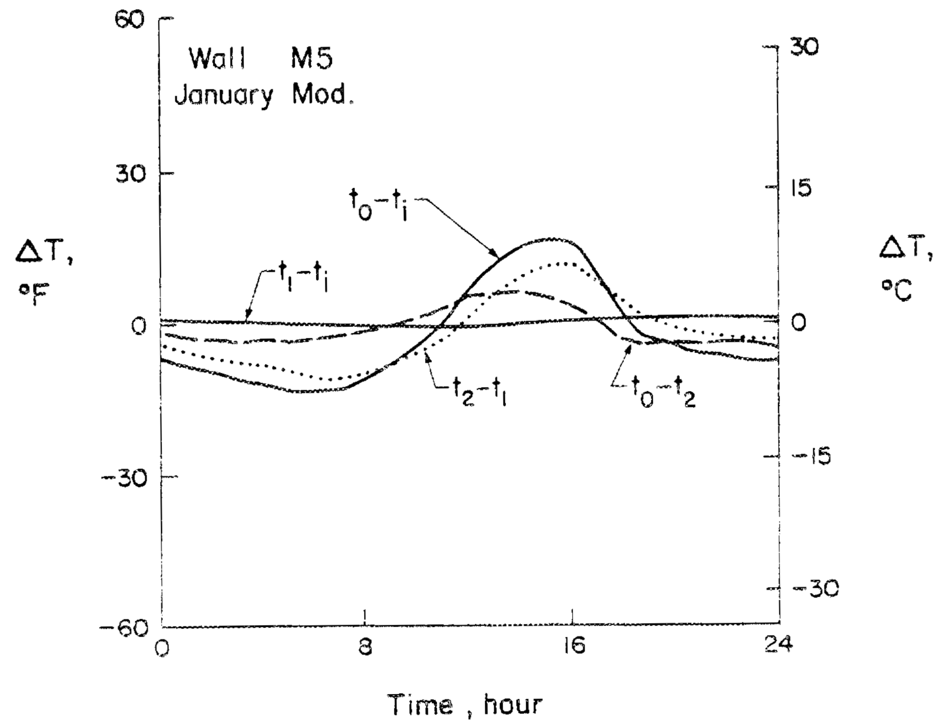
TABLE M5-8(b) - DYNAMIC TEST RESULTS (PERIODIC), ORLANDO JANUARY TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}* HFM @ Indoor Surf.	q'_{hfm}* HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
1	14.7	17.2		23.1	23.1	-2.16				-7.05
2	14.6	16.7		23.1	23.1	-2.64				-7.57
3	13.5	16.0		23.0	23.0	-3.42				-8.29
4	13.3	15.5		22.9	23.1	-3.95				-8.82
5	11.9	14.6		22.9	23.0	-4.92				-9.73
6	11.7	14.1		22.8	23.0	-5.22				-10.38
7	11.9	13.9		22.8	23.0	-5.36				-10.45
8	13.5	14.5		22.7	23.0	-5.90				-9.73
9	15.5	15.6		22.7	23.0	-5.56				-8.42
10	18.3	17.2		22.7	23.0	-5.70				-6.45
11	21.2	19.3		22.7	23.0	-6.72				-4.09
12	26.3	22.4		22.8	23.0	-5.99				-0.40
13	28.5	24.9		22.9	23.1	-4.83				2.38
14	30.9	26.9		23.0	23.1	-3.66				4.70
15	31.6	28.4		23.1	23.1	-2.35				6.30
16	31.6	29.0		23.2	23.2	-0.90				6.90
17	27.6	27.7		23.3	23.2	-1.04				5.24
18	22.1	24.5		23.4	23.2	-0.12				1.32
19	18.7	22.0		23.4	23.2	1.04				-1.72
20	18.1	20.8		23.4	23.2	1.04				-3.17
21	16.9	19.7		23.4	23.2	0.56				-4.35
22	16.7	19.0		23.3	23.2	0.27				-5.08
23	15.6	18.3		23.2	23.1	-0.46				-5.87
24	15.7	17.8		23.2	23.1	-1.43				-6.33
Mean	19.2	19.8		23.0	23.1	-2.89				-3.79

*Internal thermocouples and heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

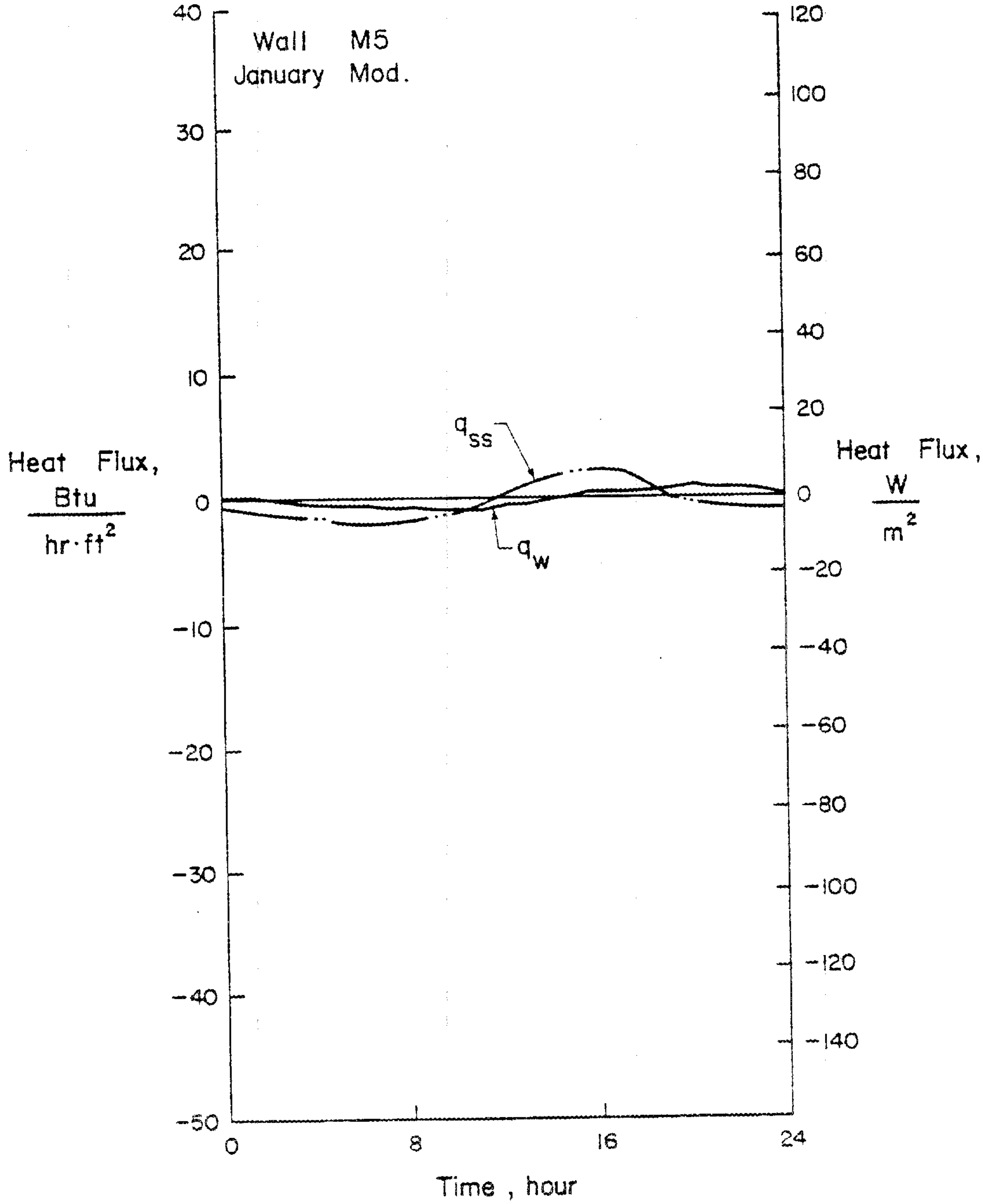


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M5-4 Wall M5 Dynamic Test Results for Orlando January Modified Test Cycle



(c) Heat Flux

Fig. M5-4 Wall M5 Dynamic Test Results for Orlando January Modified Test Cycle

TABLE M5-9(a) - DYNAMIC TEST RESULTS (PERIODIC), ORLANDO JANUARY MODIFIED TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}* HFM @ Indoor Surf.	q'_{hfm}* HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
1	64.4	68.1		73.9	73.7	-0.00				-1.21
2	64.0	67.2		73.9	73.7	-0.14				-1.38
3	61.8	65.9		73.8	73.6	-0.37				-1.65
4	61.6	65.0		73.7	73.6	-0.58				-1.82
5	59.6	63.8		73.6	73.6	-0.82				-2.05
6	60.0	63.2		73.5	73.6	-0.82				-2.15
7	60.2	63.1		73.4	73.6	-1.06				-2.15
8	62.7	64.0		73.3	73.6	-0.89				-1.94
9	65.3	65.5		73.3	73.5	-1.17				-1.63
10	69.0	67.6		73.3	73.5	-1.02				-1.19
11	73.1	70.4		73.3	73.6	-1.22				-0.61
12	80.7	75.0		73.4	73.6	-0.85				0.34
13	85.0	79.2		73.5	73.6	-0.86				1.20
14	89.3	82.7		73.7	73.7	-0.18				1.89
15	89.8	84.8		73.8	73.7	-0.18				2.31
16	89.7	85.6		74.0	73.7	0.43				2.44
17	84.2	83.9		74.2	73.8	0.42				2.04
18	76.6	79.7		74.4	73.8	0.49				1.11
19	71.0	75.8		74.4	73.8	0.60				0.29
20	70.1	73.8		74.4	73.8	1.03				-0.13
21	67.9	72.2		74.3	73.7	0.58				-0.44
22	67.8	71.1		74.2	73.7	0.72				-0.65
23	66.0	69.9		74.1	73.7	0.37				-0.88
24	66.2	69.2		74.0	73.7	0.26				-1.00
Mean	71.1	71.9		73.8	73.6	-0.22				-0.39

*Internal thermocouples and heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

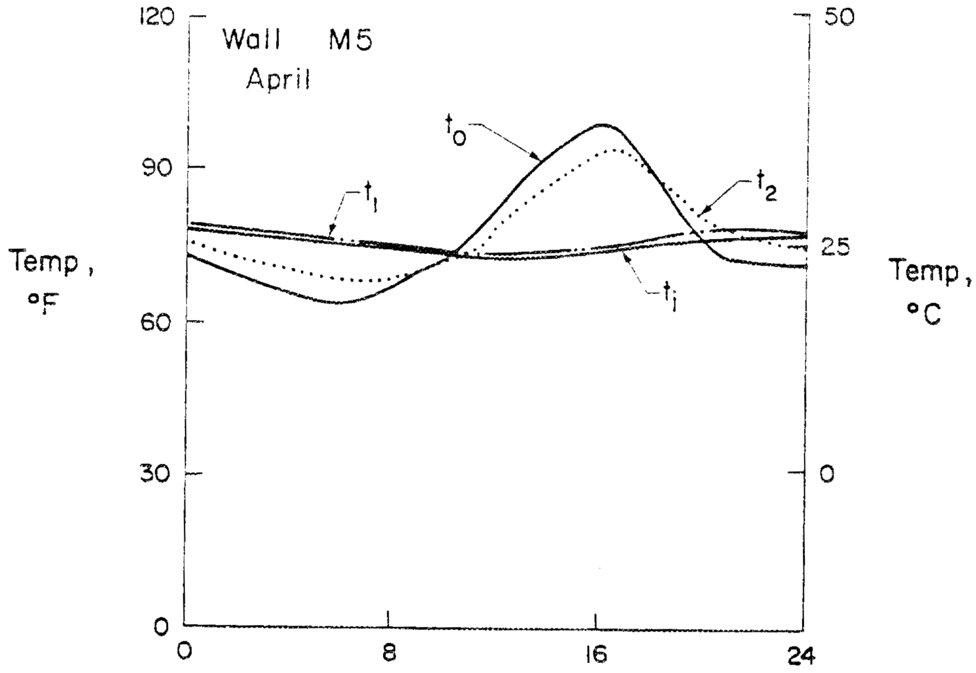
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 20%
Outdoor Chamber - 19%

Laboratory Air Temperature:
Max. - 75°F (24°C)
Min. - 71°F (22°C)

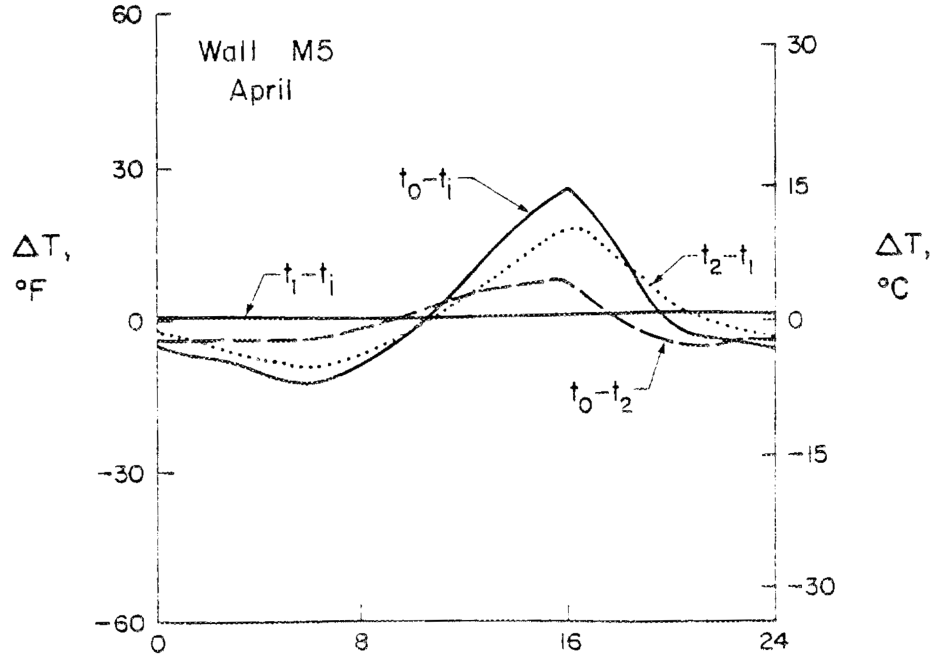
TABLE M5-9(b) - DYNAMIC TEST RESULTS (PERIODIC), ORLANDO JANUARY MODIFIED TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}* HFM @ Indoor Surf.	q'_{hfm}* HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
1	18.0	20.1		23.3	23.2	-0.00				-3.83
2	17.8	19.6		23.2	23.1	-0.44				-4.35
3	16.5	18.8		23.2	23.1	-1.16				-5.21
4	16.4	18.3		23.1	23.1	-1.84				-5.73
5	15.3	17.6		23.1	23.1	-2.57				-6.46
6	15.6	17.3		23.1	23.1	-2.57				-6.78
7	15.6	17.3		23.0	23.1	-3.35				-6.78
8	17.1	17.8		23.0	23.1	-2.81				-6.13
9	18.5	18.6		22.9	23.1	-3.69				-5.14
10	20.6	19.8		22.9	23.1	-3.20				-3.76
11	22.8	21.4		23.0	23.1	-3.83				-1.91
12	27.1	23.9		23.0	23.1	-2.67				1.06
13	29.4	26.2		23.0	23.1	-2.72				3.77
14	31.8	28.1		23.1	23.1	-0.58				5.97
15	32.1	29.3		23.2	23.1	-0.58				7.30
16	32.1	29.8		23.4	23.2	1.36				7.70
17	29.0	28.9		23.4	23.2	1.31				6.43
18	24.8	26.5		23.5	23.2	1.55				3.51
19	21.7	24.3		23.6	23.2	1.89				0.93
20	21.1	23.2		23.6	23.2	3.25				-0.40
21	19.9	22.3		23.5	23.2	1.84				-1.39
22	19.9	21.7		23.5	23.2	2.28				-2.05
23	18.9	21.1		23.4	23.2	1.16				-2.77
24	19.0	20.7		23.3	23.2	0.82				-3.17
Mean	21.7	22.2		23.2	23.1	-0.69				-1.22

*Internal thermocouples and heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

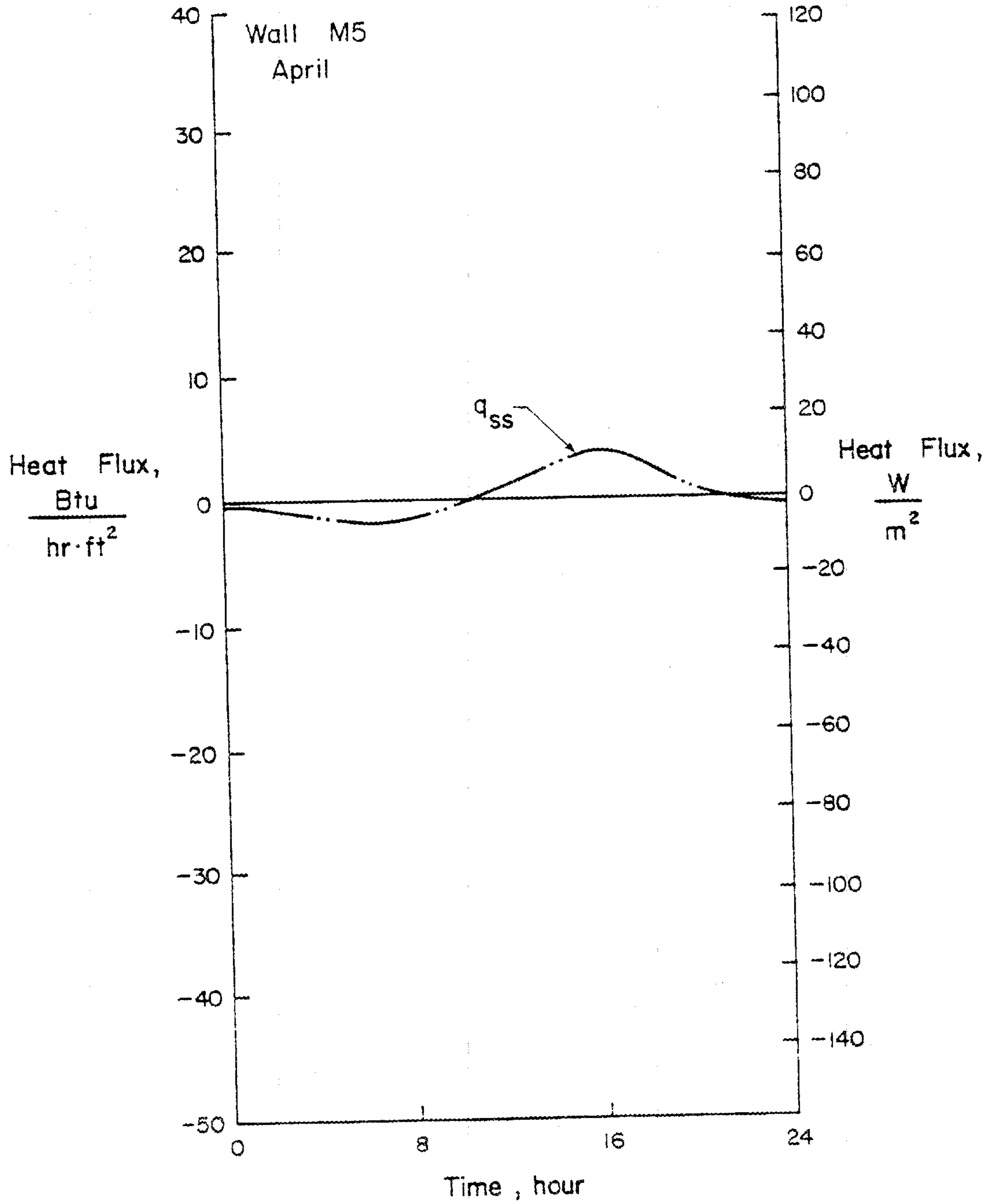


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M5-5 Wall M5 Dynamic Test Results for Orlando April Test Cycle



(c) Heat Flux

Fig. M5-5 Wall M5 Dynamic Test Results for Orlando April Test Cycle

TABLE M5-10(a) - DYNAMIC TEST RESULTS (PERIODIC), ORLANDO APRIL TEST CYCLE*

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w* Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q'_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1	70.7	74.7		78.5	77.7					-0.80
2	69.4	73.2		78.2	77.5					-1.05
3	67.5	71.9		77.9	77.3					-1.26
4	66.2	70.3		77.5	77.1					-1.51
5	64.6	69.0		77.1	76.8					-1.70
6	64.3	68.0		76.7	76.4					-1.82
7	65.0	68.0		76.2	76.0					-1.72
8	66.9	68.5		75.5	75.5					-1.46
9	70.1	70.3		75.1	75.1					-1.00
10	72.9	72.0		74.7	74.7					-0.57
11	76.8	74.7		74.5	74.4					0.04
12	82.5	78.1		74.3	74.2					0.80
13	88.2	82.5		74.3	74.1					1.72
14	93.3	86.4		74.5	74.1					2.50
15	97.7	90.5		74.9	74.3					3.29
16	100.8	93.5		75.5	74.7					3.80
17	98.5	94.3		76.3	75.3					3.80
18	91.9	91.3		77.1	75.9					3.00
19	83.7	87.0		77.9	76.5					1.92
20	78.0	82.7		78.5	77.1					0.88
21	74.7	79.8		78.8	77.5					0.21
22	73.9	78.0		79.0	77.7					-0.21
23	73.0	76.9		78.9	77.8					-0.42
24	72.6	75.9		78.7	77.8					-0.59
Mean	77.6	78.2		76.7	76.1					0.33

*Test was conducted under floating conditions. Indoor surface and air temperatures were permitted to respond to outdoor changes without heating, cooling, or forced air circulation on the indoor side. No heat flow through wall was measured.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

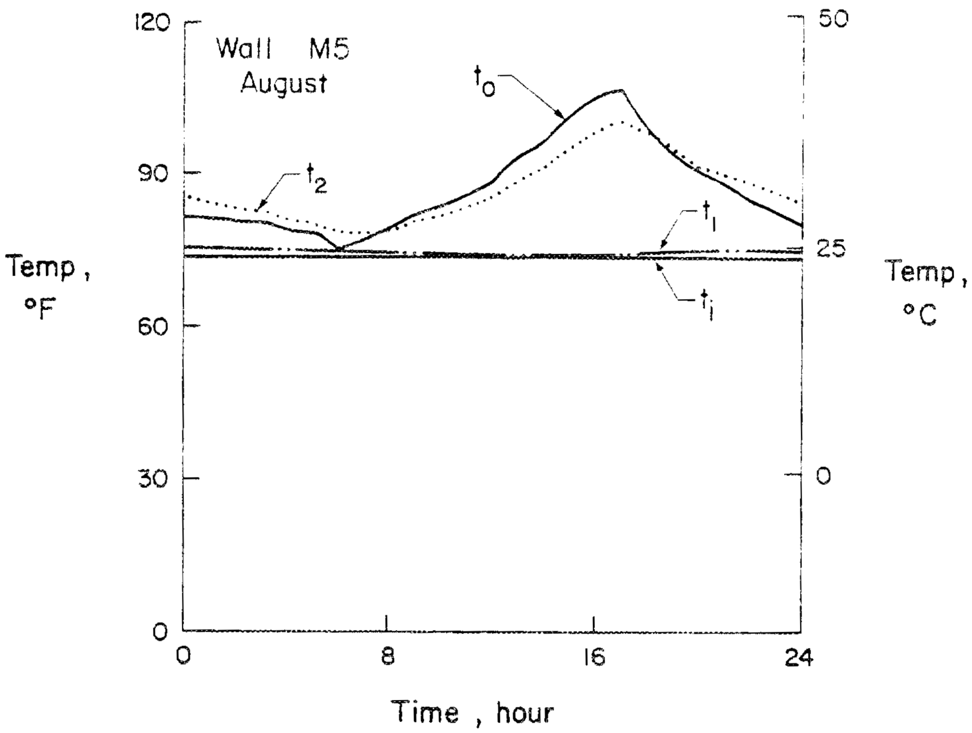
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 25%
Outdoor Chamber - 21%

Laboratory Air Temperature:
Max. - 72°F (22°C)
Min. - 68°F (20°C)

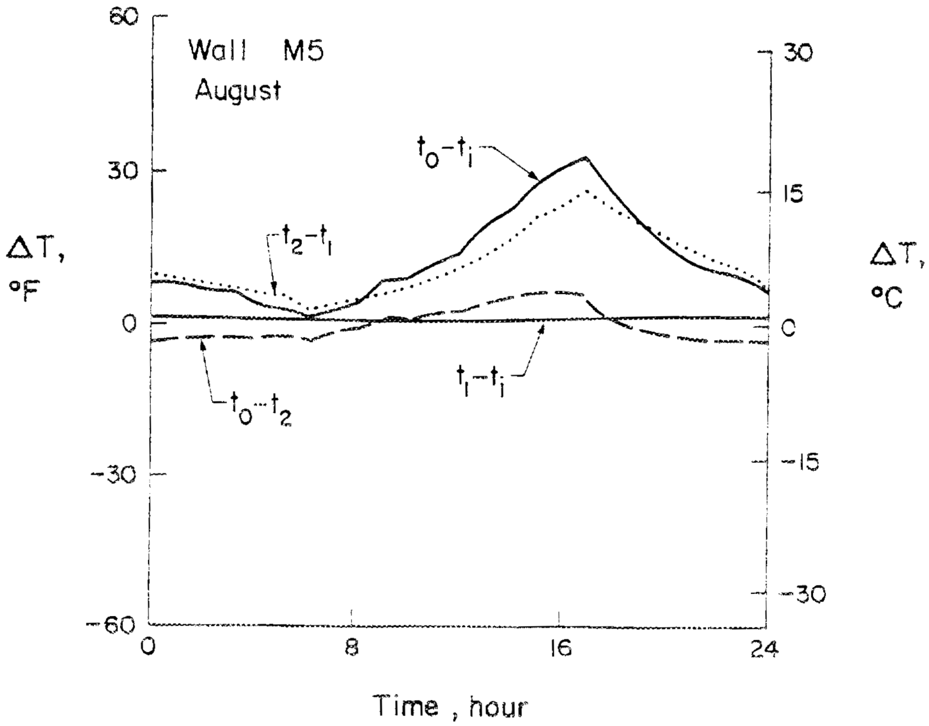
TABLE M5-10(b) - DYNAMIC TEST RESULTS (PERIODIC), ORLANDO APRIL TEST CYCLE, SI UNITS*

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w* Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q'_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1	21.5	23.7		25.8	25.4					-2.52
2	20.8	22.9		25.7	25.3					-3.31
3	19.7	22.1		25.5	25.2					-3.97
4	19.0	21.3		25.3	25.0					-4.76
5	18.1	20.6		25.0	24.9					-5.35
6	17.9	20.0		24.8	24.7					-5.75
7	18.3	20.0		24.5	24.5					-5.41
8	19.4	20.3		24.2	24.2					-4.62
9	21.2	21.3		24.0	23.9					-3.17
10	22.7	22.2		23.7	23.7					-1.78
11	24.9	23.7		23.6	23.6					0.13
12	28.1	25.6		23.5	23.5					2.52
13	31.2	28.1		23.5	23.4					5.44
14	34.1	30.2		23.6	23.4					7.90
15	36.5	32.5		23.8	23.5					10.37
16	38.2	34.2		24.2	23.7					11.98
17	36.9	34.6		24.6	24.0					11.99
18	33.3	32.9		25.1	24.4					9.45
19	28.7	30.5		25.5	24.7					6.05
20	25.6	28.2		25.8	25.0					2.79
21	23.7	26.6		26.0	25.3					0.66
22	23.3	25.5		26.1	25.4					-0.66
23	22.8	25.0		26.1	25.5					-1.33
24	22.5	24.4		26.0	25.4					-1.86
Mean	25.4	25.7		24.8	24.5					1.03

*Test was conducted under floating conditions. Indoor surface and air temperatures were permitted to respond to outdoor changes without heating, cooling, or forced air circulation on the indoor side. No heat flow through wall was measured.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

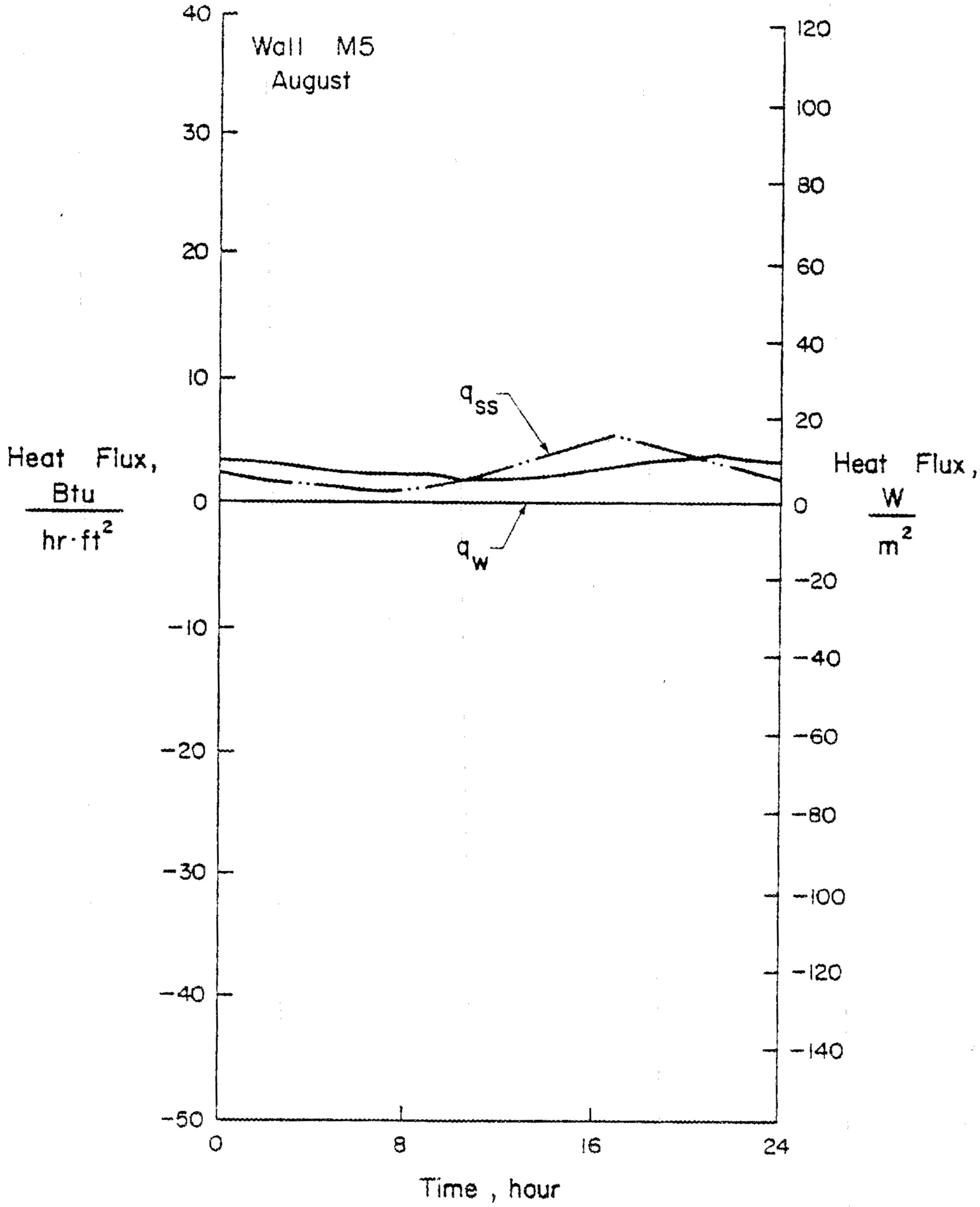


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M5-6 Wall M5 Dynamic Test Results for Orlando August Test Cycle



(c) Heat Flux

Fig. M5-6 Wall M5 Dynamic Test Results for Orlando August Test Cycle

TABLE M5-11(a) - DYNAMIC TEST RESULTS (PERIODIC), ORLANDO AUGUST TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft²			Calculated Heat Flux, Btu/hr·ft²	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}* HFM @ Indoor Surf.	q'_{hfm}* HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
1	81.7	84.4		75.3	73.9	3.31				1.91
2	80.3	83.0		75.2	73.9	2.97				1.64
3	80.4	82.7		75.1	73.8	2.85				1.60
4	77.9	80.9		75.0	73.9	2.52				1.24
5	77.4	80.1		74.9	73.8	2.43				1.09
6	75.3	78.5		74.8	73.8	2.15				0.78
7	77.1	78.8		74.7	73.8	2.21				0.86
8	78.6	79.3		74.6	73.8	1.97				0.99
9	82.7	81.5		74.6	73.8	2.20				1.45
10	83.3	82.3		74.5	73.8	1.71				1.64
11	86.4	84.2		74.6	73.8	1.89				2.04
12	88.2	85.6		74.6	73.8	1.88				2.31
13	93.8	89.2		74.6	73.8	2.00				3.08
14	96.8	91.7		74.7	73.9	2.14				3.58
15	102.7	96.0		74.9	73.9	2.32				4.45
16	105.0	98.5		75.0	73.9	2.54				4.97
17	107.5	101.6		75.2	73.9	2.80				5.56
18	100.7	99.0		75.4	74.0	3.11				4.99
19	95.4	96.2		75.5	74.0	3.34				4.37
20	90.7	92.8		75.6	74.0	3.57				3.63
21	88.4	90.9		75.6	74.0	3.72				3.23
22	85.3	88.4		75.6	74.0	3.69				2.70
23	84.5	87.3		75.5	74.0	3.71				2.48
24	81.8	85.1		75.4	73.9	3.37				2.04
Mean	87.6	87.4		75.0	73.9	2.68				2.61

*Internal thermocouples and heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

Calibrated Hot Box Relative Humidity:
Indoor Chamber - 19%
Outdoor Chamber - 20%

Laboratory Air Temperature:
Max. - 75°F (24°C)
Min. - 69°F (21°C)

TABLE M5-11(b) - DYNAMIC TEST RESULTS (PERIODIC), ORLANDO AUGUST TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}* HFM @ Indoor Surf.	q'_{hfm}* HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
1	27.6	29.1		24.0	23.3	10.43				6.04
2	26.8	28.3		24.0	23.3	9.32				5.17
3	26.9	28.1		23.9	23.2	8.98				5.04
4	25.5	27.2		23.9	23.3	7.96				3.91
5	25.2	26.7		23.8	23.2	7.67				3.45
6	24.1	25.8		23.8	23.2	6.79				2.45
7	25.0	26.0		23.7	23.2	6.99				2.72
8	25.9	26.3		23.7	23.2	6.21				3.11
9	28.2	27.5		23.6	23.2	6.94				4.57
10	28.5	27.9		23.6	23.2	5.39				5.17
11	30.2	29.0		23.6	23.2	5.97				6.44
12	31.2	29.8		23.7	23.2	5.92				7.30
13	34.3	31.8		23.7	23.2	6.31				9.70
14	36.0	33.2		23.7	23.3	6.74				11.31
15	39.3	35.6		23.8	23.3	7.33				14.05
16	40.6	37.0		23.9	23.3	8.01				15.67
17	41.9	38.6		24.0	23.3	8.83				17.55
18	38.2	37.2		24.1	23.3	9.80				15.74
19	35.2	35.7		24.2	23.3	10.53				13.79
20	32.6	33.8		24.2	23.3	11.26				11.45
21	31.3	32.7		24.2	23.3	11.74				10.18
22	29.6	31.3		24.2	23.3	11.64				8.51
23	29.2	30.7		24.2	23.3	11.69				7.84
24	27.7	29.5		24.1	23.3	10.63				6.44
Mean	30.9	30.8		23.9	23.3	8.46				8.23

*Internal thermocouples and heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

TABLE M5-12 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), THERMAL LAG

Test Cycle	Thermal Lag, hrs											Calc. Time Constant, hrs
	Measured								Calculated			
	Calibrated Hot Box					Heat Flow Meter**			Response Factor***			
	t_o vs t_1		q_{ss} vs q_w		Avg.	q_{ss} vs q_{hfm}		Avg.	q_{ss} vs q_{rf}		Avg.	
	@ Max.	@ Min.	@ Max.	@ Min.		@ Max.	@ Min.		@ Max.	@ Min.		
NBS	4.5	2.5	3	2	3							1.5
Orlando January	3	4	3.5	4	3.5							1.5
Orlando Jan. Mod.	4	4.5	4	4.5	4.5							1.5
Orlando April	6	6.5	*	*	6.5							1.5
Orlando August	4	4	4	4	4							1.5

*Not available. See note beneath Table M5-10(a).
**Heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

TABLE M5-13 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), REDUCTION IN AMPLITUDE

Test Cycle	Measured, %						Calculated, %		
	Calibrated Hot Box			Heat Flow Meter**			Response Factor***		
	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.
NBS	55	47	51						
Orlando January	63	55	59						
Orlando Jan. Mod.	56	43	49.5						
Orlando April	*	*	*						
Orlando August	65	47	56						

*Not available. See note beneath Table M5-10(a).
**Heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

TABLE M5-14 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), ENERGY REQUIREMENTS

Test Cycle	Total Energy, Btu/ft^2 (W·hr/m^2)				Total Energy Comparisons, %			Net Energy, Btu/ft^2 (W·hr/m^2)				Net Energy Comparisons, %		
	Measured		Calculated					Measured		Calculated				
	q_w^T	q_{hfm}^T **	q_{rf}^T ***	q_{ss}^T	$\frac{q_w^T}{q_{ss}^T}$	$\frac{q_{hfm}^T}{q_{ss}^T}$	$\frac{q_{rf}^T}{q_{ss}^T}$	q_w^N	q_{hfm}^N **	q_{rf}^N ***	q_{ss}^N	$\frac{q_w^N}{q_{ss}^N}$	$\frac{q_{hfm}^N}{q_{ss}^N}$	$\frac{q_{rf}^N}{q_{ss}^N}$
NBS	33.2 (104.9)			64.9 (204.7)	51			5.2 (16.4)			11.6 (36.7)	45		
Orlando January	23.8 (75.2)			45.9 (144.7)	52			-22.0 (-69.4)			-28.9 (-91.1)	76		
Orlando Jan. Mod.	15.0 (47.5)			32.5 (102.5)	46			-5.2 (-16.6)			-9.3 (-29.2)	57		
Orlando April	*			36.1 (113.8)	*			*			7.9 (24.8)	*		
Orlando August	64.4 (203.1)			62.6 (197.6)	103			64.4 (203.1)			62.6 (197.6)	103		

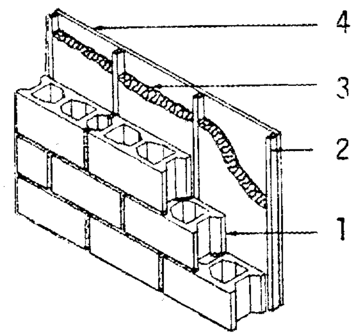
*Not available. See note beneath Table M5-10(a).
**Heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

WALL M6: 8-IN. (203-MM) LIGHTWEIGHT CONCRETE BLOCK WITH INSULATION ON INSIDE SURFACE

DESCRIPTION: Lightweight 8-in. (203-mm) hollow core concrete block wall with fiberglass batt insulation between furring strips and gypsum wallboard on interior surface.

REFERENCE: Fiorato, A. E. and Bravinsky, E., "Heat Transfer Characteristics of Walls Under Arizona Temperature Conditions," Construction Technology Laboratories, Portland Cement Association, Skokie, 1981, 61 pages.

COMPOSITION:



1. 8x8x16-in. (203x203x406-mm) Lightweight Hollow Core Concrete Block - 2 cores per block
2. 1-1/2-in.x1-3/4-in. (38x44-mm) Furring Strips at 16-in. (406-mm) center-to-center
3. 1-3/4-in. (44-mm) R-8 Fiberglass Insulation
4. 1/2-in. (13-mm) Gypsum Wallboard

TABLE M6-1 - PHYSICAL PROPERTIES OF WALL AT TIME OF TEST

Property	Measured Value
Unit weight, psf (kg/m^2)	42.1 (205)
Average Thickness, in. (mm)	9.9 (251)
Area, ft^2 (m^2)	73.67 (6.84)
Moisture Content,* % by ovendry weight	1.0

*Measured on masonry, including mortar joints, after test.

TABLE M6-2(a) - MATERIAL PROPERTIES, LIGHTWEIGHT CONCRETE BLOCK

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Standard Dimensions, in. (mm)	--	--	--	7-5/8x7-5/8x15-5/8 (194x194x397)
Measured Dimensions, in. (mm)	ASTM C140	--	--	7.56x7.56x15.56 (192x192x395)
Percent Solid Volume	--	--	--	53
Ovendry Unit Weight, pcf (kg/m^3)	--	--	--	111 (1778)
Moisture Content, % ovendry weight	ASTM C140	--	--	1.0
Absorption, % ovendry weight	ASTM C140	--	--	9.2

TABLE M6-2(b) - MATERIAL PROPERTIES, MORTAR*

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Average Mortar Bed Joint Spacing, in. (mm)	--	--	--	0.39 (10)
Compressive Strength,** psi (MPa)	--	moist	--	2560 (17.7)

*One part Type S masonry cement to three parts masonry sand by volume.
**Measured on 2-in. (51-mm) cubes moist cured for 28 days.

TABLE M6-2(c) - MATERIAL PROPERTIES, R-8 FIBERGLASS BATT INSULATION

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Nominal Thickness, in. (mm)	--	--	--	2.5 (64)
Thickness, as received, in. (mm)	ASTM C167	--	--	2.42 (61)
Installed Thickness, in. (mm)	--	--	--	1.75 (44)
Density, as received, pcf (kg/m^3)	ASTM C167	--	--	0.75 (12)

TABLE M6-3 - DESIGN HEAT TRANSMISSION COEFFICIENTS

Component	R, Thermal Resistance	
	Between Furring $hr \cdot ft^2 \cdot °F/Btu$ ($m^2 \cdot K/W$)	At Furring $hr \cdot ft^2 \cdot °F/Btu$ ($m^2 \cdot K/W$)
1. Outside Air Film	0.17 (0.03)	0.17 (0.03)
2. 8x8x16-in. (203x203x406-mm) Hollow Core Block	2.18* (0.38)	2.18 (0.38)
3. 1-3/4x1-1/2-in. (44x38-mm) Furring Strips	-	2.19* (0.39)
4. 1-3/4-in. (44-mm) Fiberglass Insulation	6.00* (1.06)	-
5. 1/2-in. (13-mm) Gypsum Wallboard	0.45* (0.08)	0.45 (0.08)
6. Inside Air Film	0.68 (0.12)	0.68 (0.12)
Total R	9.48 (1.67)	5.67 (1.00)
Total U	0.11 (0.60)	0.18 (1.00)

*Source: ASHRAE Handbook of Fundamentals, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., New York, 1977, Chapter 22.

Adjust for Furring (11.7%):

$$U = 0.883\ (0.105) + 0.117\ (0.176)$$

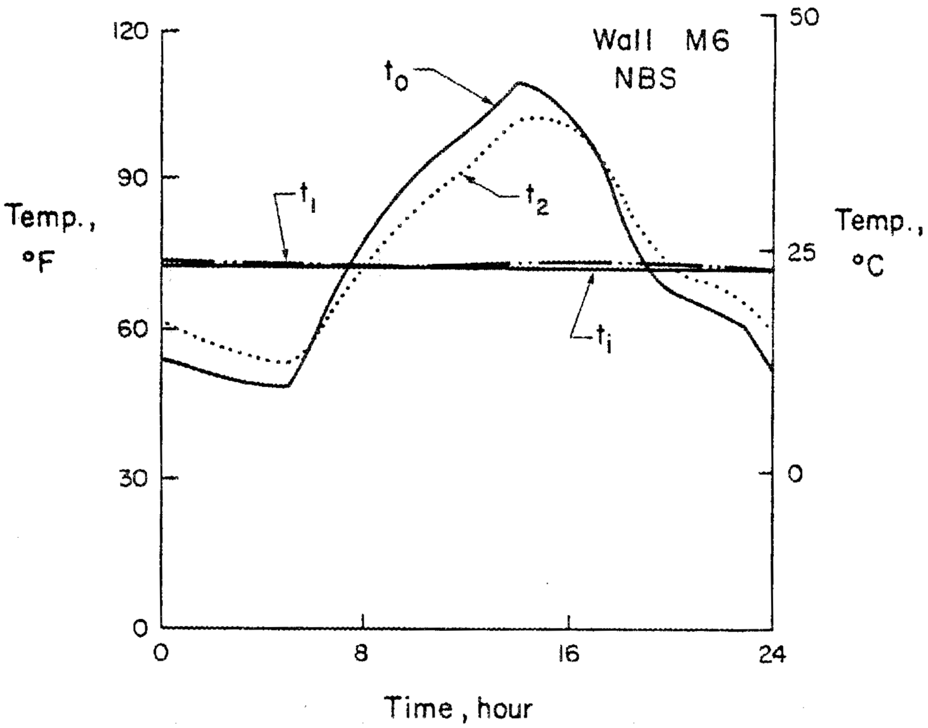
$$= 0.11\ Btu/hr \cdot ft^2 \cdot °F\ (0.64\ W/m^2 \cdot K)$$

$$R = 1/U = 8.83\ hr \cdot ft^2 \cdot °F/Btu\ (1.56\ K \cdot m^2/W)$$

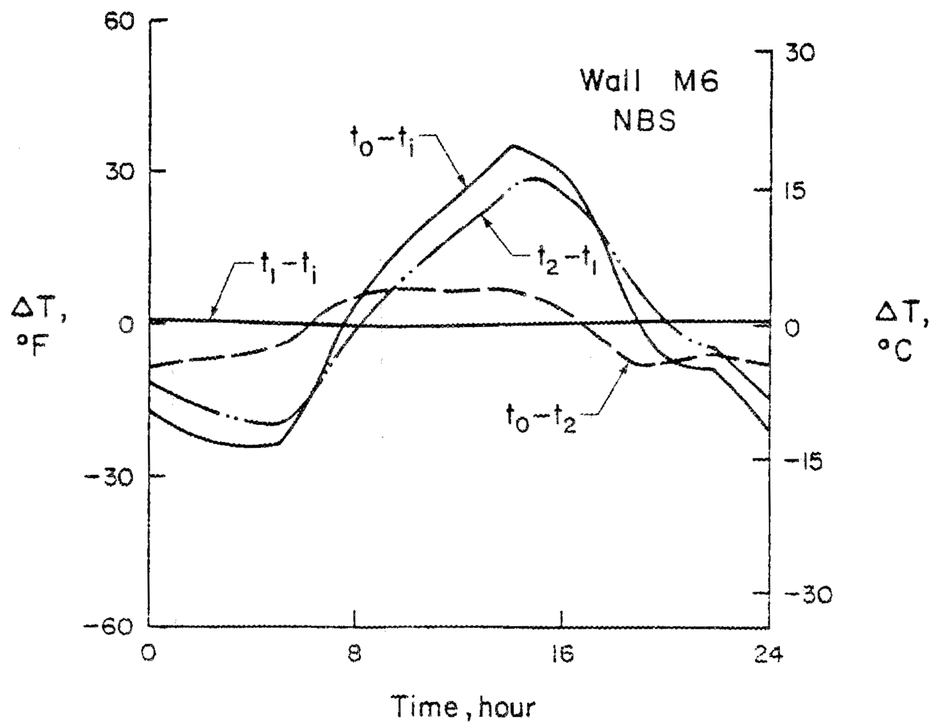
TABLE M6-4 - STEADY-STATE TEST RESULTS

Nominal Test Condition	q Heat Flux, Btu/hr·ft² (W/m²)	R_T, hr·ft²·°F/Btu (m²·K/W)	U, Btu/hr·ft²·°F (W/m²·K)	Measured Temperatures, °F (°C)					Relative Humidity		Laboratory Air Temperature	
				t_o Outdoor Air	t_2 Outdoor Surface	t_3* Internal	t_1 Indoor Surface	t_i Indoor Air	Indoor Chamber, %	Outdoor Chamber, %	Max. °F (°C)	Min. °F (°C)
t_m = 102°F (39°C)	7.91 (24.9)	7.40 (1.30)	0.14 (0.77)	130 (54)	128 (53)	-	76 (24)	74 (23)	37	44	74 (23)	73 (23)
t_m = 38°F (3°C)	-7.82 (-24.7)	9.03 (1.59)	0.11 (0.63)	3 (-16)	7 (-14)	-	71 (21)	73 (23)	27	24	74 (23)	73 (23)
Design Values	-	8.83 (1.56)	0.11 (0.64)	-	-	-	-	-	-	-	-	-

*Internal thermocouples were not used for this wall assembly.

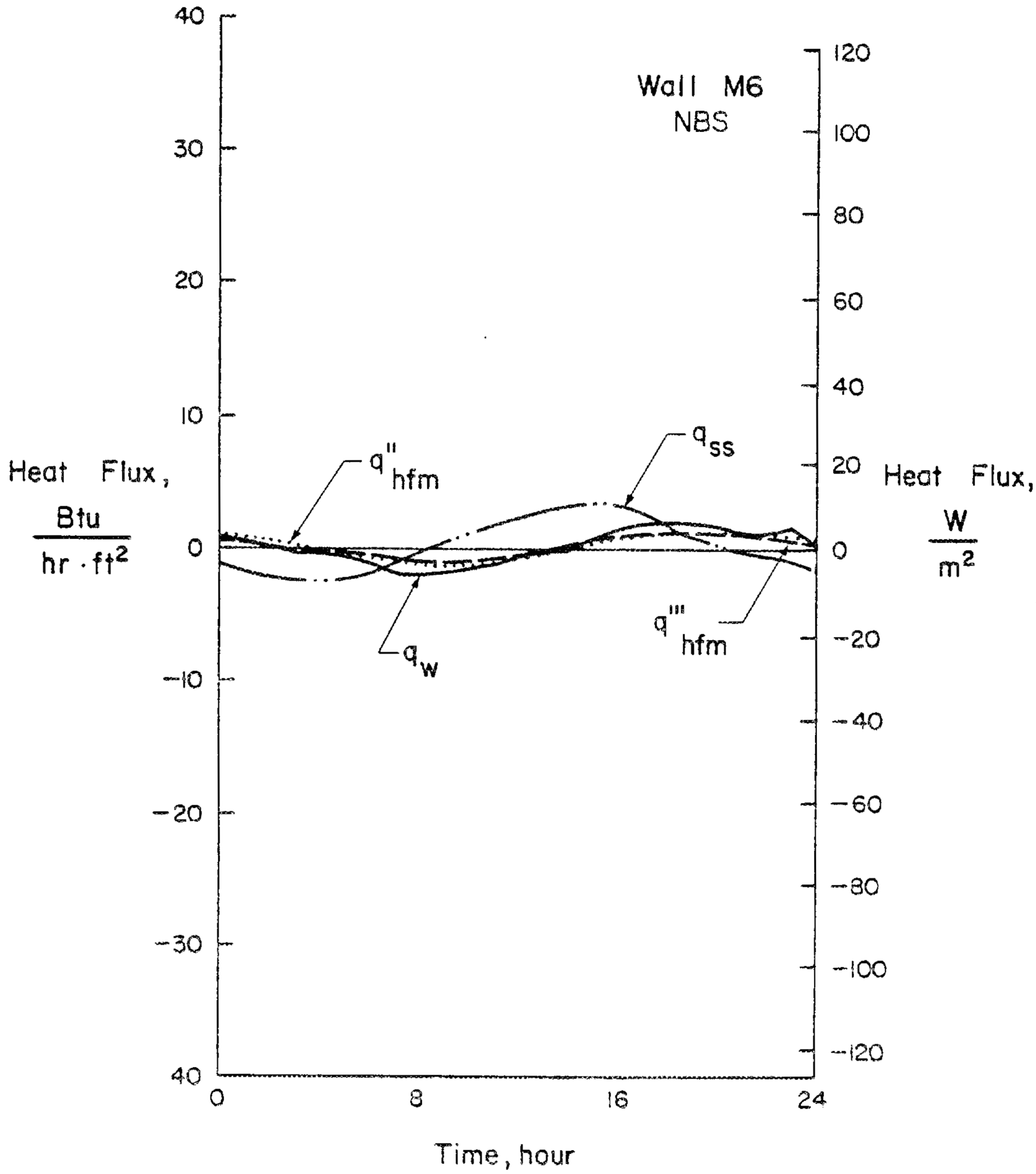


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M6-2 Wall M6 Dynamic Test Results for NBS Test Cycle



(c) Heat Flux

Fig. M6-2 Wall M6 Dynamic Test Results for NBS Test Cycle

TABLE M6-7(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	52.3	59.0		73.6	73.3	0.69	0.85	0.44		-1.98
2	50.3	56.9		73.5	73.3	0.32	0.51	0.18		-2.24
3	49.1	55.2		73.3	73.3	-0.24	0.15	-0.09		-2.44
4	48.6	54.1		73.2	73.3	-0.37	-0.18	-0.33		-2.56
5	48.9	53.6		73.1	73.2	-0.88	-0.51	-0.55		-2.62
6	56.6	57.3		73.0	73.2	-1.67	-0.83	-0.74		-2.12
7	69.0	65.4		73.0	73.3	-2.26	-1.10	-0.89		-1.04
8	77.3	72.2		73.0	73.2	-2.26	-1.26	-0.96		-0.11
9	84.4	78.3		72.9	73.3	-2.41	-1.29	-0.89		0.76
10	91.1	84.1		73.0	73.2	-1.68	-1.21	-0.74		1.57
11	95.7	88.9		73.2	73.2	-1.73	-1.01	-0.51		2.24
12	98.5	92.1		73.2	73.3	-0.80	-0.71	-0.22		2.71
13	104.3	96.8		73.4	73.3	-0.58	-0.38	0.08		3.39
14	109.4	101.8		73.6	73.3	-0.13	0.01	0.39		4.12
15	107.7	102.5		73.8	73.3	0.43	0.46	0.74		4.20
16	103.8	100.7		73.9	73.4	1.77	0.91	1.08		3.91
17	97.1	96.9		74.0	73.3	2.10	1.33	1.37		3.32
18	85.8	89.7		74.1	73.3	2.39	1.68	1.55		2.23
19	74.3	81.3		74.1	73.3	2.30	1.90	1.64		1.02
20	67.9	75.0		74.1	73.3	2.17	1.95	1.57		0.13
21	65.0	71.4		74.0	73.4	1.87	1.87	1.41		-0.36
22	64.7	69.9		73.9	73.3	1.53	1.72	1.22		-0.55
23	60.2	66.6		73.8	73.3	1.86	1.45	0.95		-0.99
24	53.9	61.2		73.7	73.2	0.98	1.16	0.71		-1.70
Mean	75.7	76.3		73.5	73.3	0.14	0.31	0.31		0.45

*Internal thermocouples were not used on wall assembly.
**Response factor analysis was not performed for this wall assembly.

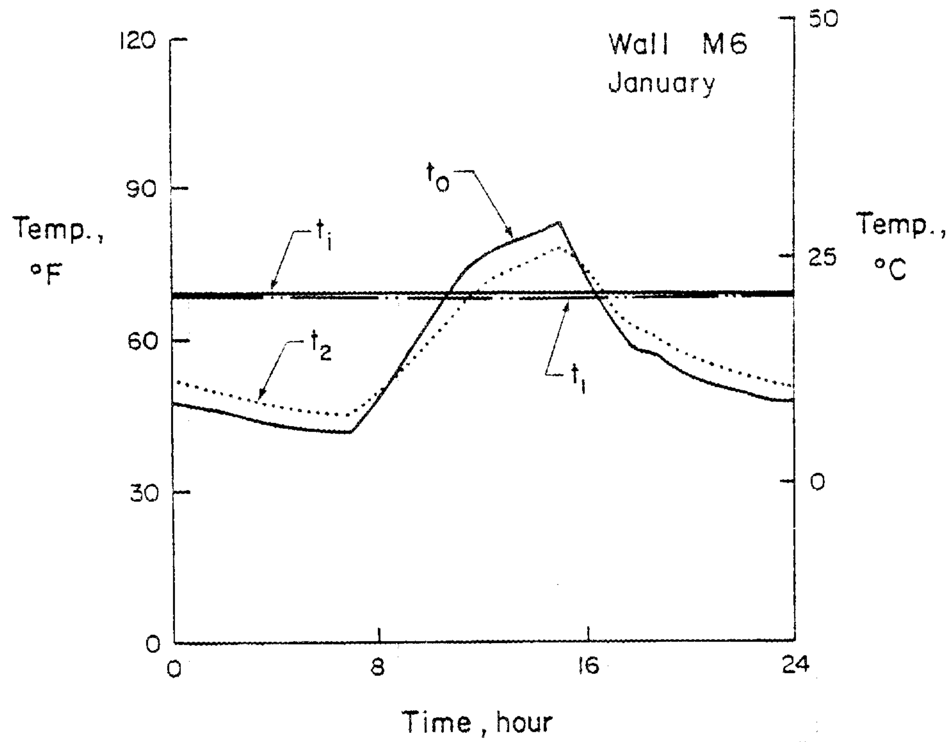
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 36%
Outdoor Chamber - 35%

Laboratory Air Temperature:
Max. - 74°F (23°C)
Min. - 69°F (21°C)

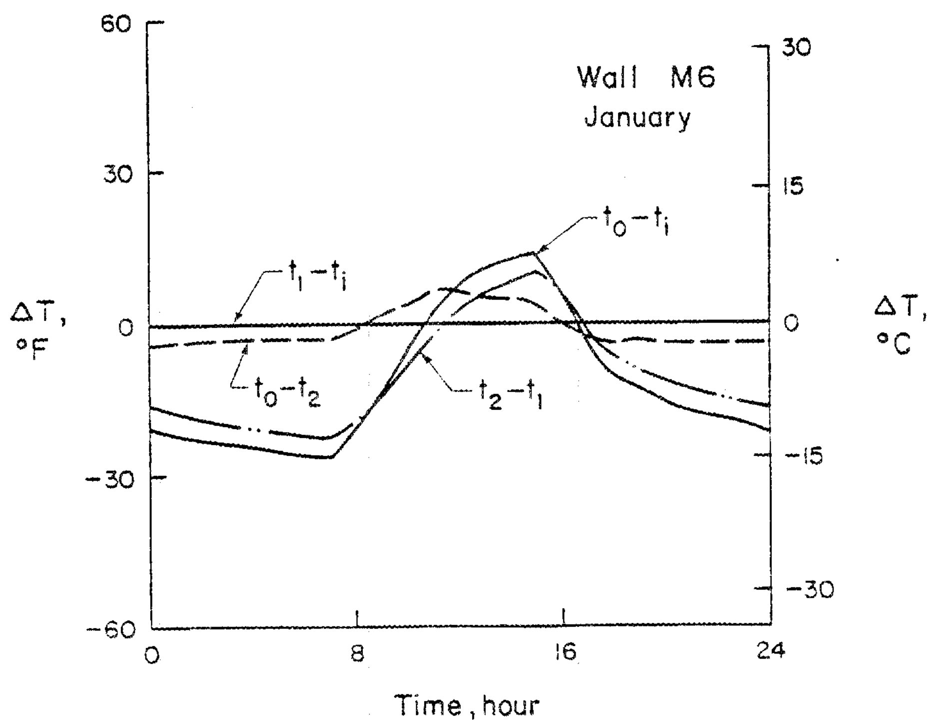
TABLE M6-7(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	11.3	15.0		23.1	22.9	2.17	2.67	1.38		-6.24
2	10.2	13.8		23.1	22.9	1.00	1.60	0.57		-7.07
3	9.5	12.9		22.9	22.9	-0.75	0.47	-0.27		-7.68
4	9.2	12.3		22.9	22.9	-1.16	-0.58	-1.03		-8.09
5	9.4	12.0		22.8	22.9	-2.78	-1.61	-1.73		-8.25
6	13.7	14.1		22.8	22.9	-5.25	-2.61	-2.34		-6.68
7	20.6	18.6		22.8	22.9	-7.14	-3.46	-2.82		-3.28
8	25.2	22.3		22.8	22.9	-7.14	-3.97	-3.03		-0.35
9	29.1	25.7		22.7	22.9	-7.59	-4.08	-2.82		2.39
10	32.8	28.9		22.8	22.9	-5.31	-3.81	-2.35		4.96
11	35.4	31.6		22.9	22.9	-5.44	-3.20	-1.61		7.07
12	36.9	33.4		22.9	22.9	-2.53	-2.23	-0.69		8.56
13	40.2	36.0		23.0	22.9	-1.82	-1.19	0.24		10.68
14	43.0	38.8		23.1	22.9	-0.41	0.04	1.24		12.99
15	42.1	39.2		23.2	22.9	1.36	1.44	2.34		13.24
16	39.9	38.2		23.3	23.0	5.58	2.88	3.40		12.33
17	36.2	36.1		23.3	22.9	6.63	4.20	4.31		10.47
18	29.9	32.1		23.4	22.9	7.52	5.29	4.89		7.05
19	23.5	27.4		23.4	22.9	7.25	5.98	5.18		3.20
20	19.9	23.9		23.4	22.9	6.84	6.16	4.96		0.40
21	18.3	21.9		23.3	23.0	5.89	5.90	4.44		-1.14
22	18.2	21.1		23.1	22.9	4.84	5.44	3.85		-1.74
23	15.7	19.2		23.0	22.9	5.86	4.56	3.00		-3.12
24	12.2	16.2		23.2	22.9	3.08	3.66	2.25		-5.37
Mean	24.3	24.6		23.1	22.9	0.44	0.98	0.97		1.43

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

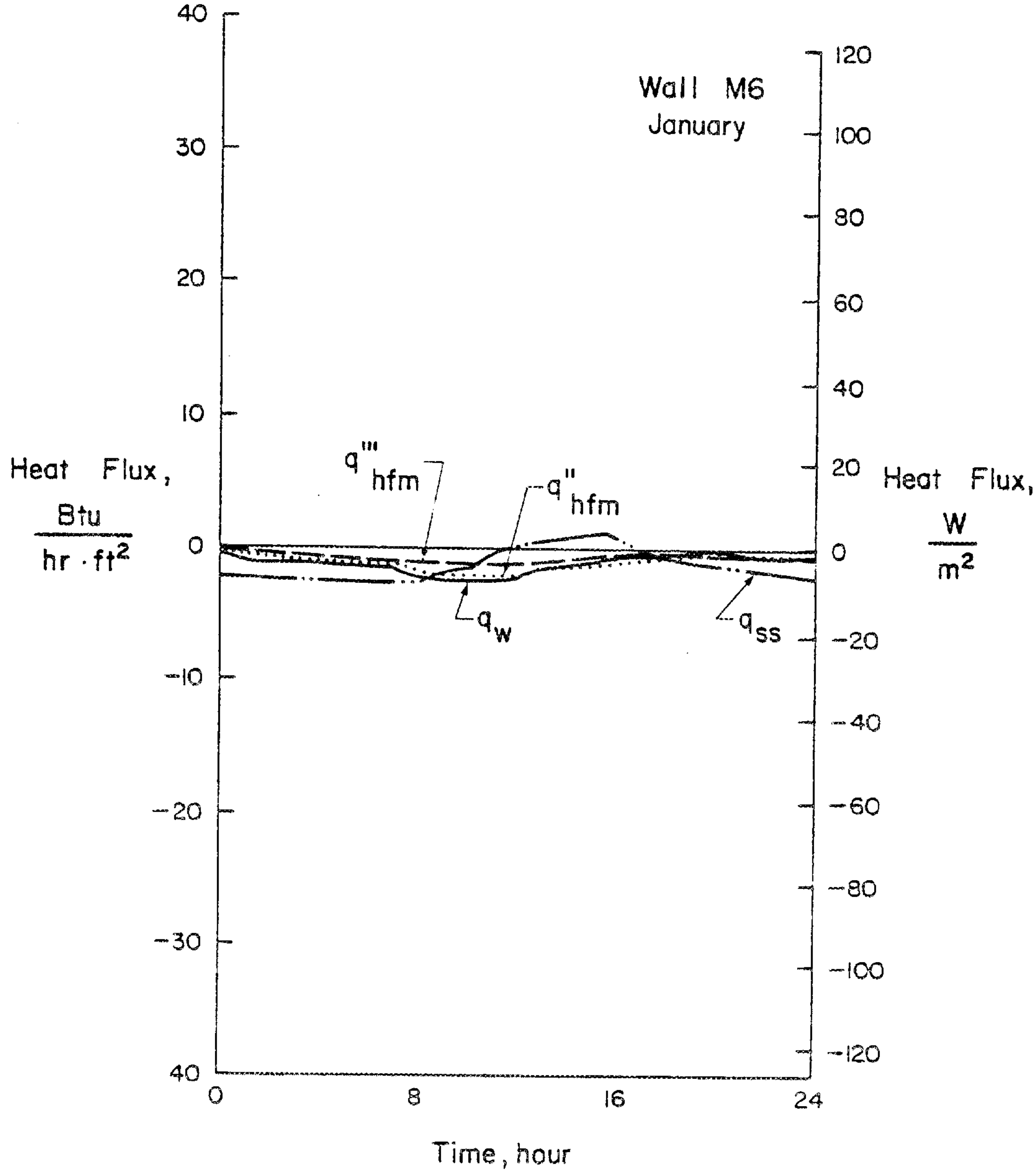


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M6-3 Wall M6 Dynamic Test Results for Phoenix January Test Cycle



(c) Heat Flux

Fig. M6-3 Wall M6 Dynamic Test Results for Phoenix January Test Cycle

TABLE M6-8(a) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX JANUARY TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft²			Calculated Heat Flux, Btu/hr·ft²	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	46.3	50.4		68.3	68.6	-1.09	-0.99	-0.74		-2.37
2	45.1	49.2		68.2	68.6	-1.41	-1.16	-0.86		-2.51
3	44.3	48.2		68.1	68.6	-1.13	-1.34	-1.00		-2.62
4	43.4	47.3		68.1	68.6	-1.59	-1.48	-1.09		-2.73
5	43.0	46.6		68.0	68.6	-1.82	-1.66	-1.21		-2.81
6	42.1	45.8		68.0	68.6	-1.91	-1.80	-1.31		-2.91
7	42.1	45.4		67.9	68.6	-1.96	-1.95	-1.41		-2.94
8	48.1	48.5		67.9	68.5	-2.51	-2.07	-1.48		-2.55
9	56.4	54.1		67.9	68.5	-2.43	-2.20	-1.56		-1.83
10	63.9	59.8		67.9	68.5	-2.53	-2.28	-1.56		-1.09
11	71.2	65.8		68.0	68.5	-2.59	-2.25	-1.50		-0.30
12	76.2	70.6		68.0	68.5	-2.46	-2.15	-1.39		0.36
13	79.3	74.0		68.2	68.6	-1.78	-1.97	-1.15		0.80
14	81.7	76.7		68.3	68.6	-1.70	-1.69	-0.90		1.16
15	83.1	78.8		68.4	68.6	-1.24	-1.38	-0.63		1.45
16	74.9	75.1		68.6	68.6	-0.42	-1.04	-0.37		0.90
17	64.9	67.4		68.6	68.6	-0.14	-0.72	-0.16		-0.16
18	58.2	62.7		68.7	68.7	-0.09	-0.49	-0.05		-0.81
19	56.7	60.5		68.7	68.7	-0.08	-0.37	-0.05		-1.10
20	53.0	57.6		68.7	68.7	0.21	-0.36	-0.12		-1.49
21	50.7	55.3		68.7	68.7	-0.15	-0.40	-0.21		-1.79
22	50.0	54.2		68.6	68.7	-0.53	-0.52	-0.34		-1.92
23	48.8	53.0		68.5	68.6	-0.44	-0.68	-0.49		-2.06
24	47.5	51.7		68.4	68.7	-0.52	-0.85	-0.82		-2.21
Mean	57.1	58.3		68.3	68.6	-1.26	-1.33	-0.84		-1.31

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

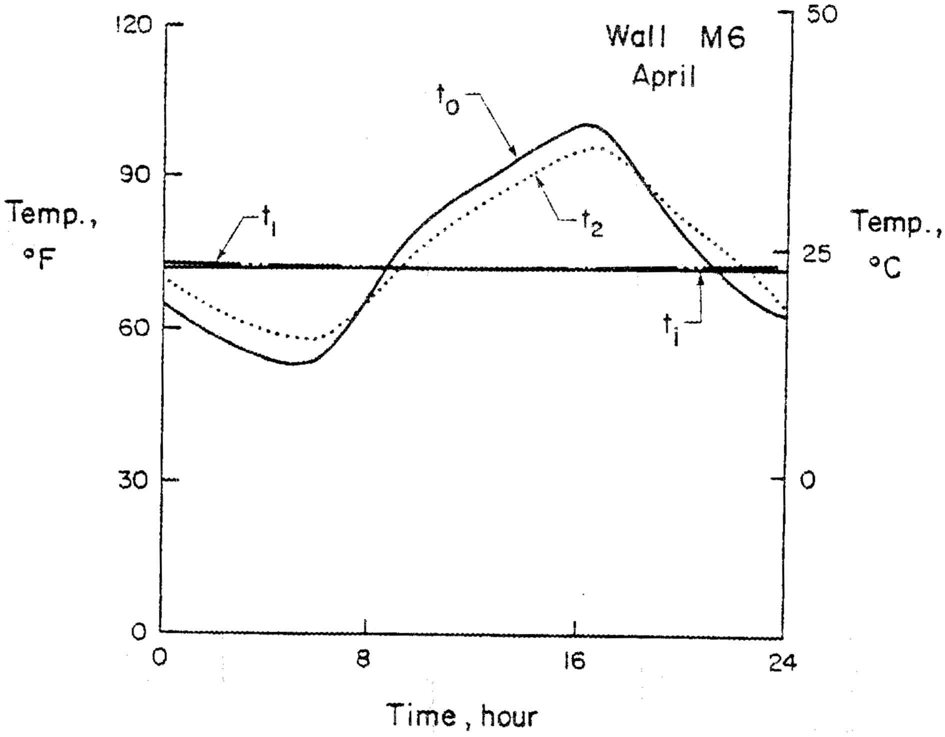
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 34%
Outdoor Chamber - 33%

Laboratory Air Temperature:
Max. - 75°F (24°C)
Min. - 72°F (22°C)

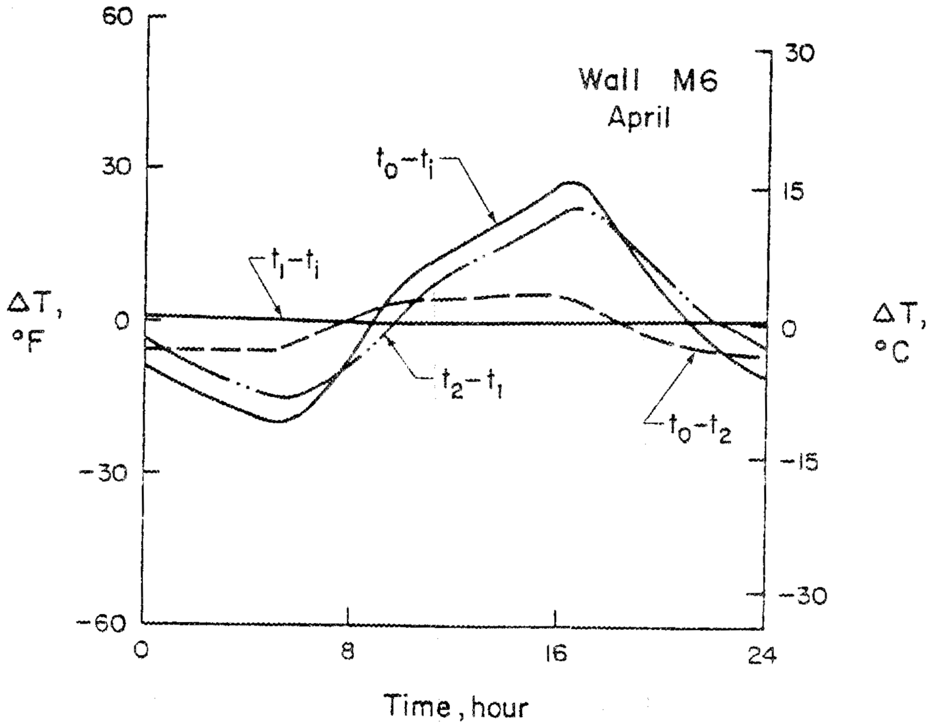
TABLE M6-8(b) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX JANUARY TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	7.9	10.2		20.2	20.3	-3.44	-3.11	-2.32		-7.46
2	7.3	9.5		20.1	20.3	-4.46	-3.65	-2.72		-7.90
3	6.8	9.0		20.1	20.3	-3.57	-4.23	-3.14		-8.26
4	6.3	8.5		20.1	20.3	-5.02	-4.67	-3.44		-8.62
5	6.1	8.1		20.0	20.3	-5.75	-5.24	-3.81		-8.85
6	5.6	7.7		20.0	20.3	-6.03	-5.69	-4.13		-9.17
7	5.6	7.4		19.9	20.3	-6.19	-6.16	-4.43		-9.28
8	8.9	9.2		19.9	20.3	-7.93	-6.54	-4.67		-8.05
9	13.6	12.3		19.9	20.3	-7.66	-6.95	-4.82		-5.79
10	17.7	15.4		19.9	20.3	-7.97	-7.14	-4.92		-3.43
11	21.8	18.8		20.0	20.3	-8.16	-7.11	-4.72		-0.94
12	24.6	21.4		20.0	20.3	-7.77	-6.77	-4.28		1.12
13	26.3	23.3		20.1	20.3	-5.62	-6.23	-3.64		2.52
14	27.6	24.8		20.2	20.3	-5.35	-5.33	-2.83		3.67
15	28.4	26.0		20.2	20.3	-3.92	-4.34	-1.98		4.56
16	23.8	23.9		20.3	20.3	-1.32	-3.28	-1.18		2.83
17	18.3	19.7		20.3	20.3	-0.44	-2.27	-0.52		-0.52
18	14.6	17.1		20.4	20.4	-0.30	-1.53	-0.15		-2.56
19	13.7	15.8		20.4	20.4	-0.25	-1.17	-0.16		-3.48
20	11.7	14.2		20.4	20.4	0.66	-1.13	-0.38		-4.69
21	10.4	12.9		20.4	20.4	-0.49	-1.28	-0.66		-5.64
22	10.0	12.3		20.3	20.4	-1.67	-1.65	-1.07		-6.05
23	9.3	11.7		20.3	20.3	-1.38	-2.16	-1.54		-6.48
24	8.6	10.9		20.2	20.4	-1.66	-2.68	-1.97		-6.98
Mean	14.0	14.6		20.2	20.3	-3.99	-4.18	-2.65		-4.14

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

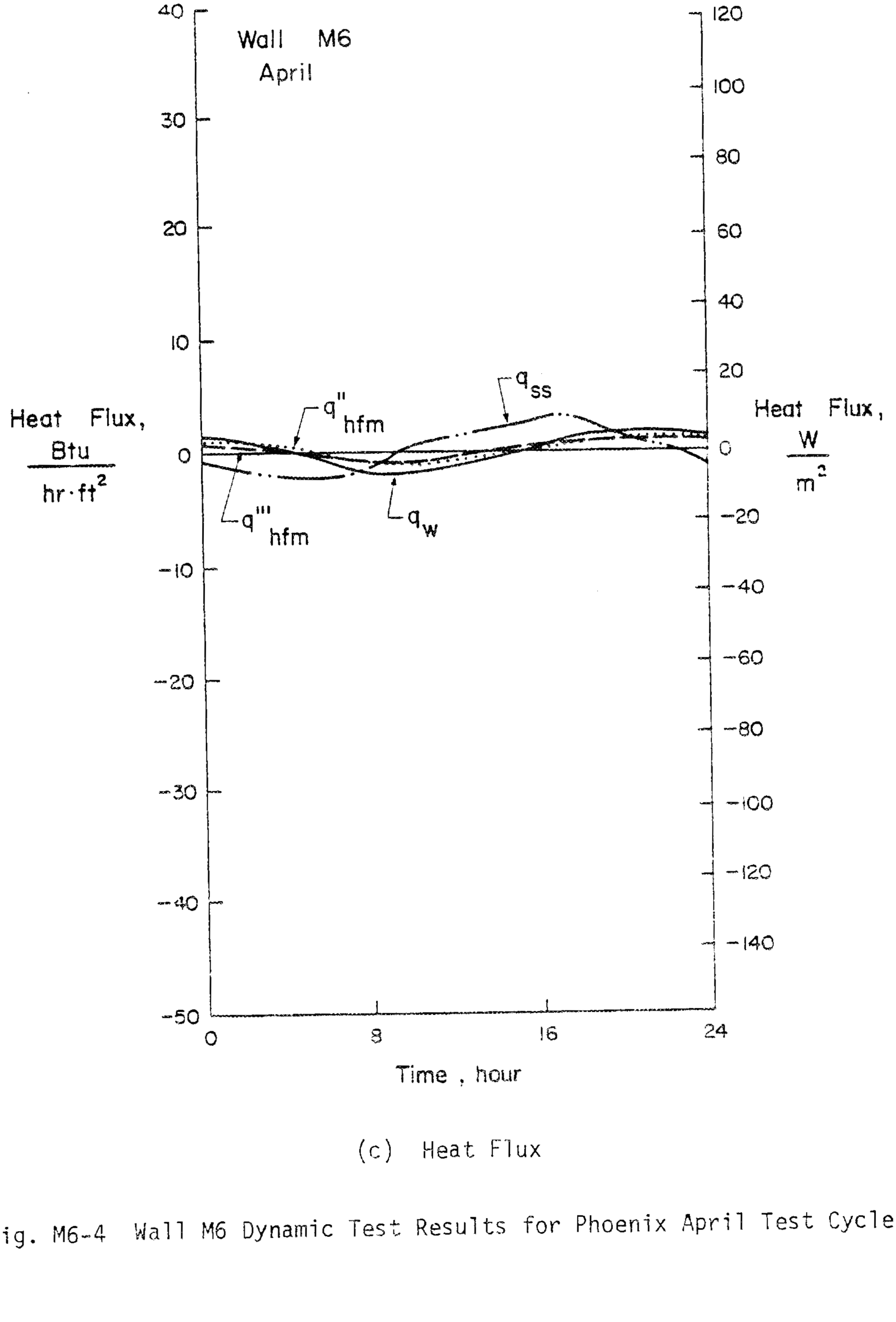


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M6-4 Wall M6 Dynamic Test Results for Phoenix April Test Cycle



(c) Heat Flux

Fig. M6-4 Wall M6 Dynamic Test Results for Phoenix April Test Cycle

TABLE M6-9(a) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX APRIL TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	61.1	66.6		73.6	73.1	1.50	1.18	0.78		-0.96
2	58.6	64.0		73.5	73.2	0.81	0.94	0.59		-1.30
3	56.2	61.7		73.4	73.1	0.58	0.67	0.38		-1.59
4	54.4	59.7		73.3	73.1	0.13	0.40	0.18		-1.85
5	53.0	58.1		73.1	73.0	-0.34	0.13	-0.02		-2.03
6	54.9	58.4		73.1	73.1	-0.75	-0.16	-0.22		-1.99
7	59.4	60.8		73.0	73.0	-1.21	-0.42	-0.41		-1.66
8	67.3	65.6		72.9	73.1	-1.71	-0.65	-0.54		-1.00
9	75.9	72.0		72.8	73.1	-1.48	-0.80	-0.81		-0.11
10	81.5	76.9		72.8	73.0	-1.32	-0.86	-0.80		0.57
11	85.2	80.4		72.8	72.9	-1.47	-0.85	-0.52		1.07
12	88.2	83.7		72.9	73.0	-1.07	-0.72	-0.35		1.53
13	91.4	86.6		73.0	73.0	-0.71	-0.52	-0.16		1.93
14	95.0	89.8		73.2	73.1	-0.50	-0.20	0.01		2.37
15	97.9	92.7		73.3	73.1	0.14	-0.02	0.27		2.79
16	101.3	95.8		73.5	73.1	0.18	0.26	0.51		3.22
17	101.0	97.0		73.6	73.2	0.69	0.56	0.74		3.39
18	95.4	94.3		73.7	73.2	1.34	0.92	0.99		2.97
19	87.5	89.3		73.8	73.2	1.96	1.18	1.16		2.22
20	81.3	84.5		73.8	73.2	1.78	1.42	1.29		1.52
21	75.1	79.8		73.9	73.2	2.07	1.53	1.30		0.83
22	70.1	75.4		73.8	73.2	1.79	1.58	1.26		0.22
23	67.0	72.2		73.8	73.3	1.66	1.49	1.14		-0.22
24	64.2	69.5		73.7	73.3	1.54	1.35	0.98		-0.58
Mean	76.0	76.5		73.3	73.1	0.23	0.35	0.34		0.47

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

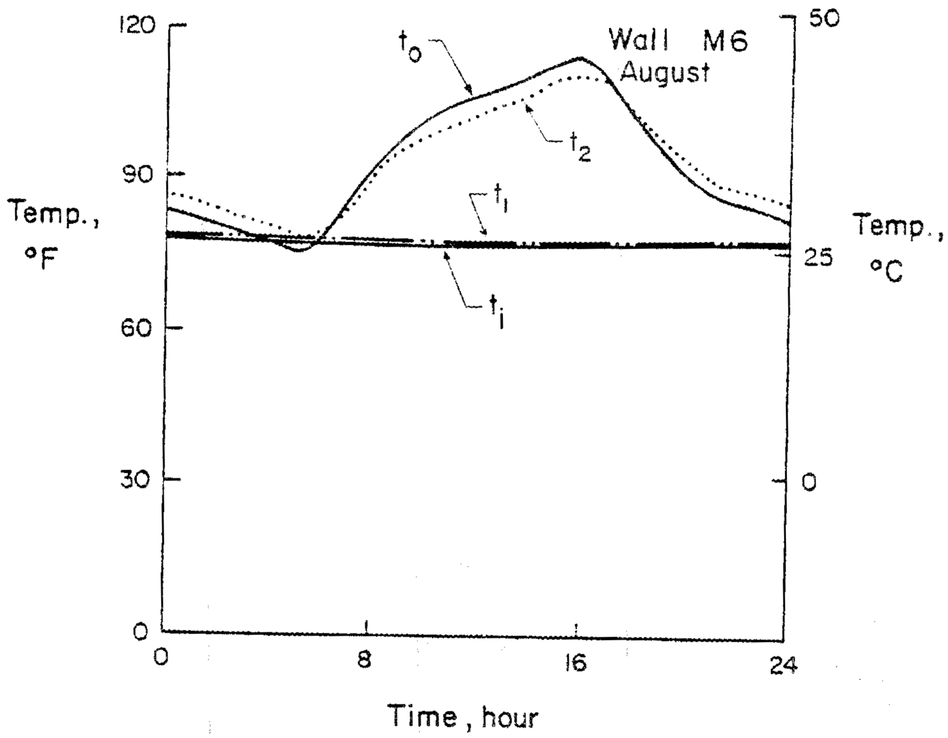
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 34%
Outdoor Chamber - 33%

Laboratory Air Temperature:
Max. - 74°F (23°C)
Min. - 69°F (20°C)

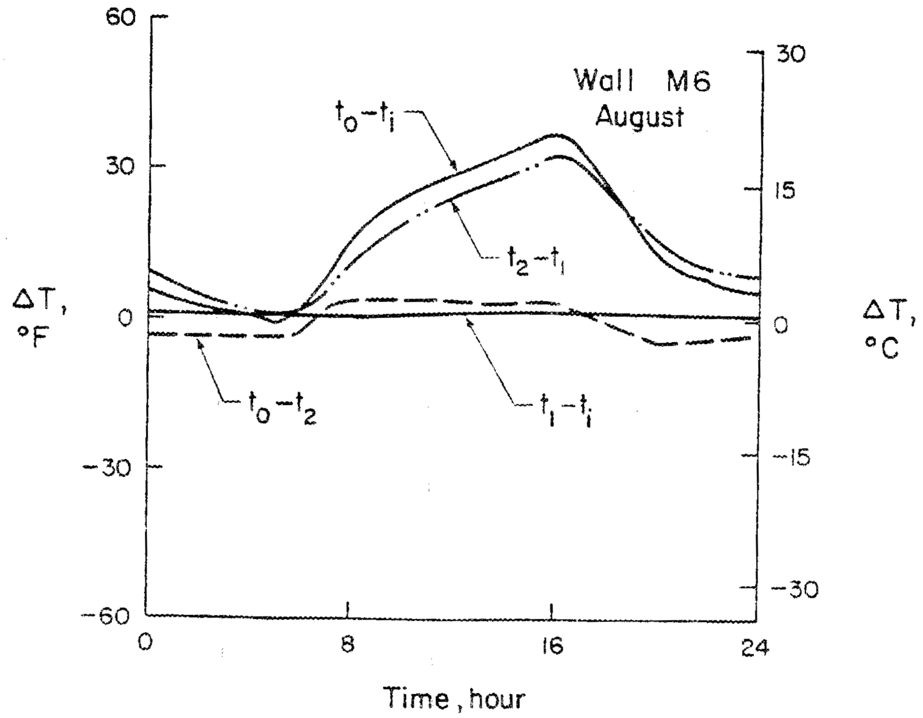
TABLE M6-9(b) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX APRIL TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	16.2	19.2		23.1	22.8	4.74	3.72	2.49		-3.03
2	14.8	17.8		23.1	22.9	2.55	2.96	1.87		-4.10
3	13.4	16.5		23.0	22.8	1.83	2.12	1.19		-5.02
4	12.4	15.4		22.9	22.8	0.40	1.25	0.55		-5.82
5	11.7	14.5		22.8	22.8	-1.07	0.40	-0.06		-6.40
6	12.7	14.7		22.8	22.8	-2.37	-0.49	-0.70		-6.27
7	15.2	16.0		22.8	22.8	-3.81	-1.32	-1.29		-5.23
8	19.6	18.7		22.7	22.8	-5.41	-2.05	-1.72		-3.15
9	24.4	22.2		22.7	22.8	-4.68	-2.52	-1.92		-0.35
10	27.5	24.9		22.7	22.8	-4.15	-2.73	-1.90		1.81
11	29.6	26.9		22.7	22.7	-4.65	-2.68	-1.63		3.37
12	31.2	28.7		22.7	22.8	-3.38	-2.28	-1.11		4.82
13	33.0	30.3		22.8	22.8	-2.24	-1.63	-0.49		6.10
14	35.0	32.1		22.9	22.8	-1.56	-0.63	0.04		7.49
15	36.6	33.7		22.9	22.8	0.44	-0.08	0.86		8.79
16	38.5	35.4		23.0	22.8	0.56	0.81	1.62		10.17
17	38.3	36.1		23.1	22.9	2.18	1.75	2.33		10.69
18	35.2	34.6		23.2	22.9	4.24	2.91	3.13		9.37
19	30.8	31.8		23.2	22.9	6.19	3.72	3.67		6.99
20	27.4	29.2		23.2	22.9	5.60	4.47	4.06		4.79
21	23.9	26.6		23.3	22.9	6.52	4.81	4.11		2.62
22	21.2	24.1		23.2	22.9	5.66	4.93	3.98		0.70
23	19.4	22.3		23.2	22.9	5.25	4.68	3.58		-0.70
24	17.9	20.8		23.1	22.9	4.84	4.25	3.08		-1.83
Mean	24.4	24.7		23.0	22.8	0.74	1.10	1.07		1.49

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

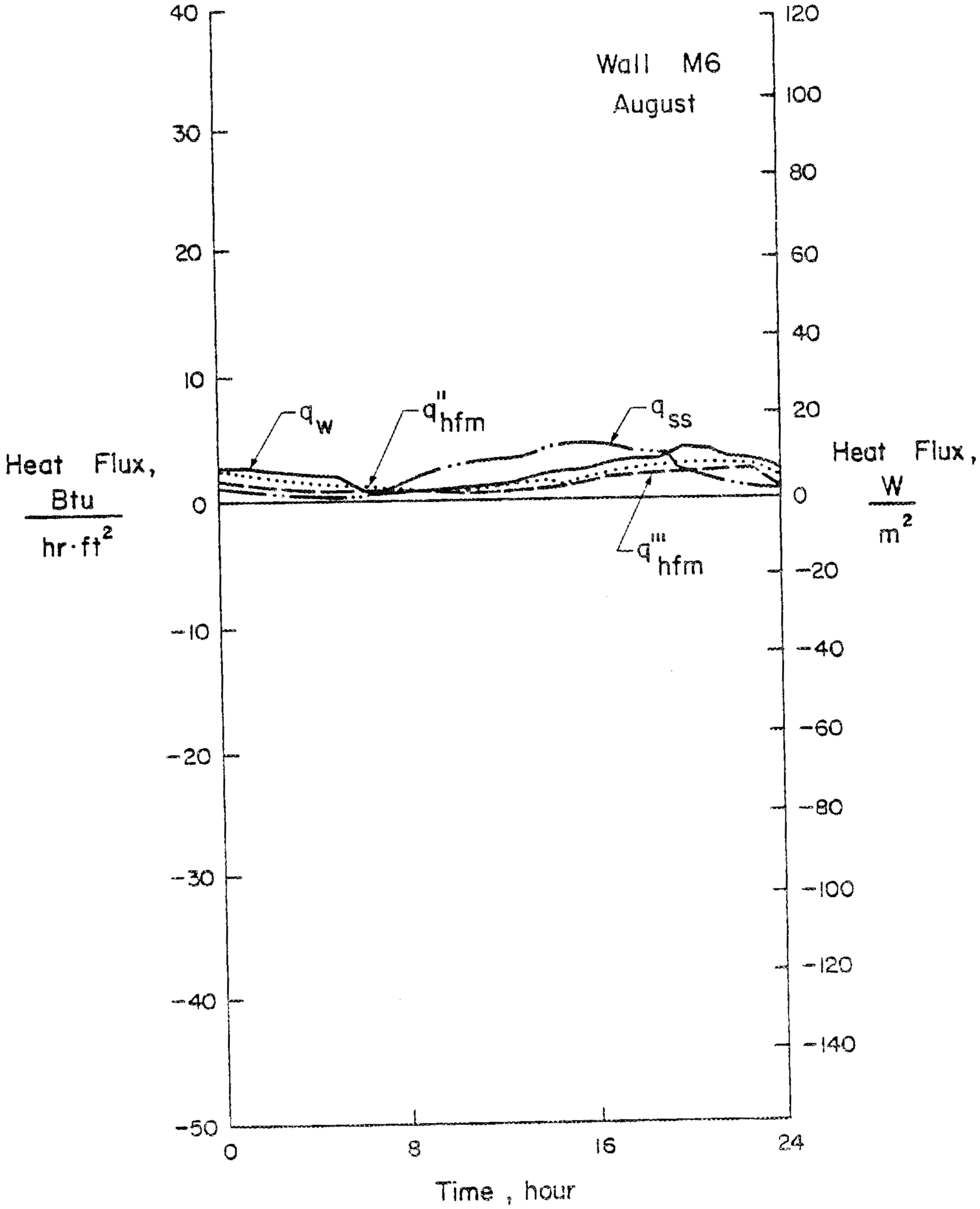


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M6-5 Wall M6 Dynamic Test Results for Phoenix August Test Cycle



(c) Heat Flux

Fig. M6-5 Wall M6 Dynamic Test Results for Phoenix August Test Cycle

TABLE M6-10(a) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX AUGUST TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	82.6	85.6		79.2	78.4	2.98	2.23	1.62		0.92
2	81.0	84.0		79.1	78.3	2.56	2.10	1.53		0.70
3	79.6	82.6		79.0	78.3	2.51	1.87	1.34		0.51
4	78.0	81.1		78.9	78.2	2.19	1.73	1.24		0.31
5	76.6	79.8		78.8	78.2	2.19	1.53	1.09		0.14
6	78.9	80.6		78.8	78.2	1.11	1.35	0.94		0.26
7	85.8	84.8		78.7	78.3	0.80	1.15	0.80		0.87
8	94.2	90.7		78.7	78.2	0.56	1.04	0.75		1.73
9	99.3	95.3		78.6	78.2	0.89	0.95	0.74		2.43
10	102.6	98.6		78.7	78.2	0.73	0.97	0.81		2.92
11	105.3	101.3		78.7	78.1	1.32	1.06	0.96		3.33
12	107.5	103.6		78.9	78.2	1.56	1.20	1.10		3.65
13	109.4	105.7		79.0	78.3	1.60	1.36	1.26		3.96
14	111.5	107.7		79.0	78.3	2.11	1.64	1.47		4.27
15	114.2	110.0		79.2	78.4	2.07	1.82	1.63		4.60
16	115.8	111.9		79.3	78.3	2.47	2.09	1.86		4.89
17	113.1	111.0		79.4	78.3	3.36	2.32	2.04		4.73
18	105.6	106.4		79.5	78.4	3.93	2.60	2.24		4.00
19	98.5	101.1		79.6	78.4	3.88	2.76	2.35		3.17
20	92.0	96.0		79.5	78.4	4.12	2.90	2.38		2.41
21	88.3	92.2		79.4	78.3	4.04	2.92	2.33		1.86
22	86.6	90.2		79.4	78.4	3.71	2.84	2.20		1.56
23	85.5	88.7		79.3	78.3	3.52	2.70	2.03		1.36
24	84.3	87.3		79.2	78.3	3.29	2.54	1.87		1.17
Mean	94.8	94.8		79.1	78.3	2.40	1.90	1.52		2.32

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

Calibrated Hot Box Relative Humidity:
Indoor Chamber - 34%
Outdoor Chamber - 35%

Laboratory Air Temperature:
Max. - 76°F (24°C)
Min. - 73°F (23°C)

TABLE M6-10(b) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX AUGUST TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	28.1	29.8		26.2	25.8	9.39	7.04	5.11		2.90
2	27.2	28.9		26.2	25.7	8.08	6.62	4.82		2.21
3	26.4	28.1		26.1	25.7	7.90	5.90	4.24		1.62
4	25.6	27.3		26.1	25.7	6.89	5.46	3.92		0.99
5	24.8	26.6		26.0	25.7	6.89	4.83	3.43		0.45
6	26.0	27.0		26.0	25.7	3.51	4.26	2.97		0.81
7	29.8	29.9		25.9	25.7	2.52	3.61	2.53		2.75
8	34.6	32.6		25.9	25.7	1.78	3.28	2.36		5.47
9	37.4	35.2		25.9	25.7	2.80	3.01	2.33		7.67
10	39.2	37.0		25.9	25.7	2.32	3.05	2.54		9.19
11	40.7	38.5		25.9	25.6	4.16	3.33	3.02		10.49
12	41.9	39.8		26.1	25.7	4.92	3.78	3.48		11.51
13	43.0	40.9		26.1	25.7	5.05	4.29	3.97		12.49
14	44.2	42.1		26.1	25.7	6.66	5.16	4.65		13.47
15	45.7	43.3		26.2	25.8	6.53	5.72	5.13		14.51
16	46.6	44.4		26.3	25.7	7.80	6.59	5.88		15.41
17	45.1	43.9		26.3	25.7	10.59	7.31	6.43		14.92
18	40.9	41.3		26.4	25.8	12.41	8.19	7.07		12.81
19	36.9	38.4		26.4	25.8	12.24	8.71	7.40		9.99
20	33.3	35.6		26.4	25.8	12.99	8.15	7.49		7.80
21	31.3	33.4		26.3	25.7	12.73	8.21	7.34		5.86
22	30.3	32.3		26.3	25.8	11.70	8.94	6.92		4.93
23	29.7	31.5		26.3	25.7	11.10	8.50	6.41		4.28
24	29.1	30.7		26.2	25.7	10.39	8.01	5.91		3.67
Mean	34.9	34.9		26.2	25.7	7.56	6.00	4.81		7.32

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

TABLE M6-12 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), THERMAL LAG

Test Cycle	Thermal Lag, hrs												Calc. Time Constant, hrs
	Measured												
	Calibrated Hot Box					Heat Flow Meter @ Stud			Heat Flow Meter Between Studs				
	t_o vs t_1		q_{ss} vs q_w		Avg.	q_{ss} vs q''_{hfm}		Avg.	q_{ss} vs q'''_{hfm}		Avg.		
	@ Max.	@ Min.	@ Max.	@ Min.		@ Max.	@ Min.		@ Max.	@ Min.			
NBS	5	5	3	4	4.5	5	4	4.5	4	3	3.5	2.1
Phoenix January	4.5	2	5	4	4	4	3	3.5	3.5	3	3.5	2.1
Phoenix April	5	5	4	3	4.5	5	5	5	4	4.5	4.5	2.1
Phoenix August	3	4	4	3	3.5	4.5	4	4.5	4	4	4	2.1

TABLE M6-13 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), REDUCTION IN AMPLITUDE

Test Cycle	Reduction in Amplitude, %								
	Calibrated Hot Box			Heat Flow Meter @ Stud			Heat Flow Meter Between Studs		
	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.
NBS	40	22	31	56	48	52	65	59	62
Phoenix January	47	18	33	65	42	54	71	56	64
Phoenix April	37	22	30	58	51	55	67	54	61
Phoenix August	22	16	25	60	56	58	67	64	66

TABLE M6-14 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), ENERGY REQUIREMENTS

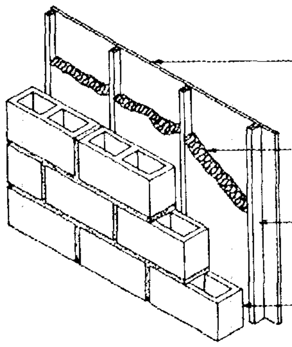
Test Cycle	Total Energy, Btu/ft^2 (W·hr/m^2)				Total Energy Comparisons, %			Net Energy, Btu/ft^2 (W·hr/m^2)				Net Energy Comparisons, %		
	Measured			Calc.	q_w^T / q_{ss}^T	$q_{hfm}^{T''} / q_{ss}^T$	$q_{hfm}^{T'''} / q_{ss}^T$	Measured			Calc.	q_w^N / q_{ss}^N	$q_{hfm}^{N''} / q_{ss}^N$	$q_{hfm}^{N'''} / q_{ss}^N$
	q_w^T	$q_{hfm}^{T''}$	$q_{hfm}^{T'''}$	q_{ss}^T				q_w^N	$q_{hfm}^{N''}$	$q_{hfm}^{N'''}$	q_{ss}^N			
NBS	33.4 (105.4)	24.6 (77.5)	19.2 (60.6)	48.3 (152.4)	69	51	40	3.4 (10.6)	7.7 (24.4)	7.4 (23.4)	10.9 (34.4)	31	71	68
Phoenix January	-30.7 (-97.0)	-31.9 (-100.7)	-20.2 (-63.6)	-41.0 (-129.3)	75	78	49	-30.3 (-95.6)	-31.9 (-100.7)	-20.2 (-63.6)	-31.6 (-99.8)	96	101	64
Phoenix April	26.7 (84.3)	18.8 (59.2)	15.4 (48.6)	37.9 (119.6)	70	49	41	5.6 (17.7)	8.3 (26.2)	7.8 (24.5)	11.3 (35.7)	50	73	69
Phoenix August	57.5 (181.4)	45.6 (143.9)	36.5 (115.1)	55.7 (175.7)	103	82	66	57.5 (181.4)	45.6 (143.9)	36.5 (115.1)	55.7 (175.7)	103	82	66

WALL M7: 6-IN. (152-MM) LIGHTWEIGHT CONCRETE BLOCK WITH INSULATION ON INSIDE SURFACE

DESCRIPTION: Lightweight 6-in. (152-mm) hollow core concrete block wall with fiberglass batt insulation between furring strips and gypsum wallboard on interior surface.

REFERENCE: Fiorato, A. E. and Bravinsky, E., "Heat Transfer Characteristics of Walls Under Arizona Temperature Conditions," Construction Technology Laboratories, Portland Cement Association, Skokie, 1981, 61 pages.

COMPOSITION:



1. 6x8x16-in. (152x203x406-mm) Hollow Core Concrete Block - 2 cores per block
2. 1-1/2-in.x1-3/4-in. (38x44-mm) Furring Strips at 16-in. (406-mm) center-to-center
3. 1-3/4-in. (44-mm) Fiberglass Insulation
4. 1/2-in. (13-mm) Gypsum Wallboard

TABLE M7-1 - PHYSICAL PROPERTIES OF WALL AT TIME OF TEST

Property	Measured Value
Unit weight, psf (kg/m^2)	33.4 (163)
Average Thickness, in. (mm)	7.9 (201)
Area, ft^2 (m^2)	73.83 (6.96)
Moisture Content,* % by ovendry weight	1.9

*Measured on masonry, including mortar joints, after test.

TABLE M7-2(a) - MATERIAL PROPERTIES, LIGHTWEIGHT CONCRETE BLOCK

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Standard Dimensions, in. (mm)	--	--	--	5-5/8x7-5/8x15-5/8 (143x194x397)
Measured Dimensions, in. (mm)	ASTM C140	--	--	5.60x7.56x15.58 (142x192x396)
Percent Solid Volume	--	--	--	58
Ovendry Unit Weight, pcf (kg/m^3)	--	--	--	109 (1746)
Moisture Content, % ovendry weight	ASTM C140	--	--	1.2
Absorption, % ovendry weight	ASTM C140	--	--	10.5

TABLE M7-2(b) - MATERIAL PROPERTIES, MORTAR*

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Average Mortar Bed Joint Spacing, in. (mm)	--	--	--	0.41 (10 mm)
Compressive Strength,** psi (MPa)	--	moist	--	1860 (13)

*One part Type S masonry cement to three parts masonry sand by volume.
**Measured on 2-in. (51-mm) cubes moist cured for 28 days.

TABLE M7-2(c) - MATERIAL PROPERTIES, R-8 FIBERGLASS BATT INSULATION

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Nominal Thickness, in. (mm)	--	--	--	2.5 (64)
Thickness, as received, in. (mm)	ASTM C167	--	--	2.52 (64)
Installed Thickness, in. (mm)	--	--	--	1.75 (44)
Density, as received, pcf (kg/m^3)	ASTM C167	--	--	0.58 (9)

TABLE M7-3 - DESIGN HEAT TRANSMISSION COEFFICIENTS

Component	R, Thermal Resistance	
	Between Furring hr·ft^2·°F/Btu (m^2·K/W)	At Furring hr·ft^2·°F/Btu (m^2·K/W)
1. Outside Air Film	0.17 (0.03)	0.17 (0.03)
2. 6x8x16-in. (152x203x406-mm) Hollow Core Block	1.65* (0.29)	1.65 (0.29)
3. 1-3/4x1-1/2-in. (44x38-mm) Furring Strips	-	2.19* (0.39)
4. 1-3/4-in. (44-mm) Fiberglass Insulation	6.00* (1.06)	-
5. 1/2-in. (13-mm) Gypsum Wallboard	0.45* (0.08)	0.45 (0.08)
6. Inside Air Film	0.68 (0.12)	0.68 (0.12)
Total R	8.95 (1.58)	5.14 (0.91)
Total U	0.11 (0.64)	0.20 (1.11)

Source: <u>ASHRAE Handbook of Fundamentals</u>, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., New York, 1977, Chapter 22.

Adjust for Furring (11.7%):

$$U = 0.883\ (0.112) + 0.117\ (0.195)$$

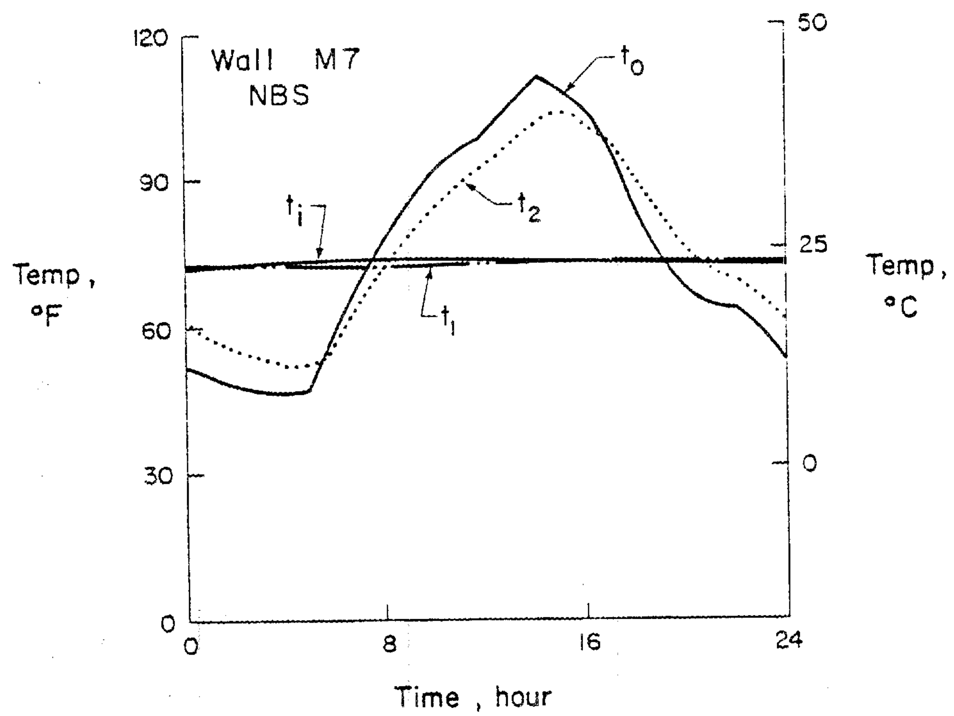
$$= 0.12\ \text{Btu/hr}\cdot\text{ft}^2\cdot{}^\circ\text{F}\ (0.69\ \text{W/m}^2\cdot\text{K})$$

$$R = 1/U = 8.22\ \text{hr}\cdot\text{ft}^2\cdot{}^\circ\text{F/Btu}\ (1.45\ \text{K}\cdot\text{m}^2\text{/W})$$

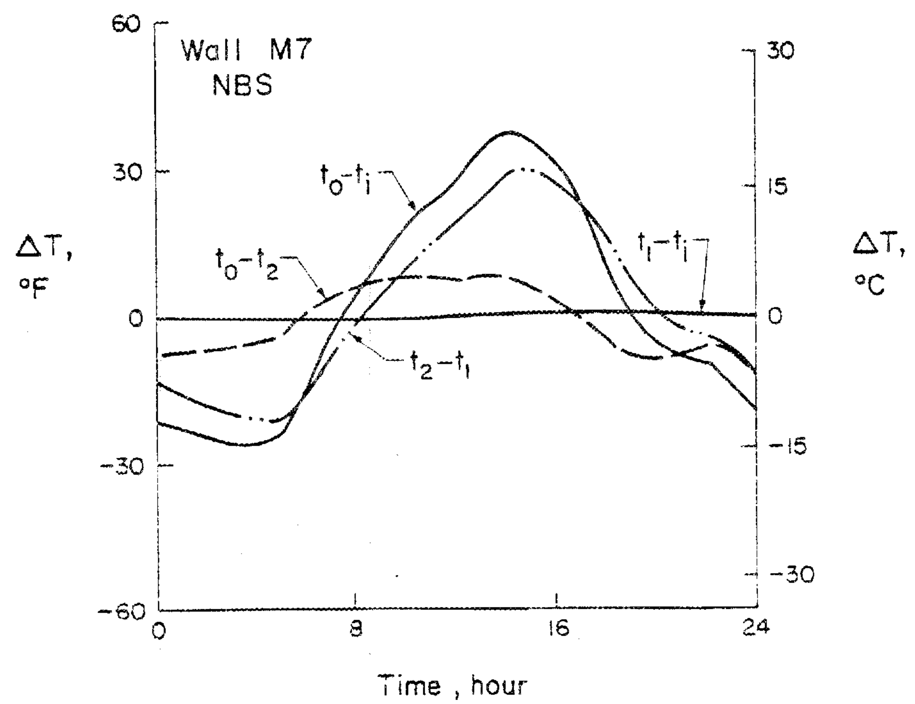
TABLE M7-4 - STEADY-STATE TEST RESULTS

Nominal Test Condition	q Heat Flux, Btu/hr·ft^2 (W/m^2)	R_T, hr·ft^2·°F/Btu (m^2·K/W)	U, Btu/hr·ft^2·°F (W/m^2·K)	Measured Temperatures, °F (°C)					Relative Humidity		Laboratory Air Temperature	
				t_o Outdoor Air	t_2 Outdoor Surface	t_3* Internal	t_1 Indoor Surface	t_i Indoor Air	Indoor Chamber, %	Outdoor Chamber, %	Max. °F (°C)	Min. °F (°C)
t_m = 102°F (39°C)	7.36 (23.2)	7.90 (1.39)	0.13 (0.72)	130 (55)	128 (53)	-	76 (25)	74 (23)	36	34	73 (23)	72 (22)
t_m = 38°F (3°C)	-7.72 (-24.4)	9.08 (1.60)	0.11 (0.63)	3 (-16)	7 (-14)	-	71 (21)	73 (23)	22	20	74 (23)	71 (22)
Design Values	-	8.22 (1.45)	0.12 (0.69)	-	-	-	-	-	-	-	-	-

*Internal thermocouples were not used for this wall assembly.

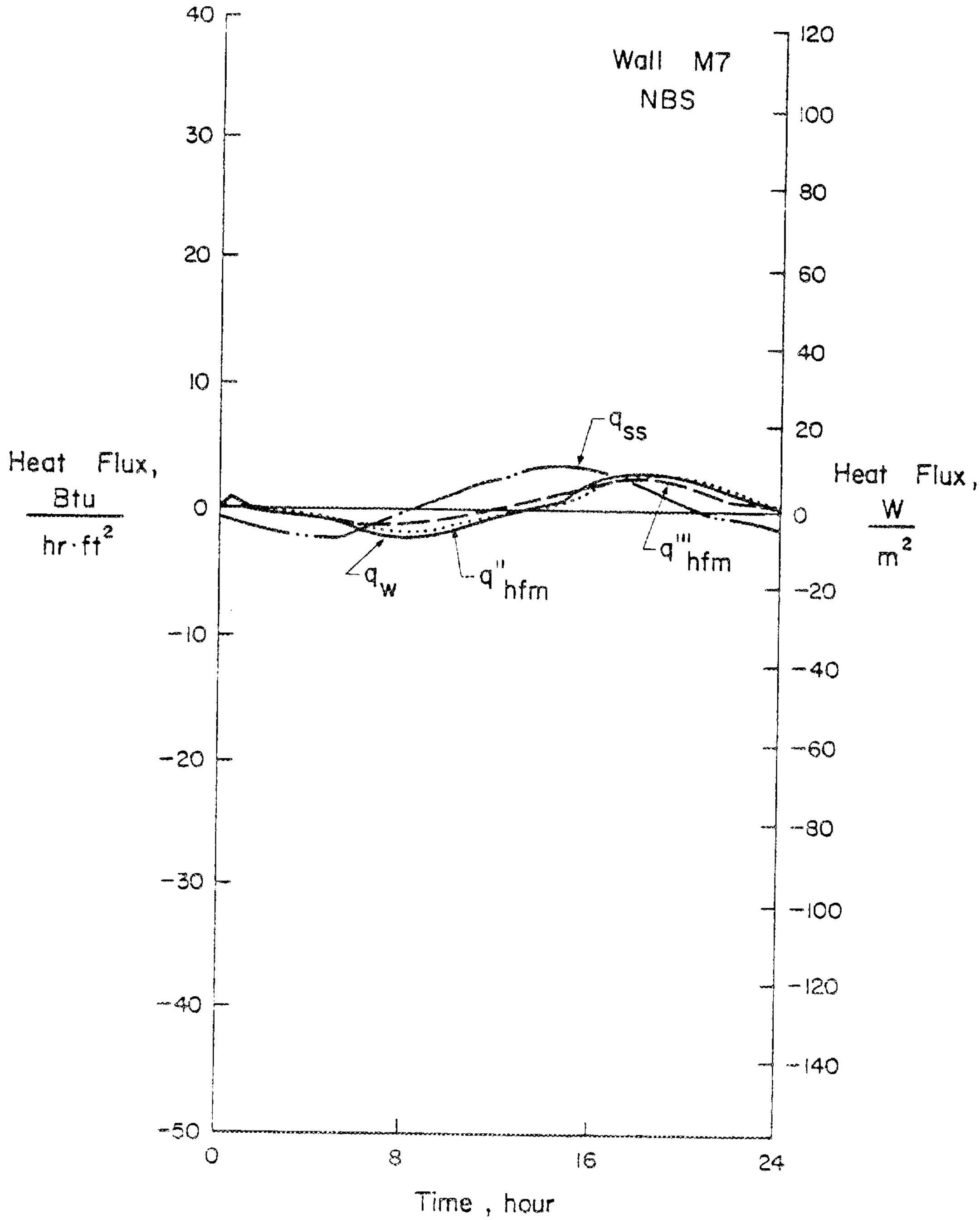


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M7-2 Wall M7 Dynamic Test Results for NBS Test Cycle



(c) Heat Flux

Fig. M7-2 Wall M7 Dynamic Test Results for NBS Test Cycle

TABLE M7-7(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft²			Calculated Heat Flux, Btu/hr·ft²	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	51.8	58.5		73.5	73.5	0.49	0.39	0.09		1.95
2	49.6	56.3		73.4	73.4	-0.01	-0.15	-0.31		-2.22
3	48.4	54.5		73.2	73.4	-0.38	-0.61	-0.64		-2.42
4	48.0	53.4		73.1	73.4	-0.89	-1.08	-0.98		-2.54
5	48.4	52.8		73.0	73.3	-1.31	-1.49	-1.27		-2.61
6	57.4	56.9		72.9	73.3	-2.19	-1.85	-1.47		-2.07
7	69.6	64.9		72.8	73.4	-2.80	-2.12	-1.61		-1.03
8	77.9	71.8		72.9	73.3	-2.90	-2.19	-1.51		-0.15
9	85.1	78.0		73.0	73.4	-2.31	-2.09	-1.34		0.67
10	92.2	84.1		73.2	73.4	-2.17	-1.71	-0.91		1.46
11	96.5	89.0		73.3	73.5	-1.43	-1.25	-0.49		2.12
12	99.4	92.3		73.6	73.5	-0.82	-0.66	0.01		2.54
13	105.7	97.4		73.7	73.5	-0.17	-0.04	0.54		3.24
14	110.3	102.3		74.0	73.5	0.37	0.60	1.05		3.89
15	108.3	103.2		74.2	73.6	1.11	1.22	1.53		3.99
16	103.9	101.4		74.4	73.6	2.23	1.91	2.04		3.71
17	96.5	97.3		74.5	73.6	2.75	2.43	2.35		3.12
18	84.4	89.7		74.6	73.6	2.81	2.79	2.52		2.04
19	73.5	81.3		74.6	73.6	3.00	2.87	2.39		0.90
20	67.4	75.3		74.4	73.6	2.72	2.78	2.17		0.12
21	64.9	71.7		74.3	73.5	2.17	2.47	1.75		-0.34
22	64.5	70.0		74.1	73.6	1.84	1.95	1.32		-0.54
23	58.9	66.2		73.9	73.5	1.48	1.45	0.91		-1.01
24	53.3	61.3		73.8	73.5	0.82	0.95	0.54		-1.63
Mean	75.7	76.2		73.7	73.5	0.18	0.27	0.36		0.39

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

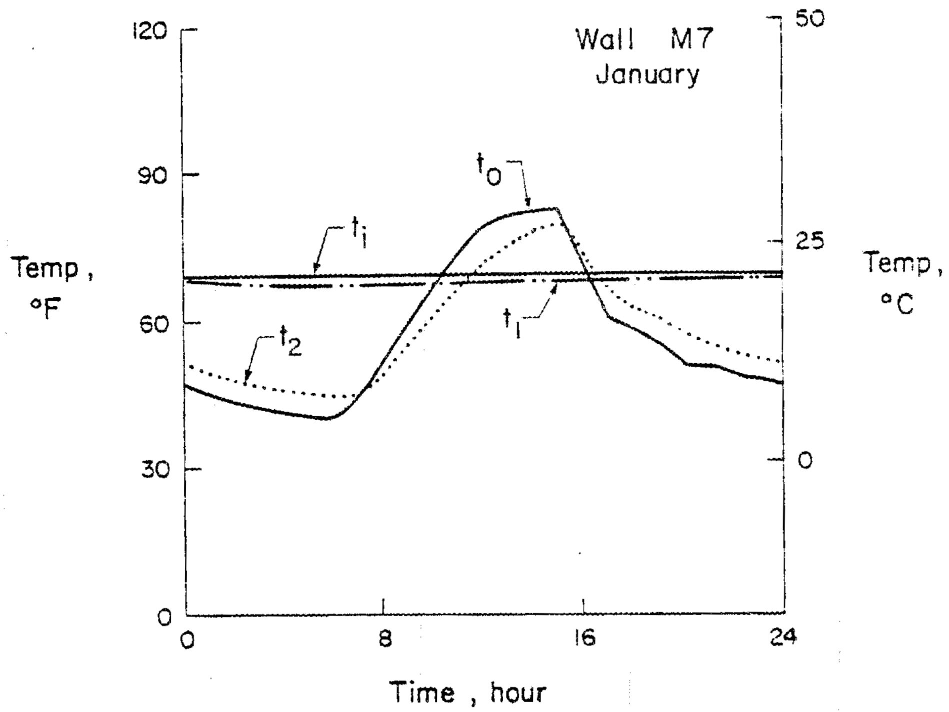
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 27%
Outdoor Chamber - 25%

Laboratory Air Temperature:
Max. - 74°F (23°C)
Min. - 71°F (21°C)

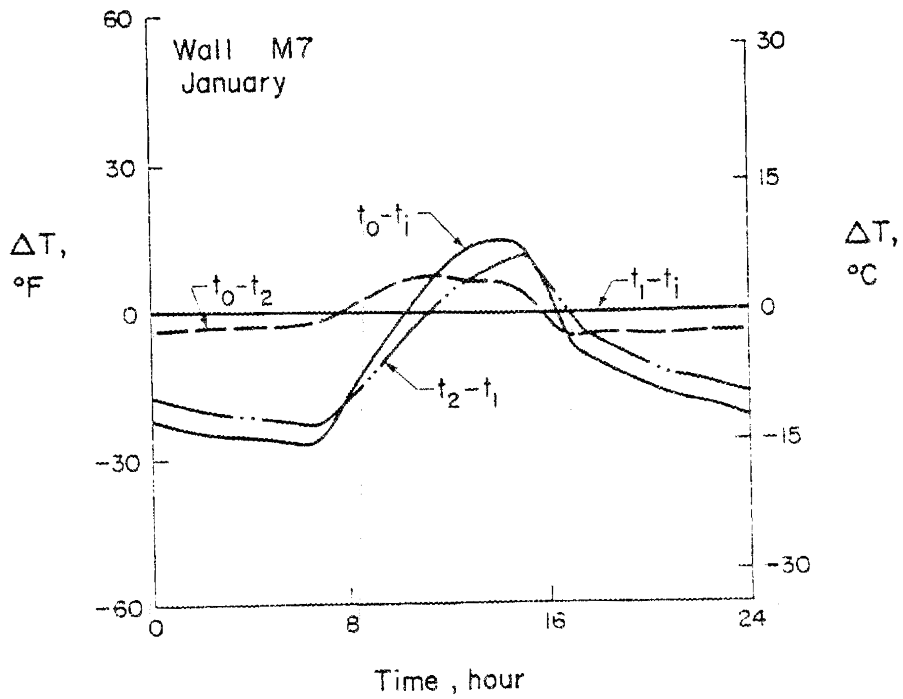
TABLE M7-7(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	11.0	14.7		23.1	23.1	1.55	1.22	0.29		-6.15
2	9.8	13.5		23.0	23.0	-0.04	-0.47	-0.97		-6.99
3	9.1	12.5		22.9	23.0	-1.20	-1.93	-2.02		-7.63
4	8.9	11.9		22.8	23.0	-2.81	-3.39	-3.09		-8.02
5	9.1	11.6		22.8	22.9	-4.12	-4.69	-4.00		-8.22
6	14.1	13.8		22.7	22.9	-6.92	-5.84	-4.65		-6.54
7	20.9	18.3		22.7	23.0	-8.83	-6.70	-5.09		-3.26
8	25.5	22.1		22.7	22.9	-9.13	-6.91	-4.77		-0.46
9	29.5	25.6		22.8	23.0	-7.28	-6.58	-4.22		2.10
10	33.4	28.9		22.9	23.0	-6.85	-5.39	-2.86		4.61
11	35.8	31.7		22.9	23.1	-4.51	-3.95	-1.54		6.69
12	37.4	33.5		23.1	23.1	-2.59	-2.08	0.04		8.00
13	40.9	36.3		23.2	23.1	-0.53	-0.12	1.69		10.20
14	43.5	39.0		23.3	23.1	1.16	1.88	3.30		12.26
15	42.4	39.6		23.4	23.1	3.49	3.85	4.84		12.58
16	39.9	38.6		23.6	23.1	7.02	6.04	6.43		11.69
17	35.8	36.3		23.6	23.1	8.66	7.67	7.40		9.82
18	29.1	32.0		23.7	23.1	8.85	8.81	7.96		6.45
19	23.1	27.4		23.7	23.1	9.45	9.06	7.54		2.83
20	19.7	24.1		23.6	23.1	8.58	8.78	6.83		0.38
21	18.3	22.1		23.5	23.1	6.83	7.79	5.51		-1.09
22	18.1	21.1		23.4	23.1	5.81	6.14	4.16		-1.71
23	14.9	19.0		23.3	23.1	4.66	4.56	2.87		-3.19
24	11.8	16.3		23.2	23.1	2.60	3.01	1.70		-5.15
Mean	24.3	24.6		23.2	23.0	0.58	0.86	1.14		1.22

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

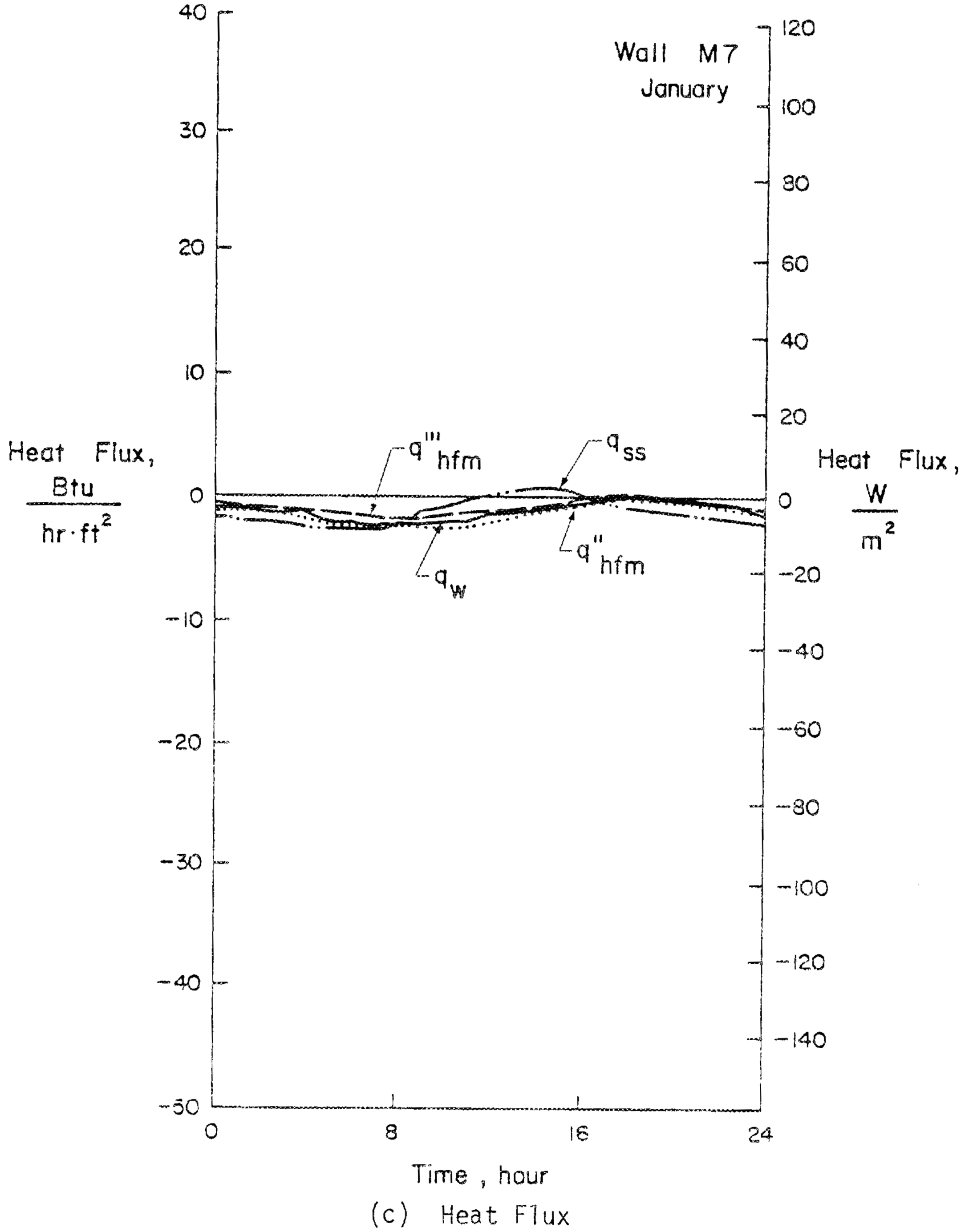


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M7-3 Wall M7 Dynamic Test Results for Phoenix January Test Cycle



(c) Heat Flux

Fig. M7-3 Wall M7 Dynamic Test Results for Phoenix January Test Cycle

TABLE M7-8(a) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX JANUARY TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	46.1	50.4		68.3	68.6	-1.25	-1.48	-1.15		-2.29
2	44.9	49.1		68.2	68.6	-1.61	-1.72	-1.31		-2.44
3	44.1	48.1		68.2	68.6	-1.88	-1.96	-1.47		-2.56
4	43.5	47.2		68.0	68.4	-1.84	-2.17	-1.61		-2.65
5	43.0	46.6		68.0	68.6	-2.20	-2.34	-1.72		-2.72
6	41.9	45.6		67.9	68.6	-2.15	-2.56	-1.88		-2.83
7	42.7	45.5		67.9	68.5	-2.52	-2.66	-1.92		-2.84
8	50.7	49.7		67.8	68.5	-2.15	-2.84	-2.04		-2.31
9	58.5	55.2		67.8	68.5	-2.58	-2.93	-2.07		-1.62
10	66.3	61.1		67.8	68.5	-2.23	-2.93	-1.99		-0.87
11	73.4	67.1		68.0	68.5	-2.23	-2.75	-1.77		-0.12
12	77.9	71.7		68.1	68.6	-1.82	-2.46	-1.47		0.47
13	80.4	74.9		68.3	68.6	-1.64	-1.99	-1.04		0.87
14	82.9	77.7		68.5	68.6	-1.09	-1.55	-0.69		1.22
15	82.5	79.0		68.6	68.7	-0.74	-1.03	-0.28		1.38
16	71.3	73.6		68.8	68.7	-0.42	-0.54	0.08		0.63
17	61.0	66.4		68.9	68.8	0.04	-0.14	0.30		-0.33
18	57.8	62.6		69.0	68.7	0.18	0.04	0.28		-0.83
19	55.9	60.4		68.9	68.7	-0.15	0.00	0.13		-1.10
20	51.9	57.3		68.8	68.8	-0.15	-0.17	-0.06		-1.48
21	50.5	55.4		68.7	68.7	-0.39	-0.45	-0.36		-1.71
22	49.8	54.2		68.6	68.7	-0.85	-0.67	-0.52		-1.85
23	48.6	53.0		68.5	68.7	-0.75	-1.02	-0.79		-1.99
24	47.2	51.6		68.4	68.7	-1.24	-1.26	-0.96		-2.15
Mean	57.2	58.5		68.3	68.6	-1.32	-1.57	-1.01		-1.26

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

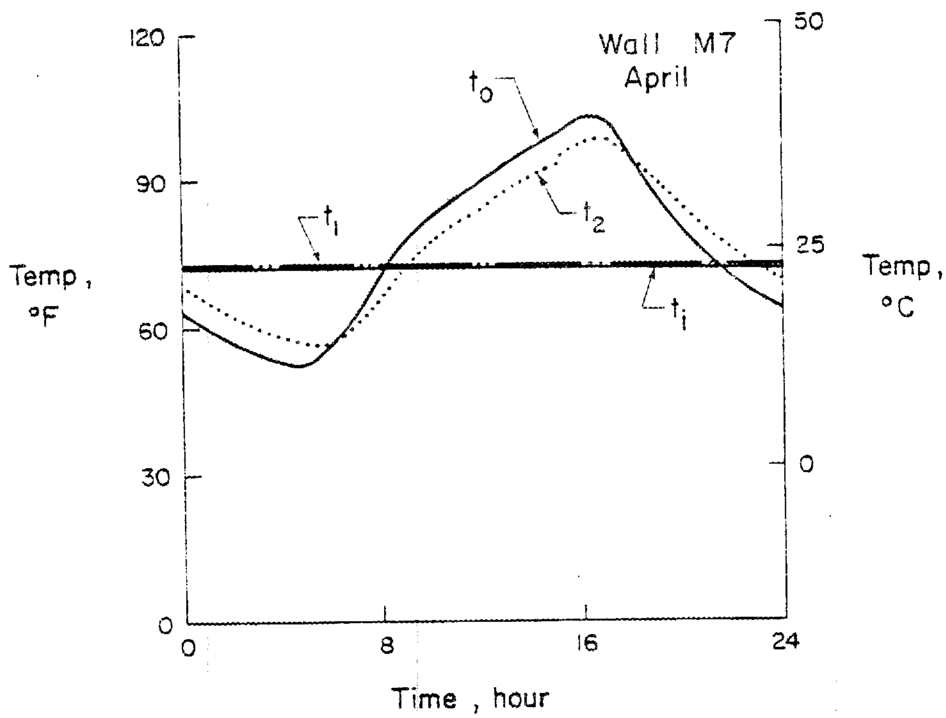
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 26%
Outdoor Chamber - 24%

Laboratory Air Temperature:
Max. - 74°F (23°C)
Min. - 71°F (22°C)

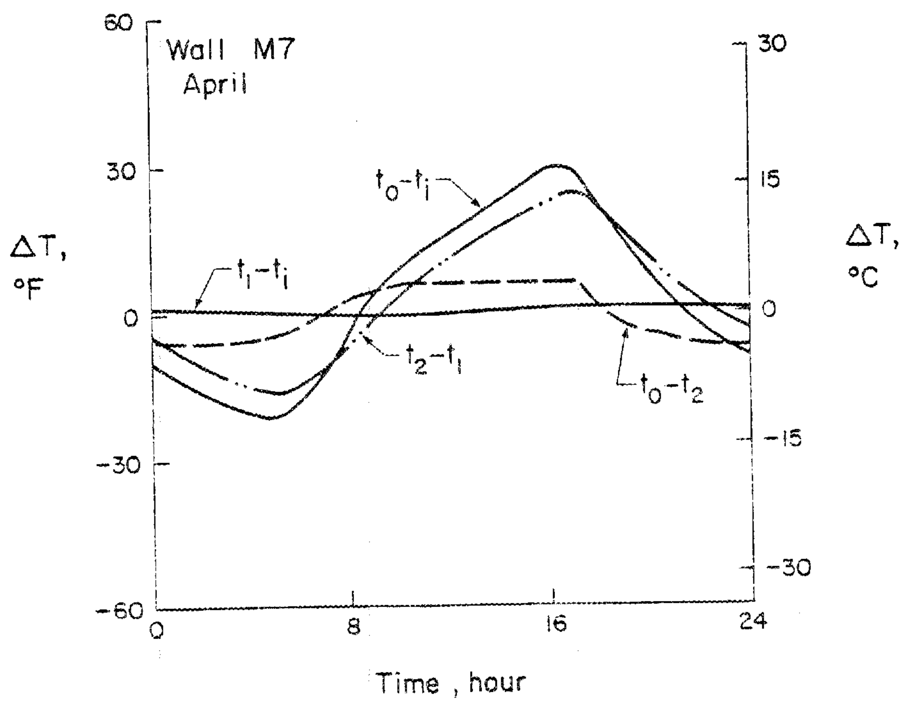
TABLE M7-8(b) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX JANUARY TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	7.8	10.2		20.2	20.3	-3.95	-4.67	-3.63		-7.22
2	7.2	9.5		20.1	20.3	-5.09	-5.44	-4.12		-7.69
3	6.7	8.9		20.1	20.3	-5.93	-6.19	-4.63		-8.08
4	6.4	8.4		20.0	20.2	-5.79	-6.85	-5.07		-8.35
5	6.1	8.1		20.0	20.3	-6.94	-7.37	-5.42		-8.58
6	5.5	7.6		19.9	20.3	-6.78	-8.08	-5.93		-8.93
7	5.9	7.5		19.9	20.3	-7.95	-8.40	-6.05		-8.97
8	10.4	9.8		19.9	20.3	-6.78	-8.94	-6.44		-7.29
9	14.7	12.9		19.9	20.3	-8.14	-9.24	-6.53		-5.11
10	19.0	16.2		19.9	20.3	-7.03	-9.24	-6.28		-2.74
11	23.0	19.5		20.0	20.3	-7.03	-8.66	-5.58		-0.37
12	25.5	22.1		20.1	20.3	-5.73	-7.74	-4.63		1.49
13	26.9	23.8		20.2	20.3	-5.18	-6.27	-3.29		2.75
14	28.3	25.4		20.3	20.3	-3.44	-4.89	-2.17		3.84
15	28.1	26.1		20.3	20.4	-2.32	-3.23	-0.88		4.35
16	21.8	23.1		20.4	20.4	-1.33	-1.71	0.26		1.99
17	16.1	19.1		20.5	20.4	0.13	-0.45	0.93		-1.03
18	14.3	17.0		20.6	20.4	0.55	0.11	0.87		-2.62
19	13.3	15.8		20.5	20.4	-0.48	0.01	0.42		-3.47
20	11.1	14.1		20.4	20.4	-0.48	-0.54	-0.20		-4.68
21	10.3	13.0		20.4	20.4	-1.23	-1.42	-1.13		-5.40
22	9.9	12.3		20.3	20.4	-2.67	-2.13	-1.64		-5.84
23	9.2	11.7		20.3	20.4	-2.36	-3.20	-2.50		-6.27
24	8.4	10.9		20.2	20.4	-3.92	-3.98	-3.03		-6.78
Mean	14.0	14.7		20.2	20.3	-4.16	-4.94	-3.19		-3.96

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

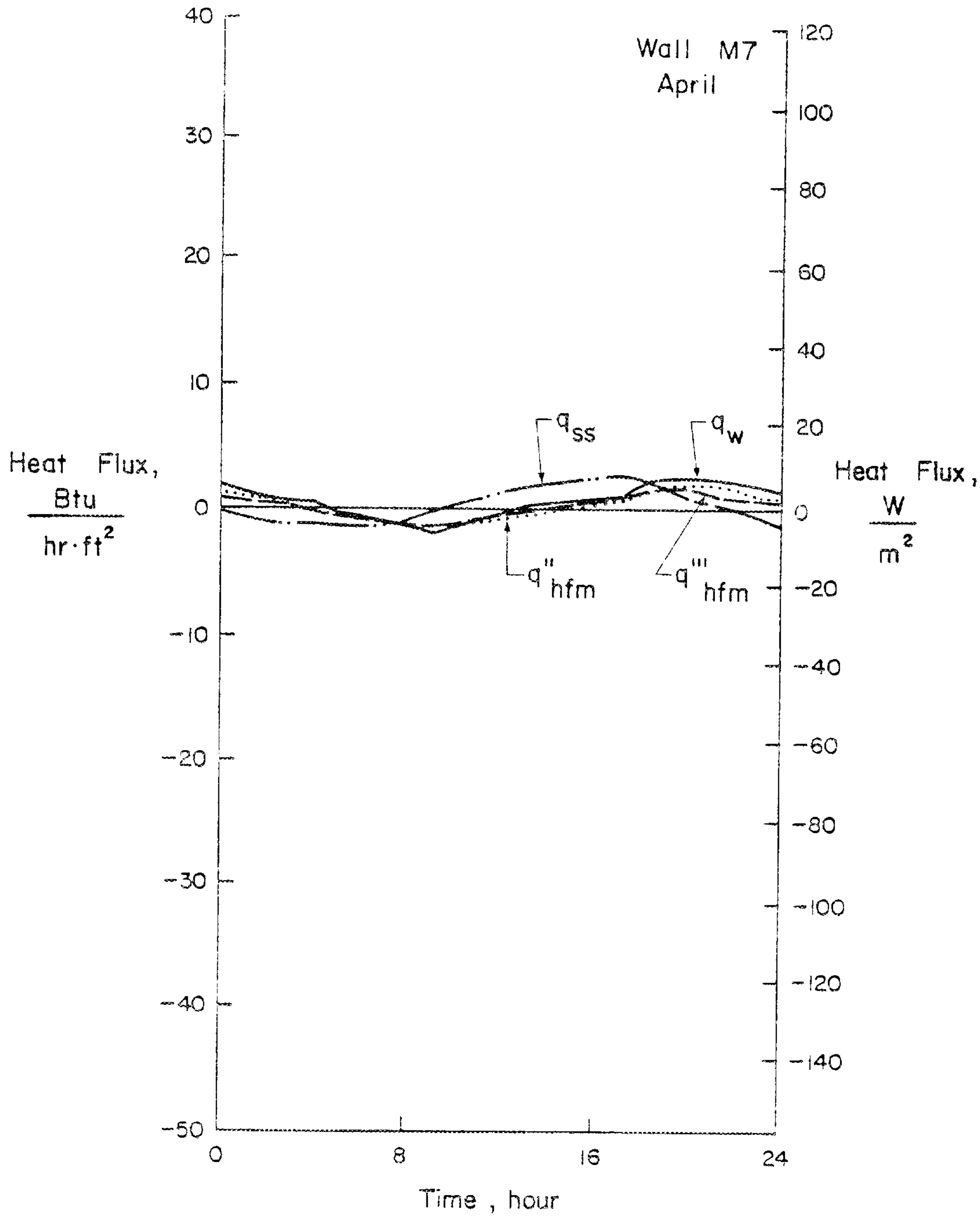


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M7-4 Wall M7 Dynamic Test Results for Phoenix April Test Cycle



(c) Heat Flux

Fig. M7-4 Wall M7 Dynamic Test Results for Phoenix April Test Cycle

TABLE M7-9(a) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX APRIL TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	60.7	66.5		73.8	73.5	1.44	1.09	0.71		-0.96
2	58.3	63.9		73.7	73.4	0.89	0.70	0.41		-1.28
3	55.9	61.5		73.5	73.4	0.47	0.29	0.10		-1.57
4	54.1	59.5		73.3	73.4	0.24	-0.11	-0.23		-1.80
5	52.9	57.9		73.2	73.4	-0.22	-0.50	-0.52		-1.99
6	55.6	58.4		73.2	73.4	-0.73	-0.90	-0.79		-1.92
7	60.1	60.7		73.1	73.4	-1.24	-1.21	-0.99		-1.62
8	69.3	66.3		73.1	73.4	-1.88	-1.47	-1.12		-0.89
9	77.5	72.6		73.1	73.4	-2.03	-1.56	-1.08		-0.07
10	82.8	77.5		73.1	73.4	-1.70	-1.46	-0.90		0.59
11	86.4	81.2		73.2	73.4	-1.30	-1.23	-0.64		1.07
12	89.3	84.2		73.4	73.4	-0.51	-0.89	-0.32		1.45
13	93.0	87.5		73.5	73.3	0.11	-0.48	0.03		1.89
14	96.3	90.7		73.7	73.4	0.41	-0.06	0.37		2.30
15	99.2	93.6		73.8	73.4	0.82	0.40	0.74		2.69
16	102.6	96.8		74.0	73.4	1.14	0.84	1.08		3.11
17	101.4	97.6		74.2	73.5	1.65	1.30	1.45		3.20
18	94.5	94.4		74.3	73.4	2.67	1.80	1.80		2.74
19	86.6	89.3		74.4	73.5	2.82	2.16	2.03		2.02
20	80.7	84.7		74.4	73.5	2.98	2.33	2.02		1.39
21	74.2	79.7		74.3	73.6	2.97	2.30	1.88		0.72
22	69.8	75.5		74.2	73.5	2.64	2.17	1.67		0.17
23	66.7	72.4		74.1	73.5	2.18	1.89	1.39		-0.23
24	64.0	69.6		74.0	73.5	2.00	1.51	1.04		-0.58
Mean	76.3	76.8		73.7	73.4	0.66	0.37	0.42		0.43

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

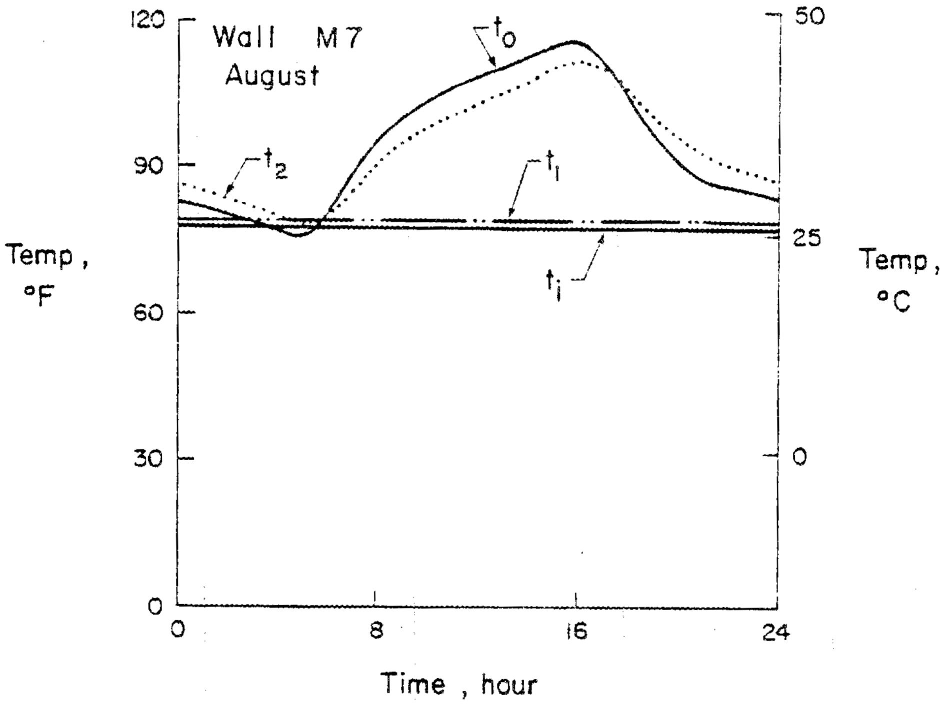
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 27%
Outdoor Chamber - 25%

Laboratory Air Temperature:
Max. - 73°F (23°C)
Min. - 67°F (19°C)

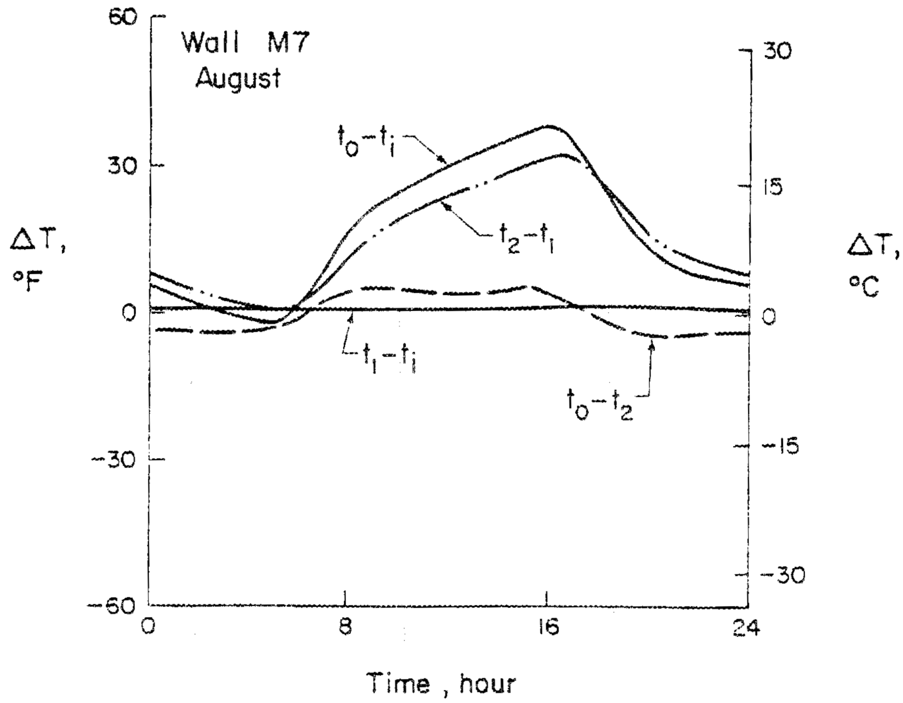
TABLE M7-9(b) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX APRIL TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	15.9	19.2		23.2	23.1	4.53	3.44	2.23		-3.03
2	14.6	17.7		23.2	23.0	2.79	2.20	1.30		-4.05
3	13.3	16.4		23.1	23.0	1.50	0.91	0.31		-4.94
4	12.3	15.3		22.9	23.0	0.77	-0.36	-0.72		-5.67
5	11.6	14.4		22.9	23.0	-0.70	-1.57	-1.65		-6.27
6	13.1	14.7		22.9	23.0	-2.31	-2.83	-2.50		-6.07
7	15.6	15.9		22.8	23.0	-3.90	-3.83	-3.13		-5.10
8	20.7	19.1		22.8	23.0	-5.92	-4.63	-3.52		-2.81
9	25.3	22.6		22.8	23.0	-6.39	-4.91	-3.40		-0.21
10	28.2	25.3		22.8	23.0	-5.37	-4.61	-2.84		1.85
11	30.2	27.3		22.9	23.0	-4.10	-3.89	-2.01		3.37
12	31.8	29.0		23.0	23.0	-1.61	-2.79	-1.00		4.57
13	33.9	30.8		23.1	22.9	0.35	-1.50	0.08		5.95
14	35.7	32.6		23.2	23.0	1.28	-0.20	1.18		7.26
15	37.3	34.2		23.2	23.0	2.58	1.26	2.34		8.49
16	39.2	36.0		23.3	23.0	3.58	2.65	3.41		9.81
17	38.6	36.4		23.4	23.1	5.20	4.11	4.57		10.08
18	34.7	34.7		23.5	23.0	8.42	5.68	5.68		8.63
19	30.3	31.8		23.6	23.1	8.89	6.81	6.39		6.36
20	27.1	29.3		23.6	23.1	9.40	7.34	6.38		4.37
21	23.4	26.5		23.6	23.1	9.35	7.26	5.93		2.28
22	21.0	24.2		23.4	23.1	8.32	6.85	5.26		0.55
23	19.3	22.4		23.4	23.1	6.88	5.97	4.39		-0.71
24	17.8	20.9		23.5	23.1	6.32	4.76	3.28		-1.83
Mean	24.6	24.9		23.2	23.0	2.08	1.17	1.33		1.37

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

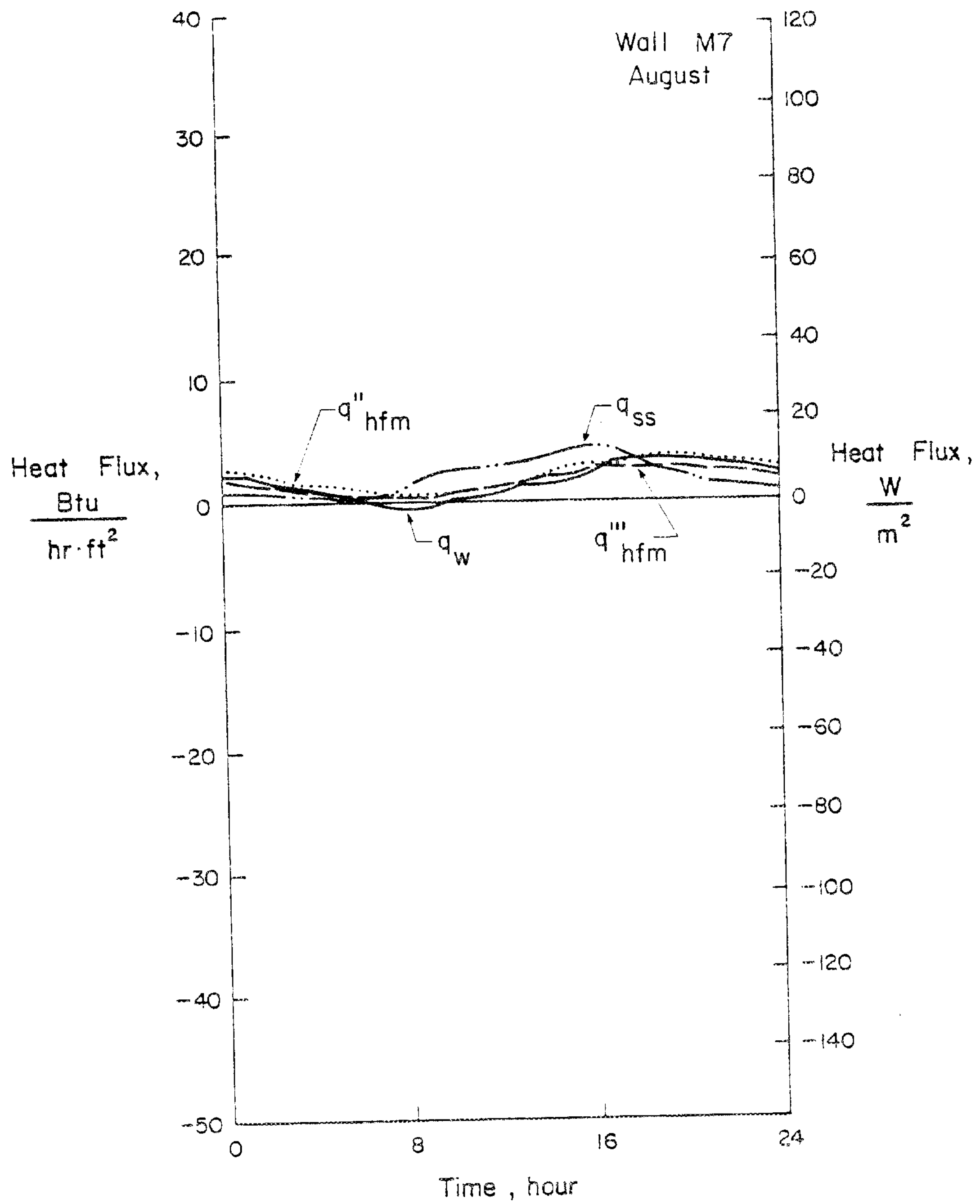


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M7-5 Wall M7 Dynamic Test Results for Phoenix August Test Cycle



(c) Heat Flux

Fig. M7-5 Wall M7 Dynamic Test Results for Phoenix August Test Cycle

TABLE M7-10(a) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX AUGUST TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	82.1	85.3		79.1	78.4	2.20	2.47	1.77		0.84
2	80.3	83.7		79.0	78.3	1.98	2.13	1.50		0.64
3	79.0	82.2		78.9	78.3	1.57	1.87	1.32		0.45
4	77.3	80.7		78.9	78.3	1.48	1.56	1.07		0.24
5	76.3	79.3		78.8	78.3	0.80	1.36	0.95		0.07
6	79.4	80.3		78.7	78.4	0.11	1.00	0.70		0.22
7	87.6	84.9		78.7	78.4	-0.34	0.83	0.61		0.84
8	95.6	90.7		78.7	78.4	-0.49	0.71	0.59		1.63
9	100.2	95.1		78.7	78.4	-0.31	0.72	0.69		2.25
10	103.3	98.3		78.8	78.4	0.48	0.92	0.91		2.68
11	106.0	101.1		78.9	78.4	0.33	1.23	1.24		3.06
12	108.1	103.4		78.8	78.4	0.83	1.57	1.53		3.40
13	110.0	105.6		79.2	78.4	1.48	1.92	1.80		3.66
14	112.4	107.7		79.3	78.4	1.64	2.35	2.14		3.95
15	115.3	110.2		79.5	78.4	1.96	2.71	2.45		4.29
16	116.1	112.0		79.6	78.5	2.55	3.05	2.69		4.53
17	111.9	110.5		79.7	78.4	3.56	3.51	3.01		4.30
18	103.8	105.7		79.8	78.4	3.66	3.82	3.22		3.60
19	96.9	100.5		79.8	78.4	3.71	4.00	3.29		2.86
20	90.5	95.4		79.7	78.4	3.71	3.99	3.13		2.15
21	87.6	92.0		79.7	78.4	3.30	3.78	2.88		1.68
22	86.2	90.1		79.5	78.4	3.25	3.53	2.60		1.44
23	85.1	88.5		79.3	78.4	3.03	3.17	2.32		1.25
24	83.7	87.0		79.2	78.4	2.67	2.79	2.00		1.06
Mean	94.8	94.6		79.2	78.4	1.80	2.29	1.85		2.13

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

Calibrated Hot Box Relative Humidity:
Indoor Chamber - 27%
Outdoor Chamber - 25%

Laboratory Air Temperature:
Max. - 74°F (23°C)
Min. - 71°F (22°C)

TABLE M7-10(b) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX AUGUST TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	27.8	29.6		26.2	25.8	6.95	7.79	5.58		2.65
2	26.8	28.7		26.1	25.7	6.23	6.70	4.75		2.00
3	26.1	27.9		26.1	25.7	4.93	5.90	4.17		1.40
4	25.2	27.0		26.1	25.7	4.66	4.91	3.36		0.76
5	24.6	26.3		26.0	25.7	2.52	4.27	3.01		0.21
6	26.3	26.8		25.9	25.8	0.36	3.16	2.20		0.68
7	30.9	29.4		25.9	25.8	-1.08	2.61	1.93		2.64
8	35.3	32.6		25.9	25.8	-1.54	2.23	1.86		5.16
9	37.9	35.1		25.9	25.8	-0.98	2.27	2.17		7.08
10	39.6	36.8		26.0	25.8	1.51	2.89	2.87		8.46
11	41.1	38.4		26.1	25.8	1.03	3.89	3.92		9.66
12	42.3	39.7		26.0	25.8	2.63	4.94	4.82		10.73
13	43.3	40.9		26.2	25.8	4.66	6.05	5.68		11.55
14	44.7	42.0		26.2	25.8	5.18	7.40	6.76		12.46
15	46.3	43.3		26.4	25.8	6.17	8.56	7.72		13.52
16	46.7	44.4		26.4	25.8	8.04	9.61	8.47		14.30
17	44.4	43.6		26.5	25.8	11.23	11.06	9.50		13.57
18	39.9	40.9		26.6	25.8	11.54	12.04	10.17		11.35
19	36.1	38.1		26.6	25.8	11.69	12.61	10.37		9.01
20	32.5	35.2		26.5	25.8	11.70	12.59	9.86		6.79
21	30.9	33.3		26.5	25.8	10.40	11.94	9.10		5.30
22	30.1	32.2		26.4	25.8	10.26	11.13	8.21		4.56
23	29.5	31.3		26.3	25.8	9.56	9.99	7.30		3.94
24	28.7	30.6		26.2	25.8	8.41	8.81	6.30		3.34
Mean	34.9	34.8		26.2	25.8	5.67	7.22	5.84		6.71

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

TABLE M7-12 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), THERMAL LAG

Test Cycle	Thermal Lag, hrs											Calc. Time Constant, hrs
	Measured											
	Calibrated Hot Box					Heat Flow Meter @ Stud			Heat Flow Meter Between Studs			
	t_o vs t_1		q_{ss} vs q_w		Avg.	q_{ss} vs q''_{hfm}		Avg.	q_{ss} vs q'''_{hfm}		Avg.	
	@ Max.	@ Min.	@ Max.	@ Min.		@ Max.	@ Min.		@ Max.	@ Min.		
NBS	4.5	3	4	3	3.5	4	3	3.5	3	2	2.5	1.2
Phoenix January	4	3	3	2	3	3	2.5	3	2.5	2	2.5	1.2
Phoenix April	3.5	3.5	3.5	4	3.5	3	4	3.5	2.5	3	3	1.2
Phoenix August	2.5	2.5	3.5	3	3	3.5	3.5	3.5	3	2.5	3	1.2

TABLE M7-13 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), REDUCTION IN AMPLITUDE

Test Cycle	Reduction in Amplitude, %								
	Calibrated Hot Box			Heat Flow Meter @ Stud			Heat Flow Meter Between Studs		
	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.
NBS	22	-3	10	28	18	23	40	34	37
Phoenix January	43	20	32	39	14	27	50	33	42
Phoenix April	16	-11	3	29	20	25	42	36	39
Phoenix August	20	-11	5	29	23	26	40	39	40

TABLE M7-14 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), ENERGY REQUIREMENTS

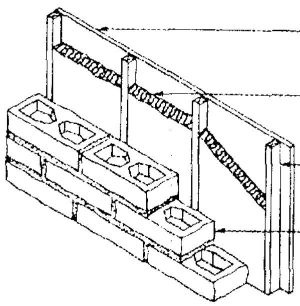
Test Cycle	Total Energy, Btu/ft^2 (W·hr/m^2)				Total Energy Comparisons, %			Net Energy, Btu/ft^2 (W·hr/m^2)				Net Energy Comparisons, %		
	Measured			Calc.				Measured			Calc.			
	q_w^T	$q_{hfm}^{T''}$	$q_{hfm}^{T'''}$	q_{ss}^T	$\frac{q_w^T}{q_{ss}^T}$	$\frac{q_{hfm}^{T''}}{q_{ss}^T}$	$\frac{q_{hfm}^{T'''}}{q_{ss}^T}$	q_w^N	$q_{hfm}^{N''}$	$q_{hfm}^{N'''}$	q_{ss}^N	$\frac{q_w^N}{q_{ss}^N}$	$\frac{q_{hfm}^{N''}}{q_{ss}^N}$	$\frac{q_{hfm}^{N'''}}{q_{ss}^N}$
NBS	39.2 (123.6)	37.1 (116.9)	29.7 (93.8)	46.3 (146.1)	85	80	64	4.4 (13.9)	6.6 (20.7)	8.7 (27.4)	9.3 (29.3)	47	71	94
Phoenix January	32.1 (101.3)	37.7 (118.8)	25.9 (81.7)	39.3 (123.9)	82	96	66	-31.7 (-99.9)	-37.6 (-118.6)	-24.3 (-76.7)	-30.1 (-95.0)	105	125	81
Phoenix April	35.0 (110.6)	28.7 (90.4)	23.3 (73.5)	36.3 (114.4)	96	79	64	15.8 (49.9)	8.9 (28.1)	10.1 (32.0)	10.4 (32.9)	152	86	97
Phoenix August	45.4 (143.3)	55.0 (173.5)	44.4 (140.1)	51.1 (161.2)	89	108	87	43.2 (136.2)	55.0 (173.5)	44.4 (140.1)	51.1 (161.2)	85	108	87

WALL M8: 8-IN. (203-MM) NORMAL WEIGHT CONCRETE BLOCK WITH INSULATION ON INSIDE SURFACE

DESCRIPTION: Normal weight 8-in. (203-mm) hollow core concrete block wall with fiberglass batt insulation between furring strips and gypsum wallboard on interior surface.

REFERENCE: Fiorato, A. E. and Bravinsky, E., "Heat Transfer Characteristics of Walls Under Arizona Temperature Conditions," Construction Technology Laboratories, Portland Cement Association, Skokie, 1981, 61 pages.

COMPOSITION:



1. 8x4x16-in. (203x102x406-mm) Normal Weight Hollow Core Concrete Slump Block - 2 cores per block
2. 1-1/2-in.x1-3/4-in. (38x44-mm) Furring Strips at 16-in. (406-mm) center-to-center
3. 1-3/4-in. (44-mm) R-8 Fiberglass Insulation
4. 1/2-in. (13-mm) Gypsum Wallboard

TABLE M8-1 - PHYSICAL PROPERTIES OF WALL AT TIME OF TEST

Property	Measured Value
Unit weight, psf (kg/m^2)	48.9 (239)
Average Thickness, in. (mm)	9.4 (239)
Area, ft^2 (m^2)	73.74 (6.85)
Moisture Content,* % by ovendry weight	1.0

*Measured on masonry, including mortar joints, after test.

TABLE M8-2(a) - MATERIAL PROPERTIES, NORMAL WEIGHT CONCRETE BLOCK

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Standard Dimensions, in. (mm)	--	--	--	7-5/8x3-5/8x15-5/8 (194x92x397)
Measured Dimensions, in. (mm)	ASTM C140	--	--	7.13x3.61x15.21 (181x92x386)
Percent Solid Volume	--	--	--	59
Ovendry Unit Weight, pcf (kg/m^3)	--	--	--	130 (2082)
Moisture Content, % ovendry weight	ASTM C140	--	--	1.7
Absorption, % ovendry weight	ASTM C140	--	--	7.6

TABLE M8-2(b) - MATERIAL PROPERTIES, MORTAR*

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Average Mortar Bed Joint Spacing, in. (mm)	--	--	--	0.47 (12)
Compressive Strength,** psi (MPa)	--	moist	--	2830 (20)

*One part Type S masonry cement to three parts masonry sand by volume.
**Measured on 2-in. (51-mm) cubes moist cured for 28 days.

TABLE M8-2(c) - MATERIAL PROPERTIES, R-8 FIBERGLASS BATT INSULATION

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Nominal Thickness, in. (mm)	--	--	--	2.5 (64)
Thickness, as received, in. (mm)	ASTM C167	--	--	2.52 (64)
Installed Thickness, in. (mm)	--	--	--	1.75 (44)
Density, as received, pcf (kg/m^3)	ASTM C167	--	--	0.58 (9)

TABLE M8-3 - DESIGN HEAT TRANSMISSION COEFFICIENTS

Component	R, Thermal Resistance	
	Between Furring $hr \cdot ft^2 \cdot °F/Btu$ ($m^2 \cdot K/W$)	At Furring $hr \cdot ft^2 \cdot °F/Btu$ ($m^2 \cdot K/W$)
1. Outside Air Film	0.17 (0.03)	0.17 (0.03)
2. 8x4x16-in. (203x102x406-mm) Hollow Core Slump Block	1.11* (0.20)	1.11 (0.20)
3. 1-3/4x1-1/2-in. (44x38-mm) Furring Strips	-	2.19* (0.39)
4. 1-3/4-in. (44-mm) Fiberglass Insulation	6.00* (1.06)	-
5. 1/2-in. (13-mm) Gypsum Wallboard	0.45* (0.08)	0.45 (0.08)
6. Inside Air Film	0.68 (0.12)	0.68 (0.12)
Total R	8.41 (1.48)	4.60 (0.81)
Total U	0.12 (0.68)	0.22 (1.23)

*Source: ASHRAE Handbook of Fundamentals, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., New York, 1977, Chapter 22.

Adjust for Furring (11.7%):

$$U = 0.883\ (0.119) + 0.117\ (0.217)$$

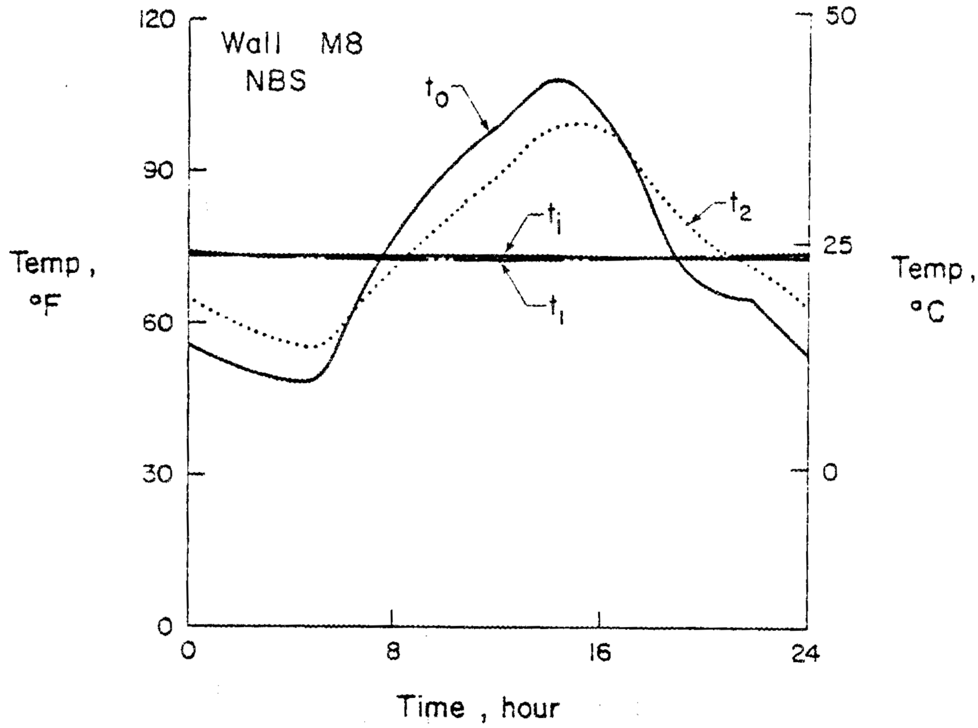
$$= 0.13\ Btu/hr \cdot ft^2 \cdot °F\ (0.74\ W/m^2 \cdot K)$$

$$R = 1/U = 7.67\ hr \cdot ft^2 \cdot °F/Btu\ (1.35\ K \cdot m^2/W)$$

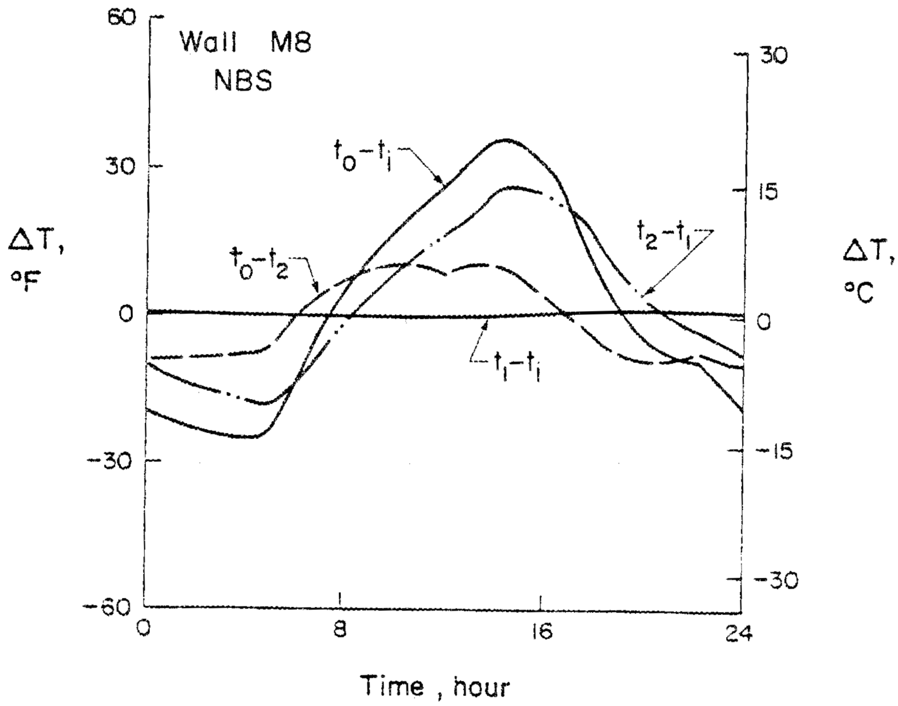
TABLE M8-4 – STEADY-STATE TEST RESULTS

Nominal Test Condition	q Heat Flux, Btu/hr·ft^2 (W/m^2)	R_T, hr·ft^2·°F/Btu (m^2·K/W)	U, Btu/hr·ft^2·°F (W/m^2·K)	Measured Temperatures, °F (°C)					Relative Humidity		Laboratory Air Temperature	
				t_o Outdoor Air	t_2 Outdoor Surface	t_3* Internal	t_1 Indoor Surface	t_i Indoor Air	Indoor Chamber, %	Outdoor Chamber, %	Max. °F (°C)	Min. °F (°C)
t_m = 102°F (39°C)	8.13 (25.7)	7.12 (1.25)	0.14 (0.80)	130 (54)	127 (53)	–	76 (25)	74 (23)	39	44	76 (25)	75 (24)
t_m = 39°F (4°C)	-8.76 (27.6)	8.03 (1.41)	0.13 (0.71)	3 (-16)	8 (-14)	–	71 (21)	73 (23)	27	26	76 (24)	75 (24)
Design Values	–	7.67 (1.35)	0.13 (0.74)	–	–	–	–	–	–	–	–	–

*Internal thermocouples were not used for this wall assembly.

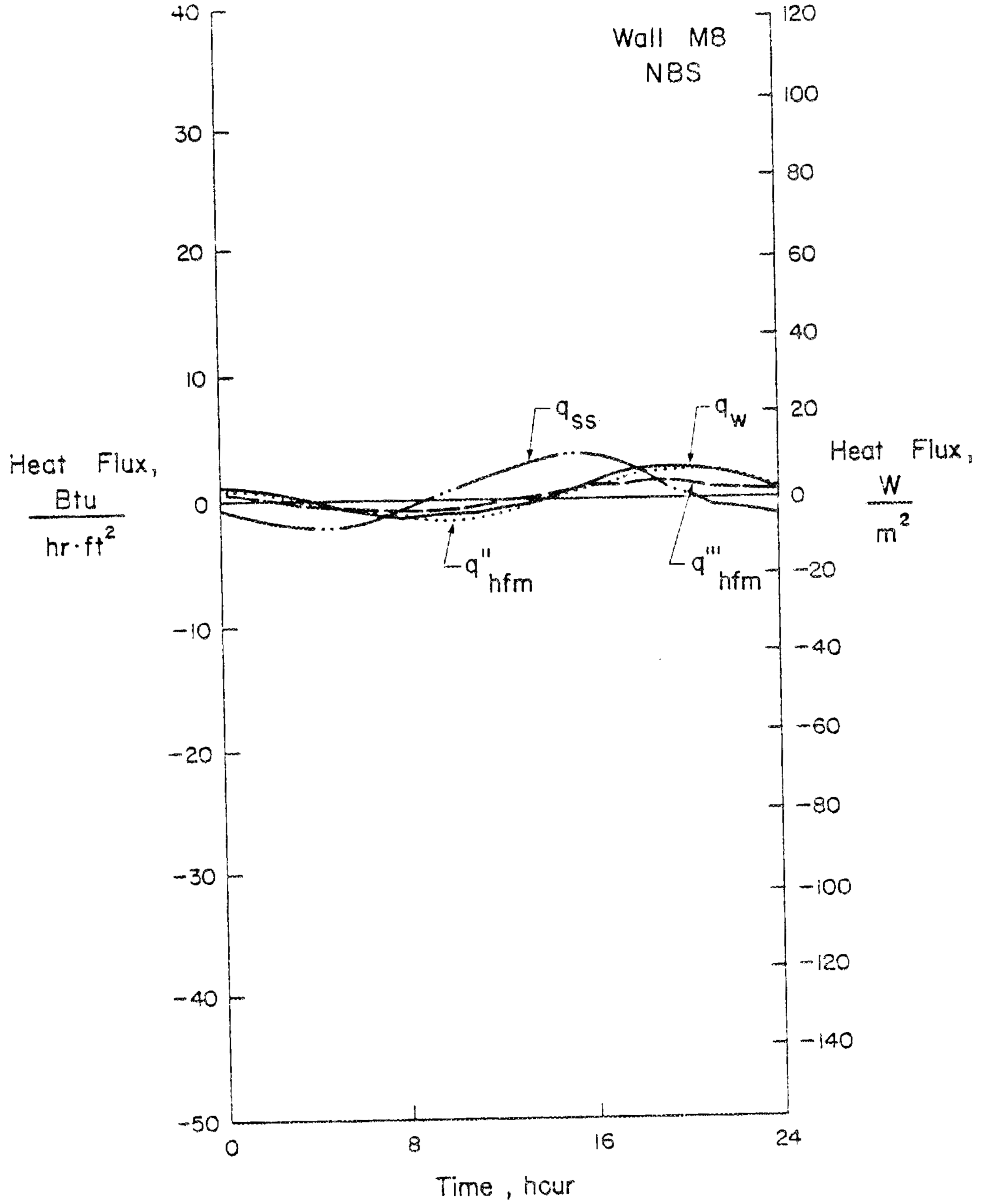


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M8-2 Wall M8 Dynamic Test Results for NBS Test Cycle



(c) Heat Flux

Fig. M8-2 Wall M8 Dynamic Test Results for NBS Test Cycle

TABLE M8-7(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}* HFM @ Stud	q_{hfm}*** HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	52.8	61.5		73.8	73.6	1.09	1.03	0.39		-1.83
2	50.7	59.4		73.6	73.6	0.68	0.58	0.09		-2.10
3	49.5	57.6		73.5	73.5	-0.01	0.10	-0.17		-2.35
4	49.0	56.3		73.4	73.5	-0.06	-0.42	-0.49		-2.52
5	49.3	55.6		73.3	73.5	-0.79	-0.82	-0.72		-2.61
6	57.8	58.7		73.2	73.5	-1.30	-1.23	-0.94		-2.15
7	69.7	65.3		73.1	73.6	-1.39	-1.64	-1.13		-1.16
8	77.9	71.3		73.1	73.5	-1.89	-1.78	-1.06		-0.27
9	84.8	76.8		73.1	73.5	-1.47	-1.89	-1.05		0.56
10	91.6	82.1		73.2	73.5	-1.43	-1.68	-0.77		1.35
11	95.9	86.6		73.4	73.5	-1.16	-1.39	-0.49		2.02
12	98.7	89.8		73.5	73.5	-0.39	-0.98	-0.15		2.50
13	104.8	94.4		73.7	73.5	-0.26	-0.44	0.23		3.19
14	109.4	99.0		73.9	73.6	0.47	0.03	0.56		3.89
15	107.3	100.1		74.2	73.5	0.92	0.71	0.95		4.02
16	103.3	98.9		74.3	73.7	1.61	1.33	1.38		3.81
17	96.3	95.8		74.5	73.7	2.59	1.86	1.66		3.29
18	84.9	89.6		74.5	73.7	2.82	2.34	1.89		2.32
19	74.2	82.5		74.6	73.7	2.82	2.61	1.91		1.20
20	68.3	77.2		74.6	73.6	2.92	2.65	1.78		0.39
21	65.8	74.0		74.4	73.7	2.42	2.58	1.60		-0.06
22	65.4	72.1		74.3	73.7	2.19	2.27	1.29		-0.33
23	59.9	68.7		74.1	73.6	2.01	1.90	1.02		-0.81
24	54.4	64.2		74.0	73.5	1.36	1.51	0.75		-1.46
Mean	75.9	76.6		73.8	73.6	0.57	0.38	0.35		0.45

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

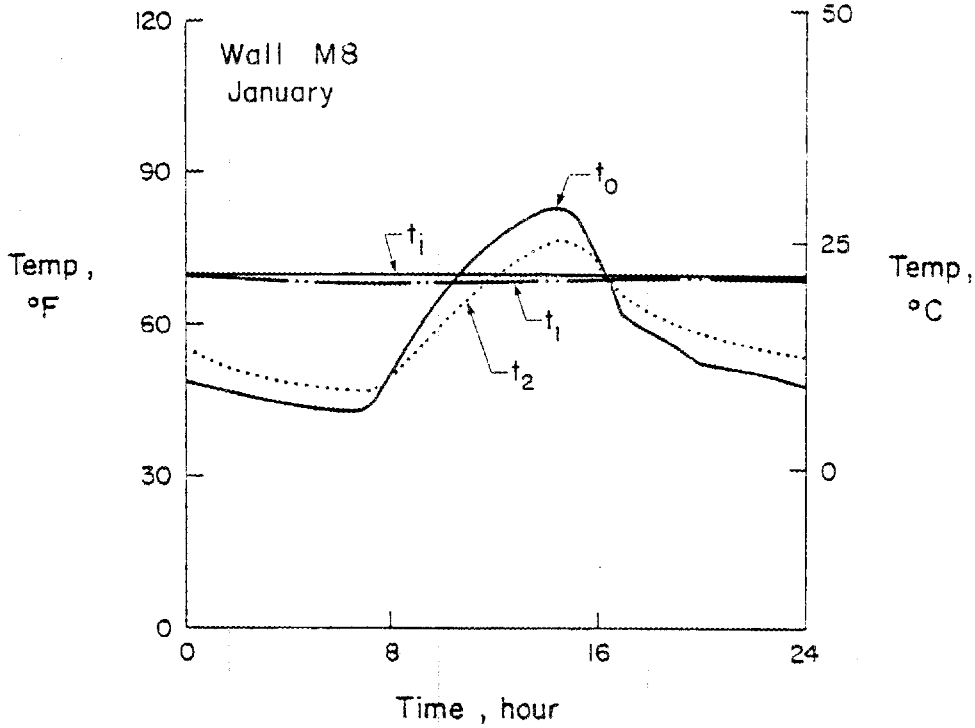
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 36%
Outdoor Chamber - 37%

Laboratory Air Temperature:
Max. - 77°F (25°C)
Min. - 74°F (23°C)

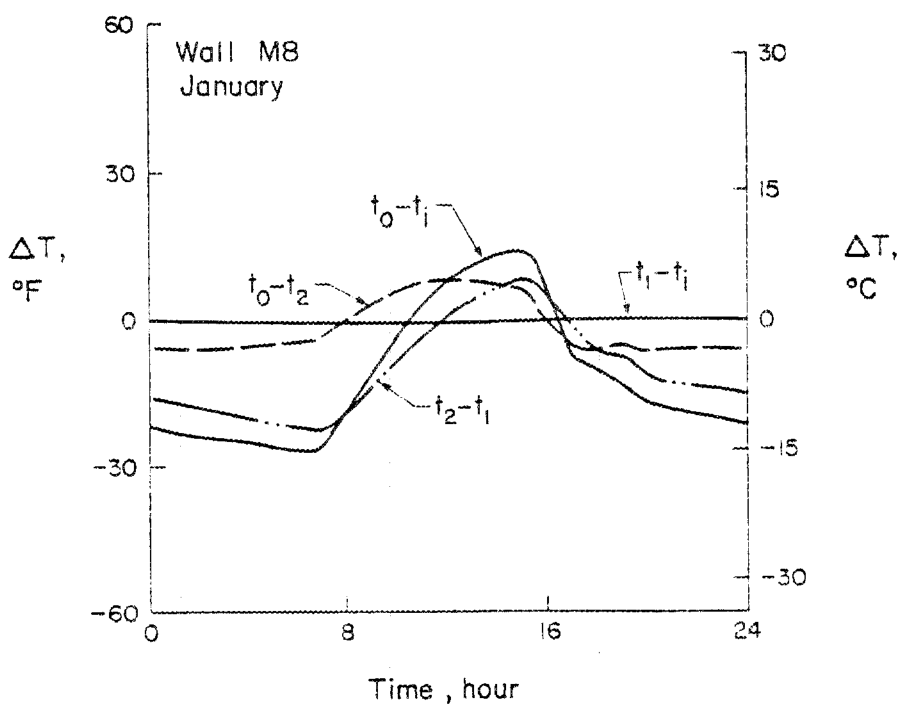
TABLE M8-7(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}^{*} HFM @ Stud	$q_{hfm}^{'''}$ HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	11.6	16.4		23.2	23.1	3.44	3.26	1.23		-5.76
2	10.4	15.2		23.1	23.1	2.14	1.82	0.29		-6.63
3	9.7	14.2		23.1	23.1	-0.04	0.32	-0.55		-7.41
4	9.4	13.5		23.0	23.1	-0.18	-1.33	-1.54		-7.96
5	9.6	13.1		22.9	23.1	-2.50	-2.58	-2.27		-8.23
6	14.3	14.8		22.9	23.1	-4.09	-3.88	-2.95		-6.77
7	20.9	18.5		22.8	23.1	-4.39	-5.16	-3.56		-3.67
8	25.5	21.8		22.8	23.1	-5.96	-5.60	-3.35		-0.85
9	29.3	24.9		22.8	23.1	-4.65	-5.95	-3.32		1.76
10	33.1	27.8		22.9	23.1	-4.50	-5.31	-2.44		4.26
11	35.5	30.3		23.0	23.1	-3.64	-4.37	-1.55		6.36
12	37.1	32.1		23.1	23.1	-1.22	-3.08	-0.46		7.88
13	40.4	34.7		23.2	23.1	-0.81	-1.39	0.72		10.06
14	43.0	37.2		23.3	23.1	1.47	0.10	1.78		12.26
15	41.8	37.8		23.4	23.1	2.91	2.22	3.00		12.67
16	39.6	37.2		23.5	23.2	5.09	4.19	4.37		12.02
17	35.7	35.4		23.6	23.2	8.17	5.86	5.23		10.37
18	29.4	32.0		23.6	23.2	8.88	7.39	5.94		7.30
19	23.4	28.1		23.7	23.2	8.90	8.23	6.04		3.79
20	20.2	25.1		23.7	23.1	9.20	8.35	5.60		1.24
21	18.8	23.3		23.6	23.2	7.63	8.13	5.03		-0.19
22	18.6	22.3		23.5	23.2	6.91	7.17	4.07		-1.04
23	15.5	20.4		23.4	23.1	6.34	5.98	3.21		-2.55
24	12.4	17.9		23.3	23.1	4.28	4.75	2.36		-4.61
Mean	24.4	24.8		23.2	23.1	1.81	1.21	1.12		1.43

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

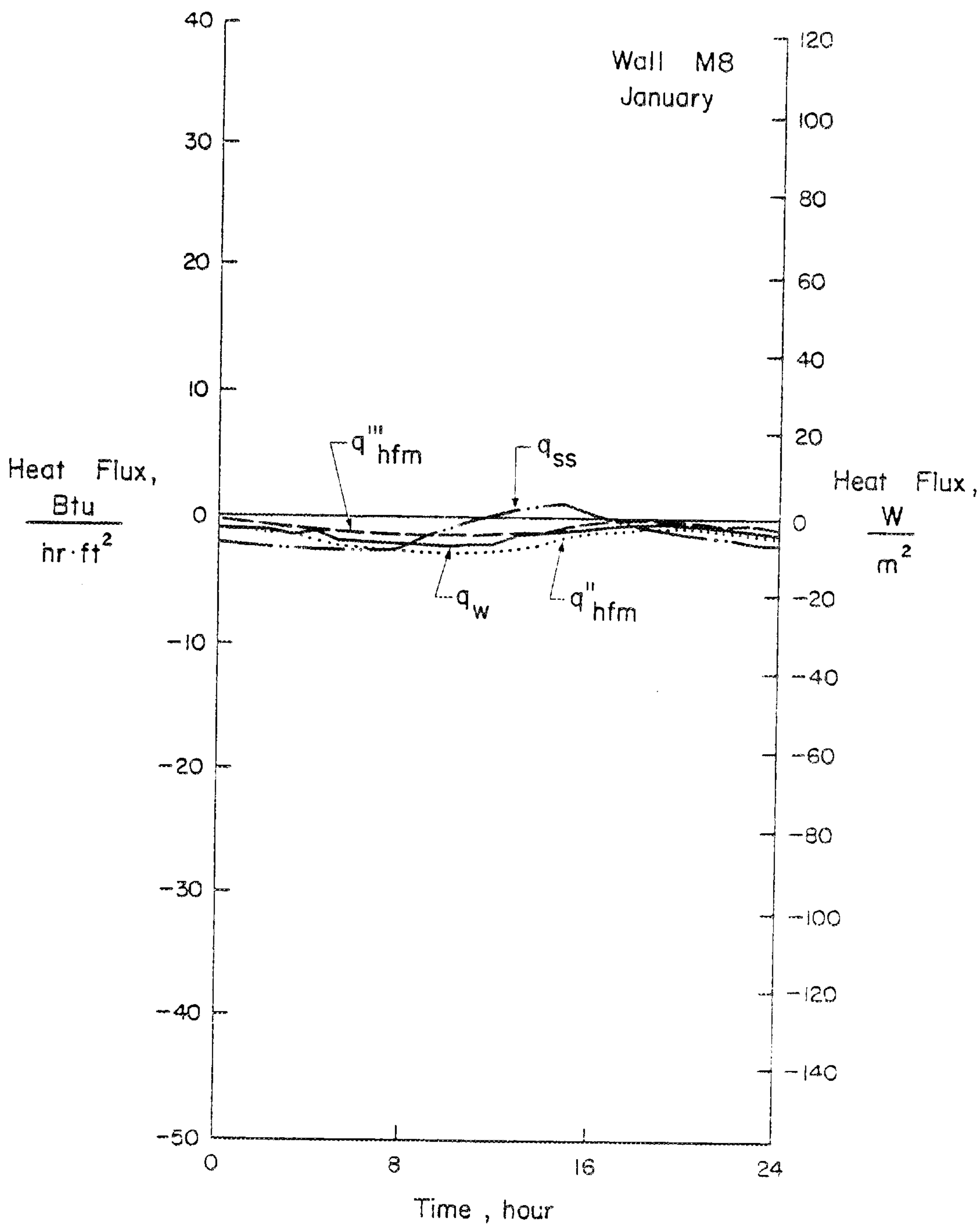


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M8-3 Wall M8 Dynamic Test Results for Phoenix January Test Cycle



(c) Heat Flux

Fig. M8-3 Wall M8 Dynamic Test Results for Phoenix January Test Cycle

TABLE M8-8(a) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX JANUARY TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	46.6	52.0		68.5	68.8	-1.34	-1.40	-0.89		-2.41
2	45.5	50.9		68.4	68.9	-1.34	-1.69	-1.06		-2.55
3	44.7	49.8		68.4	68.8	-1.95	-1.87	-1.16		-2.71
4	43.9	48.9		68.3	68.9	-1.67	-2.15	-1.35		-2.82
5	43.4	48.2		68.3	68.8	-2.17	-2.35	-1.45		-2.92
6	42.4	47.2		68.1	68.7	-2.13	-2.56	-1.55		-3.03
7	43.0	46.9		68.1	68.8	-2.27	-2.79	-1.70		-3.08
8	50.2	50.0		68.1	68.7	-2.46	-2.95	-1.77		-2.64
9	58.0	54.7		68.0	68.7	-2.51	-3.11	-1.83		-1.95
10	65.5	59.8		68.0	68.7	-2.51	-3.19	-1.83		-1.21
11	72.4	65.0		68.1	68.7	-2.33	-3.17	-1.73		-0.46
12	76.9	69.3		68.2	68.7	-2.28	-2.93	-1.51		0.16
13	79.6	72.4		68.4	68.8	-1.69	-2.67	-1.26		0.60
14	82.1	75.1		68.5	68.8	-1.78	-2.24	-0.91		0.99
15	82.4	76.8		68.7	68.9	-1.00	-1.86	-0.66		1.22
16	72.3	73.0		68.8	68.9	-0.92	-1.36	-0.31		0.63
17	61.8	66.9		69.0	68.9	-0.36	-0.95	-0.12		-0.31
18	58.1	63.3		69.0	68.9	-0.23	-0.64	-0.03		-0.84
19	56.4	61.3		69.0	69.0	-0.23	-0.52	-0.07		-1.14
20	52.5	58.6		69.0	68.9	-0.23	-0.57	-0.18		-1.53
21	51.0	56.7		68.9	69.0	-0.41	-0.68	-0.30		-1.79
22	50.3	55.5		68.8	68.9	-0.64	-0.84	-0.46		-1.95
23	49.1	54.3		68.7	68.9	-0.72	-1.09	-0.64		-2.11
24	47.8	53.1		68.6	68.9	-1.14	-1.31	-0.79		-2.27
Mean	57.3	58.7		68.5	68.8	-1.43	-1.87	-0.98		-1.42

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

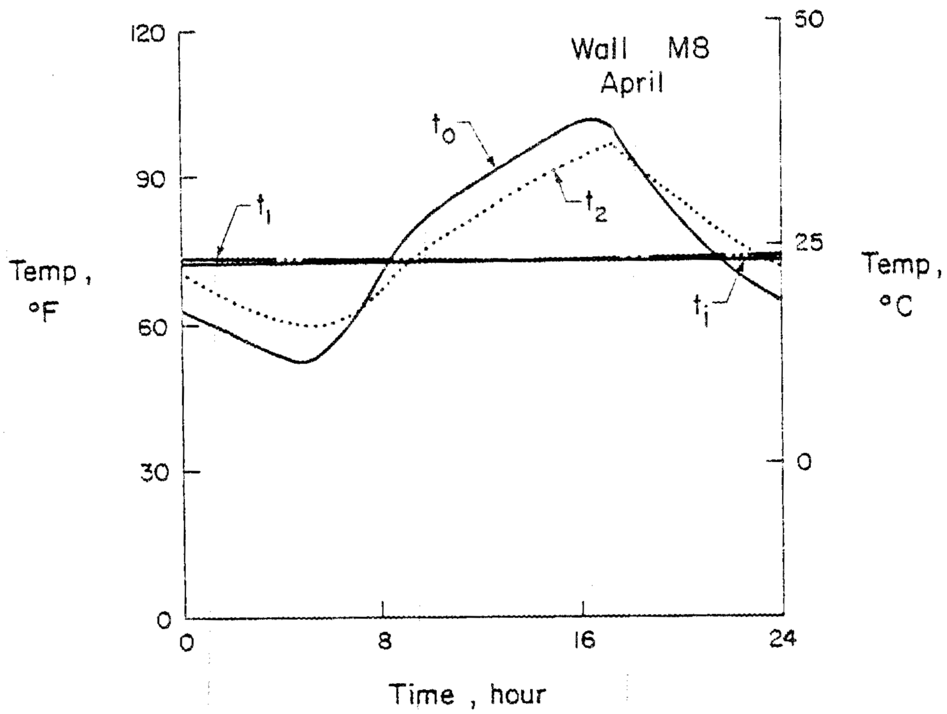
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 27%
Outdoor Chamber - 33%

Laboratory Air Temperature:
Max. - 74°F (23°C)
Min. - 71°F (22°C)

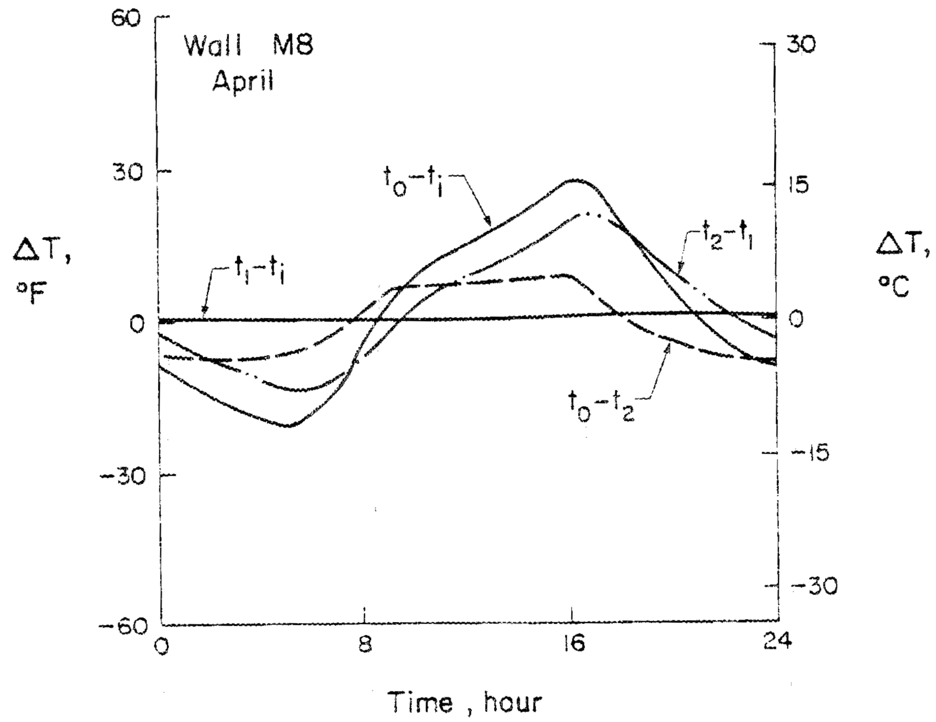
TABLE M8-8(b) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX JANUARY TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	8.1	11.1		20.3	20.4	-4.24	-4.42	-2.81		-7.60
2	7.5	10.5		20.2	20.5	-4.22	-5.34	-3.34		-8.05
3	7.1	9.8		20.2	20.4	-6.14	-5.90	-3.67		-8.55
4	6.6	9.4		20.2	20.5	-5.28	-6.79	-4.25		-8.90
5	6.3	9.0		20.2	20.4	-6.85	-7.41	-4.56		-9.22
6	5.8	8.4		20.1	20.4	-6.72	-8.08	-4.88		-9.57
7	6.1	8.3		20.1	20.4	-7.16	-8.81	-5.35		-9.70
8	10.1	10.0		20.1	20.4	-7.74	-9.29	-5.58		-8.31
9	14.4	12.6		20.0	20.4	-7.92	-9.80	-5.76		-6.14
10	18.6	15.4		20.0	20.4	-7.90	-10.06	-5.76		-3.81
11	22.4	18.3		20.1	20.4	-7.35	-10.00	-5.44		-1.45
12	24.9	20.7		20.1	20.4	-7.20	-9.26	-4.75		0.52
13	26.4	22.4		20.2	20.4	-5.32	-8.41	-3.97		1.89
14	27.8	23.9		20.3	20.4	-5.63	-7.05	-2.87		3.12
15	28.0	24.9		20.4	20.5	-3.16	-5.88	-2.08		3.84
16	22.4	22.8		20.4	20.5	-2.90	-4.30	-0.98		1.98
17	16.6	19.4		20.6	20.5	-1.14	-3.00	-0.37		-0.98
18	14.5	17.4		20.6	20.5	-0.72	-2.02	-0.10		-2.66
19	13.6	16.3		20.6	20.6	-0.72	-1.65	-0.21		-3.59
20	11.4	14.8		20.6	20.5	-0.72	-1.79	-0.58		-4.83
21	10.6	13.7		20.5	20.6	-1.29	-2.13	-0.95		-5.65
22	10.2	13.1		20.4	20.5	-2.02	-2.66	-1.46		-6.15
23	9.5	12.4		20.4	20.5	-2.27	-3.44	-2.02		-6.65
24	8.8	11.7		20.3	20.5	-3.58	-4.15	-2.48		-7.15
Mean	14.1	14.9		20.3	20.5	-4.51	-5.90	-3.09		-4.48

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

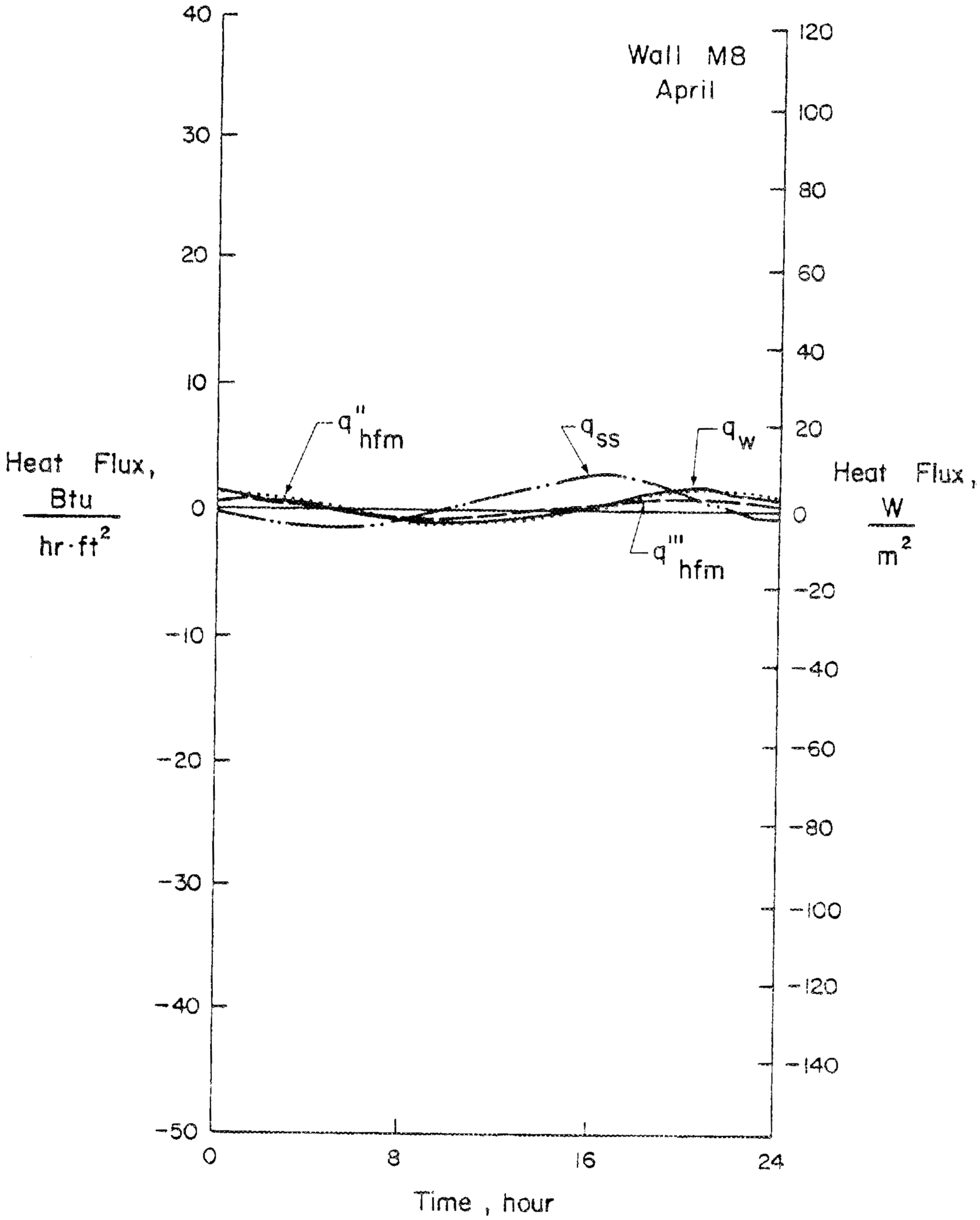


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M8-4 Wall M8 Dynamic Test Results for Phoenix April Test Cycle



(c) Heat Flux

Fig. M8-4 Wall M8 Dynamic Test Results for Phoenix April Test Cycle

TABLE M8-9(a) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX APRIL TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	61.4	68.6		74.1	73.7	1.20	1.48	0.85		-0.82
2	58.9	66.1		73.9	73.6	0.69	1.17	0.64		-1.16
3	56.6	63.9		73.8	73.6	0.64	0.78	0.35		-1.47
4	54.8	61.9		73.7	73.6	0.32	0.41	0.11		-1.75
5	53.5	60.2		73.6	73.6	-0.24	0.04	-0.09		-1.99
6	56.1	60.4		73.5	73.6	-0.51	-0.37	-0.37		-1.94
7	60.5	62.3		73.4	73.5	-0.79	-0.75	-0.57		-1.65
8	69.1	66.7		73.3	73.5	-1.11	-1.05	-0.71		-0.99
9	77.3	72.1		73.3	73.5	-1.17	-1.25	-0.78		-0.18
10	82.5	76.4		73.3	73.5	-1.13	-1.33	-0.74		0.47
11	85.8	79.7		73.4	73.5	-0.99	-1.25	-0.56		0.95
12	88.7	82.5		73.5	73.5	-0.82	-1.05	-0.36		1.37
13	92.2	85.4		73.6	73.6	-0.60	-0.76	-0.10		1.80
14	95.5	88.5		73.8	73.6	-0.18	-0.41	0.16		2.25
15	98.4	91.2		73.9	73.6	0.18	-0.03	0.43		2.66
16	101.7	94.1		74.1	73.6	0.54	0.38	0.69		3.08
17	100.4	95.1		74.2	73.7	0.82	0.81	0.99		3.22
18	94.4	92.9		74.3	73.6	1.52	1.31	1.30		2.86
19	86.7	88.8		74.4	73.7	1.76	1.65	1.46		2.21
20	80.9	84.7		74.4	73.7	2.18	1.95	1.54		1.57
21	74.7	80.6		74.5	73.7	2.14	2.12	1.57		0.93
22	70.2	76.7		74.4	73.8	1.78	2.16	1.49		0.35
23	67.2	73.8		74.3	73.7	1.69	2.00	1.29		-0.08
24	64.5	71.2		74.2	73.7	1.55	1.73	1.04		-0.45
Mean	76.3	76.8		73.9	73.6	0.39	0.41	0.40		0.47

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

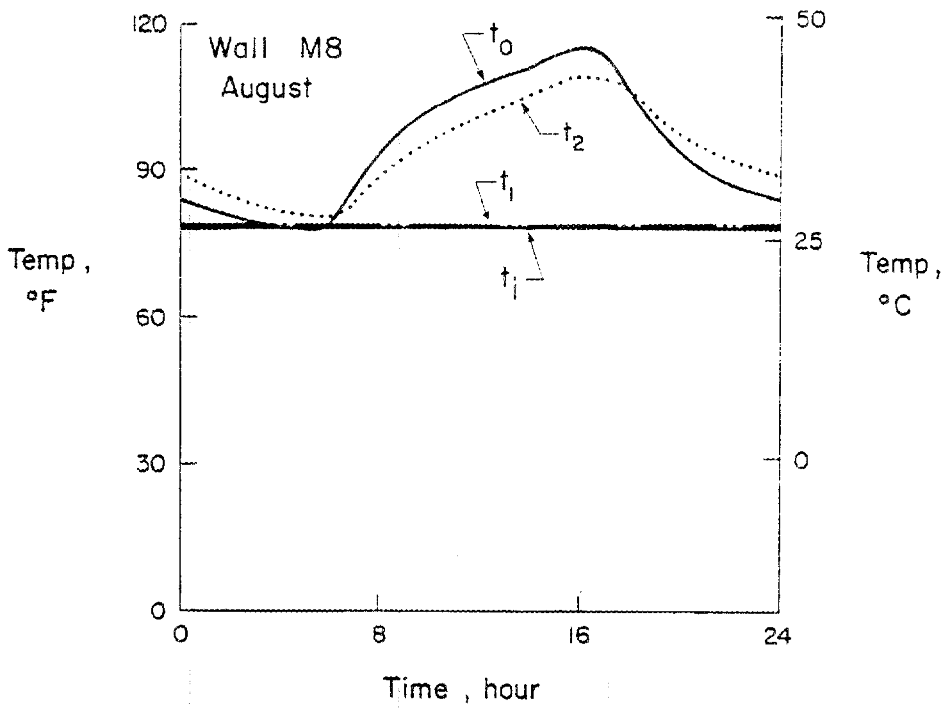
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 30%
Outdoor Chamber - 36%

Laboratory Air Temperature:
Max. - 73°F (23°C)
Min. - 72°F (22°C)

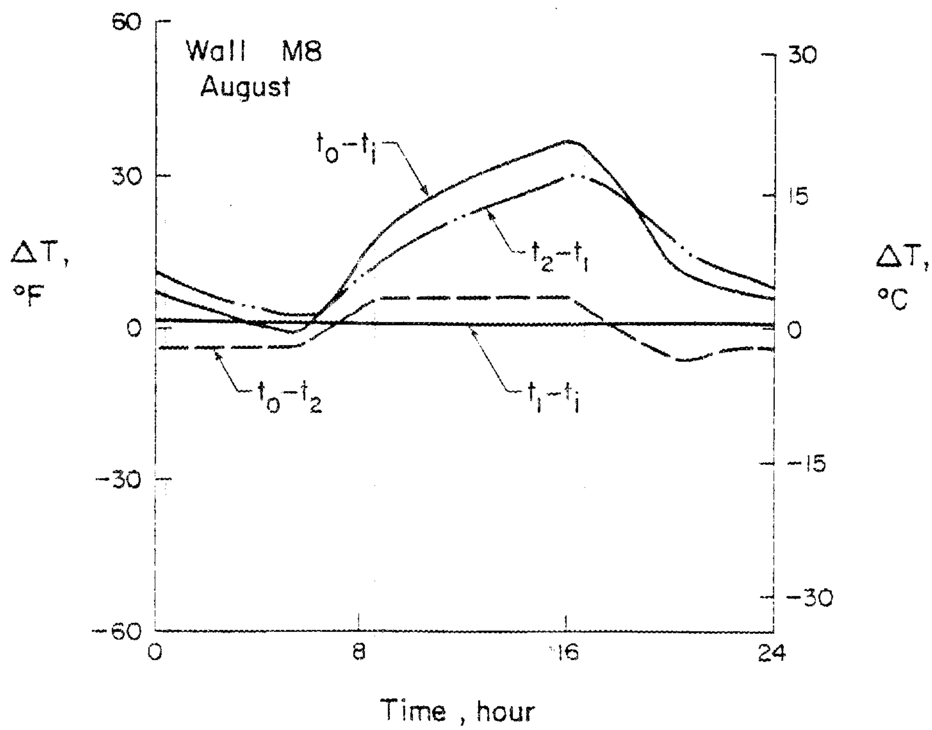
TABLE M8-9(b) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX APRIL TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q^{*}_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	16.3	20.3		23.4	23.2	3.78	4.68	2.69		-2.60
2	14.9	18.9		23.3	23.1	2.18	3.70	2.02		-3.67
3	13.7	17.7		23.2	23.1	2.02	2.45	1.09		-4.65
4	12.7	16.6		23.2	23.1	0.99	1.29	0.36		-5.53
5	11.9	15.7		23.1	23.1	-0.76	0.12	-0.29		-6.27
6	13.4	15.8		23.1	23.1	-1.62	-1.18	-1.16		-6.13
7	15.8	16.8		23.0	23.1	-2.49	-2.36	-1.81		-5.20
8	20.6	19.3		22.9	23.1	-3.50	-3.31	-2.23		-3.11
9	25.2	22.3		22.9	23.1	-3.69	-3.94	-2.45		-0.57
10	28.1	24.7		22.9	23.1	-3.56	-4.21	-2.32		1.48
11	29.9	26.5		23.0	23.1	-3.14	-3.94	-1.77		3.01
12	31.5	28.1		23.1	23.1	-2.58	-3.31	-1.12		4.31
13	33.4	29.7		23.1	23.1	-1.88	-2.39	-0.30		5.68
14	35.3	31.4		23.2	23.1	-0.58	-1.28	0.49		7.10
15	36.9	32.9		23.3	23.1	0.56	-0.11	1.36		8.38
16	38.7	34.5		23.4	23.1	1.69	1.19	2.17		9.72
17	38.0	35.1		23.4	23.2	2.60	2.55	3.13		10.17
18	34.7	33.8		23.5	23.1	4.79	4.12	4.10		9.03
19	30.4	31.5		23.6	23.2	5.55	5.22	4.60		6.96
20	27.2	29.3		23.6	23.2	6.86	6.15	4.86		4.95
21	23.7	27.0		23.6	23.2	6.75	6.69	4.94		2.92
22	21.2	24.8		23.6	23.2	5.62	6.81	4.70		1.10
23	19.6	23.2		23.5	23.2	5.34	6.30	4.08		-0.24
24	18.1	21.8		23.4	23.2	4.89	5.47	3.28		-1.42
Mean	24.6	24.9		23.3	23.1	1.24	1.28	1.27		1.48

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

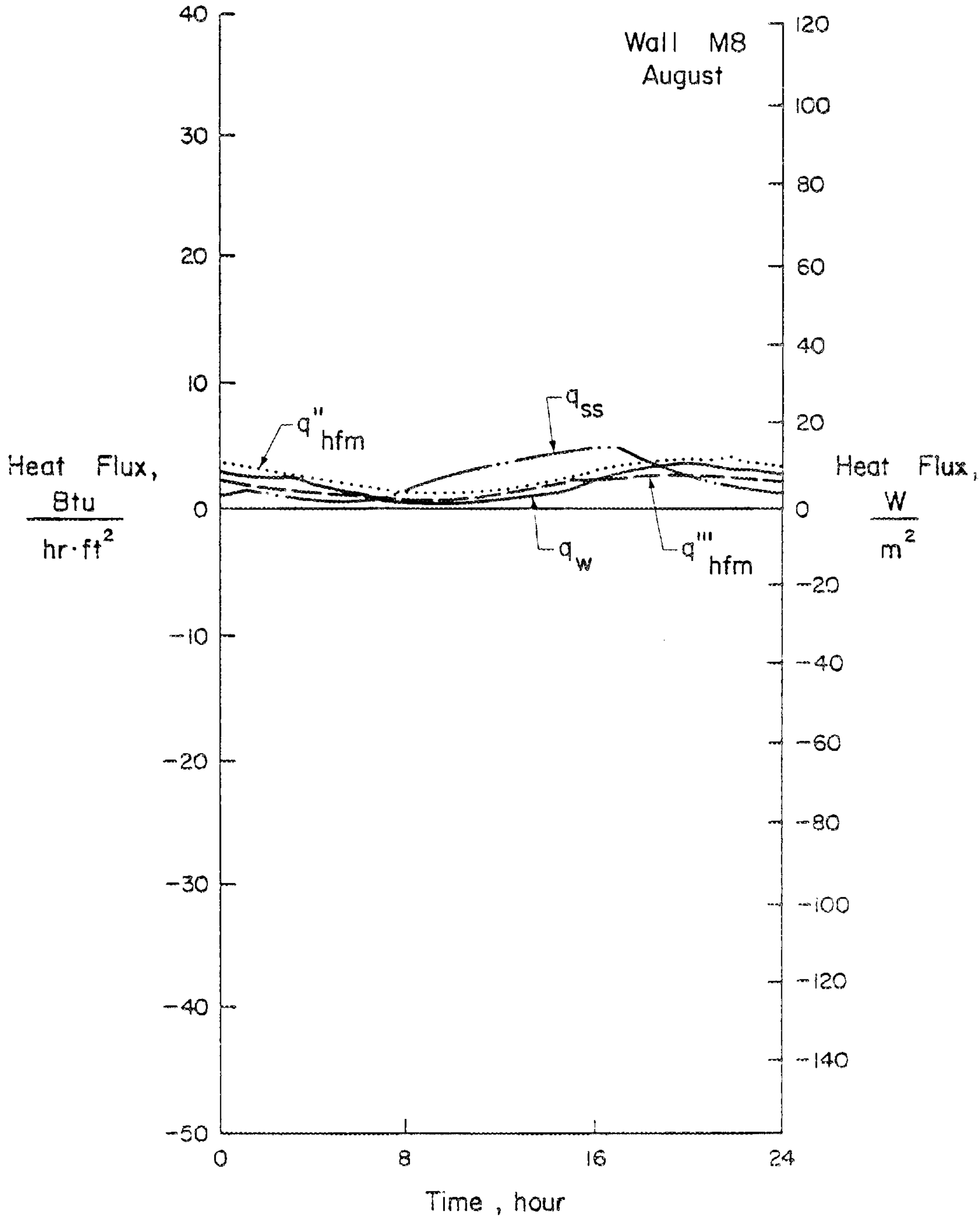


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M8-5 Wall M8 Dynamic Test Results for Phoenix August Test Cycle



(c) Heat Flux

Fig. M8-5 Wall M8 Dynamic Test Results for Phoenix August Test Cycle

TABLE M8-10(a) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX AUGUST TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Stud	q_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	83.0	87.2		79.4	78.5	2.77	3.22	1.96		1.20
2	81.4	85.6		79.3	78.5	2.50	2.93	1.75		0.97
3	80.0	84.2		79.2	78.5	2.64	2.62	1.54		0.77
4	78.5	82.8		79.1	78.5	1.96	2.41	1.44		0.57
5	77.1	81.4		79.0	78.5	1.78	2.10	1.23		0.37
6	79.4	81.7		79.0	78.4	1.23	1.88	1.06		0.41
7	86.2	84.7		79.0	78.5	0.27	1.59	0.93		0.87
8	94.4	89.6		78.9	78.4	0.36	1.43	0.84		1.65
9	99.5	93.8		78.9	78.5	0.23	1.27	0.84		2.31
10	102.6	96.8		78.9	78.4	0.23	1.33	0.97		2.78
11	105.3	99.4		79.0	78.4	0.14	1.50	1.16		3.18
12	107.3	101.7		79.1	78.4	0.72	1.72	1.35		3.53
13	109.5	103.7		79.2	78.4	0.92	2.01	1.58		3.83
14	111.7	105.8		79.4	78.5	1.24	2.34	1.79		4.14
15	114.4	108.0		79.1	78.5	1.61	2.70	2.06		4.54
16	115.9	110.0		79.6	78.5	2.03	3.08	2.31		4.79
17	113.1	109.6		79.7	78.5	2.91	3.40	2.52		4.71
18	105.7	106.2		79.8	78.6	3.43	3.79	2.77		4.15
19	98.8	101.9		79.8	78.6	3.52	4.05	2.88		3.45
20	92.2	97.4		79.8	78.5	3.90	4.21	2.86		2.74
21	88.7	94.0		79.8	78.5	3.58	4.23	2.77		2.20
22	87.2	91.9		79.7	78.6	3.22	4.12	2.62		1.89
23	86.0	90.3		79.6	78.5	3.23	3.89	2.39		1.65
24	84.6	88.9		79.5	78.5	2.96	3.60	2.16		1.45
Mean	95.1	94.9		79.3	78.5	1.97	2.73	1.82		2.42

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

Calibrated Hot Box Relative Humidity:
Indoor Chamber - 29%
Outdoor Chamber - 37%

Laboratory Air Temperature:
Max. - 76°F (24°C)
Min. - 66°F (19°C)

TABLE M8-10(b) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX AUGUST TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	28.3	30.7		26.3	25.8	8.73	10.14	6.19		3.78
2	27.4	29.8		26.3	25.8	7.90	9.23	5.51		3.05
3	26.7	29.0		26.2	25.8	8.34	8.27	4.87		2.42
4	25.8	28.2		26.2	25.8	6.18	7.61	4.54		1.79
5	25.1	27.4		26.1	25.8	5.62	6.63	3.89		1.16
6	26.3	27.6		26.1	25.8	3.87	5.93	3.35		1.30
7	30.1	29.3		26.1	25.8	0.85	5.00	2.93		2.76
8	34.7	32.0		26.1	25.8	1.14	4.51	2.64		5.20
9	37.5	34.3		26.1	25.8	0.73	4.00	2.66		7.27
10	39.2	36.0		26.1	25.8	0.73	4.19	3.06		8.77
11	40.7	37.4		26.1	25.8	0.44	4.74	3.64		10.02
12	41.8	38.7		26.2	25.8	2.28	5.43	4.26		11.13
13	43.1	39.8		26.2	25.8	2.89	6.33	4.98		12.09
14	44.3	41.0		26.3	25.8	3.90	7.36	5.65		13.06
15	45.8	42.2		26.2	25.8	5.08	8.50	6.49		14.33
16	46.6	43.3		26.4	25.8	6.39	9.71	7.27		15.11
17	45.1	43.1		26.5	25.8	9.18	10.72	7.94		14.86
18	40.9	41.2		26.6	25.9	10.83	11.94	8.73		13.07
19	37.1	38.8		26.6	25.9	11.11	12.78	9.09		10.89
20	33.4	36.3		26.6	25.8	12.29	13.28	9.03		8.63
21	31.5	34.4		26.6	25.8	11.30	13.35	8.74		6.94
22	30.7	33.3		26.5	25.9	10.15	13.01	8.26		5.95
23	30.0	32.4		26.4	25.8	10.18	12.25	7.54		5.21
24	29.2	31.6		26.4	25.8	9.34	11.35	6.82		4.57
Mean	35.1	34.9		26.3	25.8	6.23	8.59	5.75		7.64

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

TABLE M8-12 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), THERMAL LAG

Test Cycle	Thermal Lag, hrs												Calc. Time Constant, hrs
	Measured												
	Calibrated Hot Box					Heat Flow Meter @ Stud			Heat Flow Meter Between Studs				
	t_o vs t_1		q_{ss} vs q_w		Avg.	q_{ss} vs q''_{hfm}		Avg.	q_{ss} vs q'''_{hfm}		Avg.		
	@ Max.	@ Min.	@ Max.	@ Min.		@ Max.	@ Min.		@ Max.	@ Min.			
NBS	5.5	4	5	3	4.5	5	4	4.5	4	2	3		1.6
Phoenix January	3.5	3.5	4	2.5	3.5	4	3.5	4	3	2.5	3		1.6
Phoenix April	5	4	3.5	4	4	5	5	5	4	4	4		1.6
Phoenix August	3.5	4	4	6	4.5	4.5	4	4.5	3.5	3.5	3.5		1.6

TABLE M8-13 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), REDUCTION IN AMPLITUDE

Test Cycle	Reduction in Amplitude, %								
	Calibrated Hot Box			Heat Flow Meter @ Stud			Heat Flow Meter Between Studs		
	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.
NBS	34	20	27	36	26	31	56	52	54
Phoenix January	55	35	45	49	20	35	64	49	57
Phoenix April	35	37	36	36	29	33	57	52	55
Phoenix August	19	11	15	37	29	33	55	52	54

TABLE M8-14 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), ENERGY REQUIREMENTS

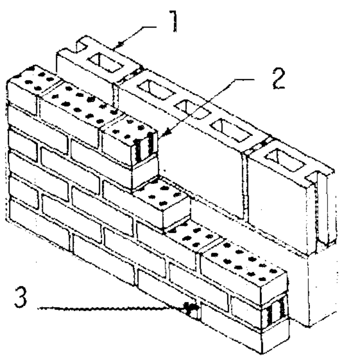
Test Cycle	Total Energy, Btu/ft^2 (W·hr/m^2)				Total Energy Comparisons, %			Net Energy, Btu/ft^2 (W·hr/m^2)				Net Energy Comparisons, %		
	Measured			Calc.				Measured			Calc.			
	q_w^T	$q_{hfm}^{T\,''}$	$q_{hfm}^{T\,'''}$	q_{ss}^T	$\frac{q_w^T}{q_{ss}^T}$	$\frac{q_{hfm}^{T\,''}}{q_{ss}^T}$	$\frac{q_{hfm}^{T\,'''}}{q_{ss}^T}$	q_w^N	$q_{hfm}^{N\,''}$	$q_{hfm}^{N\,'''}$	q_{ss}^N	$\frac{q_w^N}{q_{ss}^N}$	$\frac{q_{hfm}^{N\,''}}{q_{ss}^N}$	$\frac{q_{hfm}^{N\,'''}}{q_{ss}^N}$
NBS	34.1 (107.4)	33.8 (106.5)	22.5 (70.9)	46.2 (145.7)	74	73	49	13.8 (43.4)	9.2 (29.1)	8.5 (26.9)	10.9 (34.4)	127	84	78
Phoenix January	34.3 (108.2)	44.9 (141.6)	23.6 (74.3)	41.3 (130.4)	83	109	57	-34.3 (-108.2)	-44.9 (-141.6)	-23.6 (-74.3)	-34.1 (-107.7)	101	132	69
Phoenix April	24.6 (77.5)	26.2 (82.8)	18.2 (57.4)	36.2 (114.2)	68	72	50	9.5 (29.9)	9.7 (30.7)	9.6 (30.4)	11.2 (35.5)	84	86	86
Phoenix August	47.4 (149.5)	65.4 (206.4)	43.8 (138.1)	58.2 (183.5)	81	112	75	47.4 (149.5)	65.4 (206.4)	43.8 (138.1)	58.2 (183.5)	81	112	75

WALL M3: 10-IN. (254-MM) BLOCK-BRICK CAVITY WALL

DESCRIPTION: Uninsulated, unreinforced 10-in. (254-mm) cavity wall consisting of 4-in. (102-mm) hollow core concrete block and 4-in. (102-mm) clay brick separated by a 2-in. (51-mm) air space.

REFERENCE: Fiorato, A. E. and Cruz, C. R., "Thermal Performance of Masonry Walls," Research and Development Bulletin RD071, Portland Cement Association, Skokie, 1980, 17 pages.

COMPOSITION:



1. 4x8x16-in. (102x203x406-mm) Medium Weight Hollow Core Concrete Block - 3 cores per block
2. 4x2-1/2x8-in. (102x64x203-mm) Clay Brick - 10 cores per brick
3. Type M Mortar: one part portland cement, one-quarter part lime, and three parts masonry sand by volume
4. Metal Z-Ties Between Wythes - four in every other mortar joint of block

TABLE M3-1 - PHYSICAL PROPERTIES OF WALL AT TIME OF TEST

Property	Measured Value
Unit Weight, psf (kg/m^2)	66.7 (326)
Average Thickness, in. (mm)	9.6 (244)
Air Space Thickness, in. (mm)	2.0 (51)
Area, ft^2 (m^2)	73.90 (6.87)
Moisture Content of Block,* % by ovendry weight	1.5
Moisture Content of Brick,* % by ovendry weight	1.1

*Measured on masonry, including mortar joints, after test.

TABLE M3-2(a) - MATERIAL PROPERTIES, MEDIUM WEIGHT CONCRETE BLOCK

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Standard Dimensions, in. (mm)	--	--	--	3-5/8x7-5/8x15-5/8 (92x194x397)
Measured Dimensions, in. (mm)	ASTM C140	--	--	--
Percent Solid Volume	--	--	--	70
Ovendry Unit Weight, pcf (kg/m^3)	--	--	--	116 (1858)
Moisture Content, % ovendry weight	ASTM C140	--	--	1.1
Absorption, % ovendry weight	ASTM C140	--	--	9.1

TABLE M3-2(b) - MATERIAL PROPERTIES, CLAY BRICK

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Standard Dimensions, in. (mm)	--	--	--	3-3/4x2-1/4x8 (95x57x203)
Measured Dimensions, in. (mm)	ASTM C67	--	--	--
Percent Solid Volume	--	--	--	75
Ovendry Unit Weight, pcf (kg/m^3)	--	--	--	151 (2419)
Moisture Content, % ovendry weight	ASTM C67	--	--	0
Absorption, % ovendry weight	ASTM C67	--	--	1.8

TABLE M3-3 - DESIGN HEAT TRANSMISSION COEFFICIENTS

Component	R, Thermal Resistance hr·ft²·°F/Btu ($m^2 \cdot K/W$)
1. Outside Air Film	0.17 (0.03)
2. 4x2-1/2x8-in. (102x64x203-mm) Clay Brick	0.44* (0.08)
3. 2-in. (51-mm) Air Space	0.97** (0.17)
4. 4x8x16-in. (102x203x406-mm) Hollow Core Block	1.20*** (0.21)
5. Inside Air Film	0.68 (0.12)
Total R	3.46 (0.61)
Total U	0.29 (1.64)

*Source: Heat Transmission Coefficients of Brick Masonry Walls, Technical Notes on Brick Construction No. 4, Brick Institute of America, McLean, Virginia, August/September 1974.

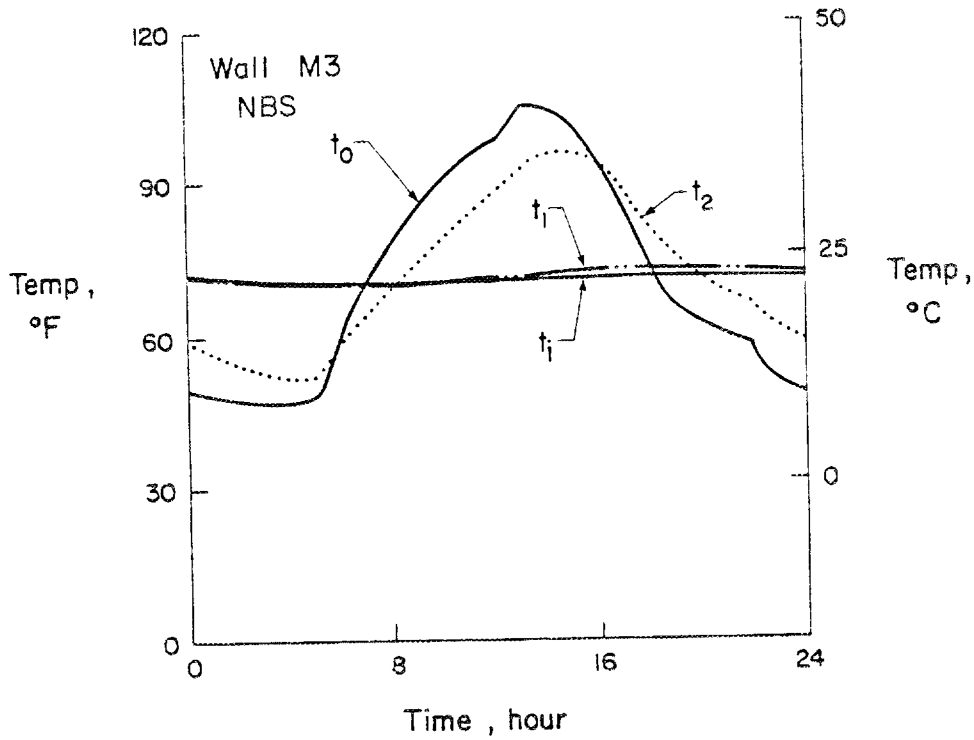
**Source: ASHRAE Handbook of Fundamentals, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., New York, 1977, Chapter 22.

***Source: Tables of U-Values for Concrete Masonry Walls, NCMA-TEK 67, National Concrete Masonry Association, McLean, Virginia, 1975.

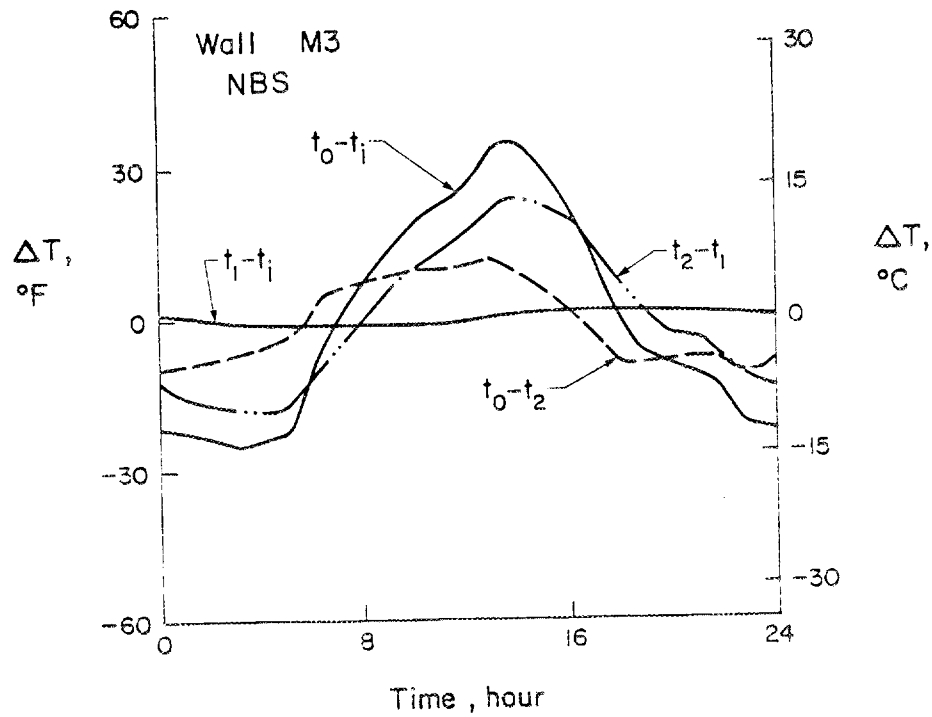
TABLE M3-4 - STEADY-STATE TEST RESULTS

Nominal Test Condition	q Heat Flux, Btu/hr·ft^2 (W/m^2)	R_T, hr·ft^2·°F/Btu (m^2·K/W)	U, Btu/hr·ft^2·°F (W/m^2·K)	Measured Temperatures, °F (°C)					Relative Humidity**		Laboratory Air Temperature	
				t_o Outdoor Air	t_2 Outdoor Surface	t_3* Internal	t_1 Indoor Surface	t_i Indoor Air	Indoor Chamber, %	Outdoor Chamber, %	Max. °F (°C)	Min. °F (°C)
t_m = 97°F (36°C)	13.7 (43.2)	3.61 (0.64)	0.28 (1.57)	122 (50)	116 (47)	-	79 (26)	73 (23)	-	-	73 (23)	71 (22)
t_m = 83°F (28°C)	6.5 (20.4)	3.43 (0.60)	0.29 (1.66)	94 (34)	92 (33)	-	75 (24)	72 (22)	-	-	75 (24)	75 (24)
t_m = 56°F (13°C)	-8.8 (-27.9)	3.70 (0.65)	0.27 (1.53)	38 (3)	43 (6)	-	68 (20)	71 (22)	-	-	76 (24)	74 (23)
t_m = 36°F (2°C)	-20.6 (-64.9)	3.59 (0.63)	0.28 (1.58)	-3 (-19)	7 (-14)	-	64 (18)	70 (21)	-	-	***	***
Design Values	-	3.46 (0.61)	0.29 (1.64)	-	-	-	-	-	-	-	-	-

*Internal thermocouples were not used for this wall assembly.
**Relative humidity was not measured for this wall assembly.
***Laboratory air temperature was not measured during this test.

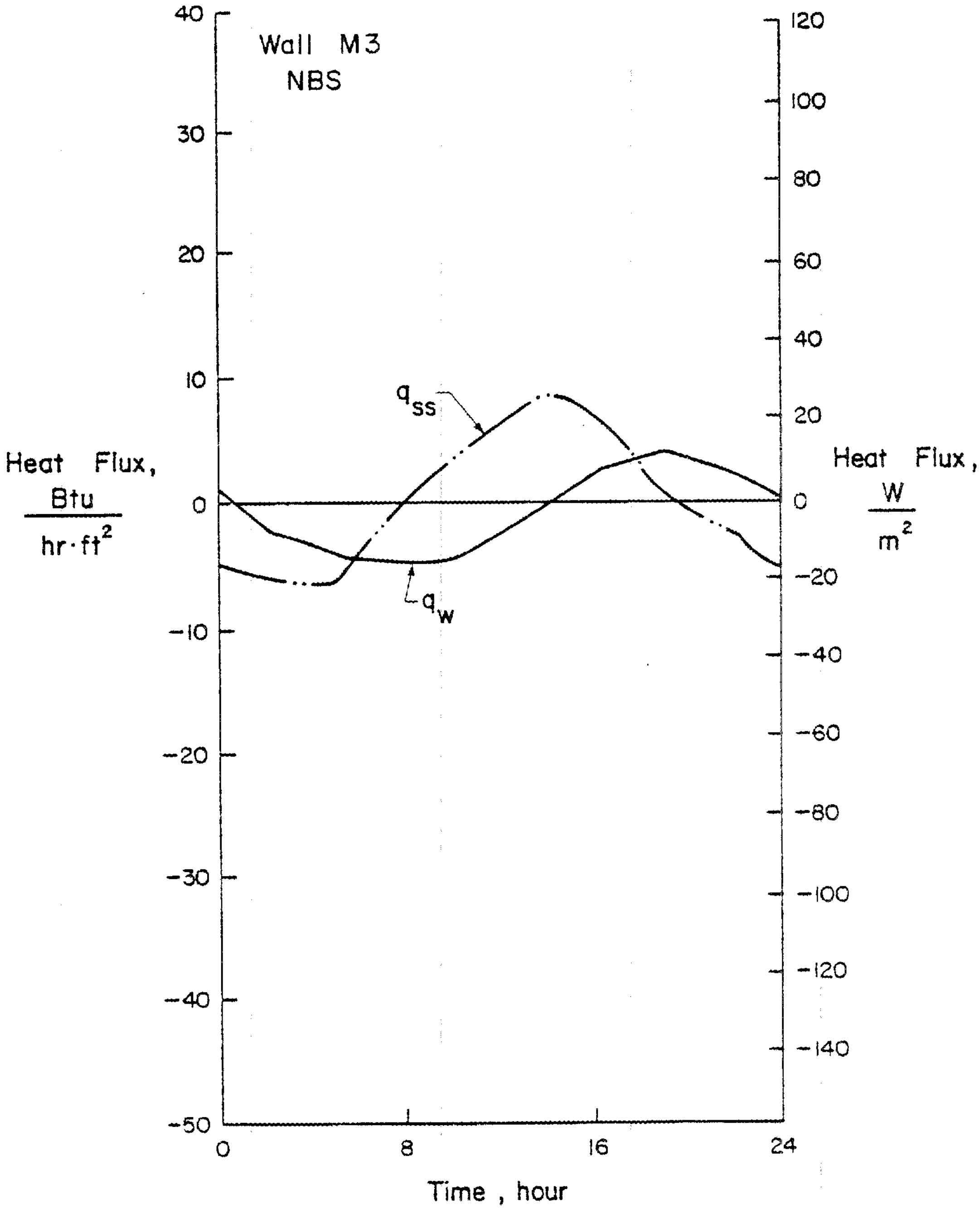


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M3-2 Wall M3 Dynamic Test Results for NBS Test Cycle



(c) Heat Flux

Fig. M3-2 Wall M3 Dynamic Test Results for NBS Test Cycle

TABLE M3-7(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q'_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1*	48.3	57.0		72.3	71.3	-0.46				-5.51
2	47.3	54.7		71.4	71.4	-2.15				-6.03
3	46.7	53.5		71.1	71.9	-2.79				-6.33
4	47.1	53.0		70.8	71.7	-3.54				-6.41
5	48.7	53.1		70.5	71.1	-4.39				-6.26
6	63.8	60.2		70.2	71.0	-4.48				-3.60
7	71.4	65.5		70.1	71.1	-4.77				-1.63
8	79.1	71.1		70.1	71.2	-4.85				0.35
9	86.0	76.5		70.3	71.2	-4.76				2.23
10	91.7	81.4		70.5	71.4	-4.20				3.91
11	95.2	85.3		71.0	71.7	-3.37				5.14
12*	99.2	88.8		71.5	71.9	-2.12				6.24
13*	106.5	94.4		72.0	71.8	-1.13				8.06
14*	106.6	96.9		72.6	71.5	-0.07				8.78
15*	102.7	96.3		73.0	71.5	1.27				8.36
16*	96.7	94.1		73.6	72.0	2.45				7.37
17*	86.5	88.9		74.0	72.3	3.35				5.36
18*	73.7	81.4		74.3	72.4	3.88				2.54
19*	66.1	75.5		74.4	72.2	4.27				0.38
20*	63.4	71.9		74.2	72.1	3.90				-0.82
21*	62.0	69.4		73.9	72.0	3.37				-1.59
22*	58.9	66.8		73.5	72.2	2.66				-2.40
23*	51.1	61.5		73.2	72.2	1.80				-4.20
24*	49.5	58.9		72.7	71.7	0.69				-4.97
Mean	72.8	73.2		72.1	71.7	-0.64				0.37

*Data are 2-day averages, not 3-day averages, of test results.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

Calibrated Hot Box Relative Humidity:
Indoor Chamber - Not measured for this wall assembly
Outdoor Chamber - Not measured for this wall assembly

Laboratory Air Temperature:
Max. - 73°F (23°C)
Min. - 66°F (19°C)

TABLE M3-7(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q'_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1*	9.1	13.9		22.4	21.9	-1.46				-17.38
2	8.5	12.6		21.9	21.9	-6.80				-19.00
3	8.2	12.0		21.7	22.2	-8.79				-29.96
4	8.4	11.7		21.6	22.1	-11.17				-20.21
5	9.3	11.7		21.4	21.7	-13.84				-19.75
6	17.7	15.7		21.2	21.7	-14.13				-11.35
7	21.9	18.6		21.2	21.7	-15.05				-5.15
8	26.1	21.7		21.2	21.8	-15.29				1.09
9	30.0	24.7		21.3	21.8	-15.00				7.04
10*	33.2	27.5		21.4	21.9	-13.26				12.34
11*	35.1	29.6		21.7	22.0	-10.63				16.20
12*	37.3	31.6		21.9	22.2	-6.70				19.66
13*	41.4	34.7		22.2	22.1	-3.57				25.42
14*	41.5	36.1		22.5	21.9	-0.22				27.69
15*	39.3	35.7		22.8	22.0	4.01				26.36
16*	36.0	34.5		23.1	22.2	7.72				23.25
17*	30.3	31.6		23.4	22.4	10.56				16.90
18*	23.1	27.4		23.5	22.4	12.24				8.02
19*	19.0	24.1		23.6	22.3	13.47				1.20
20*	17.4	22.2		23.4	22.3	12.31				-2.60
21*	16.6	20.8		23.3	22.2	10.63				-5.02
22*	14.9	19.3		23.0	22.3	8.38				-7.56
23*	10.6	16.4		22.9	22.3	5.68				-13.26
24*	9.7	15.0		22.6	22.1	-2.18				-15.67
Mean	22.7	22.9		22.3	22.1	-2.03				1.18

*Data are 2-day averages, not 3-day averages, of test results.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

TABLE M3-12 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), THERMAL LAG

Test Cycle	Thermal Lag, hrs											Calc. Time Constant, hrs
	Measured								Calculated			
	Calibrated Hot Box					Heat Flow Meter*			Response Factor**			
	t_o vs t_1		q_{ss} vs q_w		Avg.	q_{ss} vs q_{hfm}		Avg.	q_{ss} vs q_{rf}		Avg.	
	@ Max.	@ Min.	@ Max.	@ Min.		@ Max.	@ Min.		@ Max.	@ Min.		
NBS	5	4	5	4	4.5	-	-	-	-	-	-	1.2

*Heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

TABLE M3-13 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), REDUCTION IN AMPLITUDE

Test Cycle	Measured, %						Calculated, %		
	Calibrated Hot Box			Heat Flow Meter*			Response Factor**		
	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.
NBS	42	38	40	-	-	-	-	-	-

*Heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

TABLE M3-14 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), ENERGY REQUIREMENTS

Test Cycle	Total Energy, Btu/ft^2 (W·hr/m^2)				Total Energy Comparisons, %			Net Energy, Btu/ft^2 (W·hr/m^2)				Net Energy Comparisons, %		
	Measured		Calculated					Measured		Calculated				
	q_w^T	q_{hfm}^T *	q_{rf}^T **	q_{ss}^T	$\frac{q_w^T}{q_{ss}^T}$	$\frac{q_{hfm}^T}{q_{ss}^T}$	$\frac{q_{rf}^T}{q_{ss}^T}$	q_w^N	q_{hfm}^N *	q_{rf}^N **	q_{ss}^N	$\frac{q_w^N}{q_{ss}^N}$	$\frac{q_{hfm}^N}{q_{ss}^N}$	$\frac{q_{rf}^N}{q_{ss}^N}$
NBS	70.7 (223.1)			108.5 (342.2)	65			-15.4 (-48.7)			9.0 (28.3)	-171		

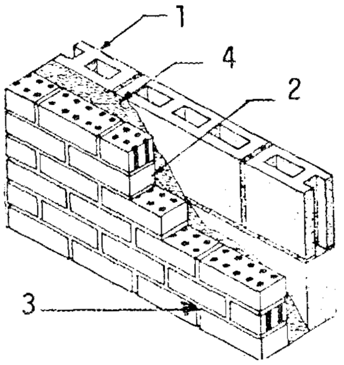
*Heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

WALL M4: 10-IN. (254-MM) BLOCK-BRICK CAVITY WALL WITH INSULATION IN CAVITY

DESCRIPTION: Unreinforced 10-in. (254-mm) cavity wall consisting of 4-in. (102-mm) hollow core concrete block and 4-in. (102-mm) clay brick separated by a 2-in. (51-mm) space filled with loose-fill insulation.

REFERENCE: Fiorato, A. E. and Cruz, C. R., "Thermal Performance of Masonry Walls," Research and Development Bulletin RD071, Portland Cement Association, Skokie, 1980, 17 pages.

COMPOSITION:



1. 4x8x16-in. (102x203x406-mm) Medium Weight Hollow Core Concrete Block - 3 cores per block
2. 4x2-1/2x8-in. (102x64x203-mm) Clay Brick - 10 cores per brick
3. Type M Mortar: one part portland cement, one-quarter part lime, and three parts masonry sand by volume
4. Silicone-Treated Perlite Insulation Loose unit weight of 6.1 pcf (97.7 kg/m^3)
5. Metal Z-Ties Between Wythes - four in every other mortar joint of block

TABLE M4-1 - PHYSICAL PROPERTIES OF WALL AT TIME OF TEST

Property	Measured Value
Unit Weight, psf (kg/m^2)	67.7 (331)
Average Thickness, in. (mm)	9.6 (244)
Cavity Thickness, in. (mm)	2.0 (51)
Area, ft^2 (m^2)	73.90 (6.87)
Moisture Content of Block,* % by ovendry weight	1.5
Moisture Content of Brick,* % by ovendry weight	1.1

*Measured on masonry, including mortar joints, after test.

TABLE M4-2(a) - MATERIAL PROPERTIES, MEDIUM WEIGHT CONCRETE BLOCK

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Standard Dimensions, in. (mm)	--	--	--	3-5/8x7-5/8x15-5/8 (92x194x397)
Measured Dimensions, in. (mm)	ASTM C140	--	--	--
Percent Solid Volume	--	--	--	70
Ovendry Unit Weight, pcf (kg/m^3)	--	--	--	116 (1858)
Moisture Content, % ovendry weight	ASTM C140	--	--	1.1
Absorption, % ovendry weight	ASTM C140	--	--	9.1

TABLE M4-2(b) - MATERIAL PROPERTIES, CLAY BRICK

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Standard Dimensions, in. (mm)	--	--	--	3-3/4x2-1/4x8 (95x57x203)
Measured Dimensions, in. (mm)	ASTM C67	--	--	--
Percent Solid Volume	--	--	--	75
Ovendry Unit Weight, pcf (kg/m^3)	--	--	--	151 (2419)
Moisture Content, % ovendry weight	ASTM C67	--	--	0
Absorption, % ovendry weight	ASTM C67	--	--	1.8

TABLE M4-3 - DESIGN HEAT TRANSMISSION COEFFICIENTS

Component	R, Thermal Resistance $hr \cdot ft^2 \cdot °F/Btu$ ($m^2 \cdot K/W$)
1. Outside Air Film	0.17 (0.03)
2. 4x2-1/2x8-in. (102x64x203-mm) Clay Brick	0.44* (0.08)
3. 2-in. (51-mm) Perlite Loose-Fill Insulation	6.06** (1.07)
4. 4x8x16-in. (102x203x406-mm) Hollow Core Block	1.20*** (0.21)
5. Inside Air Film	0.68 (0.12)
Total R	8.55 (1.51)
Total U	0.12 (0.66)

*Source: Heat Transmission Coefficients of Brick Masonry Walls, Technical Notes on Brick Construction No. 4, Brick Institute of America, McLean, Virginia, August/September 1974.

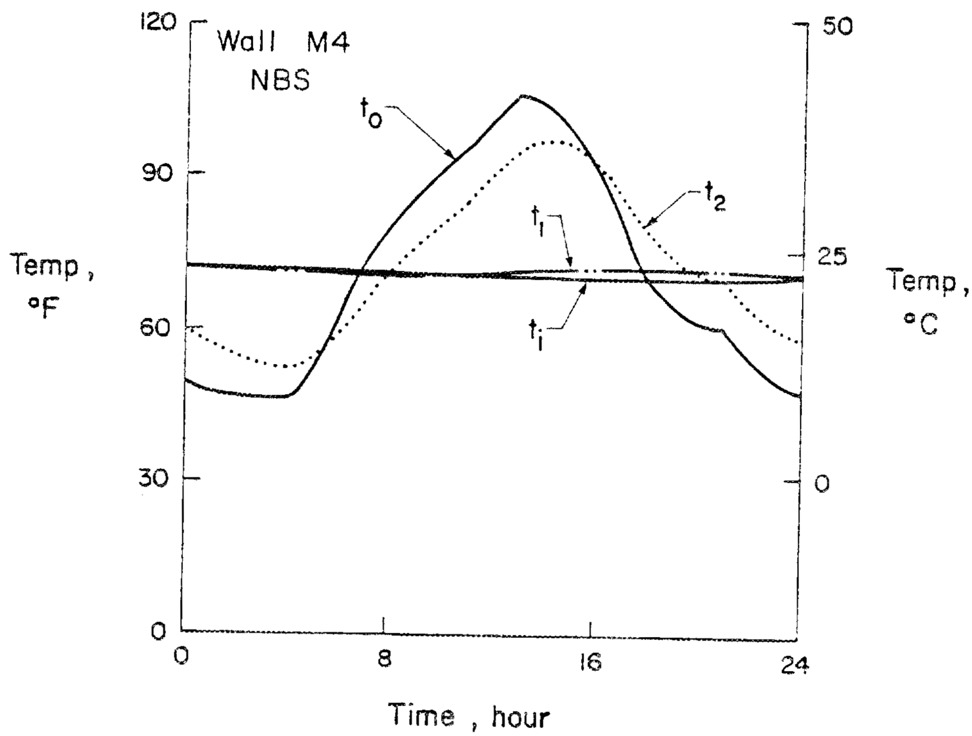
**Source: Perlite Loose Fill Insulation, Catalog Number 7.14d/Per, Perlite Institute, Inc., New York, 1978.

***Source: Tables of U-Values for Concrete Masonry Walls, NCMA-TEK 67, National Concrete Masonry Association, McLean, Virginia, 1975.

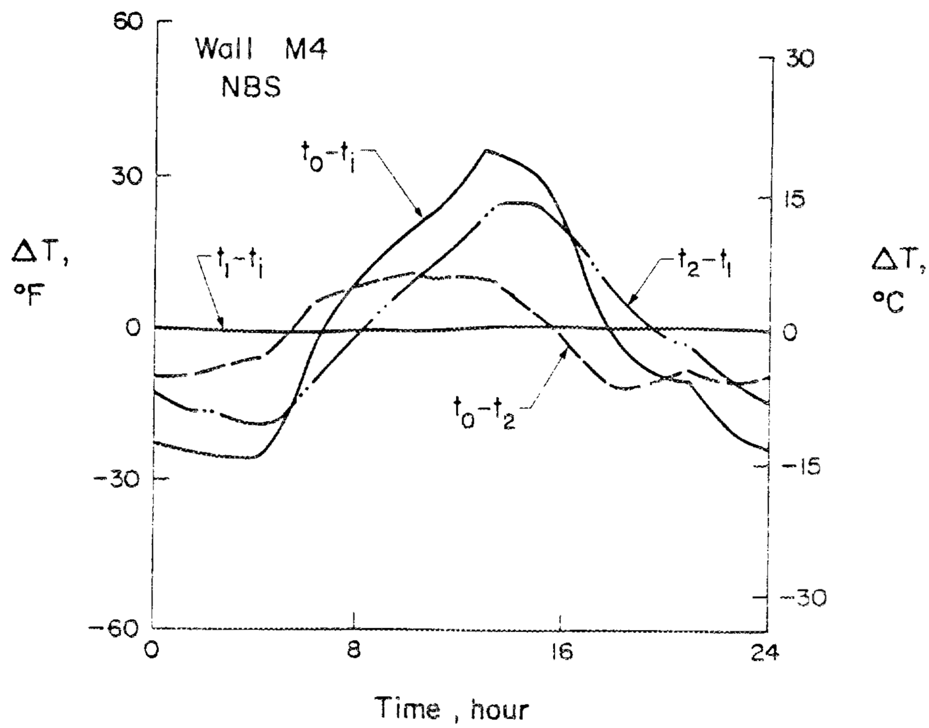
TABLE M4-4 - STEADY-STATE TEST RESULTS

Nominal Test Condition	q Heat Flux, Btu/hr·ft^2 (W/m^2)	R_T, hr·ft^2·°F/Btu (m^2·K/W)	U, Btu/hr·ft^2·°F (W/m^2·K)	Measured Temperatures, °F (°C)					Relative Humidity**		Laboratory Air Temperature	
				t_o Outdoor Air	t_2 Outdoor Surface	t_3* Internal	t_1 Indoor Surface	t_i Indoor Air	Indoor Chamber, %	Outdoor Chamber, %	Max. °F (°C)	Min. °F (°C)
t_m = 98°F (37°C)	6.0 (19.0)	8.54 (1.50)	0.12 (0.66)	123 (51)	121 (49)	-	75 (24)	72 (22)	-	-	71 (22)	71 (22)
t_m = 84°F (27°C)	2.3 (7.4)	9.63 (1.70)	0.10 (0.59)	94 (34)	94 (34)	-	73 (23)	72 (22)	-	-	72 (22)	72 (22)
t_m = 55°F (13°C)	-3.8 (-12.0)	9.03 (1.59)	0.11 (0.63)	37 (3)	39 (4)	-	71 (22)	72 (22)	-	-	74 (23)	74 (23)
t_m = 33°F (1°C)	-9.5 (-30.1)	8.33 (1.47)	0.12 (0.68)	-7 (-22)	-3 (-19)	-	69 (21)	71 (22)	-	-	75 (24)	72 (22)
Design Values	-	8.55 (1.51)	0.12 (0.66)	-	-	-	-	-	-	-	-	-

*Internal thermocouples were not used for this wall assembly.
**Relative humidity was not measured for this wall assembly.

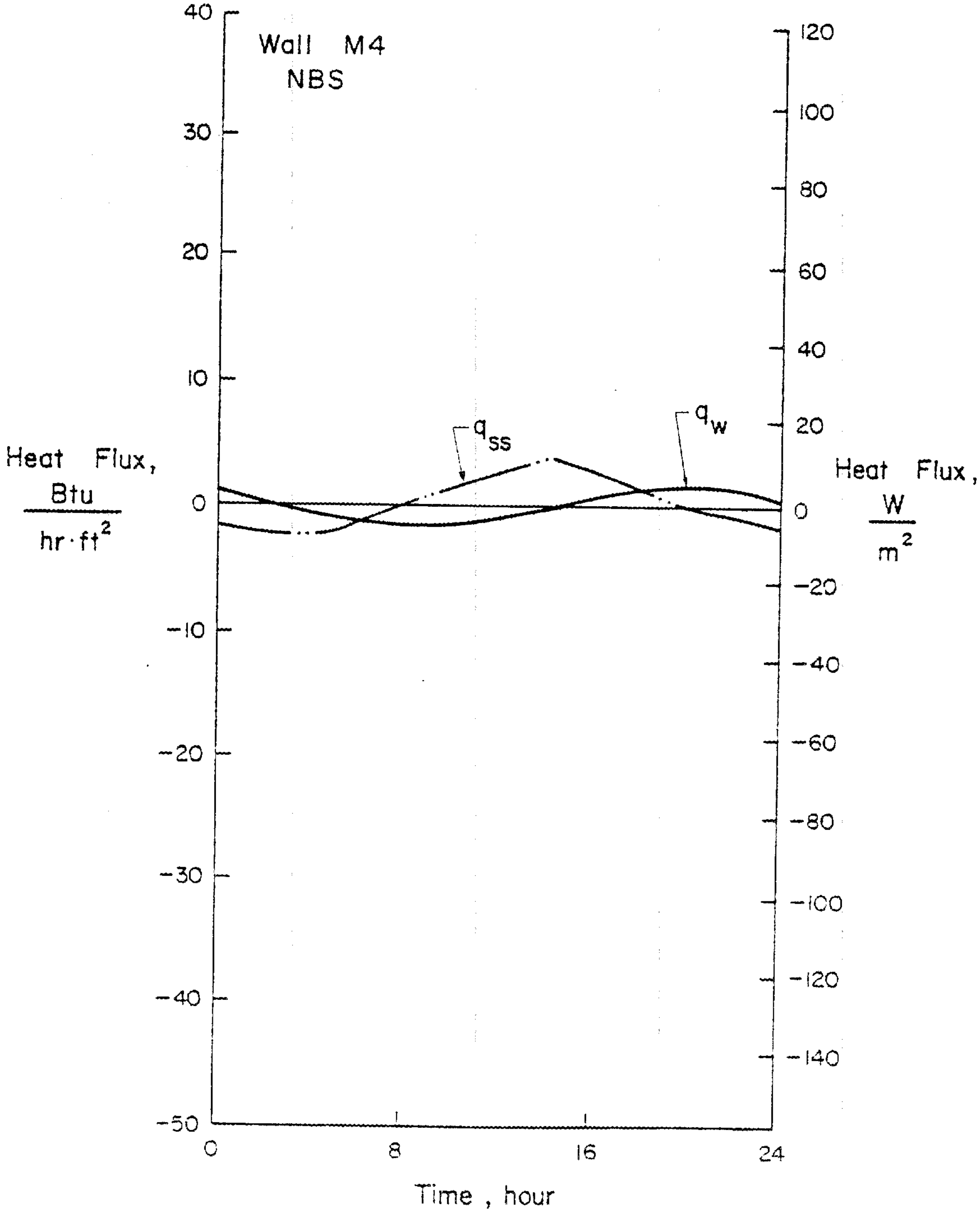


(a) Measured Temperatures



(b) Temperature Differentials

Fig. M4-2 Wall M4 Dynamic Test Results for NBS Test Cycle



(c) Heat Flux

Fig. M4-2 Wall M4 Dynamic Test Results for NBS Test Cycle

TABLE M4-7(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q'_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1	47.5	56.4		72.4	71.9	0.77				-2.09
2	46.5	54.4		72.3	72.0	0.45				-2.32
3	46.4	53.2		72.1	71.7	-0.16				-2.46
4	46.6	52.4		72.0	71.8	-0.53				-2.55
5	53.6	54.4		71.8	71.7	-0.84				-2.26
6	66.6	61.5		71.7	71.6	-1.03				-1.33
7	74.0	66.6		71.6	71.7	-1.23				-0.65
8	81.6	72.3		71.6	71.8	-1.37				0.09
9	87.6	77.2		71.6	71.9	-1.60				0.73
10	93.0	82.2		71.6	71.7	-1.53				1.38
11	96.4	86.2		71.7	71.6	-1.38				1.89
12	102.0	90.9		71.9	71.7	-0.81				2.47
13	107.8	96.4		72.0	71.3	-0.49				3.17
14	106.0	98.0		72.1	71.4	-0.09				3.37
15*	102.0	97.4		72.3	71.6	0.16				3.25
16	94.3	94.3		72.6	72.1	0.87				2.82
17	82.5	88.4		72.8	72.1	1.22				2.03
18	71.0	81.1		72.9	72.1	1.50				1.07
19	65.1	75.8		73.0	72.0	1.81				0.37
20	62.8	72.4		73.0	72.1	2.01				-0.07
21	61.8	70.1		72.9	72.2	2.07				-0.37
22	55.6	65.8		72.9	72.0	1.87				-0.91
23	50.1	61.1		72.7	71.5	1.44				-1.52
24	48.8	58.5		72.5	71.6	1.07				-1.83
Mean	72.9	73.6		72.3	71.8	0.18				0.18

*Data are 2-day averages, not 3-day averages, of test results.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

Calibrated Hot Box Relative Humidity:
Indoor Chamber - Not measured for this wall assembly
Outdoor Chamber - Not measured for this wall assembly

Laboratory Air Temperature:
Max. - 76°F (24°C)
Min. - 69°F (21°C)

TABLE M4-7(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q'_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1	8.6	13.5		22.5	22.2	2.44				-6.59
2	8.1	12.5		22.4	22.2	1.42				-7.33
3	8.0	11.8		22.3	22.1	-0.52				-7.77
4	8.1	11.3		22.2	22.1	-1.69				-8.04
5	12.0	12.4		22.1	22.1	-2.66				-7.14
6	19.2	16.4		22.1	22.0	-3.24				-4.19
7	23.3	19.2		22.0	22.1	-3.87				-2.05
8	27.6	22.4		22.0	22.1	-4.31				0.27
9	30.9	25.1		22.0	22.1	-5.04				2.30
10	33.9	27.9		22.0	22.0	-4.84				4.35
11	35.8	30.1		22.1	22.0	-4.36				5.95
12	38.9	32.7		22.1	22.0	-2.56				7.80
13	42.1	35.8		22.2	21.8	-1.54				9.99
14	41.1	36.7		22.3	21.9	-0.28				10.62
15*	38.9	36.3		22.4	22.0	0.50				10.26
16	34.6	34.6		22.6	22.3	2.73				8.90
17	28.0	31.3		22.7	22.3	3.85				6.39
18	21.7	27.3		22.7	22.3	4.72				3.37
19	18.4	24.4		22.8	22.2	6.03				1.16
20	17.1	22.5		22.8	22.3	6.33				-0.23
21	16.6	21.2		22.7	22.3	6.52				-1.17
22	13.1	18.8		22.7	22.2	5.89				-2.88
23	10.0	16.2		22.6	22.0	4.53				-4.78
24	9.3	14.7		22.5	22.0	3.36				-5.76
Mean	22.7	23.1		22.4	22.1	0.56				0.56

*Data are 2-day averages, not 3-day averages, of test results.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

TABLE M4-12 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), THERMAL LAG

Test Cycle	Thermal Lag, hrs											Calc. Time Constant, hrs
	Measured								Calculated			
	Calibrated Hot Box					Heat Flow Meter*			Response Factor**			
	t_o vs t_1		q_{ss} vs q_w		Avg.	q_{ss} vs q_{hfm}		Avg.	q_{ss} vs q_{rf}		Avg.	
	@ Max.	@ Min.	@ Max.	@ Min.		@ Max.	@ Min.		@ Max.	@ Min.		
NBS	6	5.5	7	5	6	-	-	-	-	-	-	2.1

*Heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

TABLE M4-13 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), REDUCTION IN AMPLITUDE

Test Cycle	Measured, %						Calculated, %		
	Calibrated Hot Box			Heat Flow Meter*			Response Factor**		
	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.
NBS	41	35	38	-	-	-	-	-	-

*Heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

TABLE M4-14 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), ENERGY REQUIREMENTS

Test Cycle	Total Energy, Btu/ft^2 (W·hr/m^2)				Total Energy Comparisons, %			Net Energy, Btu/ft^2 (W·hr/m^2)				Net Energy Comparisons, %		
	Measured		Calculated					Measured		Calculated				
	q_w^T	q_{hfm}^T *	q_{rf}^T **	q_{ss}^T	$\frac{q_w^T}{q_{ss}^T}$	$\frac{q_{hfm}^T}{q_{ss}^T}$	$\frac{q_{rf}^T}{q_{ss}^T}$	q_w^N	q_{hfm}^N *	q_{rf}^N **	q_{ss}^N	$\frac{q_w^N}{q_{ss}^N}$	$\frac{q_{hfm}^N}{q_{ss}^N}$	$\frac{q_{rf}^N}{q_{ss}^N}$
NBS	26.4 (83.2)			41.0 (129.4)	64			4.3 (13.4)			4.3 (13.5)	100		

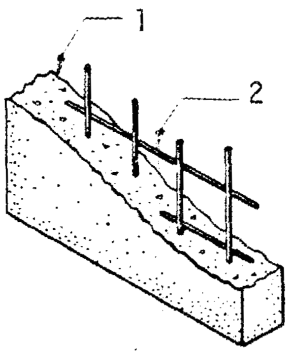
*Heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

WALL C1: NORMAL WEIGHT CONCRETE

DESCRIPTION: Normal weight structural concrete wall with reinforcement at approximate midthickness

REFERENCE: Van Geem, M. G., Fiorato, A. E., and Julien, J. T., "Heat Transfer Characteristics of a Normal Weight Concrete Wall," Construction Technology Laboratories, Portland Cement Association, Skokie, 1983, 89 pages.

COMPOSITION:



1. Normal Weight Concrete
   Portland Cement
   Elgin Gravel and Sand
   Measured Air Content: 5.9%

2. Reinforcement
   Single layer of Grade 60 No. 5 bars
   Spaced 12 in. (305 mm) center-to-center

TABLE C1-1 - PHYSICAL PROPERTIES OF WALL AT TIME OF TEST

Property	Measured Value
Unit weight, psf (kg/m^2)	100 (488)
Average Thickness, in. (mm)	8.31 (211)
Area, ft^2 (m^2)	73.5 (6.84)
Estimated Moisture Content, % by ovendry weight	2.1

TABLE C1-2 - MATERIAL PROPERTIES, NORMAL WEIGHT CONCRETE

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Unit Weight, pcf (kg/m^3)	--	ovendry	--	141 (2260)
Specific Heat, Btu/lb·°F (J/kg·K)	Similar to CRD-C124-73	saturated	73 (23)	0.214 (896)
Specific Heat, Btu/lb·°F (J/kg·K)	Calculated	air dry	73 (23)	0.193 (808)
Thermal Conductivity, Btu·in/hr·ft^2·°F (W/m·K)	Hot Wire	air dry	--	20.3 (2.93)
Thermal Conductivity, Btu·in/hr·ft^2·°F (W/m·K)	ASTM C 177	ovendry	70 (21)	16.1 (2.32)
Thermal Conductivity, Btu·in/hr·ft^2·°F (W/m·K)	ASTM C 976	air dry	70 (21)	11.7 (1.69)
Thermal Diffusivity, ft^2/hr (mm^2/s)	CRD-C36-73	saturated	--	0.037 (0.955)
Compressive Strength, psi (MPa)	ASTM C 39	air dry	--	5715 (39.4)
Splitting Tensile Strength, psi (MPa)	ASTM C 496	air dry	--	514 (3.54)

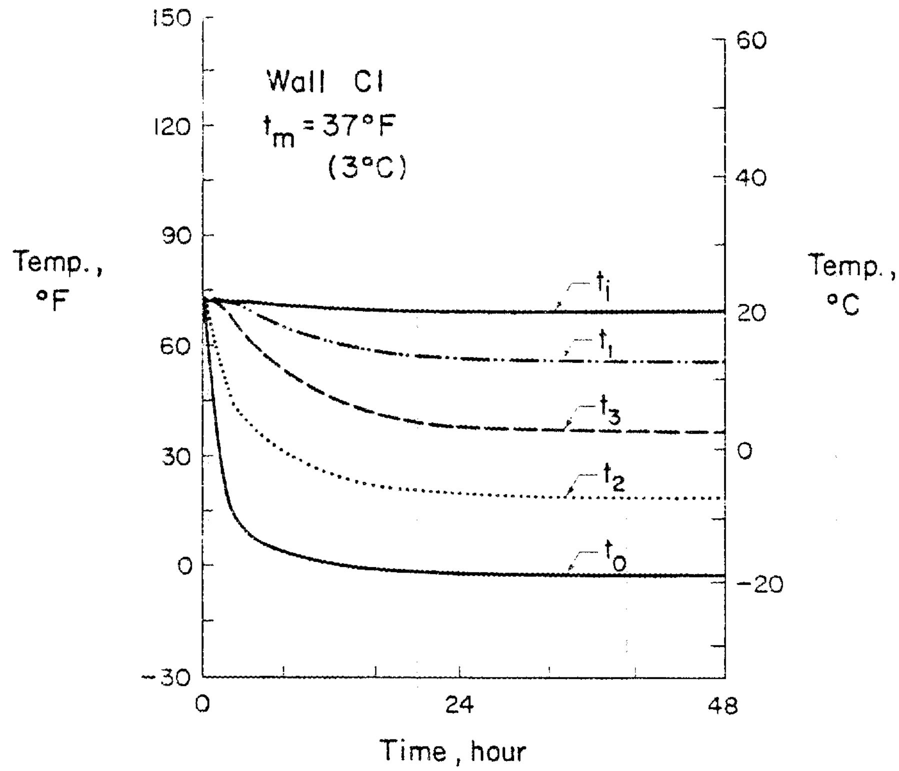
TABLE C1-3 - DESIGN HEAT TRANSMISSION COEFFICIENTS

Component	R, Thermal Resistance hr·ft^2·°F/Btu (m^2·K/W)
1. Outside Air Film	0.17 (0.03)
2. 8-in. (203-mm) Normal Weight Concrete	0.69* (0.12)
3. Inside Air Film	0.68 (0.12)
Total R	1.54 (0.27)
Total U	0.65 (3.70)

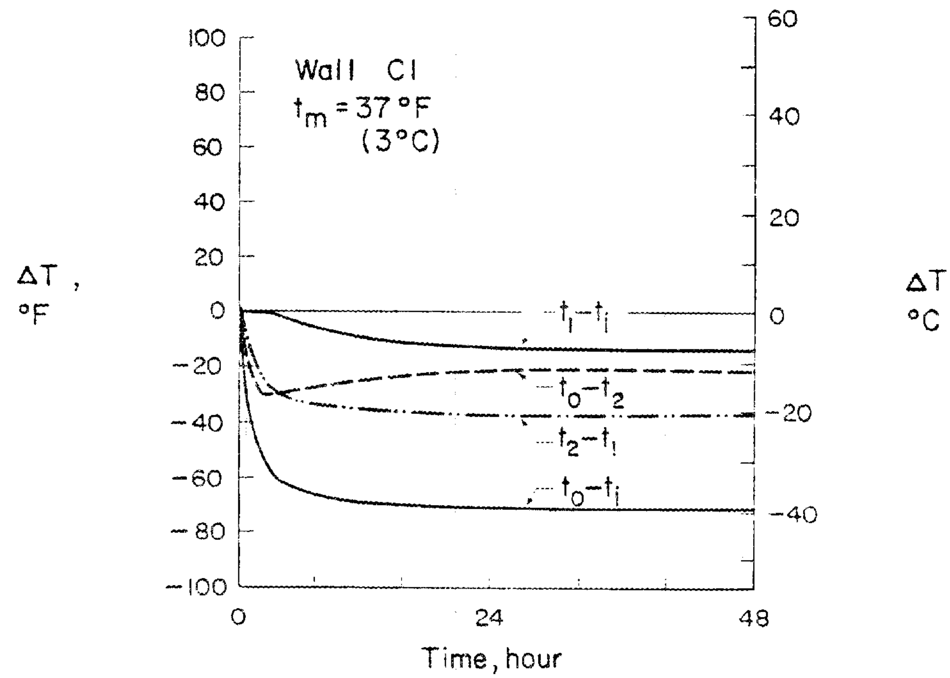
*Source: <u>ASHRAE Handbook of Fundamentals</u>, American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc., Atlanta, 1981, Chapter 23.

TABLE C1-4 - STEADY-STATE TEST RESULTS

Nominal Test Condition	q Heat Flux, Btu/hr·ft^2 (W/m^2)	R_T, hr·ft^2·°F/Btu (m^2·K/W)	U, Btu/hr·ft^2·°F (W/m^2·K)	Measured Temperatures, °F (°C)					Relative Humidity		Laboratory Air Temperature	
				t_o Outdoor Air	t_2 Outdoor Surface	t_3 Internal	t_1 Indoor Surface	t_i Indoor Air	Indoor Chamber, %	Outdoor Chamber, %	Max. °F (°C)	Min. °F (°C)
t_m = 37°F (3°C)	-51.6 (-163)	1.56 (0.28)	0.64 (3.63)	-2 (-19)	19 (-7)	36 (2)	55 (13)	69 (21)	26	22	76 (24)	73 (23)
t_m = 55°F (13°C)	-26.0 (-82)	1.56 (0.28)	0.64 (3.63)	34 (1)	46 (8)	54 (12)	64 (18)	71 (22)	31	19	73 (23)	70 (21)
t_m = 101°F (38°C)	41.6 (131)	1.55 (0.27)	0.64 (3.65)	128 (53)	116 (47)	100 (38)	86 (30)	76 (24)	31	25	74 (23)	70 (21)
Design Values	-	1.54 (0.27)	0.65 (3.70)	-	-	-	-	-	-	-	-	-

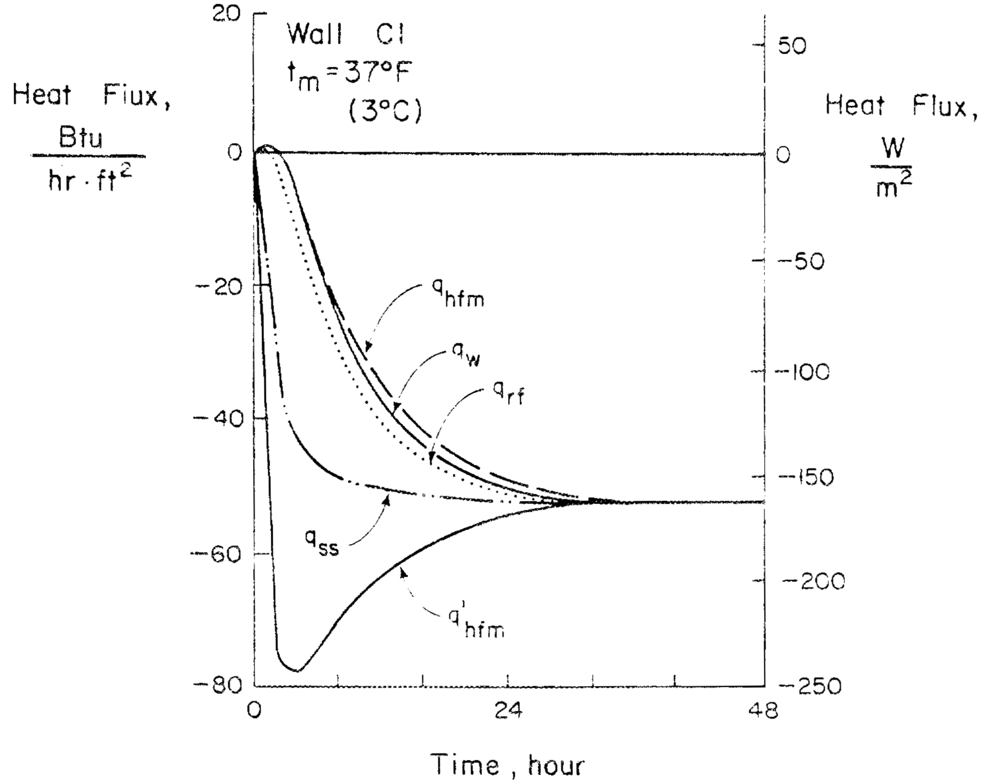


(a) Measured Temperatures



(b) Temperature Differentials

Fig. C1-1 Wall C1 Transient Test Results



(c) Heat Flux

Fig. C1-1 Wall C1 Transient Test Results

TABLE C1-5(a) - TRANSIENT TEST RESULTS

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
0	72.5	73.1	72.4	72.9	72.5	0.6	0.9	-0.6	0.0	0.3
1	39.3	60.7	71.9	72.9	72.5	1.0	0.9	-47.7	-0.1	-17.3
2	18.7	48.5	69.3	72.6	72.4	0.3	0.1	-76.2	-1.4	-33.9
3	12.6	42.6	65.7	71.3	72.0	-2.8	-2.8	-78.6	-5.0	-40.0
4	9.0	38.7	62.2	69.7	71.8	-7.8	-6.7	-78.9	-10.9	-43.3
5	7.5	36.0	59.1	68.0	71.6	-12.4	-11.1	-75.3	-16.8	-44.8
6	5.9	33.6	56.2	66.5	71.2	-17.8	-15.3	-73.9	-21.8	-46.0
7	4.4	31.5	53.6	65.1	70.9	-21.6	-19.5	-71.5	-26.3	-47.0
8	3.2	29.7	51.4	63.9	70.6	-26.0	-23.0	-70.0	-30.1	-47.8
9	2.4	28.0	49.4	62.8	70.5	-28.9	-26.5	-68.2	-33.7	-48.5
10	1.5	26.7	47.6	61.8	70.2	-32.1	-29.5	-66.8	-36.3	-49.0
11	1.0	25.6	46.1	61.0	70.1	-34.9	-32.3	-65.7	-38.7	-49.4
12	0.5	24.6	44.8	60.3	70.0	-37.0	-34.5	-63.6	-40.9	-49.8
13	0.1	23.7	43.6	59.6	69.8	-39.4	-36.9	-61.9	-42.4	-50.1
14	-0.4	23.0	42.6	59.1	69.7	-40.7	-39.0	-61.1	-43.9	-50.3
15	-0.7	22.4	41.7	58.6	69.6	-42.5	-40.4	-60.1	-45.0	-50.5
16	-0.9	21.8	41.0	58.2	69.6	-43.5	-42.3	-59.3	-46.1	-50.7
17	-1.2	21.3	40.3	57.8	69.5	-44.8	-43.3	-58.5	-47.0	-50.9
18	-1.3	21.0	39.7	57.4	69.4	-45.5	-44.5	-57.9	-47.7	-50.9
19	-1.5	20.6	39.3	57.2	69.3	-46.2	-45.6	-56.5	-48.2	-51.0
20	-1.6	20.3	38.8	56.9	69.3	-47.0	-46.4	-56.2	-48.8	-51.0
21	-1.7	20.1	38.5	56.6	69.3	-47.5	-46.8	-55.5	-49.3	-51.1
22	-1.8	19.8	38.2	56.5	69.2	-48.1	-47.9	-55.5	-49.6	-51.1
23	-1.9	19.7	37.9	56.3	69.2	-48.5	-48.4	-55.1	-49.9	-51.1
24	-1.9	19.5	37.7	56.2	69.2	-49.1	-48.5	-54.3	-50.2	-51.2
26	-2.1	19.2	37.3	56.0	69.1	-49.7	-49.7	-53.9	-50.5	-51.3
28	-2.1	19.0	37.0	55.9	69.0	-50.4	-50.3	-53.3	-50.7	-51.4
30	-2.2	18.9	36.8	55.8	69.1	-50.6	-50.8	-53.1	-51.1	-51.4
32	-2.2	18.8	36.6	55.7	69.1	-51.1	-51.4	-52.6	-51.3	-51.5
34	-2.3	18.8	36.6	55.7	69.2	-51.2	-51.8	-52.9	-51.5	-51.5
36	-2.3	18.7	36.5	55.6	69.1	-51.3	-51.8	-52.6	-51.3	-51.5
38*	-2.3	18.7	36.5	55.6	69.1	-51.3	-51.8	-52.6	-51.4	-51.5
40*	-2.4	18.7	36.4	55.5	69.0	-51.3	-51.8	-52.5	-51.5	-51.5
42*	-2.4	18.6	36.4	55.5	69.0	-51.3	-51.8	-52.4	-51.5	-51.5
44*	-2.4	18.5	36.3	55.4	69.0	-51.3	-51.8	-52.4	-51.6	-51.5
46	-2.5	18.5	36.2	55.4	69.0	-51.3	-52.0	-52.4	-51.6	-51.5
48	-2.4	18.5	36.1	55.4	68.9	-51.4	-52.1	-52.3	-51.5	-51.5

*Data for these hours derived from linear interpolation of data from hours 36 to 45.
**Response factor values supplied by Ken Childs, ORNL. Values calculated using NBS Response Factor Program by Peavy.

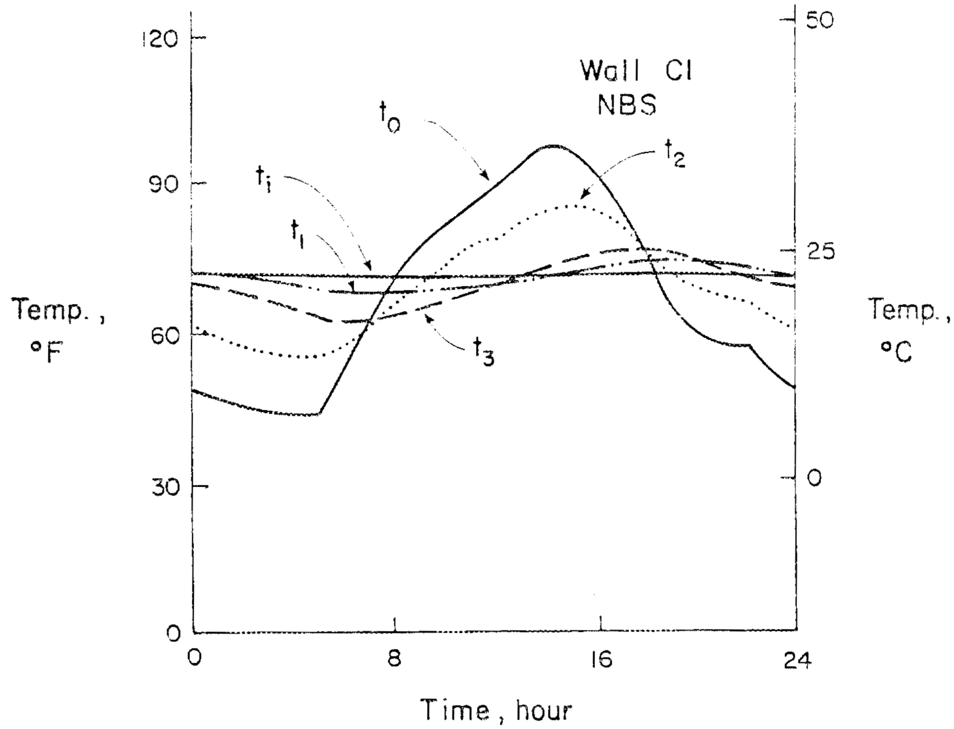
TABLE C1-5(b) - TRANSIENT TEST RESULTS, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
0	22.5	22.9	22.4	22.7	22.5	2	3	-2	0	1
1	4.1	15.9	22.2	22.7	22.5	3	3	-150	0	-55
2	-7.4	9.2	20.2	22.5	22.4	1	0	-240	-5	-107
3	-10.8	5.9	18.7	21.9	22.2	-9	-9	-248	-16	-126
4	-12.8	3.7	16.8	20.9	22.1	-25	-21	-249	-34	-137
5	-13.6	2.2	15.0	20.0	22.0	-39	-35	-238	-53	-141
6	-14.5	0.9	13.4	19.2	21.8	-56	-48	-233	-69	-145
7	-15.3	-0.3	12.0	18.4	21.6	-68	-62	-226	-83	-148
8	-16.0	-1.3	10.8	17.7	21.4	-82	-73	-221	-95	-151
9	-16.5	-2.2	9.7	17.1	21.4	-91	-84	-215	-106	-153
10	-16.9	-2.9	8.7	16.6	21.3	-101	-93	-211	-115	-155
11	-17.2	-3.6	7.8	16.1	21.2	-110	-102	-207	-122	-156
12	-17.5	-4.1	7.1	15.7	21.1	-117	-109	-201	-129	-157
13	-17.8	-4.6	6.5	15.3	21.0	-124	-116	-195	-134	-158
14	-18.0	-5.0	5.9	15.0	21.0	-128	-123	-193	-138	-159
15	-18.2	-5.3	5.4	14.8	20.9	-134	-127	-189	-142	-159
16	-18.3	-5.7	5.0	14.5	20.9	-137	-133	-187	-146	-160
17	-18.4	-6.0	4.6	14.3	20.8	-141	-137	-184	-148	-161
18	-18.5	-6.1	4.3	14.1	20.8	-143	-140	-183	-150	-161
19	-18.6	-6.3	4.0	14.0	20.7	-146	-144	-178	-152	-161
20	-18.7	-6.5	3.8	13.8	20.7	-148	-146	-177	-154	-161
21	-18.7	-6.6	3.6	13.7	20.7	-150	-148	-175	-155	-161
22	-18.8	-6.8	3.5	13.6	20.7	-152	-151	-175	-156	-161
23	-18.8	-6.8	3.3	13.5	20.7	-153	-153	-174	-157	-161
24	-18.8	-6.9	3.2	13.4	20.7	-155	-153	-171	-158	-161
26	-18.9	-7.1	2.9	13.3	20.6	-157	-157	-170	-159	-162
28	-19.0	-7.2	2.8	13.3	20.6	-159	-159	-168	-160	-162
30	-19.0	-7.3	2.7	13.2	20.6	-160	-160	-168	-161	-162
32	-19.0	-7.3	2.6	13.2	20.6	-161	-162	-166	-162	-163
34	-19.0	-7.4	2.6	13.2	20.7	-161	-163	-167	-162	-163
36	-19.1	-7.4	2.5	13.1	20.6	-162	-163	-166	-162	-162
38*	-19.1	-7.4	2.5	13.1	20.6	-162	-163	-166	-162	-162
40*	-19.1	-7.4	2.4	13.1	20.6	-162	-163	-166	-162	-162
42*	-19.1	-7.5	2.4	13.0	20.6	-162	-163	-166	-162	-162
44*	-19.1	-7.5	2.4	13.0	20.6	-162	-163	-165	-163	-162
46	-19.1	-7.5	2.3	13.0	20.6	-162	-164	-165	-163	-163
48	-19.1	-7.5	2.3	13.0	20.5	-162	-164	-165	-162	-163

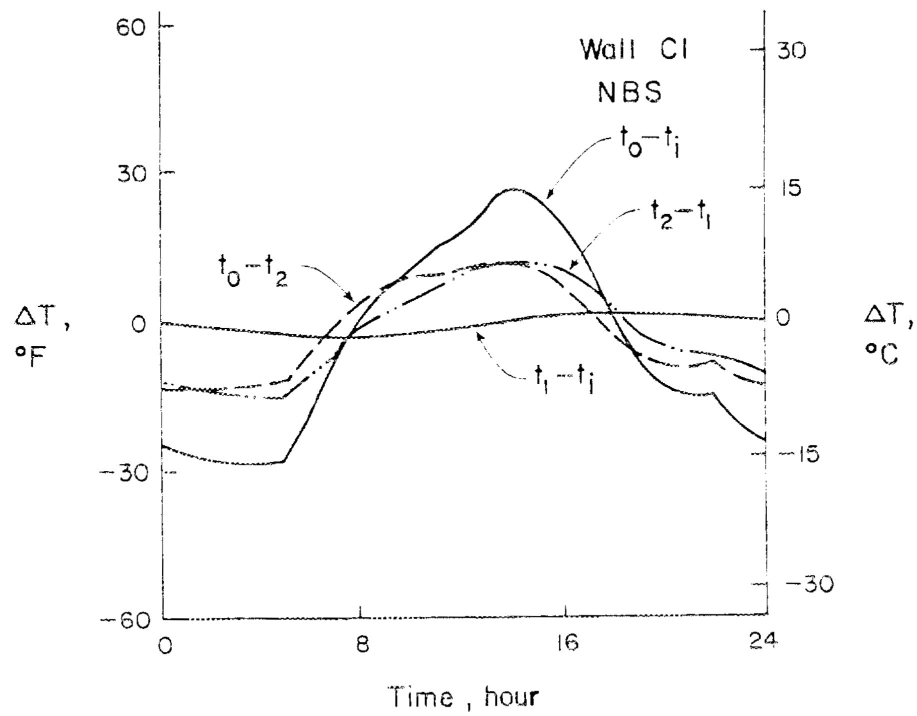
*Data for these hours derived from linear interpolation of data from hours 36 to 45.

TABLE C1-6 - SUMMARY OF TRANSIENT TEST RESULTS

Heat Flux	Measured				Calculated			
	Calib. Hot Box		HFM @ Indoor Surf.		Response Factor		Steady-State	
	q_w, Btu/hr·ft^2 (W/m^2)	Time to Reach q_w, hr	q_{hfm}, Btu/hr·ft^2 (W/m^2)	Time to Reach q_{hfm}, hr	q_{rf}, Btu/hr·ft^2 (W/m^2)	Time to Reach q_{rf}, hr	q_{ss}, Btu/hr·ft^2 (W/m^2)	Time to Reach q_{ss}, hr
99.5% of Final Heat Flux	-51.3 (-162)	36	-52.1 (-164)	47	-51.3 (-162)	32	-51.3 (-162)	26
95% of Final Heat Flux	-49.0 (-155)	24	-49.8 (-157)	27	-49.0 (-155)	21	-49.0 (-154)	10
90% of Final Heat Flux	-46.5 (-147)	20	-47.1 (-149)	22	-46.4 (-147)	17	-46.4 (-146)	7

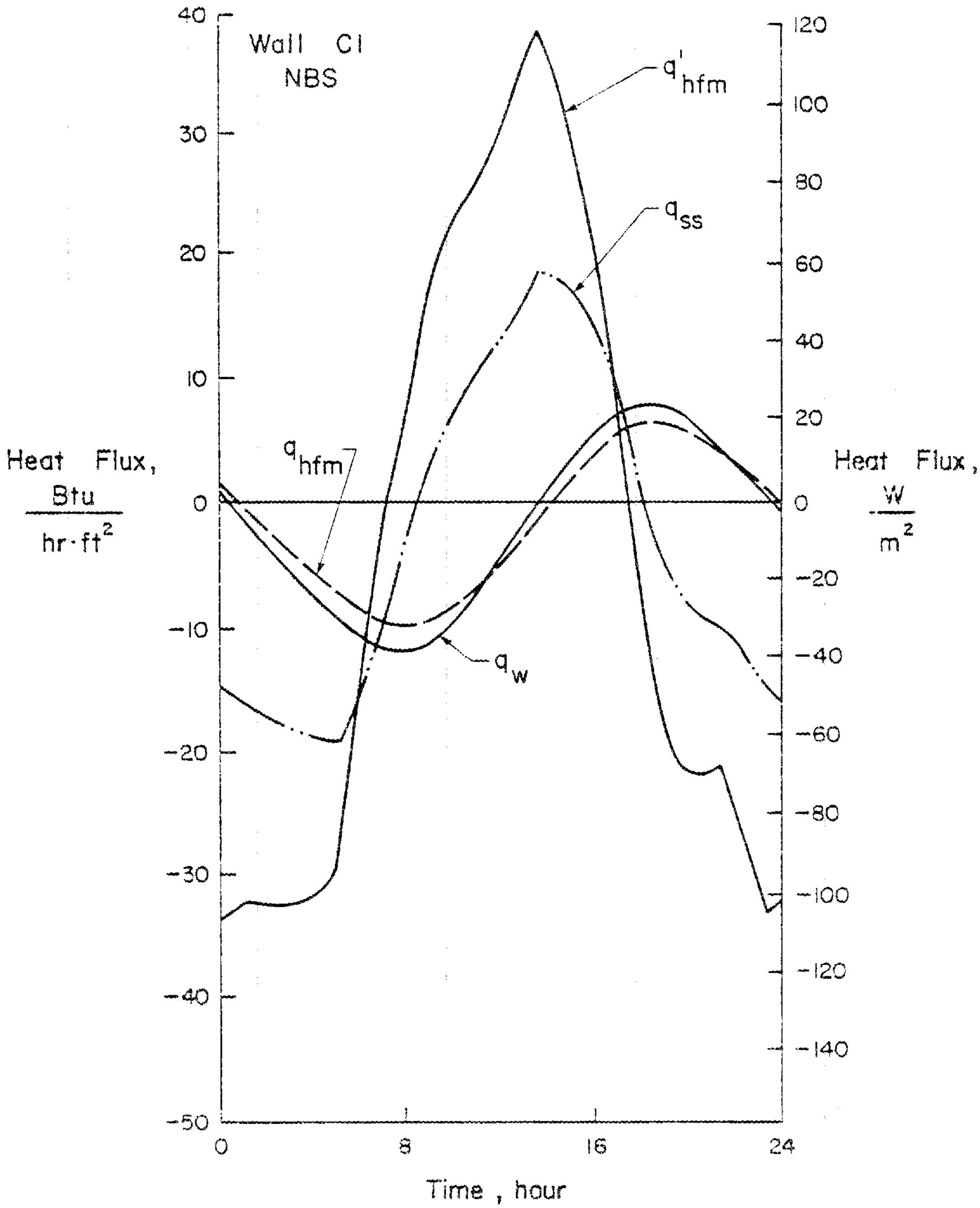


(a) Measured Temperatures



(b) Temperature Differentials

Fig. C1-2 Wall C1 Dynamic Test Results for NBS Test Cycle



(c) Heat Flux

Fig. C1-2 Wall C1 Dynamic Test Results for NBS Test Cycle

TABLE C1-7(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}* Response Factor	q_{ss} Steady-State
1	47.0	59.8	68.9	72.0	72.2	-1.7	-0.5	-32.5		-17.2
2	45.1	58.2	67.6	71.3	72.1	-3.9	-2.4	-33.0		-18.4
3	44.0	56.9	66.3	70.6	72.0	-6.0	-4.2	-32.0		-19.3
4	43.5	56.0	65.1	70.0	71.9	-7.7	-6.1	-31.7		-19.7
5	43.5	55.3	64.1	69.4	71.7	-9.8	-7.7	-30.2		-19.8
6	51.7	57.8	63.4	68.9	71.6	-11.4	-9.2	-17.7		-15.6
7	63.1	62.9	63.4	68.6	71.6	-12.4	-10.4	-1.3		-8.0
8	70.5	66.8	64.1	68.6	71.6	-13.0	-10.7	8.2		-2.5
9	76.7	70.5	65.2	68.9	71.7	-11.9	-10.4	15.7		2.2
10	82.6	74.1	66.6	69.4	71.8	-10.6	-9.3	22.7		6.6
11	87.2	77.6	68.5	70.3	72.0	-7.9	-7.5	27.1		10.4
12	89.8	79.9	70.2	71.1	72.1	-5.6	-5.6	28.5		12.4
13	95.2	83.2	71.9	71.9	72.3	-3.4	-3.6	35.1		15.9
14	99.2	86.4	73.7	73.0	72.5	-0.7	-1.5	38.8		19.2
15	97.3	86.8	75.4	73.6	72.7	1.7	0.9	32.3		18.6
16	92.8	85.6	76.8	74.5	72.9	4.4	3.1	23.1		15.8
17	86.6	83.3	77.5	75.1	73.0	6.8	4.9	12.7		11.5
18	75.6	78.6	77.6	75.4	73.0	8.0	6.2	-3.2		4.4
19	66.3	73.7	77.0	75.5	73.0	8.3	6.7	-15.9		-2.5
20	61.1	70.3	75.7	75.2	72.9	7.6	6.4	-21.5		-6.8
21	59.2	68.4	74.4	74.6	72.8	6.0	5.4	-22.4		-8.8
22	58.8	67.3	73.1	74.0	72.7	4.1	4.1	-21.2		-9.4
23	53.2	64.5	71.9	73.4	72.6	2.3	2.7	-27.8		-12.5
24	48.3	61.4	70.5	72.7	72.4	0.4	1.2	-33.1		-15.9
Mean	68.3	70.2	70.9	72.0	72.3	-2.4	-2.0	-3.3		-2.5

*Response factor analysis was not performed for this dynamic test cycle.

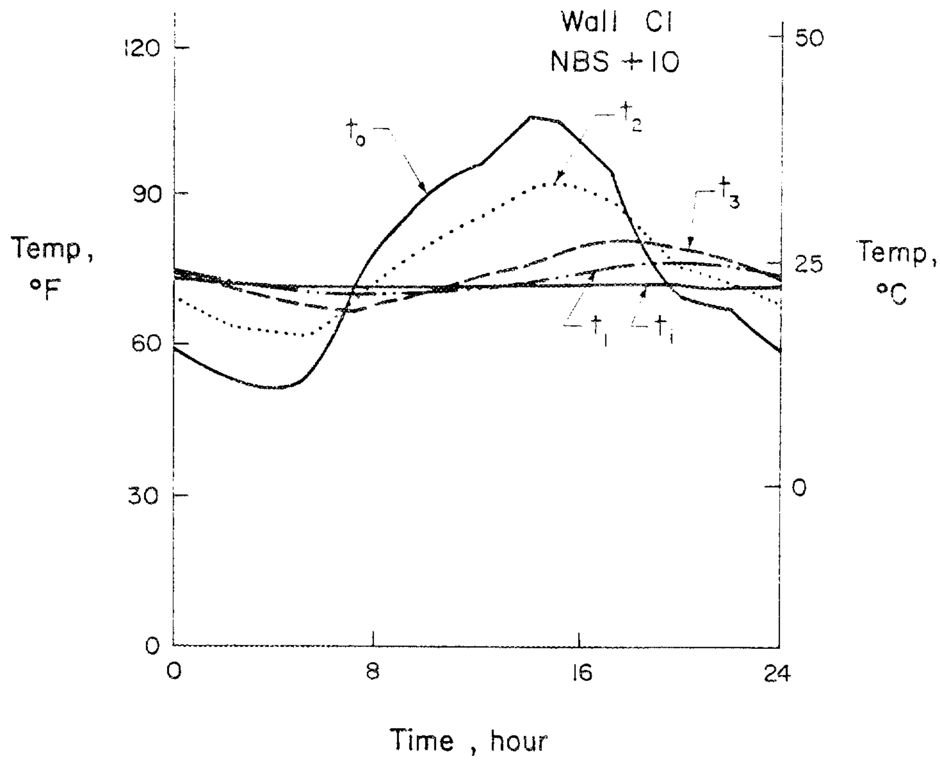
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 30%
Outdoor Chamber - 23%

Laboratory Air Temperature:
Max. - 73°F (23°C)
Min. - 70°F (21°C)

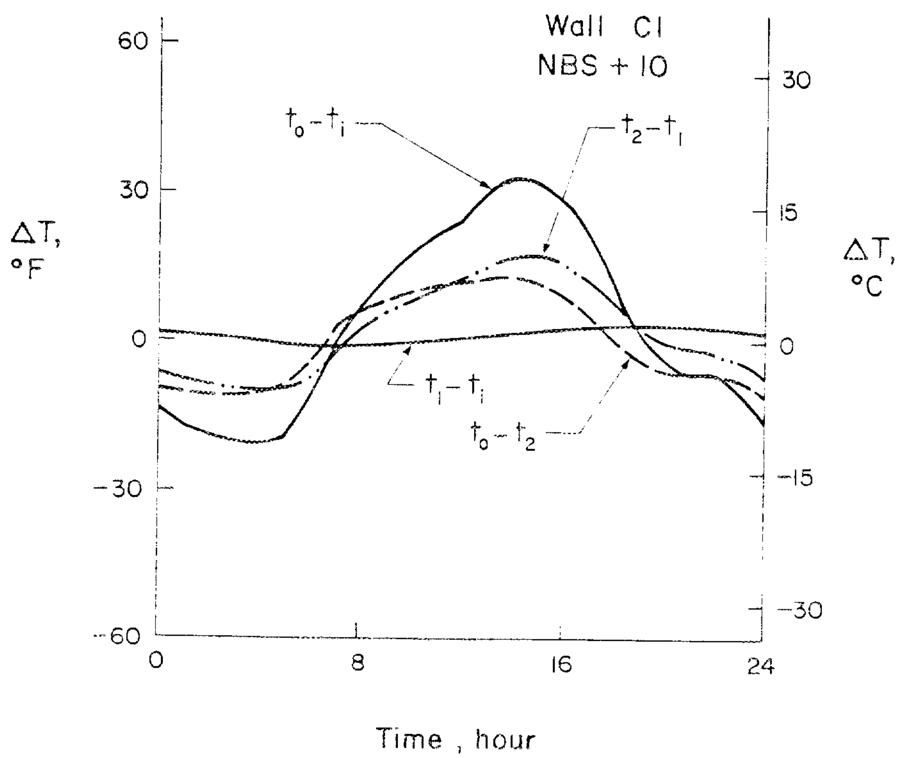
TABLE C1-7(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}* Response Factor	q_{ss} Steady-State
1	8.3	15.5	20.5	22.2	22.4	-5.5	-1.7	-102.4		-54.2
2	7.3	14.6	19.8	21.8	22.3	-12.3	-7.6	-104.2		-58.0
3	6.6	13.8	19.1	21.4	22.2	-19.0	-13.4	-103.9		-60.8
4	6.4	13.3	18.4	21.1	22.2	-24.2	-19.2	-99.9		-62.1
5	6.4	13.0	17.9	20.8	22.1	-30.9	-24.4	-95.2		-62.4
6	10.9	14.4	17.4	20.5	22.0	-36.0	-29.1	-55.8		-49.1
7	17.3	17.1	17.4	20.3	22.0	-39.3	-32.9	-4.0		-25.3
8	21.4	19.4	17.8	20.3	22.0	-41.0	-33.9	25.9		-7.7
9	24.8	21.4	18.5	20.5	22.0	-37.5	-32.7	49.6		7.0
10	28.1	23.4	19.2	20.8	22.1	-33.5	-29.2	71.5		20.8
11	30.7	25.3	20.3	21.3	22.2	-25.0	-23.7	85.4		32.7
12	32.1	26.6	21.2	21.7	22.3	-17.7	-17.6	90.0		39.0
13	35.1	28.5	22.2	22.2	22.4	-10.8	-11.3	110.6		50.3
14	37.4	30.2	23.2	22.6	22.5	-2.2	-4.7	122.4		60.5
15	36.3	30.5	24.1	23.1	22.6	5.3	2.7	101.9		58.8
16	33.8	29.8	24.9	23.6	22.7	13.8	9.6	73.0		49.7
17	30.3	28.5	25.3	23.9	22.8	21.5	15.3	40.2		36.4
18	24.2	25.9	25.4	24.1	22.8	25.3	19.5	10.0		13.9
19	19.0	23.2	25.0	24.2	22.8	26.2	21.1	50.0		-8.0
20	16.2	21.3	24.3	24.0	22.7	24.1	20.2	-67.9		-21.5
21	15.1	20.2	23.5	23.7	22.7	18.9	17.1	-70.8		-27.8
22	14.9	19.6	22.8	23.3	22.6	13.0	13.0	-66.7		-29.7
23	11.8	18.1	22.2	23.0	22.5	7.2	8.4	-87.7		-39.3
24	9.0	16.3	21.4	22.6	22.4	1.1	3.7	-104.4		-50.3
Mean	20.1	21.2	21.3	22.2	22.4	-7.4	-6.3	-10.5		-7.7

*Response factor analysis was not performed for this dynamic test cycle.

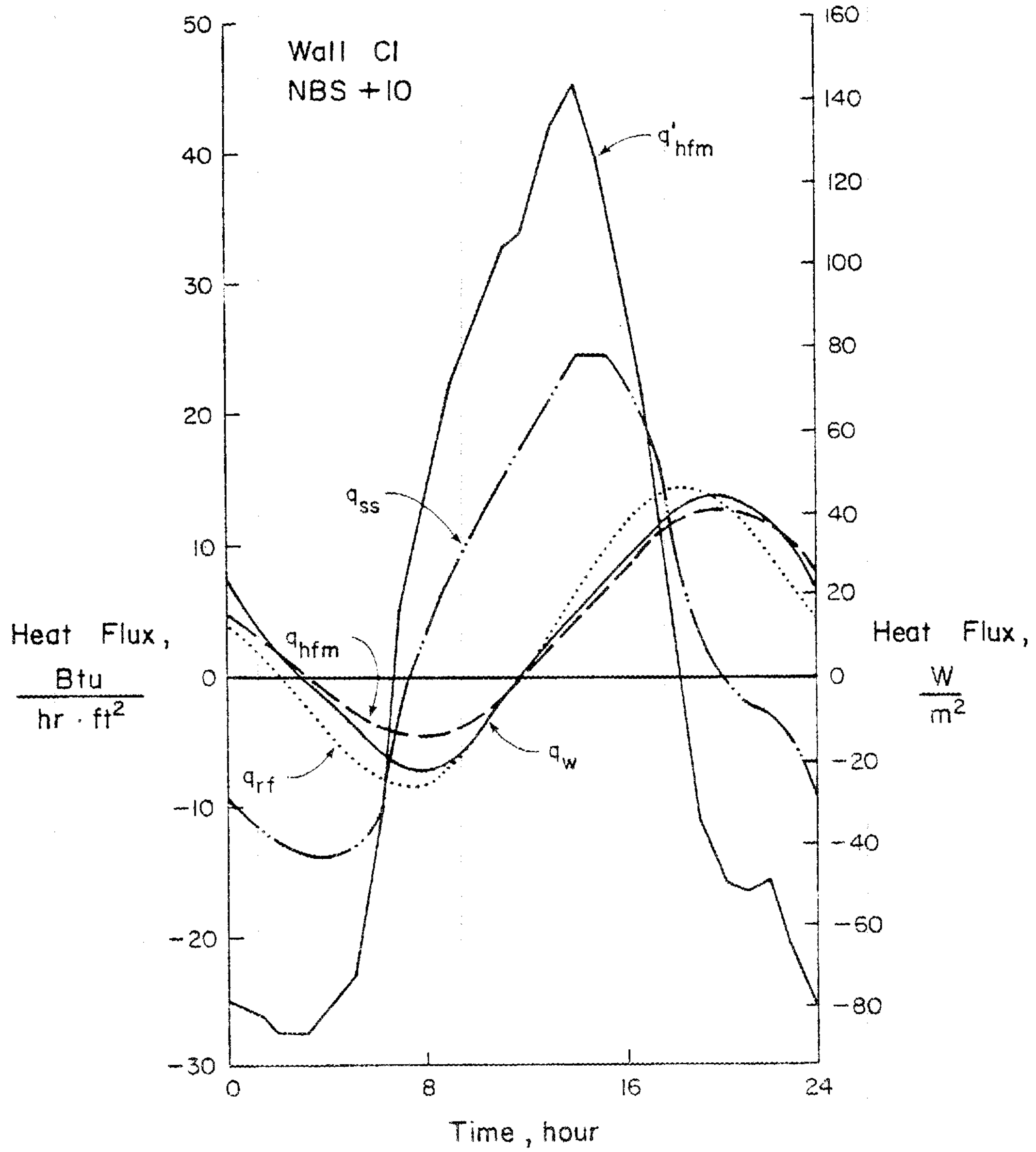


(a) Measured Temperatures



(b) Temperature Differentials

Fig. C1-3 Wall C1 Dynamic Test Results for NBS +10 Test Cycle



(c) Heat Flux

Fig. C1-3 Wall C1 Dynamic Test Results for NBS +10 Test Cycle

TABLE C1-8(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS+10 TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf} Response Factor	q_{ss} Steady-State
1	55.7	66.0	73.2	74.0	72.7	4.1	5.5	-26.8	2.5	-11.4
2	53.6	64.2	71.8	73.3	72.5	2.2	3.7	-27.7	0.1	-12.8
3	52.3	62.9	70.5	72.6	72.4	0.1	1.9	-27.7	-2.3	-13.8
4	52.0	61.9	69.3	72.0	72.3	-2.2	0.1	-26.1	-4.3	-14.1
5	52.7	61.6	68.3	71.4	72.2	-3.8	-1.6	-23.7	-6.2	-13.8
6	59.9	63.8	67.5	70.9	72.1	-5.4	-3.2	-12.4	-7.7	-9.9
7	71.9	69.1	67.5	70.6	72.1	-6.9	-4.4	5.2	-8.7	-2.0
8	79.2	73.2	68.2	70.6	72.1	-7.0	-4.7	14.7	-8.5	3.8
9	84.8	76.7	69.4	70.9	72.2	-6.3	-4.3	21.4	-7.1	8.2
10	90.4	80.2	70.8	71.5	72.2	-4.6	-3.3	28.2	-4.8	12.3
11	94.9	83.4	72.4	72.2	72.4	-2.5	-1.8	33.2	-2.3	15.9
12	97.3	85.7	74.1	72.9	72.6	-0.4	0.0	34.3	0.5	17.9
13	102.1	88.8	75.8	73.7	72.7	2.1	2.0	40.9	3.3	21.2
14	106.1	92.0	77.5	74.6	72.9	4.5	4.1	46.3	6.1	24.7
15	105.2	92.8	79.2	75.4	73.1	7.2	6.4	39.5	8.9	24.6
16	101.4	91.9	80.6	76.2	73.3	9.8	8.8	30.1	11.5	22.2
17	96.3	90.0	81.4	76.8	73.4	11.9	10.6	20.9	13.5	18.5
18	85.8	85.6	81.7	77.2	73.5	13.4	12.0	5.1	14.7	11.7
19	75.2	80.2	81.2	77.4	73.5	14.1	12.6	-9.5	14.8	4.0
20	69.9	76.7	80.0	77.1	73.4	13.5	12.4	-15.6	13.7	-0.6
21	68.1	74.8	78.6	76.6	73.3	12.1	11.4	-16.0	11.6	-2.5
22	67.4	73.6	77.3	76.0	73.1	10.0	10.2	-15.2	9.2	-3.3
23	62.8	71.1	76.2	75.3	73.0	8.1	8.8	-20.4	6.9	-6.0
24	58.0	68.0	74.8	74.7	72.9	6.3	7.3	-25.8	4.6	-9.5
Mean	76.8	76.4	74.5	73.9	72.8	3.4	3.9	3.5	2.9	3.6

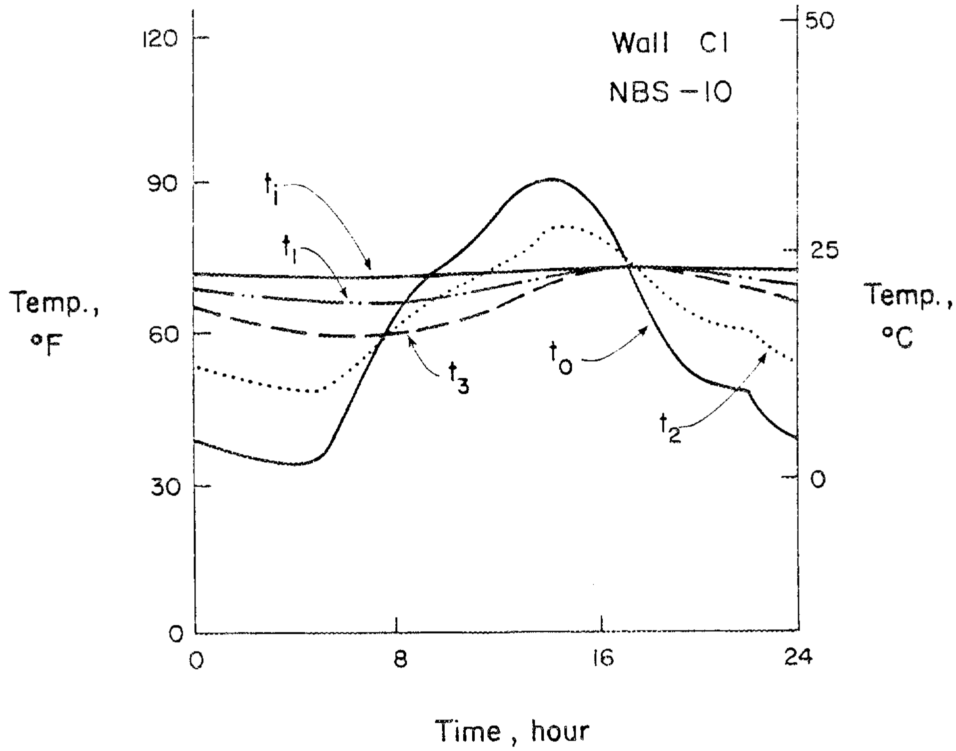
*Response factor values supplied by Ken Childs, ORNL. Values calculated using NBS Response Factor Program by Peavy.

Calibrated Hot Box Relative Humidity:
Indoor Chamber - 26%
Outdoor Chamber - 22%

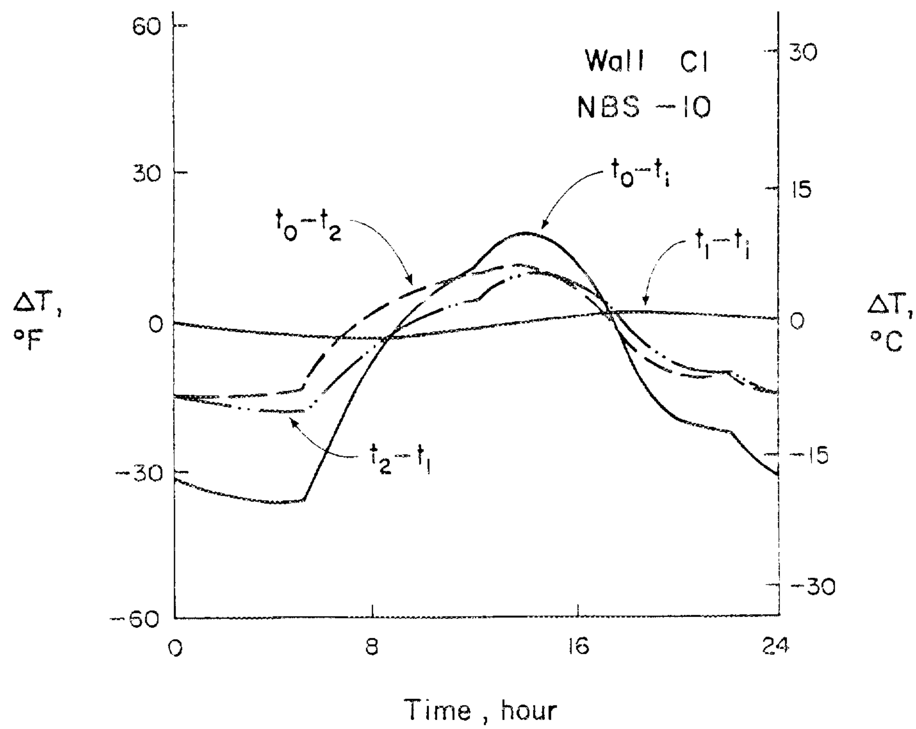
Laboratory Air Temperature:
Max. - 72°F (22°C)
Min. - 71°F (22°C)

TABLE C1-8(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS+10 TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf} Response Factor	q_{ss} Steady-State
1	13.1	18.9	22.9	23.3	22.6	12.8	17.3	-84.6	7.8	-35.8
2	12.0	17.9	22.1	23.0	22.5	6.9	11.7	-87.5	0.3	-40.5
3	11.3	17.8	21.4	22.6	22.5	0.3	5.9	-87.2	-7.2	-43.4
4	11.1	16.6	20.7	22.2	22.4	-6.8	0.3	-82.4	-13.5	-44.6
5	11.5	16.4	20.2	21.9	22.3	-12.0	-5.1	-74.8	-19.6	-43.6
6	15.5	17.7	19.7	21.6	22.3	-17.1	-10.0	-39.2	-24.4	-31.3
7	22.2	20.6	19.7	21.4	22.3	-21.7	-13.9	16.3	-27.4	-6.4
8	26.2	22.9	20.1	21.4	22.3	-22.1	-14.9	46.3	-26.7	11.8
9	29.3	24.8	20.8	21.6	22.3	-20.0	-13.6	67.6	-22.3	25.7
10	32.5	26.8	21.6	21.9	22.4	-14.5	-10.3	88.9	-15.3	38.7
11	34.9	28.6	22.4	22.3	22.4	-7.9	-5.7	104.6	-7.3	50.1
12	36.3	29.8	23.4	22.7	22.5	-1.2	0.0	108.0	1.6	56.6
13	38.9	31.5	24.3	23.2	22.6	6.7	6.3	129.2	10.5	66.9
14	41.2	33.4	25.3	23.6	22.7	14.3	12.9	145.9	19.4	77.8
15	40.6	33.8	26.2	24.1	22.8	22.8	20.3	124.6	28.1	77.6
16	38.5	33.3	27.0	24.6	22.9	30.9	27.7	94.8	36.3	69.9
17	35.7	32.2	27.5	24.9	23.0	37.4	33.6	66.0	42.7	58.5
18	29.9	29.8	27.6	25.1	23.0	42.4	37.9	16.1	46.5	37.0
19	24.0	26.8	27.3	25.2	23.1	44.4	39.8	-30.0	46.7	12.6
20	21.1	24.8	26.7	25.1	23.0	42.7	39.2	-49.0	43.1	-1.9
21	20.1	23.8	25.9	24.8	22.9	38.1	36.0	-50.6	36.7	-7.9
22	19.7	23.1	25.2	24.4	22.9	31.6	32.1	-48.1	29.1	-10.4
23	17.1	21.7	24.5	24.1	22.8	25.5	27.8	-64.3	21.8	-18.9
24	14.4	20.0	23.8	23.7	22.7	19.9	23.1	-81.5	14.6	-29.8
Mean	24.9	24.7	23.6	23.3	22.6	10.6	12.4	11.1	9.2	11.2

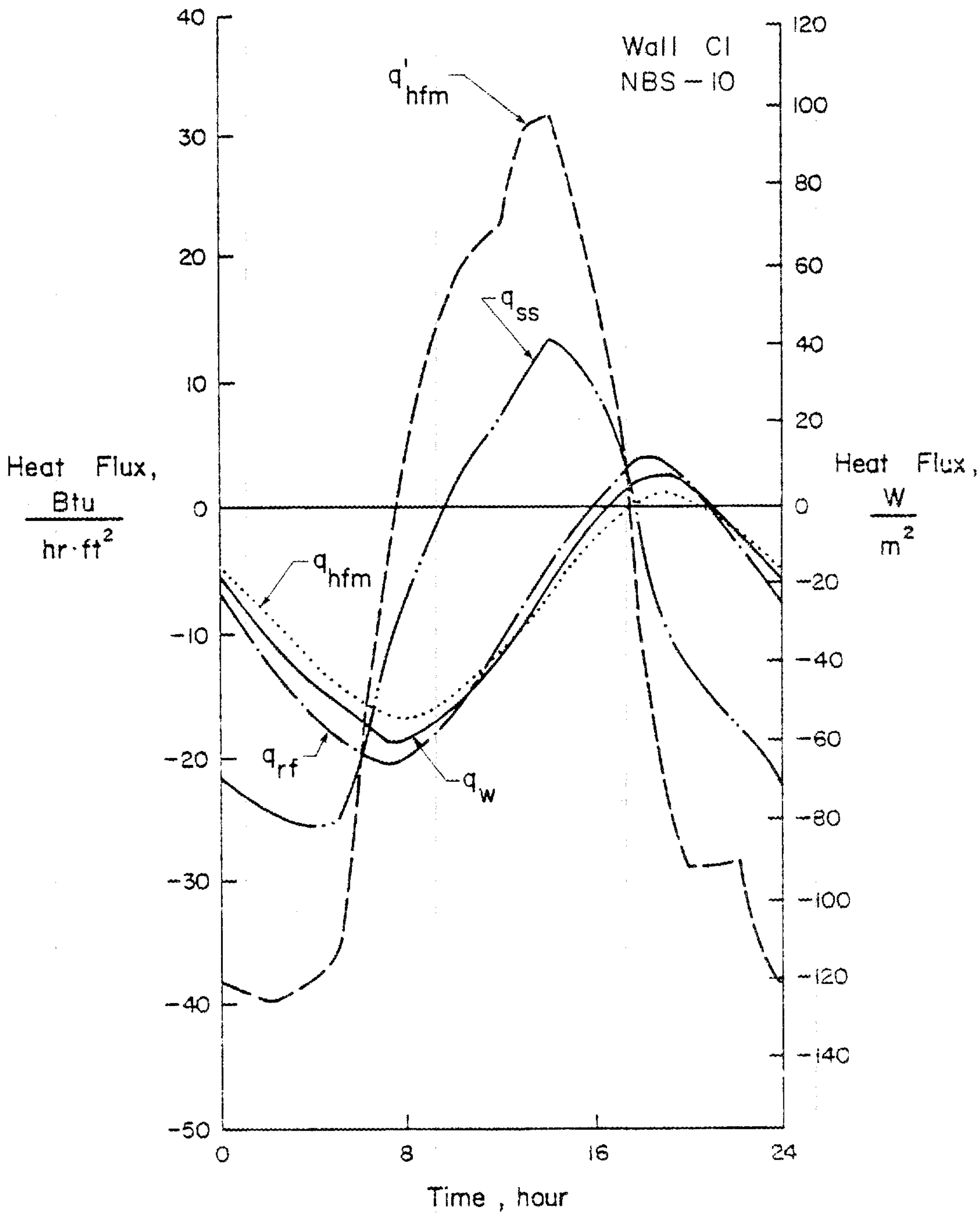


(a) Measured Temperatures



(b) Temperature Differentials

Fig. C1-4 Wall C1 Dynamic Test Results for NBS -10 Test Cycle



(c) Heat Flux

Fig. C1-4 Wall C1 Dynamic Test Results for NBS -10 Test Cycle

TABLE C1-9(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS-10 TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf} Response Factor	q_{ss} Steady-State
1	37.5	53.2	64.6	69.8	71.8	-8.1	-7.0	-39.1	-10.1	-23.4
2	35.5	51.4	63.2	69.0	71.6	-10.3	-8.8	-40.0	-12.5	-24.8
3	34.7	50.2	61.9	68.4	71.5	-12.4	-10.7	-39.1	-14.8	-25.6
4	34.4	49.4	60.8	67.7	71.4	-14.3	-12.6	-37.7	-16.8	-25.9
5	35.4	49.1	59.7	67.2	71.3	-15.9	-14.2	-34.9	-18.6	-25.5
6	45.7	52.6	59.1	66.7	71.2	-17.7	-15.8	-19.5	-20.2	-19.9
7	56.7	57.6	59.3	66.5	71.2	-19.1	-16.8	-4.2	-20.8	-12.5
8	64.3	61.7	60.2	66.6	71.2	-18.8	-16.9	5.3	-20.3	-6.8
9	70.0	65.3	61.5	67.0	71.3	-17.6	-16.2	11.9	-18.5	-2.3
10	75.7	68.8	63.1	67.6	71.4	-16.1	-14.9	18.2	-16.1	1.8
11	79.0	71.6	64.7	68.3	71.5	-14.0	-13.3	20.9	-13.3	4.6
12	81.9	73.9	66.3	69.1	71.7	-11.6	-11.4	22.8	-10.4	6.7
13	88.3	77.7	68.2	70.0	71.9	-9.0	-9.1	30.1	-7.5	10.8
14	90.7	80.2	70.0	70.9	72.0	-6.3	-6.9	31.2	-4.5	13.1
15	88.1	80.3	71.6	71.8	72.2	-3.6	-4.6	24.2	-1.7	12.0
16	84.3	79.3	72.9	72.5	72.4	-1.0	-2.5	16.6	1.0	9.5
17	77.4	76.7	73.6	73.1	72.5	0.9	-0.7	5.6	2.9	5.1
18	65.2	71.4	73.6	73.4	72.5	2.2	0.5	-11.9	3.8	-2.8
19	56.7	66.8	72.8	73.4	72.6	2.3	0.9	-23.4	3.4	-9.4
20	51.6	63.5	71.6	73.0	72.5	1.5	0.5	-28.9	1.9	-13.4
21	50.1	61.8	70.1	72.5	72.4	-0.2	-0.6	-28.9	-0.4	-15.0
22	49.2	60.6	68.8	71.8	72.2	-2.2	-2.0	-28.3	-2.9	-15.8
23	42.7	57.4	67.5	71.1	72.1	-4.1	-3.5	35.9	-5.3	-19.3
24	39.6	55.0	66.0	70.5	71.9	-6.1	-5.1	38.3	-7.6	-21.9
Mean	59.8	64.0	66.3	69.9	71.8	-8.4	-8.0	-9.3	-8.7	-8.4

Calibrated Hot Box Relative Humidity:
Indoor Chamber - 26%
Outdoor Chamber - 23%

Laboratory Air Temperature:
Max. - 72°F (22°C)
Min. - 70°F (21°C)

TABLE C1-9(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS-10 TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf} Response Factor	q_{ss} Steady-State
1	3.1	11.8	18.1	21.0	22.1	-25.5	-22.0	-123.3	-32.0	-73.8
2	1.9	10.8	17.3	20.6	22.0	-32.3	-27.7	-126.1	-39.3	-78.4
3	1.5	10.1	16.6	20.2	21.9	-39.0	-33.7	-123.4	-46.6	-80.7
4	1.3	9.7	16.0	19.8	21.9	-45.2	-39.6	-118.8	-53.1	-81.7
5	1.9	9.5	15.4	19.5	21.8	-50.0	-44.9	-110.2	-58.8	-80.4
6	7.6	11.4	15.1	19.3	21.8	-55.9	-49.9	-61.5	-63.8	-62.7
7	13.7	14.2	15.2	19.1	21.8	-60.2	-52.9	-13.4	-65.7	-39.5
8	17.9	16.5	15.7	19.2	21.8	-59.4	-53.2	16.6	-64.1	-21.3
9	21.2	18.5	16.4	19.4	21.8	-55.4	-50.9	37.6	-58.4	-7.3
10	24.3	20.5	17.3	19.8	21.9	-50.6	-47.1	57.5	-50.9	5.6
11	26.1	22.0	18.2	20.2	22.0	-44.1	-41.9	65.8	-41.9	14.5
12	27.7	23.3	19.1	20.6	22.1	-36.6	-35.9	71.9	-32.7	21.2
13	31.3	25.4	20.1	21.1	22.2	-28.3	-28.8	95.1	-23.5	34.2
14	32.6	26.8	21.1	21.6	22.2	-19.8	-21.8	98.3	-14.2	41.4
15	31.1	26.8	22.0	22.1	22.4	-11.3	-14.5	76.4	-5.2	37.9
16	29.0	26.3	22.7	22.5	22.4	-3.3	-7.7	52.2	3.1	30.0
17	25.2	24.8	23.1	22.8	22.5	2.8	-2.1	17.8	9.0	15.9
18	18.5	21.9	23.1	22.4	22.5	6.8	1.7	-37.7	11.8	-8.8
19	13.7	19.3	22.7	23.0	22.5	7.2	2.9	-73.8	10.7	-29.5
20	10.9	17.5	22.0	22.8	22.5	4.7	1.6	-91.2	6.0	-42.4
21	10.1	16.6	21.2	22.5	22.4	-0.7	-2.0	-91.2	-1.3	-47.4
22	9.6	15.9	20.4	22.1	22.3	-6.8	-6.3	-89.3	-9.2	-49.7
23	6.0	14.1	19.7	21.7	22.3	-13.0	-11.0	-113.1	-16.7	-61.0
24	4.2	12.8	18.9	21.4	22.2	-19.2	-16.1	-120.7	-24.1	-69.0
Mean	15.4	17.8	19.1	21.1	22.1	-26.5	-25.2	-29.4	-27.5	-26.4

TABLE C1-12 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), THERMAL LAG

Test Cycle	Thermal Lag, hrs												Calc. Time Constant, hrs
	Measured								Calculated				
	Calibrated Hot Box					Heat Flow Meter			Response Factor				
	t_o vs t_1		q_{ss} vs q_w		Avg.	q_{ss} vs q_{hfm}		Avg.	q_{ss} vs q_{rf}		Avg.	
	@ Max.	@ Min.	@ Max.	@ Min.		@ Max.	@ Min.		@ Max.	@ Min.		
NBS	5	3	5	3.5	4	5	3	4	*	*	*	1.4
NBS+10	5	3	4.5	3.5	4	4.5	4	4.5	4	3.5	4	1.4
NBS-10	4.5	3	4.5	3	4	5	3.5	4	4	3	3.5	1.4

*Response factor analysis was not performed for this dynamic test cycle.

TABLE C1-13 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), REDUCTION IN AMPLITUDE

Test Cycle	Measured, %						Calculated, %		
	Calibrated Hot Box			Heat Flow Meter			Response Factor		
	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.
NBS	51	39	45	60	50	55	*	*	*
NBS+10	49	41	45	59	51	55	44	34	39
NBS-10	50	40	45	59	49	54	42	31	37

*Response factor analysis was not performed for this dynamic test cycle.

TABLE C1-14 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), ENERGY REQUIREMENTS

Test Cycle	Total Energy, Btu/ft^2 (W·hr/m^2)				Total Energy Comparisons, %			Net Energy, Btu/ft^2 (W·hr/m^2)				Net Energy Comparisons, %		
	Measured		Calculated					Measured		Calculated				
	q_w^T	q_{hfm}^T	q_{rf}^T	q_{ss}^T	q_w^T / q_{ss}^T	q_{hfm}^T / q_{ss}^T	q_{rf}^T / q_{ss}^T	q_w^N	q_{hfm}^N	q_{rf}^N	q_{ss}^N	q_w^N / q_{ss}^N	q_{hfm}^N / q_{ss}^N	q_{rf}^N / q_{ss}^N
NBS	155.7 (491.0)	130.7 (412.0)	*	293.4 (925.4)	53	45	-	-56.4 (-177.9)	-47.8 (-150.7)	*	-59.2 (-186.8)	95	81	-
NBS+10	158.5 (500.0)	141.2 (445.4)	174.0 (548.9)	284.6 (897.7)	56	50	61	80.4 (253.8)	94.6 (298.3)	70.2 (221.5)	85.3 (269.0)	94	111	82
NBS-10	214.8 (677.7)	195.4 (616.2)	235.3 (742.1)	327.8 (1034.1)	66	60	72	-201.4 (-634.8)	-191.5 (-603.8)	-209.3 (-660.9)	-200.6 (-632.9)	100	95	104

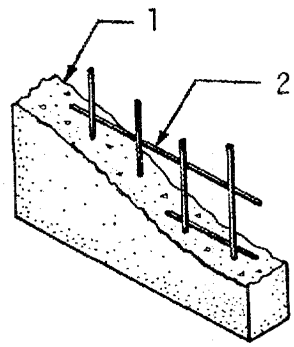
*Response factor analysis was not performed for this dynamic test cycle.

WALL C2: STRUCTURAL LIGHTWEIGHT CONCRETE

DESCRIPTION: Structural lightweight concrete wall with reinforcement at approximate midthickness.

REFERENCE: Van Geem, M. G. and Fiorato, A. E., "Heat Transfer Characteristics of a Structural Lightweight Concrete Wall," Construction Technology Laboratories, Portland Cement Association, Skokie, 1983, 88 pages.

COMPOSITION:



1. Structural Lightweight Concrete
   Portland Cement
   Fine and Coarse Expanded Shale Aggregate
   Measured Air Content: 6.3%

2. Reinforcement
   Single layer of Grade 60 No. 5 bars
   Spaced 12 in. (305 mm) center-to-center

TABLE C2-1 - PHYSICAL PROPERTIES OF WALL AT TIME OF TEST

Property	Measured Value
Unit Weight, psf (kg/m^2)	70.4 (344)
Average Thickness, in. (mm)	8.28 (210)
Area, ft^2 (m^2)	73.67 (6.84)
Estimated Moisture Content, % by ovendry weight	8.5

TABLE C2-2 - MATERIAL PROPERTIES, STRUCTURAL LIGHTWEIGHT CONCRETE

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Unit Weight, pcf (kg/m^3)	--	ovendry	--	94 (1510)
Specific Heat, Btu/lb·°F (J/kg·K)	Similar to CRD-C124-73	saturated	73 (23)	0.257 (1080)
Specific Heat, Btu/lb·°F (J/kg·K)	Calculated	air dry	73 (23)	0.230 (960)
Thermal Conductivity, Btu·in/hr·ft^2·°F (W/m·K)	Hot Wire	air dry	--	6.0 (0.87)
Thermal Conductivity, Btu·in/hr·ft^2·°F (W/m·K)	ASTM C 177	ovendry	70 (21)	4.5 (0.65)
Thermal Conductivity, Btu·in/hr·ft^2·°F (W/m·K)	ASTM C 976	air dry	70 (21)	4.7 (0.68)
Thermal Diffusivity, ft^2/hr (mm^2/s)	CRD-C36-73	saturated	--	0.0307 (0.792)
Compressive Strength, psi (MPa)	ASTM C 39	air dry	--	5350 (36.9)
Splitting Tensile Strength, psi (MPa)	ASTM C 496	air dry	--	434 (2.99)

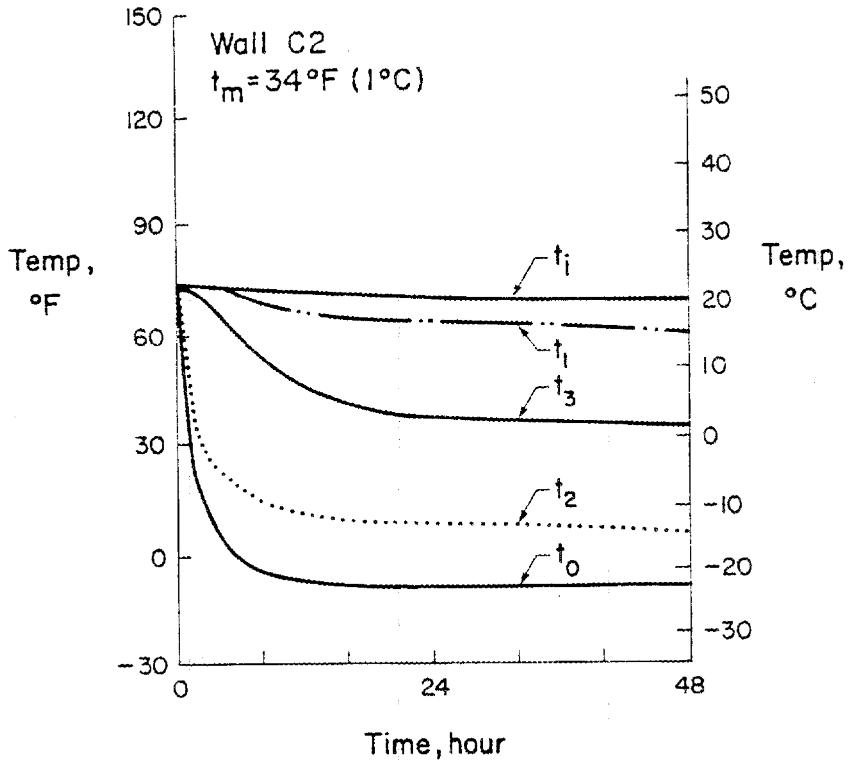
TABLE C2-3 - DESIGN HEAT TRANSMISSION COEFFICIENTS

Component	R, Thermal Resistance $hr \cdot ft^2 \cdot °F/Btu$ ($m^2 \cdot K/W$)
1. Outside Air Film	0.17 (0.03)
2. 8-in. (203-mm) Structural Lightweight Concrete	2.20* (0.39)
3. Inside Air Film	0.68 (0.12)
Total R	3.05 (0.54)
Total U	0.33 (1.85)

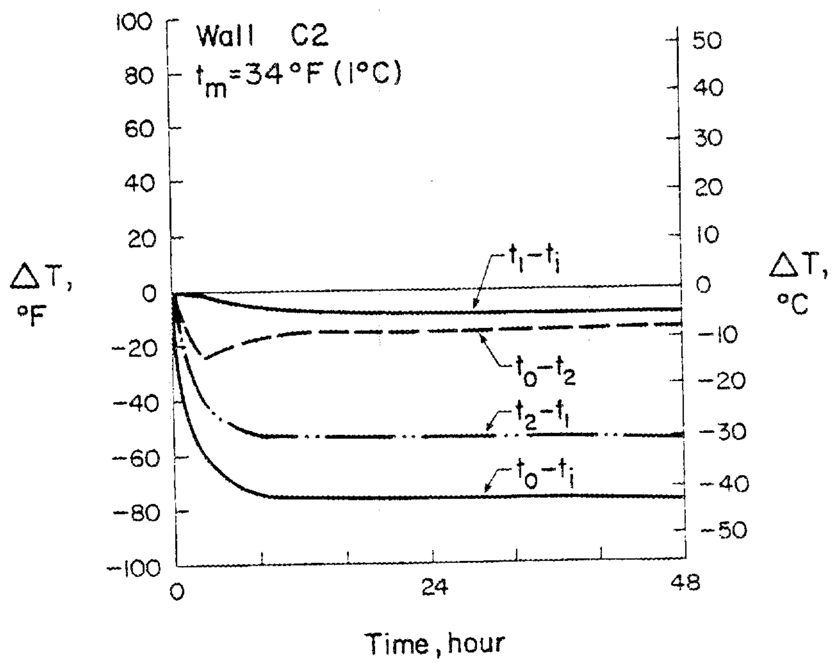
*Source: <u>ASHRAE Handbook of Fundamentals</u>, American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc., Atlanta, 1981, Chapter 23.

TABLE C2-4 - STEADY-STATE TEST RESULTS

Nominal Test Condition	q Heat Flux, Btu/hr·ft^2 (W/m^2)	R_T, hr·ft^2·°F/Btu (m^2·K/W)	U, Btu/hr·ft^2·°F (W/m^2·K)	Measured Temperatures, °F (°C)					Relative Humidity		Laboratory Air Temperature	
				t_o Outdoor Air	t_2 Outdoor Surface	t_3 Internal	t_1 Indoor Surface	t_i Indoor Air	Indoor Chamber, %	Outdoor Chamber, %	Max. °F (°C)	Min. °F (°C)
t_m = 34°F (1°C)	-31.1 (-98.2)	2.63 (0.46)	0.38 (2.16)	-7 (-22)	6 (-14)	35 (1)	62 (16)	70 (21)	18	21	72 (22)	69 (21)
t_m = 52°F (11°C)	-16.8 (-52.9)	2.62 (0.46)	0.38 (2.17)	30 (-1)	37 (3)	52 (11)	67 (19)	71 (22)	19	19	70 (21)	69 (20)
t_m = 88°F (31°C)	12.2 (38.6)	2.59 (0.46)	0.39 (2.19)	102 (39)	98 (37)	87 (30)	77 (25)	73 (23)	20	23	72 (22)	70 (21)
t_m = 99°F (37°C)	21.5 (67.9)	2.56 (0.45)	0.39 (2.22)	124 (51)	117 (47)	98 (37)	80 (27)	74 (23)	19	27	72 (22)	70 (21)
Design Values	-	3.05 (0.54)	0.33 (1.85)	-	-	-	-	-	-	-	-	-

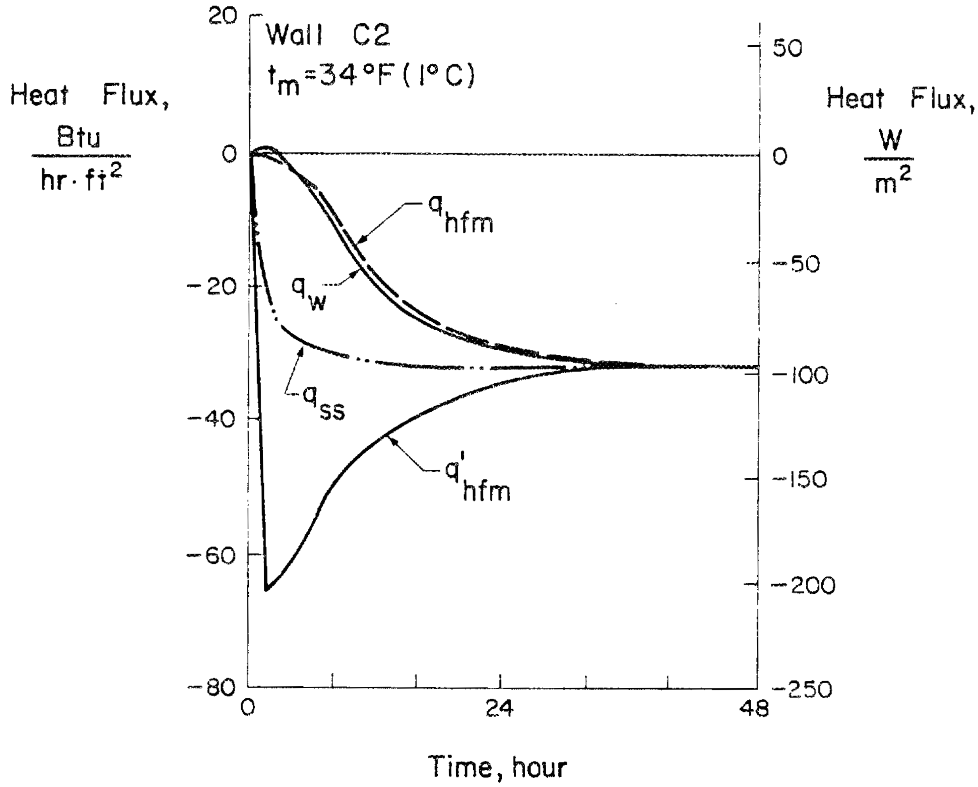


(a) Measured Temperatures



(b) Temperature Differentials

Fig. C2-1 Wall C2 Transient Test Results



(c) Heat Flux

Fig. C2-1 Wall C2 Transient Test Results

TABLE C2-5(a) - TRANSIENT TEST RESULTS

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft²			Calculated Heat Flux, Btu/hr·ft²	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
0	72.0	72.7	72.2	72.8	72.5	-0.1	-0.1	-0.3		-0.0
1	36.5	55.5	72.0	72.8	72.4	0.3	-0.1	-40.9		-9.9
2	10.3	36.1	70.8	72.7	72.5	0.3	-0.1	-64.5		-20.8
3	3.7	28.2	68.0	72.5	72.4	0.0	-0.5	-62.4		-25.1
4	1.1	23.9	64.7	72.0	72.4	-1.3	-1.8	-58.8		-27.2
5	0.0	21.4	61.5	71.3	72.2	-3.8	-3.6	-54.8		-28.2
6	-1.5	19.1	58.6	70.4	72.1	-5.6	-5.8	-52.1		-29.0
7	-2.4	17.3	55.9	69.5	71.8	-8.7	-8.0	-50.0		-29.5
8	-3.2	15.8	53.5	68.6	71.7	-10.5	-10.3	-48.0		-29.7
9	-3.8	14.6	51.3	67.8	71.5	-13.3	-12.3	-46.3		-30.0
10	-4.3	13.6	49.4	67.1	71.3	-15.0	-14.3	-44.7		-30.2
11	-4.7	12.7	47.7	66.5	71.2	-17.0	-16.1	-43.2		-30.3
12	-5.0	11.8	46.1	65.9	71.1	-18.6	-17.7	-41.8		-30.5
13	-5.4	11.2	44.7	65.4	71.0	-20.0	-19.3	-40.9		-30.6
14	-5.7	10.6	43.5	65.0	70.8	-21.6	-20.5	-40.2		-30.7
15*	-6.0	9.8	42.1	64.4	70.8	-23.1	-22.1	-38.7		-30.8
16	-6.3	9.0	40.7	63.9	70.7	-24.6	-23.7	-37.2		-30.9
17	-6.5	8.6	39.9	63.5	70.6	-25.2	-24.7	-36.4		-30.9
18	-6.7	8.4	39.3	63.3	70.6	-26.1	-25.3	-35.9		-30.9
19	-6.8	8.1	38.7	63.2	70.6	-26.8	-26.1	-35.2		-31.0
20	-6.9	7.8	38.2	62.8	70.5	-27.2	-26.7	-35.1		-30.9
21	-7.0	7.6	37.7	62.8	70.4	-27.8	-27.1	-34.3		-31.0
22	-7.2	7.4	37.2	62.6	70.3	-27.8	-27.5	-34.2		-31.1
23	-7.2	7.1	37.0	62.4	70.4	-28.5	-28.0	-33.9		-31.1
24	-7.2	7.0	36.7	62.3	70.4	-28.6	-28.3	-33.3		-31.1
26	-7.3	6.8	36.2	62.2	70.3	-29.3	-29.0	-32.9		-31.2
28	-7.2	6.7	35.7	62.1	70.2	-29.9	-29.5	-32.6		-31.2
30	-7.1	6.6	35.5	62.0	70.2	-30.3	-30.0	-32.0		-31.1
32	-7.1	6.5	35.3	61.8	70.2	-30.5	-30.1	-31.7		-31.1
34	-7.1	6.5	35.1	61.8	70.2	-30.6	-30.4	-31.6		-31.1
36	-7.1	6.4	35.0	61.7	70.3	-30.5	-30.7	-31.6		-31.1
38	-7.2	6.4	34.9	61.7	70.2	-30.9	-30.8	-31.3		-31.1
40	-7.2	6.3	34.8	61.7	70.1	-30.7	-30.8	-31.1		-31.1
42	-7.2	6.3	34.7	61.5	70.1	-31.1	-30.8	-31.3		-31.1
44	-7.2	6.2	34.6	61.5	70.0	-31.1	-31.0	-31.0		-31.1
46	-7.2	6.2	34.6	61.5	70.0	-31.0	-31.0	-31.1		-31.1
48	-7.2	6.2	34.5	61.4	70.0	-31.1	-31.1	-31.0		-31.0

*Data for this hour derived from linear interpolation of data from hours 14 to 16.
**Response factor analysis was not performed for this wall assembly.

TABLE C2-5(b) - TRANSIENT TEST RESULTS, SI UNITS

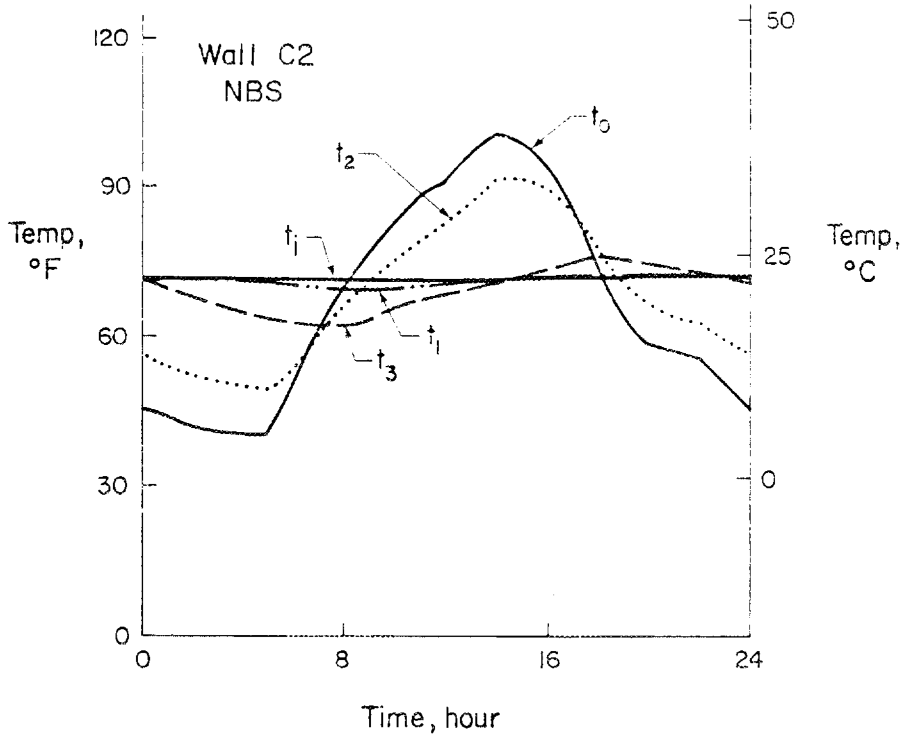
Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
0	22.2	22.6	22.3	22.7	22.5	-0.4	-0.2	-0.9		-0.1
1	2.5	13.1	22.2	22.7	22.5	0.9	-0.3	-129.1		-31.1
2	-12.1	2.3	21.6	22.6	22.5	1.0	-0.5	-203.4		-65.6
3	-15.7	-2.1	20.0	22.5	22.4	0.1	-1.7	-196.8		-79.2
4	-17.2	-4.5	18.2	22.2	22.4	-4.1	-5.7	-185.4		-85.8
5	-17.8	-5.9	16.4	21.8	22.3	-11.8	-11.4	-172.9		-89.0
6	-18.6	-7.2	14.8	21.3	22.3	-17.7	-18.3	-164.2		-91.5
7	-19.1	-8.2	13.3	20.8	22.1	-27.3	-25.2	-157.8		-93.1
8	-19.6	-9.0	11.9	20.3	22.1	-33.2	-32.5	-151.5		-93.8
9	-19.9	-9.7	10.7	19.9	21.9	-41.9	-38.9	-145.9		-94.5
10	-20.2	-10.2	9.7	19.5	21.8	-47.2	-45.1	-141.1		-95.3
11	-20.4	-10.7	8.7	19.1	21.8	-53.6	-50.6	-136.4		-95.7
12	-20.6	-11.2	7.8	18.8	21.7	-58.7	-55.8	-131.1		-96.1
13	-20.8	-11.6	7.1	18.6	21.7	-63.0	-60.8	-128.9		-96.4
14	-20.9	-11.9	6.4	18.3	21.6	-68.2	-64.6	-126.7		-96.7
15*	-21.1	-12.3	5.6	18.0	21.6	-72.8	-69.7	-122.1		-97.0
16	-21.3	-12.8	4.8	17.7	21.5	-77.4	-74.8	-117.4		-97.3
17	-21.4	-13.0	4.4	17.5	21.5	-79.5	-77.8	-114.9		-97.5
18	-21.5	-13.1	4.1	17.4	21.4	-82.3	-79.8	-113.3		-97.6
19	-21.5	-13.3	3.7	17.3	21.4	-84.6	-82.2	-110.9		-97.8
20	-21.6	-13.4	3.4	17.1	21.4	-85.7	-84.1	-110.6		-97.6
21	-21.7	-13.5	3.2	17.1	21.3	-87.7	-85.6	-108.3		-97.9
22	-21.8	-13.7	2.9	17.0	21.3	-87.7	-86.8	-107.8		-98.0
23	-21.8	-13.8	2.8	16.9	21.3	-90.0	-88.3	-106.9		-98.2
24	-21.8	-13.9	2.6	16.9	21.3	-90.2	-89.4	-105.2		-98.3
26	-21.8	-14.0	2.3	16.8	21.3	-92.3	-91.5	-103.7		-98.3
28	-21.8	-14.1	2.1	16.7	21.2	-94.2	-93.0	-103.0		-98.2
30	-21.7	-14.1	1.9	16.6	21.2	-95.6	-94.2	-100.9		-98.2
32	-21.7	-14.1	1.8	16.6	21.2	-96.1	-95.0	-99.9		-98.2
34	-21.7	-14.2	1.7	16.5	21.2	-96.4	-96.0	-99.8		-98.2
36	-21.7	-14.2	1.7	16.5	21.3	-96.3	-96.8	-99.7		-98.2
38	-21.8	-14.2	1.6	16.5	21.2	-97.3	-97.1	-98.6		-98.2
40	-21.8	-14.3	1.6	16.5	21.2	-96.6	-97.1	-97.9		-98.2
42	-21.8	-14.3	1.5	16.4	21.1	-98.0	-97.3	-98.6		-98.2
44	-21.8	-14.3	1.4	16.4	21.1	-98.0	-97.7	-97.8		-98.2
46	-21.8	-14.3	1.4	16.4	21.1	-97.9	-97.8	-98.1		-98.2
48	-21.8	-14.3	1.4	16.3	21.1	-98.1	-98.0	-97.7		-97.9

*Data for this hour derived from linear interpolation of data from hours 14 to 16.
**Response factor analysis was not performed for this wall assembly.

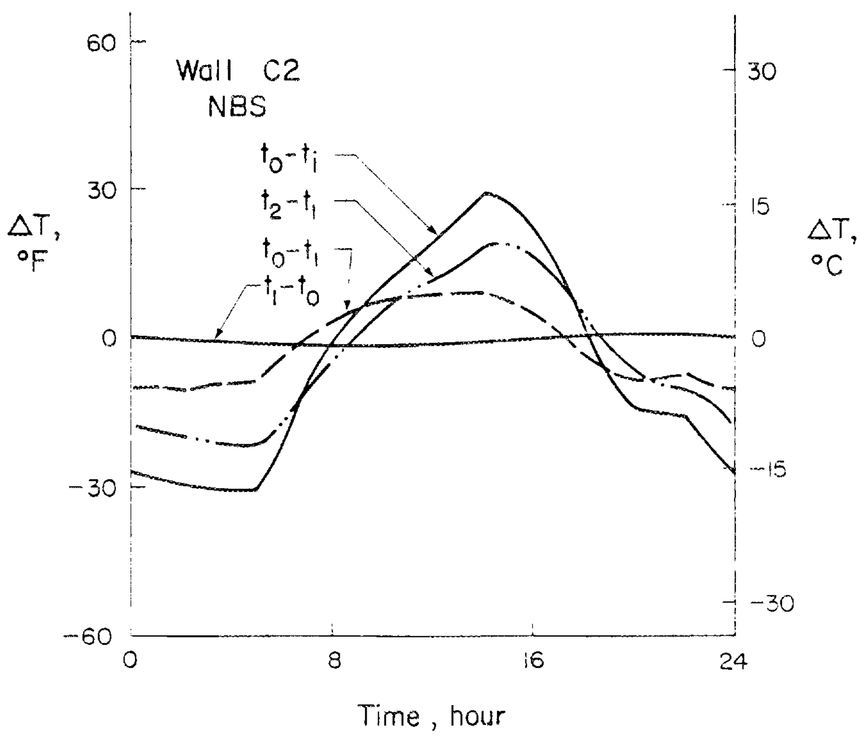
TABLE C2-6 - SUMMARY OF TRANSIENT TEST RESULTS

Heat Flux	Measured				Calculated			
	Calib. Hot Box		HFM @ Indoor Surf.		Response Factor*		Steady-State	
	q_w, Btu/hr·ft^2 (W/m^2)	Time to Reach q_w, hr	q_{hfm}, Btu/hr·ft^2 (W/m^2)	Time to Reach q_{hfm}, hr	q_{rf}, Btu/hr·ft^2 (W/m^2)	Time to Reach q_{rf}, hr	q_{ss}, Btu/hr·ft^2 (W/m^2)	Time to Reach q_{ss}, hr
99.5% of Final Heat Flux	-30.9 (-97.7)	38	-30.9 (-97.7)	44			-30.9 (-97.7)	16
95% of Final Heat Flux	-29.6 (-93.3)	28	-29.6 (-93.3)	29			-29.6 (-93.3)	8
90% of Final Heat Flux	-28.0 (-88.4)	23	-28.0 (-88.4)	23			-28.0 (-88.4)	5

*Response factor analysis was not performed for this dynamic test cycle.

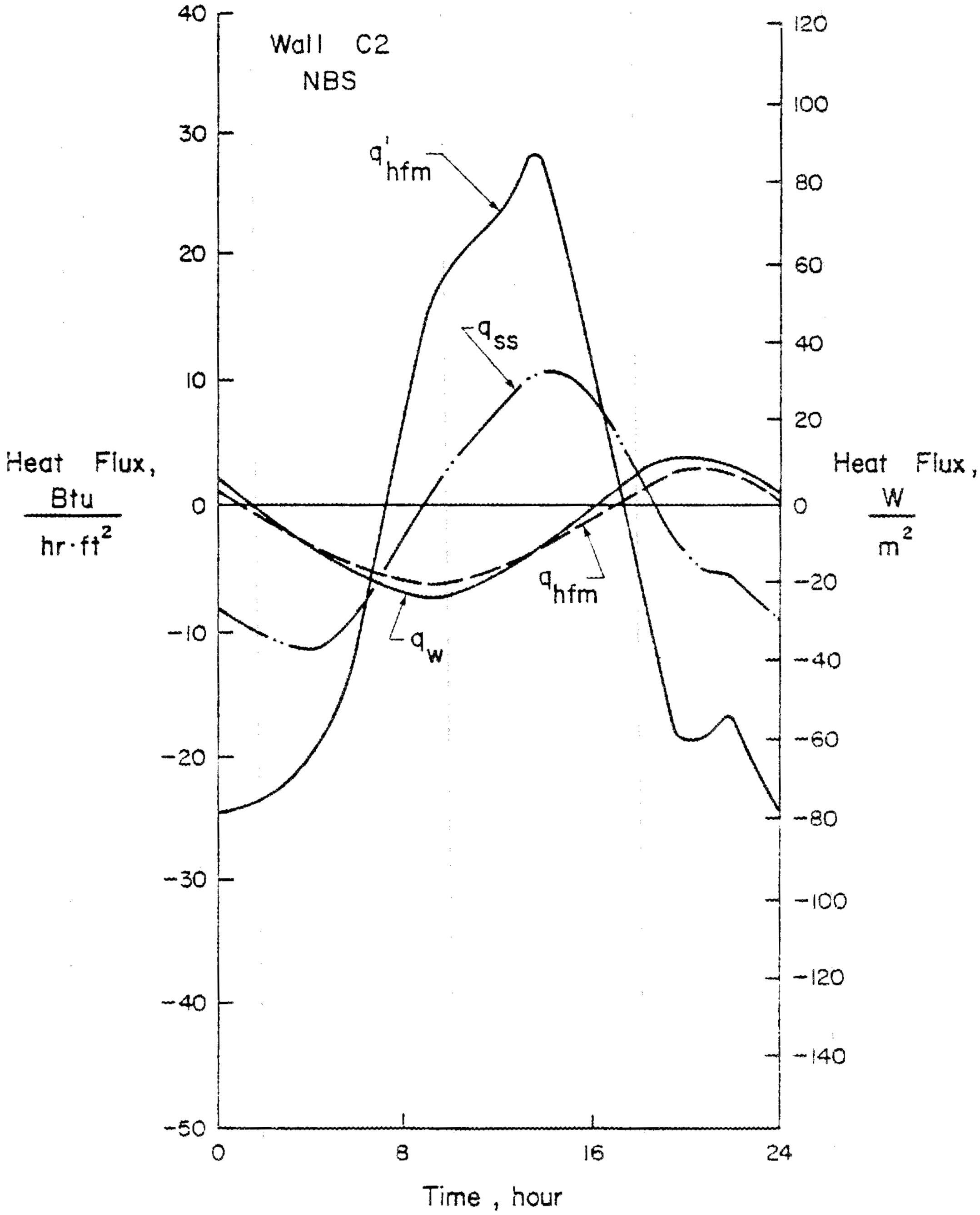


(a) Measured Temperatures



(b) Temperature Differentials

Fig. C2-2 Wall C2 Dynamic Test Results for NBS Test Cycle



(c) Heat Flux

Fig. C2-2 Wall C2 Dynamic Test Results for NBS Test Cycle

TABLE C2-7(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}* Response Factor	q_{ss} Steady-State
1	44.2	54.1	69.7	72.5	72.1	0.5	0.3	-23.9		-10.5
2	42.1	52.2	68.4	72.1	72.0	-0.5	-0.6	-24.1		-11.3
3	41.2	50.9	67.1	71.7	71.9	-1.8	-1.6	-23.4		-11.8
4	40.9	50.1	65.9	71.3	71.9	-2.7	-2.6	-22.1		-12.0
5	41.1	49.7	64.8	71.0	71.8	-3.7	-3.6	-20.5		-12.1
6	50.1	53.6	63.9	70.6	71.7	-5.3	-4.5	-9.5		-9.7
7	62.3	60.8	63.4	70.3	71.7	-5.9	-5.4	3.5		-5.4
8	70.3	66.4	63.6	70.1	71.7	-7.0	-6.1	10.3		-2.1
9	77.1	71.5	64.3	70.0	71.6	-7.2	-6.4	15.5		0.8
10	83.5	76.3	65.4	70.1	71.6	-7.0	-6.4	20.2		3.6
11	88.0	80.3	66.7	70.3	71.7	-6.6	-6.0	22.4		5.7
12	91.1	83.2	68.3	70.7	71.8	-5.9	-5.2	22.9		7.2
13	97.0	87.4	69.9	71.1	71.9	-4.5	-4.4	27.4		9.4
14	100.9	91.1	71.6	71.5	72.0	-3.5	-3.3	29.2		11.3
15	98.6	91.1	73.2	72.0	72.0	-2.3	-2.2	23.3		11.0
16	94.1	89.2	74.7	72.4	72.2	-0.4	-1.0	16.4		9.6
17	86.4	85.1	75.9	72.9	72.2	1.0	0.3	6.7		7.0
18	74.0	78.0	76.4	73.3	72.3	2.3	1.3	-7.0		2.7
19	64.2	71.2	76.3	73.6	72.4	3.3	2.2	-16.0		-1.3
20	58.8	66.7	75.6	73.7	72.4	3.3	2.7	-19.0		-4.0
21	57.0	64.4	74.5	73.7	72.4	3.6	2.7	-18.1		-5.3
22	56.5	63.3	73.4	73.4	72.3	3.1	2.4	-16.6		-5.8
23	50.1	59.5	72.3	73.2	72.3	2.5	1.8	-22.3		-7.8
24	45.5	55.8	71.1	72.8	72.2	1.3	1.1	-24.9		-9.7
Mean	67.3	68.8	69.8	71.8	72.0	-1.8	-1.9	-2.1		-1.7

*Response factor analysis was not performed for this wall assembly.

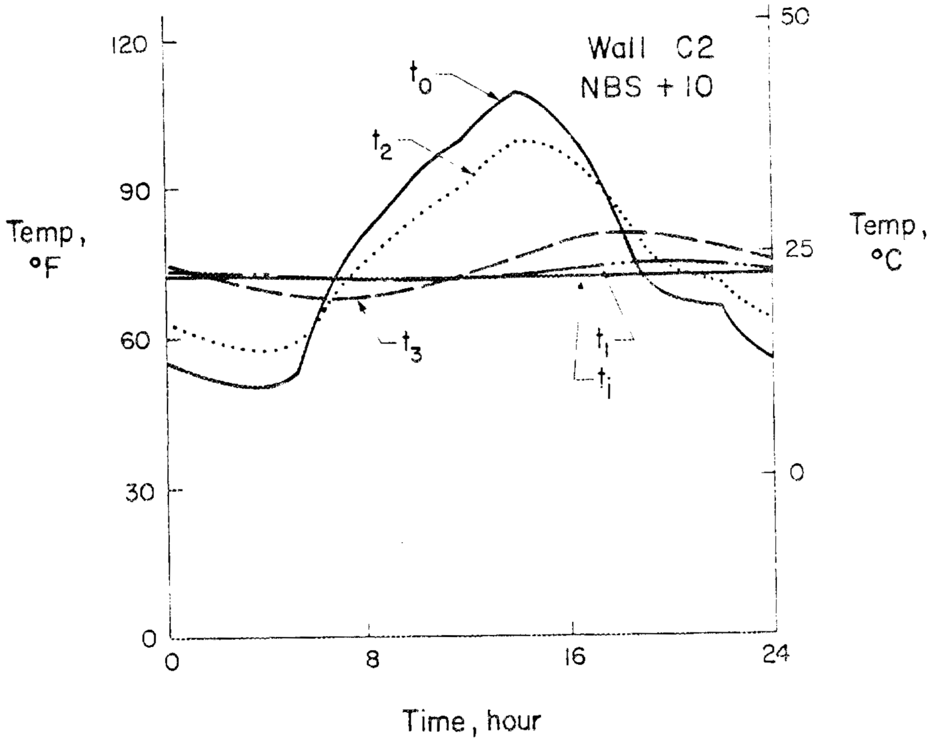
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 18%
Outdoor Chamber - 24%

Laboratory Air Temperature:
Max. - 71°F (22°C)
Min. - 66°F (19°C)

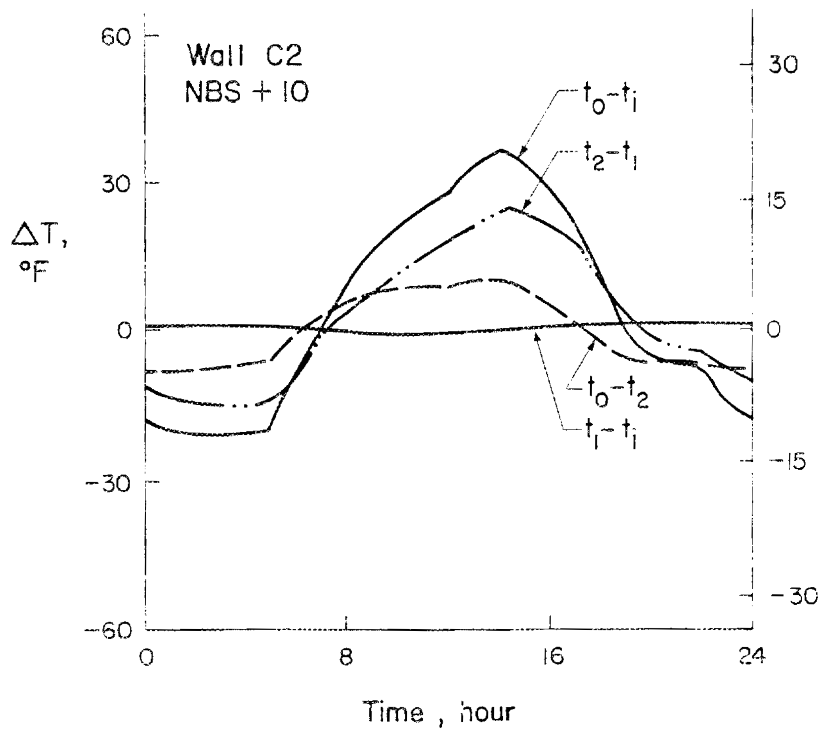
TABLE C2-7(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}* Response Factor	q_{ss} Steady-State
1	6.8	12.3	20.9	22.5	22.3	1.6	1.0	-75.5		-33.0
2	5.6	11.2	20.2	22.3	22.2	-1.6	-2.0	-75.9		-35.7
3	5.1	10.5	19.5	22.1	22.2	-5.6	-4.9	-73.7		-37.3
4	4.9	10.1	18.8	21.8	22.2	-8.5	-8.1	-69.6		-38.0
5	5.0	9.8	18.2	21.6	22.1	-11.7	-11.2	-64.6		-38.1
6	10.0	12.0	17.7	21.5	22.1	-16.8	-14.1	-30.0		-30.5
7	16.8	16.0	17.4	21.3	22.1	-18.7	-17.1	11.2		-17.1
8	21.3	19.1	17.5	21.1	22.0	-22.1	-19.1	32.6		-6.6
9	25.1	21.9	17.9	21.1	22.0	-22.6	-20.1	48.9		2.6
10	28.6	24.6	18.5	21.1	22.0	-22.1	-20.1	63.6		11.3
11	31.1	26.8	19.3	21.3	22.1	-20.9	-18.8	70.8		18.0
12	32.8	28.4	20.2	21.5	22.1	-18.7	-16.5	72.2		22.6
13	36.1	30.8	21.1	21.7	22.2	-14.2	-13.8	86.5		29.5
14	38.3	32.8	22.0	21.9	22.2	-11.1	-10.5	92.2		35.5
15	37.0	32.8	22.9	22.2	22.2	-7.2	-7.0	73.5		34.8
16	34.5	31.8	23.7	22.5	22.3	-1.3	-3.1	51.7		30.4
17	30.2	29.5	24.4	22.7	22.4	3.1	0.9	21.3		22.1
18	23.3	25.6	24.7	23.0	22.4	7.2	4.2	-22.2		8.5
19	17.9	21.8	24.6	23.1	22.4	10.4	6.8	-50.3		-4.2
20	14.9	19.3	24.2	23.2	22.4	10.5	8.4	-59.9		-12.6
21	13.9	18.0	23.6	23.1	22.4	11.3	8.4	-57.1		-16.7
22	13.6	17.4	23.0	23.0	21.4	9.6	7.5	-52.3		-18.3
23	10.0	15.3	22.4	22.9	22.4	7.7	5.6	-70.4		-24.5
24	7.5	13.2	21.7	22.7	22.3	4.2	3.5	-78.6		-30.7
Mean	19.6	20.5	21.0	22.1	22.2	-5.7	-5.8	-6.5		-5.3

*Response factor analysis was not performed for this wall assembly.

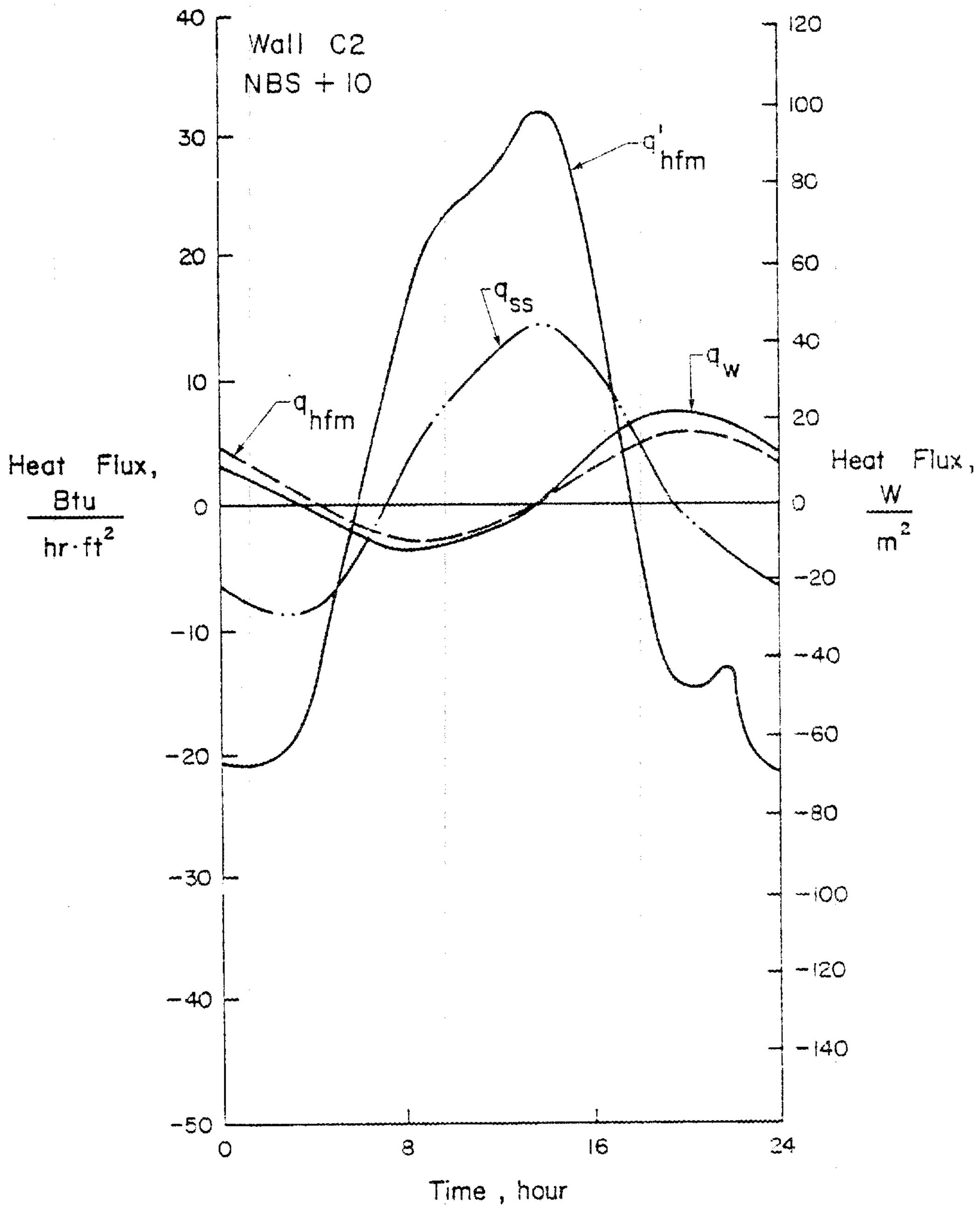


(a) Measured Temperatures



(b) Temperature Differentials

Fig. C2-3 Wall C2 Dynamic Test Results for NBS +10 Test Cycle



(c) Heat Flux

Fig. C2-3 Wall C2 Dynamic Test Results for NBS +10 Test Cycle

TABLE C2-8(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS+10 TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}* Response Factor	q_{ss} Steady-State
1	52.9	61.3	73.9	73.9	72.6	4.2	3.7	-21.1		-7.2
2	51.1	59.5	72.6	73.6	72.6	3.2	2.8	-20.9		-8.1
3	50.1	58.2	71.3	73.2	72.5	1.7	1.8	-20.1		-8.5
4	50.6	57.8	70.1	72.8	72.4	1.0	0.8	-18.0		-8.6
5	51.8	57.9	69.0	72.4	72.3	-0.2	-0.1	-15.6		-8.2
6	62.7	63.1	68.2	72.1	72.3	-1.7	-1.1	-2.0		-5.1
7	74.3	70.5	67.9	71.8	72.2	-2.4	-1.9	10.0		-0.8
8	81.5	75.8	68.2	71.6	72.2	-3.2	-2.5	15.7		2.4
9	87.2	80.1	68.8	71.4	72.1	-3.6	-2.9	19.7		5.0
10	93.5	84.8	70.0	71.5	72.1	-3.2	-2.7	24.3		7.6
11	97.2	88.4	71.4	71.8	72.2	-2.7	-2.3	25.5		9.5
12	100.6	91.3	73.0	72.1	72.3	-1.9	-1.5	26.9		11.0
13	106.3	95.7	74.5	72.5	72.4	-0.7	-0.7	31.6		13.3
14	108.9	98.4	76.2	73.0	72.5	0.6	0.4	31.4		14.8
15	106.0	98.2	77.8	73.5	72.6	1.7	1.5	25.4		14.3
16	101.8	96.2	79.3	74.0	72.7	3.2	2.7	18.6		12.7
17	94.0	92.0	80.3	74.4	72.8	4.9	3.9	8.9		10.1
18	80.9	84.4	80.8	74.8	72.8	6.1	5.0	-5.7		5.5
19	71.5	77.6	80.6	75.1	72.9	6.9	5.8	-13.8		1.5
20	67.5	73.8	79.8	75.2	72.9	7.4	6.1	-15.1		-0.8
21	66.4	72.0	78.7	75.1	72.9	7.1	6.2	-13.6		-1.8
22	65.1	70.7	77.5	74.9	72.8	6.7	5.8	-13.2		-2.4
23	58.0	66.2	76.4	74.6	72.8	6.1	5.2	-20.1		-4.8
24	55.3	63.5	75.2	74.3	72.7	4.8	4.5	-20.5		-6.2
Mean	76.5	76.6	74.2	73.3	72.5	1.9	1.7	1.6		1.9

*Response factor analysis was not performed for this wall assembly.

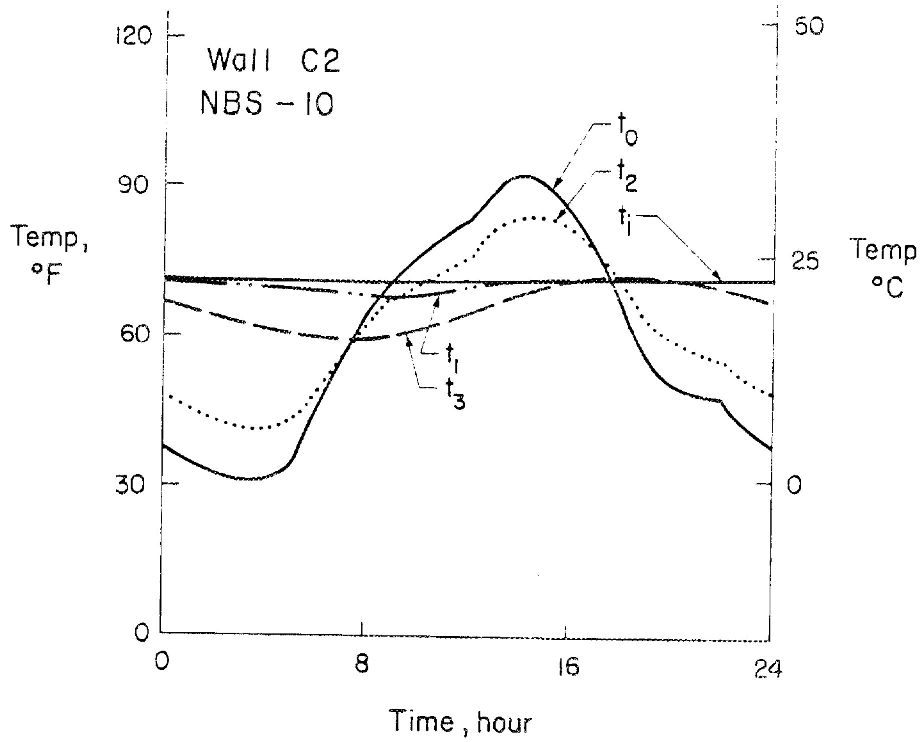
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 21%
Outdoor Chamber - 25%

Laboratory Air Temperature:
Max. - 73°F (23°C)
Min. - 70°F (21°C)

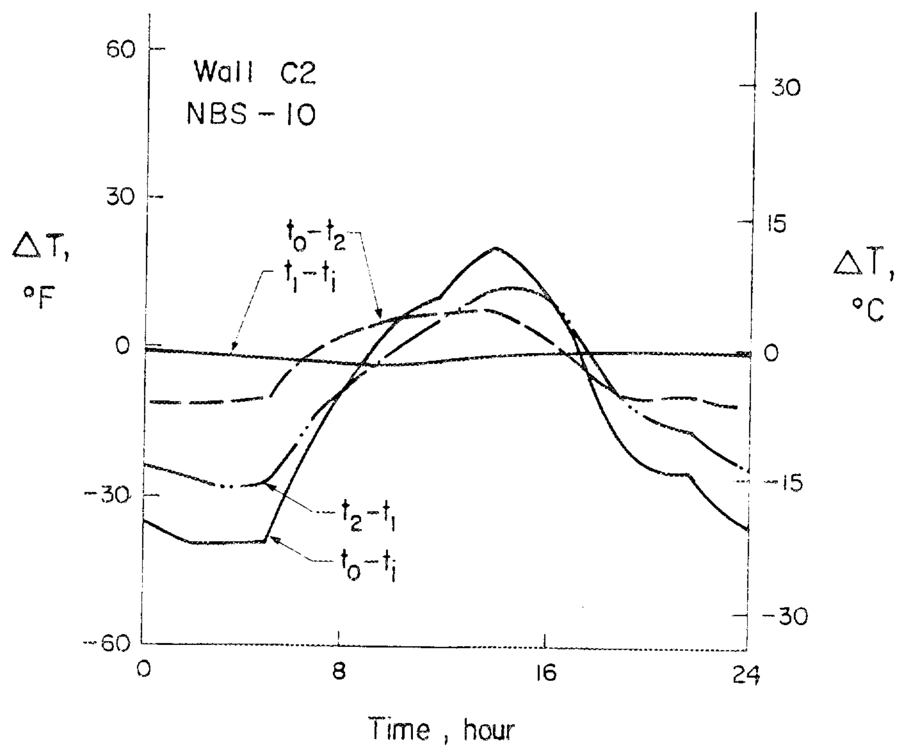
TABLE C2-8(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS+10 TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}* Response Factor	q_{ss} Steady-State
1	11.6	16.3	23.2	23.3	22.6	13.3	11.6	-66.5		-22.8
2	10.6	15.3	22.6	23.1	22.5	10.1	8.7	-65.9		-25.4
3	10.1	14.6	21.8	22.9	22.5	5.3	5.8	-63.5		-26.9
4	10.3	14.3	21.2	22.7	22.5	3.2	2.5	-56.9		-27.0
5	11.0	14.4	26.6	22.5	22.4	-0.6	-0.5	-49.1		-26.0
6	17.1	17.3	20.1	22.3	22.4	-5.4	-3.6	-6.3		-16.1
7	23.5	21.4	19.9	22.1	22.4	-7.5	-6.1	31.5		-2.5
8	27.5	24.3	20.1	22.0	22.3	-9.9	-8.0	49.4		7.6
9	30.7	26.7	20.5	21.9	22.3	-11.4	-9.0	62.1		15.8
10	34.2	29.4	21.1	22.0	22.3	-10.2	-8.6	76.6		24.1
11	36.2	31.3	21.9	22.1	22.3	-8.5	-7.1	80.4		30.0
12	38.1	33.0	22.8	22.3	22.4	-5.8	-4.8	84.8		34.8
13	41.3	35.4	23.6	22.5	22.4	-2.3	-2.1	99.8		41.9
14	42.7	37.1	24.6	22.8	22.5	1.9	1.2	99.1		46.6
15	41.1	36.8	25.4	23.0	22.5	5.3	4.8	80.1		45.0
16	38.8	35.7	26.3	23.3	22.6	10.2	8.5	58.5		40.2
17	34.4	33.4	26.9	23.6	22.6	15.5	12.4	28.1		32.0
18	27.1	29.1	27.1	23.8	22.7	19.1	15.8	-17.8		17.2
19	22.0	25.3	27.0	22.3	22.7	21.8	18.2	-43.5		4.7
20	19.7	23.2	26.6	24.0	22.7	23.4	19.3	-47.7		-2.5
21	19.1	22.2	25.9	23.9	22.7	22.5	19.4	-43.0		-5.6
22	18.4	21.5	25.3	23.8	22.7	21.0	18.3	-41.7		-7.6
23	14.4	19.0	24.7	23.7	22.7	19.1	16.3	-63.4		-15.0
24	13.0	17.5	24.0	23.5	22.6	15.0	14.3	-64.7		-19.4
Mean	24.7	24.8	23.5	22.9	22.5	6.0	5.3	5.0		6.0

*Response factor analysis was not performed for this wall assembly.

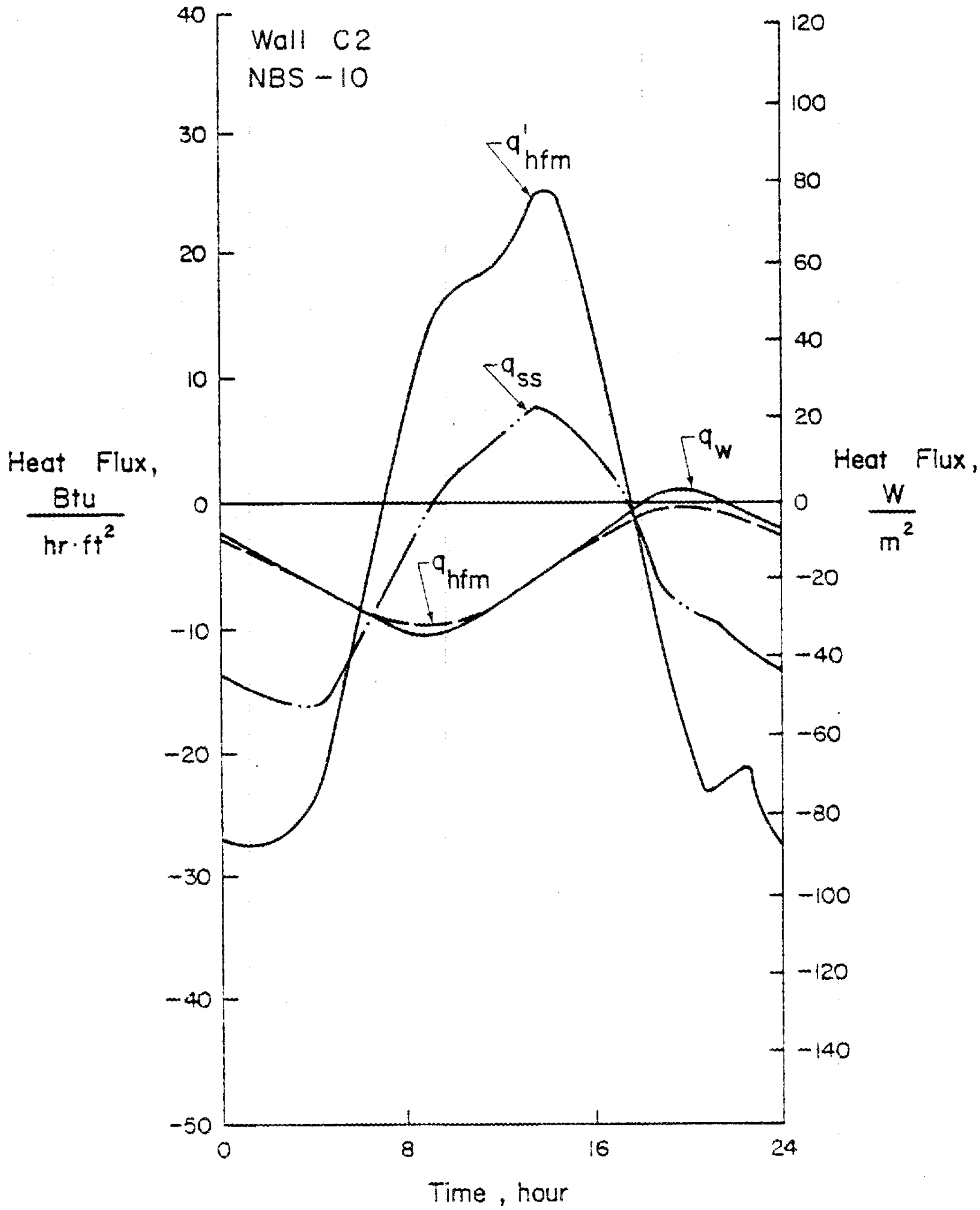


(a) Measured Temperatures



(b) Temperature Differentials

Fig. C2-4 Wall C2 Dynamic Test Results for NBS -10 Test Cycle



(c) Heat Flux

Fig. C2-4 Wall C2 Dynamic Test Results for NBS -10 Test Cycle

TABLE C2-9(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS-10 TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}* Response Factor	q_{ss} Steady-State
1	35.0	46.6	65.7	71.4	72.1	-2.7	-3.2	-27.2		-14.2
2	33.0	44.6	64.3	71.0	72.0	-3.8	-4.1	-27.3		-15.1
3	32.2	43.4	63.1	70.6	72.0	-4.9	-5.1	-26.3		-15.6
4	32.1	42.6	61.9	70.2	71.8	-6.0	-6.1	-25.1		-15.8
5	33.4	42.7	60.8	69.9	71.8	-7.1	-7.1	-22.4		-15.5
6	44.7	48.2	59.9	69.5	71.8	-8.4	-8.1	-9.3		-12.1
7	56.3	55.4	59.6	69.2	71.7	-9.3	-8.9	2.1		-7.9
8	64.4	61.1	59.9	69.1	71.7	-10.1	-9.5	8.8		-4.5
9	70.6	65.8	60.7	69.0	71.7	-10.3	-9.7	13.0		-1.8
10	76.8	70.7	62.1	69.2	71.7	-10.0	-9.5	17.1		0.9
11	80.2	73.9	63.5	69.4	71.7	-9.4	-9.0	18.1		2.6
12	83.4	76.7	65.0	69.7	71.8	-8.5	-8.3	19.4		4.0
13	89.9	81.2	66.5	70.1	71.9	-7.4	-7.4	24.6		6.4
14	92.6	84.3	68.1	70.6	72.0	-6.2	-6.3	24.5		7.9
15	89.4	83.7	69.8	71.1	72.1	-5.0	-5.2	18.3		7.3
16	85.0	81.7	71.2	71.5	72.1	-3.2	-4.0	11.7		5.9
17	77.1	77.6	72.3	72.0	72.3	-1.8	-2.9	2.1		3.2
18	63.8	69.9	72.7	72.4	72.3	-0.6	-1.8	-12.6		-1.4
19	54.7	63.4	72.5	72.6	72.4	0.1	-1.0	-20.1		-5.3
20	49.6	59.1	71.7	72.7	72.4	0.6	-0.6	-22.6		-7.8
21	48.1	57.1	70.6	72.6	72.3	0.3	-0.6	-21.4		-8.9
22	47.2	55.8	69.4	72.4	72.3	-0.1	-1.0	-20.2		-9.5
23	40.3	51.7	68.2	72.1	72.2	-0.7	-1.6	-26.3		-11.7
24	37.2	48.7	67.0	71.8	72.2	-1.7	-2.4	-27.1		-13.2
Mean	59.0	61.9	66.1	70.8	72.0	-4.9	-5.1	-5.3		-5.1

*Response factor analysis was not performed for this wall assembly.

Calibrated Hot Box Relative Humidity:
Indoor Chamber - 20%
Outdoor Chamber - 25%

Laboratory Air Temperature:
Max. - 73°F (23°C)
Min. - 68°F (20°C)

TABLE C2-9(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS-10 TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}* Response Factor	q_{ss} Steady-State
1	1.7	8.1	18.7	21.9	22.3	-8.6	-10.1	-85.8		-44.7
2	0.6	7.0	17.9	21.7	22.2	-12.1	-13.1	-86.2		-47.6
3	0.1	6.3	17.3	21.5	22.2	-15.3	-16.2	-83.0		-49.1
4	0.0	5.9	16.6	21.2	22.2	-19.0	-19.4	-79.1		-49.7
5	0.8	6.0	16.0	21.0	22.1	-22.4	-22.3	-70.6		-48.8
6	7.0	9.0	15.5	20.9	22.1	-26.4	-25.5	-29.2		-38.3
7	13.5	13.0	15.3	20.7	22.1	-29.4	-28.0	6.6		-25.0
8	18.0	16.2	15.5	20.6	22.0	-31.7	-30.0	27.9		-14.3
9	21.4	18.8	16.0	20.6	22.0	-32.6	-30.7	41.0		-5.7
10	24.9	21.5	16.7	20.6	22.1	-31.6	-29.8	54.1		2.8
11	26.8	23.3	17.5	20.8	22.1	-29.5	-28.5	57.1		8.2
12	28.6	24.8	18.3	21.0	22.1	-26.7	-26.2	61.0		12.6
13	32.2	27.4	19.1	21.2	22.2	-23.4	-23.3	77.4		20.2
14	33.7	29.0	20.1	21.4	22.2	-19.6	-20.0	77.4		24.8
15	31.9	28.7	21.0	21.7	22.3	-15.9	-16.5	57.6		22.9
16	29.4	27.6	21.8	22.0	22.3	-9.9	-12.6	36.8		18.6
17	25.1	25.4	22.4	22.2	22.4	-5.7	-9.0	6.7		10.2
18	17.7	21.1	22.6	22.4	22.4	-2.0	-5.8	-39.7		-4.5
19	12.6	17.4	22.5	22.6	22.4	0.4	-3.2	-63.5		-16.8
20	9.8	15.1	22.1	22.6	22.4	1.8	-1.9	-71.4		-24.5
21	8.9	13.9	21.4	22.6	22.4	1.0	-2.0	-67.4		-28.1
22	8.4	13.2	20.8	22.4	22.4	-0.3	-3.2	-63.6		-30.0
23	4.6	10.9	20.1	22.3	22.4	-2.3	-5.2	-82.9		-36.8
24	2.9	9.3	19.4	22.1	22.3	-5.4	-7.5	-85.4		-41.5
Mean	15.0	16.6	18.9	21.6	22.2	-15.3	-16.2	-16.8		-16.0

*Response factor analysis was not performed for this wall assembly.

TABLE C2-12 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), THERMAL LAG

Test Cycle	Thermal Lag, hrs												Calc. Time Constant, hrs
	Measured									Calculated			
	Calibrated Hot Box					Heat Flow Meter				Response Factor*			
	t_o vs t_1		q_{ss} vs q_w		Avg.	q_{ss} vs q_{hfm}		Avg.		q_{ss} vs q_{rf}		Avg.	
	@ Max.	@ Min.	@ Max.	@ Min.		@ Max.	@ Min.			@ Max.	@ Min.		
NBS	6	5	7	4.5	5.5	6.5	5	6					2.9
NBS+10	6	6	6	5.5	6	6.5	5.5	6					2.9
NBS-10	6	5	6	5	5.5	5.5	4	5					2.9

*Response factor analysis was not performed for this wall assembly.

TABLE C2-13 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), REDUCTION IN AMPLITUDE

Test Cycle	Measured, %						Calculated, %		
	Calibrated Hot Box			Heat Flow Meter			Response Factor*		
	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.
NBS	58	48	53	65	56	61			
NBS+10	57	48	53	65	56	61			
NBS-10	58	50	54	65	57	61			

*Response factor analysis was not performed for this wall assembly.

TABLE C2-14 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), ENERGY REQUIREMENTS

Test Cycle	Total Energy, Btu/ft^2 (W·hr/m^2)				Total Energy Comparisons, %			Net Energy, Btu/ft^2 (W·hr/m^2)				Net Energy Comparisons, %		
	Measured		Calculated					Measured		Calculated				
	q^T_w	q^T_{hfm}	q^T_{rf} *	q^T_{ss}	$\frac{q^T_w}{q^T_{ss}}$	$\frac{q^T_{hfm}}{q^T_{ss}}$	$\frac{q^T_{rf}}{q^T_{ss}}$	q^N_w	q^N_{hfm}	q^N_{rf} *	q^N_{ss}	$\frac{q^N_w}{q^N_{ss}}$	$\frac{q^N_{hfm}}{q^N_{ss}}$	$\frac{q^N_{rf}}{q^N_{ss}}$
NBS	85.2 (268.7)	73.8 (232.7)		177.1 (558.6)	48	42		-43.6 (-137.5)	-44.4 (-140.1)		-40.6 (-128.0)	107	109	
NBS+10	85.0 (268.3)	71.9 (226.9)		170.1 (536.7)	50	42		46.0 (145.1)	40.3 (127.3)		45.4 (143.1)	101	89	
NBS-10	118.2 (373.0)	123.6 (390.0)		198.3 (625.7)	60	62		-116.2 (-366.6)	-123.6 (-390.0)		-122.1 (-385.1)	95	101	

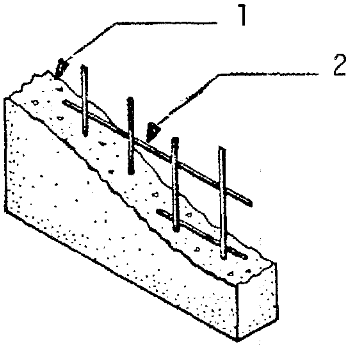
*Response factor analysis was not performed for this wall assembly.

WALL C3: LOW DENSITY CONCRETE

DESCRIPTION: Low density concrete wall with reinforcement at approximate midthickness.

REFERENCE: Van Geem, M. G. and Fiorato, A. E., "Heat Transfer Characteristics of Low Density Concrete Wall," Construction Technology Laboratories, Portland Cement Association, Skokie, 1983, 89 pages.

COMPOSITION:



1. Low Density Concrete
   Portland Cement
   Perlite Aggregate*
      Loose unit weight of 7.9 pcf (126 kg/m^3)
   Measured Air Content: not available

2. Reinforcement
   Single layer of 6-mm diameter bars
      Spaced 12 in. (305 mm)
      center-to-center

TABLE C3-1 - PHYSICAL PROPERTIES OF WALL AT TIME OF TEST

Property	Measured Value
Weight, psf (kg/m^2)	32.7 (160)
Average Thickness, in. (mm)	8.52 (216)
Area, ft^2 (m^2)	73.79 (6.86)
Estimated Moisture Content, % by ovendry weight	9.5

*Perlite only, no sand was used as aggregate.

TABLE C3-2(a) - MATERIAL PROPERTIES, LOW DENSITY CONCRETE

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Unit Weight, pcf (kg/m^3)	--	ovendry	--	42 (670)
Specific Heat, Btu/lb·°F (J/kg·K)	Similar to CRD-C124-73	saturated	73 (23)	0.444 (1860)
Specific Heat, Btu/lb·°F (J/kg·K)	Calculated	air dry*	73 (23)	0.179 (750)
Thermal Conductivity, Btu·in/hr·ft^2·°F (W/m·K)	Hot Wire	air dry**	--	3.05 (0.440)
Thermal Conductivity, Btu·in/hr·ft^2·°F (W/m·K)	ASTM C 177	ovendry	70 (21)	1.44 (0.207)
Thermal Conductivity, Btu·in/hr·ft^2·°F (W/m·K)	ASTM C 976	air dry*	70 (21)	1.44 (0.207)
Thermal Diffusivity, ft^2/hr (mm^2/s)	CRD-C36-73	saturated	--	0.00849 (0.219)
Compressive Strength, psi (MPa)	ASTM C 39	air dry	--	880 (6.1)
Splitting Tensile Strength, psi (MPa)	ASTM C 496	air dry	--	65 (0.45)

*9.5% moisture content relative to ovendry weight
**17.3% moisture content relative to ovendry weight

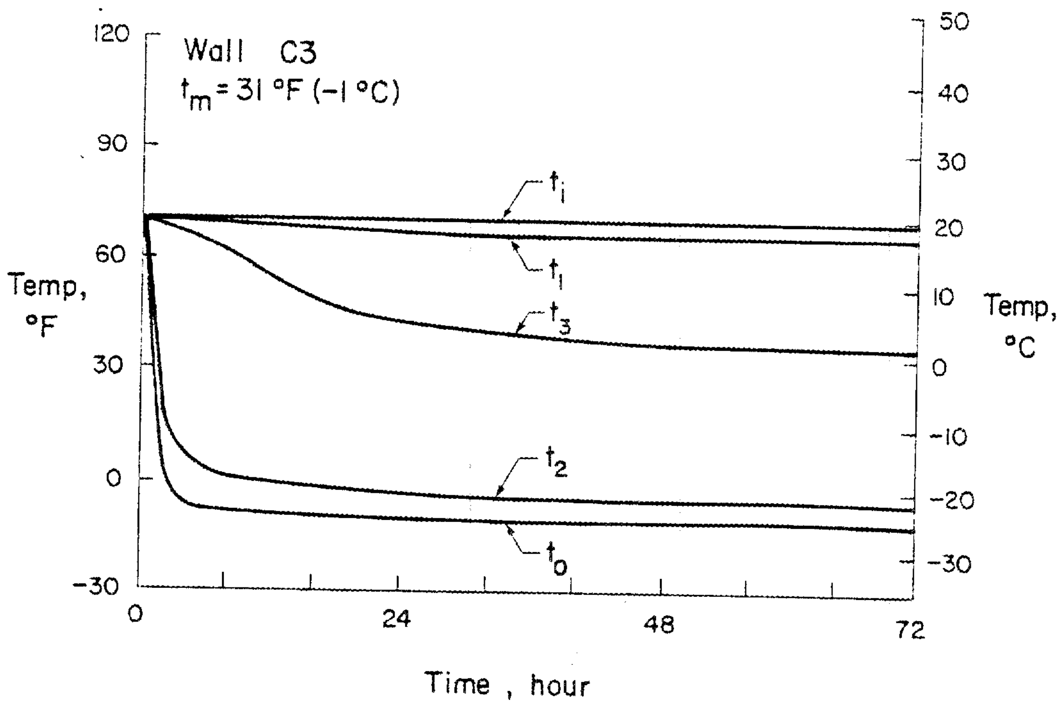
TABLE C3-3 - DESIGN HEAT TRANSMISSION COEFFICIENTS

Component	R, Thermal Resistance $hr \cdot ft^2 \cdot °F/Btu$ $(m^2 \cdot K/W)$
1. Outside Air Film	0.17 (0.03)
2. 8-in. (203-mm) Low Density Concrete	8.02* (1.41)
3. Inside Air Film	0.68 (0.12)
Total R	8.87 (1.56)
Total U	0.11 (0.64)

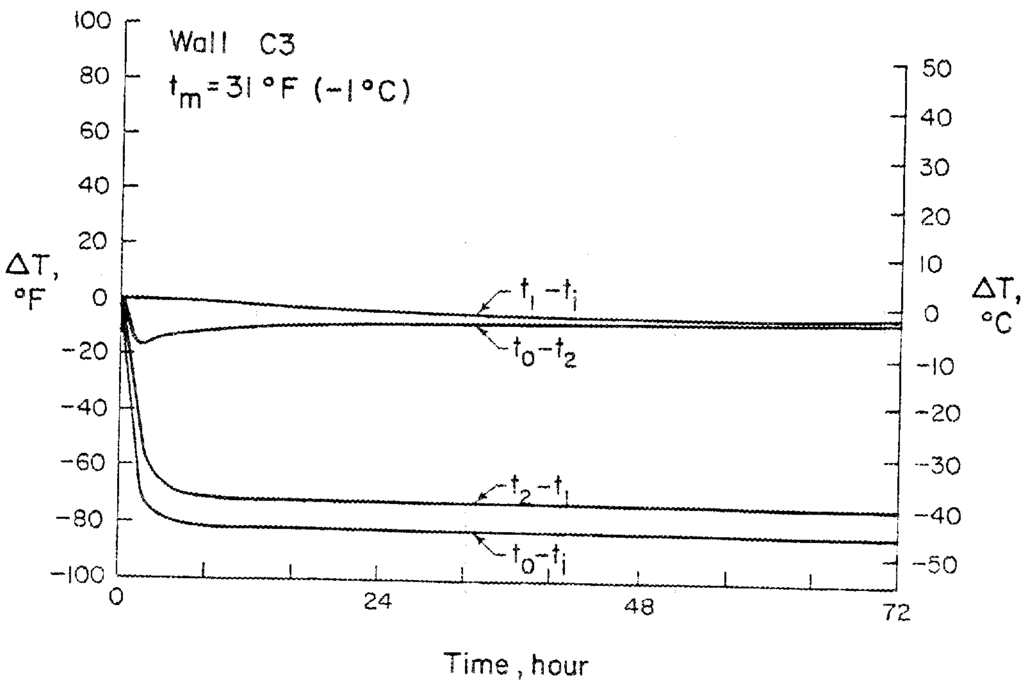
*Source: ASHRAE Handbook of Fundamentals, American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc., Atlanta, 1981, Chapter 23.

TABLE C3-4 – STEADY-STATE TEST RESULTS

Nominal Test Condition	q Heat Flux, Btu/hr·ft^2 (W/m^2)	R_T, hr·ft^2·°F/Btu (m^2·K/W)	U, Btu/hr·ft^2·°F (W/m^2·K)	Measured Temperatures, °F (°C)					Relative Humidity		Laboratory Air Temperature	
				t_o Outdoor Air	t_2 Outdoor Surface	t_3 Internal	t_1 Indoor Surface	t_i Indoor Air	Indoor Chamber, %	Outdoor Chamber, %	Max. °F (°C)	Min. °F (°C)
t_m = 53°F (11°C)	-5.69 (-17.9)	7.02 (1.24)	0.14 (0.81)	32 (0)	35 (2)	55 (13)	70 (21)	72 (22)	24	22	72 (22)	70 (21)
t_m = 89°F (32°C)	5.13 (16.2)	6.53 (1.15)	0.15 (0.87)	105 (41)	104 (40)	86 (30)	75 (24)	73 (23)	26	25	72 (22)	70 (21)
t_m = 100°F (38°C)	8.64 (27.3)	6.31 (1.11)	0.16 (0.90)	126 (52)	123 (51)	95 (35)	76 (24)	73 (23)	24	28	72 (22)	68 (20)
Design Values	-	8.87 (1.56)	0.11 (0.64)	-	-	-	-	-	-	-	-	-

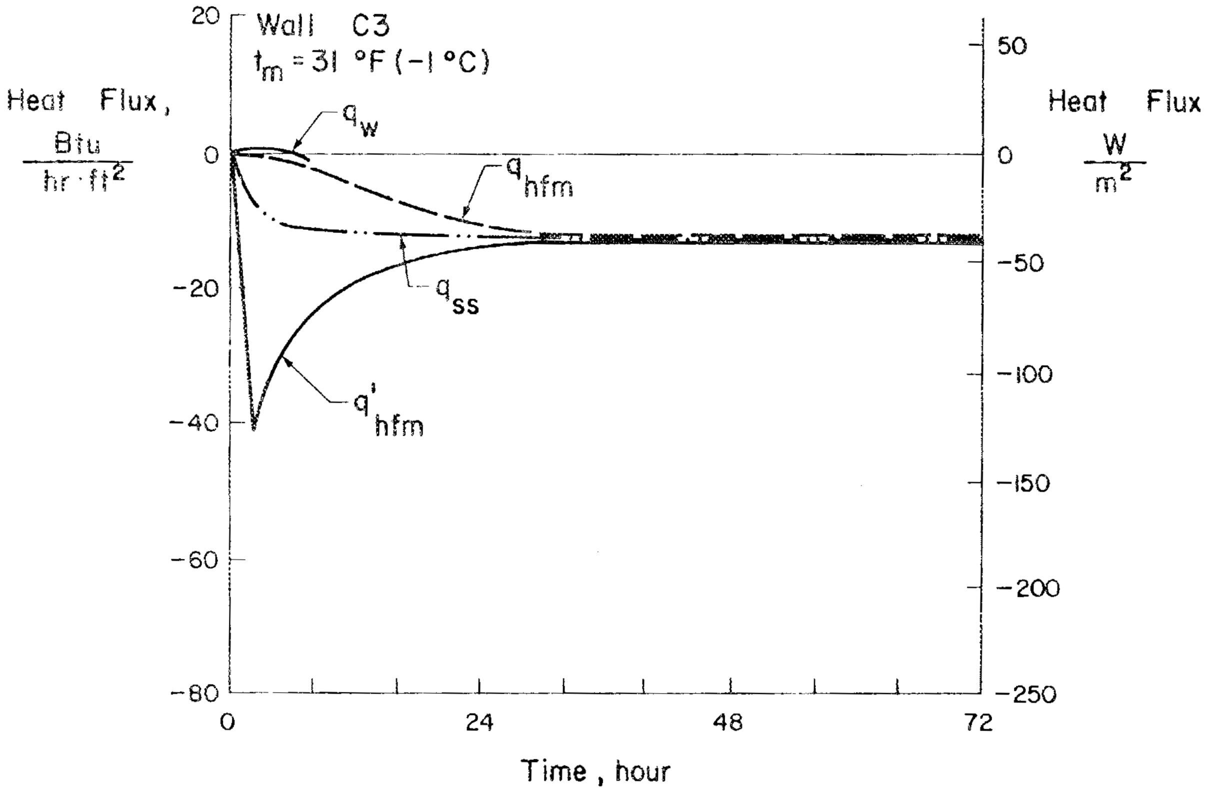


(a) Measured Temperatures



(b) Temperature Differentials

Fig. C3-1 Wall C3 Transient Test Results



(c) Heat Flux

Fig. C3-1 Wall C3 Transient Test Results

TABLE C3-5(a) - TRANSIENT TEST RESULTS

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft²			Calculated Heat Flux, Btu/hr·ft²	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
0	72.0	72.7	71.8	72.7	72.4	-0.1	-0.1	-0.0		0.0
1	39.9	52.4	71.7	72.7	72.4	0.6	-0.1	-26.9		-3.4
2	3.3	20.0	71.6	72.7	72.4	0.6	-0.0	-41.7		-8.4
3	-4.7	9.4	70.7	72.7	72.4	0.6	-0.0	-34.3		-10.0
4	-6.3	6.0	69.1	72.6	72.5	0.9	-0.1	-29.0		-10.5
5	-7.3	4.1	67.0	72.6	72.4	0.3	-0.3	-25.6		-10.7
6	-8.0	2.7	64.8	72.4	72.3	-0.3	-0.7	-23.9		-10.9
7	-8.4	1.8	62.8	72.1	72.3	-0.5	-1.2	-22.4		-11.0
8	-8.8	0.9	60.8	71.9	72.3	-1.1	-1.8	-20.9		-11.1
9	-9.1	0.3	58.9	71.6	72.2	-2.2	-2.4	-20.3		-11.1
10	-9.4	-0.2	57.2	71.3	72.2	-3.0	-3.1	-19.3		-11.1
11	-9.5	-0.7	55.7	71.0	72.1	-3.4	-3.8	-18.6		-11.1
12	-9.7	-1.1	54.2	70.7	72.1	-4.5	-4.4	-17.5		-11.1
13	-9.9	-1.5	52.8	70.3	72.0	-4.9	-4.9	-17.3		-11.1
14	-10.1	-1.9	51.5	70.2	71.9	-5.5	-5.5	-17.1		-11.2
15	-10.2	-2.2	50.3	69.9	71.9	-5.8	-6.0	-16.4		-11.2
16	-10.4	-2.4	49.1	69.8	71.8	-6.7	-6.5	-16.0		-11.2
17	-10.6	-2.6	47.8	69.6	71.4	-7.2	-6.9	-15.8		-11.2
18	-10.7	-3.0	46.9	69.4	71.5	-7.7	-7.3	-15.3		-11.2
19	-10.6	-3.2	46.3	69.1	71.6	-7.5	-7.6	-15.1		-11.2
20	-10.7	-3.3	45.5	69.0	71.6	-7.8	-8.0	-14.8		-11.2
21	-10.8	-3.5	44.9	68.9	71.6	-8.5	-8.3	-14.6		-11.2
22	-10.9	-3.7	44.1	68.8	71.5	-8.8	-8.6	-14.4		-11.1
23	-10.9	-3.8	43.6	68.7	71.6	-8.8	-8.9	-14.2		-11.2
24	-10.9	-4.0	43.0	68.6	71.6	-9.1	-9.2	-13.7		-11.2
26	-11.0	-4.2	42.0	68.4	71.6	-9.7	-9.7	-13.6		-11.2
28	-11.0	-4.3	41.2	68.3	71.6	-10.0	-10.0	-13.0		-11.2
30	-11.2	-4.5	40.4	68.1	71.4	-10.3	-10.3	-12.9		-11.2
32	-11.1	-4.7	39.9	68.0	71.6	-10.5	-10.6	-12.7		-11.2
34	-11.2	-4.8	39.3	67.9	71.5	-10.8	-10.8	-12.5		-11.2
36	-11.2	-4.9	38.7	67.8	71.5	-11.0	-10.9	-12.6		-11.2
38	-11.3	-4.9	38.6	67.8	71.5	-11.2	-11.1	-12.2		-11.2
40	-11.2	-4.9	38.3	67.7	71.5	-11.3	-11.2	-12.2		-11.2
42	-11.3	-5.0	38.0	67.6	71.4	-11.0	-11.3	-12.0		-11.2
44	-11.3	-5.1	37.8	67.5	71.4	-11.1	-11.4	-11.7		-11.2
46	-11.2	-5.1	37.6	67.4	71.4	-11.3*	-11.7	-12.1		-11.1
48	-11.3	-5.1	37.5	67.5	71.4	-11.3	-11.6	-11.9		-11.2
50	-11.3	-5.2	37.3	67.4	71.4	-11.6	-11.7	-11.7		-11.2
52	-11.4	-5.3	37.2	67.4	71.4	-11.0	-11.7	-12.0		-11.2
54	-11.5	-5.3	37.1	67.4	71.4	-11.5	-11.7	-11.7		-11.2
56	-11.5	-5.3	37.0	67.5	71.4	-11.5	-11.8	-11.6		-11.2
58	-11.5	-5.4	37.0	67.5	71.5	-11.6	-11.8	-11.7		-11.2
60	-11.5	-5.3	36.9	67.5	71.3	-12.1	-11.8	-11.7		-11.2
62	-11.5	-5.4	36.8	67.5	71.5	-11.7	-11.8	-11.7		-11.2
64	-11.5	-5.4	36.8	67.5	71.4	-12.0	-11.8	-11.6		-11.2
66	-11.5	-5.4	36.8	67.5	71.5	-11.8	-11.9	-11.5		-11.2
68	-11.5	-5.4	36.7	67.5	71.3	-11.9	-11.9	-11.6		-11.2
70	-11.5	-5.4	36.6	67.5	71.4	-12.0	-11.9	-11.7		-11.2
72	-11.5	-5.4	36.6	67.5	71.4	-11.9	-12.0	-11.7		-11.2

*Calibrated hot box data for this hour derived from linear interpolation of data from hours 44 to 47.
**Response factor analysis was not performed for this wall assembly.

TABLE C3-5(b) - TRANSIENT TEST RESULTS, SI UNITS

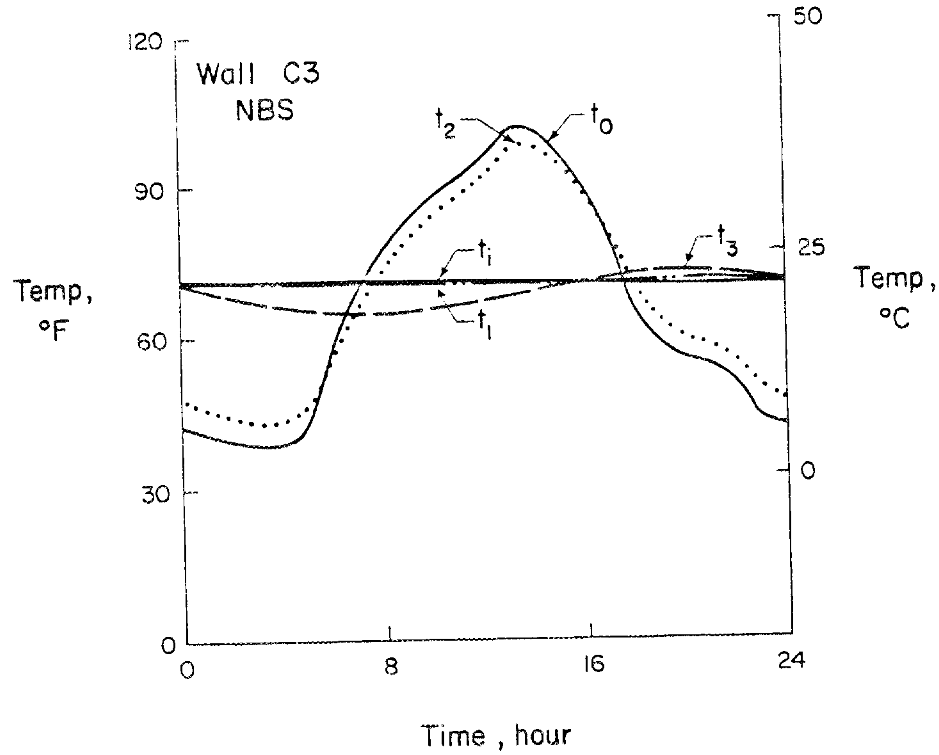
Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
0	22.3	22.6	22.1	22.6	22.4	-0.5	-0.3	-0.1		0.0
1	4.4	11.4	22.1	22.6	22.5	1.9	-0.2	-84.8		-10.6
2	-16.0	-6.7	22.0	22.6	22.4	1.7	-0.1	-131.5		-26.6
3	-20.4	-12.6	21.5	22.6	22.4	1.9	-0.1	-108.1		-31.4
4	-21.3	-14.4	20.6	22.6	22.5	2.7	-0.4	-91.5		-33.0
5	-21.8	-15.5	19.4	22.5	22.5	0.9	-1.0	-80.7		-33.7
6	-22.2	-16.3	18.2	22.4	22.4	-0.9	-2.1	-75.5		-34.3
7	-22.4	-16.8	17.1	22.3	22.4	-1.5	-3.9	-70.8		-34.7
8	-22.7	-17.3	16.0	22.1	22.4	-3.6	-5.8	-65.8		-34.9
9	-22.9	-17.6	15.0	22.0	22.3	-6.9	-7.6	-63.9		-35.1
10	-23.0	-17.9	14.0	21.8	22.3	-9.6	-9.9	-60.8		-35.0
11	-23.1	-18.2	13.2	21.7	22.3	-10.8	-12.0	-58.6		-35.0
12	-23.2	-18.4	12.3	21.5	22.3	-14.3	-13.8	-55.2		-35.1
13	-23.3	-18.6	11.6	21.3	22.2	-15.5	-15.5	-54.7		-35.1
14	-23.4	-18.8	10.9	21.2	22.2	-17.2	-17.3	-53.8		-35.2
15	-23.4	-19.0	10.2	21.1	22.2	-18.3	-18.9	-51.8		-35.2
16	-23.5	-19.1	9.5	21.0	22.1	-21.0	-20.5	-50.6		-35.3
17	-23.7	-19.2	8.8	20.9	21.9	-22.8	-21.8	-49.9		-35.3
18	-23.7	-19.4	8.3	20.8	22.0	-24.2	-23.1	-48.3		-35.4
19	-23.7	-19.6	7.9	20.6	22.0	-23.8	-24.1	-47.7		-35.4
20	-23.7	-19.6	7.5	20.6	22.0	-24.5	-25.3	-46.7		-35.4
21	-23.8	-19.7	7.2	20.5	22.0	-26.7	-26.1	-46.2		-35.4
22	-23.8	-19.8	6.7	20.4	22.0	-27.8	-27.2	-45.3		-35.1
23	-23.8	-19.9	6.4	20.4	22.0	-27.7	-28.0	-44.6		-35.2
24	-23.8	-20.0	6.1	20.3	22.0	-28.7	-28.9	-43.2		-35.2
26	-23.9	-20.1	5.6	20.2	22.0	-30.5	-30.5	-42.8		-35.2
28	-23.9	-20.2	5.1	20.1	22.0	-31.5	-31.4	-41.1		-35.2
30	-24.0	-20.3	4.7	20.1	21.9	-32.5	-32.3	-40.8		-35.2
32	-24.0	-20.4	4.4	20.0	22.0	-33.0	-33.4	-40.2		-35.3
34	-24.0	-20.4	4.1	20.0	21.9	-34.2	-34.1	-39.4		-35.3
36	-24.0	-20.5	3.7	19.9	22.0	-34.7	-34.3	-39.7		-35.3
38	-24.1	-20.5	3.6	19.9	21.9	-35.2	-35.0	-38.4		-35.3
40	-24.0	-20.5	3.5	19.8	21.9	-35.6	-35.5	-38.4		-35.2
42	-24.0	-20.6	3.3	19.8	21.9	-34.7	-35.6	-37.8		-35.2
44	-24.1	-20.6	3.2	19.7	21.9	-35.0	-36.0	-37.0		-35.2
46	-24.0	-20.6	3.1	19.7	21.9	-35.7*	-36.9	-38.0		-35.1
48	-24.1	-20.6	3.0	19.7	21.9	-35.6	-36.6	-37.6		-35.2
50	-24.1	-20.7	2.9	19.7	21.9	-36.5	-36.8	-37.0		-35.2
52	-24.1	-20.7	2.9	19.7	21.9	-34.8	-36.9	-37.7		-35.3
54	-24.1	-20.7	2.8	19.7	21.9	-36.1	-37.0	-36.9		-35.3
56	-24.2	-20.7	2.8	19.7	21.9	-36.3	-37.3	-36.7		-35.3
58	-24.2	-20.8	2.8	19.7	22.0	-36.5	-37.3	-37.0		-35.4
60	-24.1	-20.7	2.7	19.7	21.9	-38.3	-37.3	-36.8		-35.3
62	-24.2	-20.8	2.7	19.7	21.9	-37.0	-37.3	-36.9		-35.3
64	-24.2	-20.8	2.6	19.7	21.9	-37.9	-37.4	-36.6		-35.3
66	-24.2	-20.8	2.6	19.7	22.0	-37.1	-37.5	-36.4		-35.3
68	-24.2	-20.8	2.6	19.7	21.9	-37.7	-37.4	-36.6		-35.3
70	-24.2	-20.8	2.6	19.7	21.9	-38.0	-37.5	-36.9		-35.4
72	-24.2	-20.8	2.6	19.7	21.9	-37.4	-37.8	-36.8		-35.4

*Calibrated hot box data for this hour derived from linear interpolation of data from hours 44 to 47.
**Response factor analysis was not performed for this wall assembly.

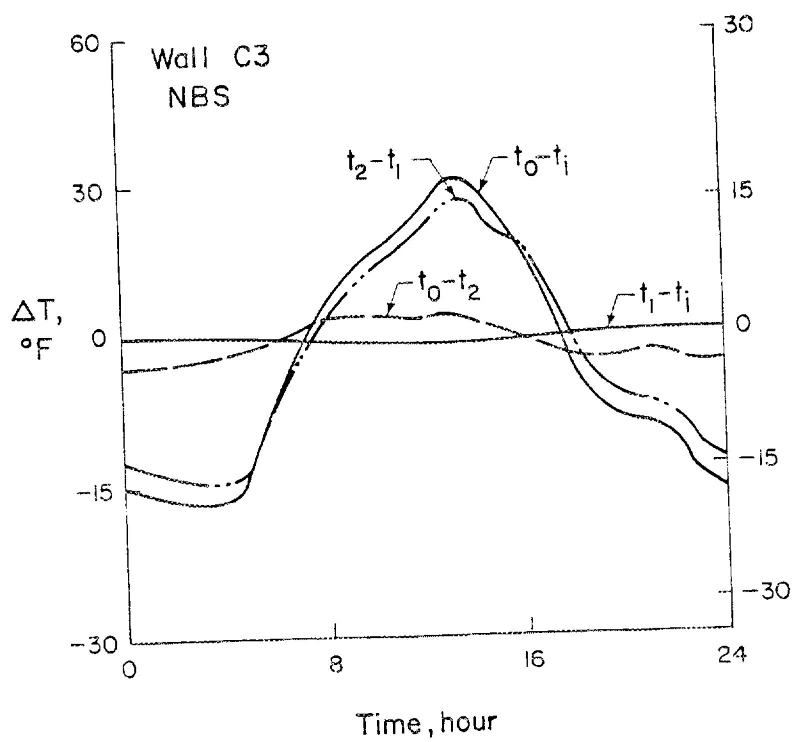
TABLE C3-6 - SUMMARY OF TRANSIENT TEST RESULTS

Heat Flux	Measured				Calculated			
	Calib. Hot Box		HFM @ Indoor Surf.		Response Factor*		Steady-State	
	q_w, Btu/hr·ft^2 (W/m^2)	Time to Reach q_w, hr	q_{hfm}, Btu/hr·ft^2 (W/m^2)	Time to Reach q_{hfm}, hr	q_{rf}, Btu/hr·ft^2 (W/m^2)	Time to Reach q_{rf}, hr	q_{ss}, Btu/hr·ft^2 (W/m^2)	Time to Reach q_{ss}, hr
99.5% of Final Heat Flux	-12.0 (-37.7)	57	-11.9 (-37.4)	65			-11.1 (-35.1)	9
95% of Final Heat Flux	-11.4 (-36.0)	47	-11.3 (-35.7)	43			-10.6 (-33.6)	5
90% of Final Heat Flux	-10.8 (-34.1)	33	-10.7 (-33.9)	34			-10.1 (-31.8)	4

*Response factor analysis was not performed for this dynamic test cycle.

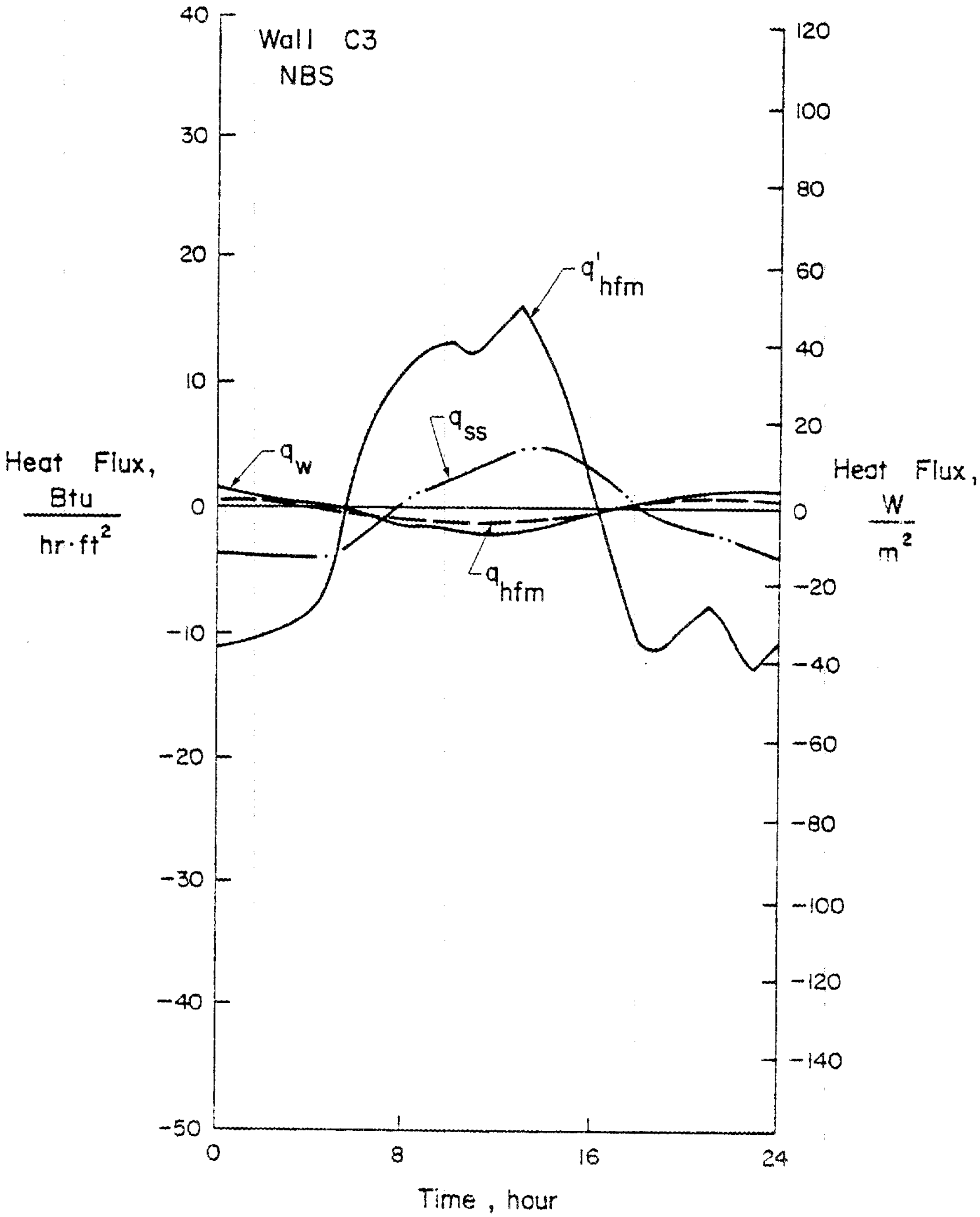


(a) Measured Temperatures



(b) Temperature Differentials

Fig. C3-2 Wall C3 Dynamic Test Results for NBS Test Cycle



(c) Heat Flux

Fig. C3-2 Wall C3 Dynamic Test Results for NBS Test Cycle

TABLE C3-7(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}* Response Factor	q_{ss} Steady-State
1	41.6	46.9	70.9	72.8	72.4	0.93	0.43	-11.16		-4.26
2	40.2	45.2	70.0	72.7	72.4	0.51	0.23	-10.81		-4.49
3	39.8	44.6	69.1	72.6	72.4	0.32	-0.03	-9.91		-4.58
4	39.7	44.2	68.2	72.4	72.3	0.19	-0.29	-9.17		-4.63
5	44.1	46.7	67.4	72.3	72.3	-0.28	-0.58	-5.06		-4.21
6	58.1	57.0	66.6	72.2	72.3	-0.93	-0.88	4.47		-2.50
7	68.0	65.7	66.1	72.1	72.3	-1.39	-1.13	8.07		-1.06
8	77.7	74.4	66.0	72.0	72.3	-1.90	-1.46	10.86		0.42
9	84.5	80.6	66.1	71.9	72.3	-1.80	-1.64	12.58		1.48
10	90.0	85.9	66.6	71.8	72.2	-2.08	-1.78	13.23		2.41
11	92.1	88.5	67.4	71.8	72.2	-2.08	-1.76	11.84		2.87
12	97.3	92.8	68.3	71.8	72.2	-2.27	-1.73	14.19		3.65
13	103.4	98.4	69.3	71.9	72.2	-2.08	-1.58	16.25		4.63
14	103.2	99.5	70.4	72.0	72.3	-1.62	-1.36	12.65		4.81
15	98.3	96.5	71.5	72.1	72.2	-1.25	-1.09	7.39		4.21
16	91.0	91.0	72.7	72.3	72.3	-0.93	-0.77	1.98		3.24
17	79.1	82.0	73.6	72.4	72.4	-0.32	-0.39	-5.62		1.62
18	66.5	71.2	74.2	72.6	72.4	0.37	-0.08	-11.28		-0.23
19	59.5	64.4	74.4	72.8	72.4	0.83	0.22	-11.80		-1.39
20	56.7	61.0	74.2	72.9	72.5	1.06	0.49	-10.03		-1.99
21	56.2	59.9	73.7	72.9	72.5	1.02	0.68	-8.12		-2.17
22	52.2	57.0	73.2	72.9	72.5	1.06	0.72	-10.25		-2.64
23	44.8	50.8	72.5	72.9	72.5	1.34	0.67	-13.30		-3.65
24	43.3	48.7	71.7	72.9	72.4	1.25	0.57	-11.52		-4.02
Mean	67.8	68.9	70.2	72.4	72.3	-0.42	-0.52	-0.60		-0.52

*Response factor analysis was not performed for this wall assembly.

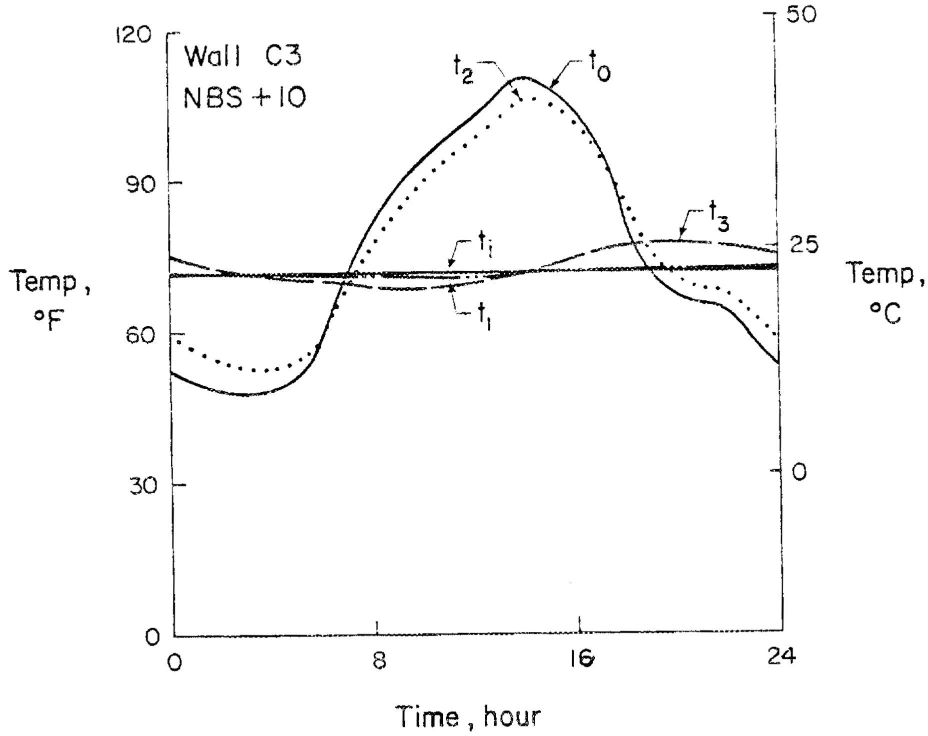
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 24%
Outdoor Chamber - 24%

Laboratory Air Temperature:
Max. - 72°F (22°C)
Min. - 68°F (20°C)

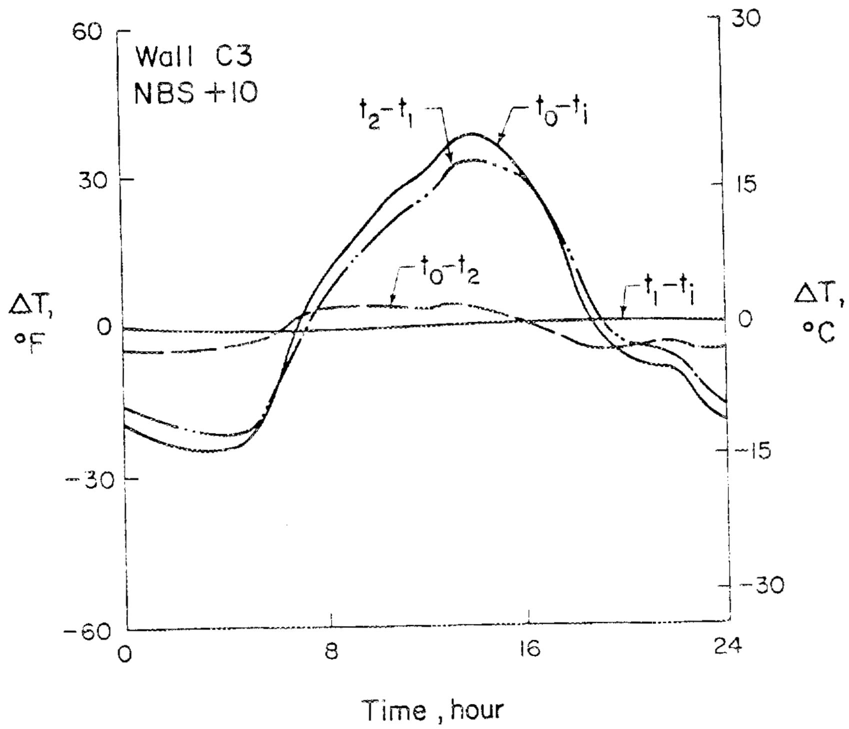
TABLE C3-7(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}* Response Factor	q_{ss} Steady-State
1	5.3	8.3	21.6	22.7	22.5	2.92	1.35	-35.21		-13.42
2	4.5	7.4	21.1	22.6	22.4	1.60	0.72	-34.11		-14.15
3	4.4	7.0	20.6	22.5	22.4	1.02	-0.10	-31.27		-14.44
4	4.3	6.8	20.1	22.5	22.4	0.58	-0.92	-28.93		-14.59
5	6.7	8.1	19.7	22.4	22.4	-0.88	-1.83	-15.89		-13.27
6	14.5	13.9	19.2	22.3	22.4	-2.92	-2.77	14.10		-7.88
7	20.0	18.7	18.9	22.3	22.4	-4.38	-3.57	25.47		-3.36
8	25.4	22.5	18.9	22.2	22.4	-5.98	-4.61	34.25		1.31
9	29.2	27.0	19.0	22.2	22.3	-5.69	-5.17	39.68		4.67
10	32.2	30.0	19.2	22.1	22.3	-6.56	-5.60	41.73		7.59
11	33.4	31.4	19.7	22.1	22.3	-6.56	-5.57	37.37		9.04
12	36.3	33.8	20.2	22.1	22.3	-7.15	-5.44	44.77		11.52
13	39.7	36.9	20.7	22.2	22.3	-6.56	-4.97	51.26		14.59
14	39.5	37.5	21.3	22.2	22.4	-5.11	-4.28	39.92		15.17
15	36.9	35.8	21.9	22.3	22.3	-3.94	-3.43	23.30		13.27
16	32.8	32.8	22.6	22.4	22.4	-2.92	-2.42	6.25		10.21
17	26.2	27.8	23.1	22.5	22.4	-1.02	-1.24	-17.73		5.11
18	19.1	21.8	23.4	22.6	22.5	1.17	-0.25	-35.60		-0.73
19	15.3	18.0	23.5	22.6	22.5	2.63	0.71	-37.17		-4.38
20	13.7	16.1	23.4	22.7	22.5	3.36	1.55	-31.66		-6.27
21	13.5	15.5	23.2	22.7	22.5	3.21	2.13	-25.61		-6.86
22	11.2	13.9	22.9	22.7	22.5	3.36	2.28	-32.28		-8.32
23	7.1	10.4	22.5	22.7	22.5	4.23	2.12	-41.97		-11.52
24	6.3	9.3	22.1	22.7	22.5	3.94	1.80	-36.35		-12.69
Mean	19.9	20.5	21.2	22.4	22.4	-1.32	-1.65	-1.90		-1.64

*Response factor analysis was not performed for this wall assembly.

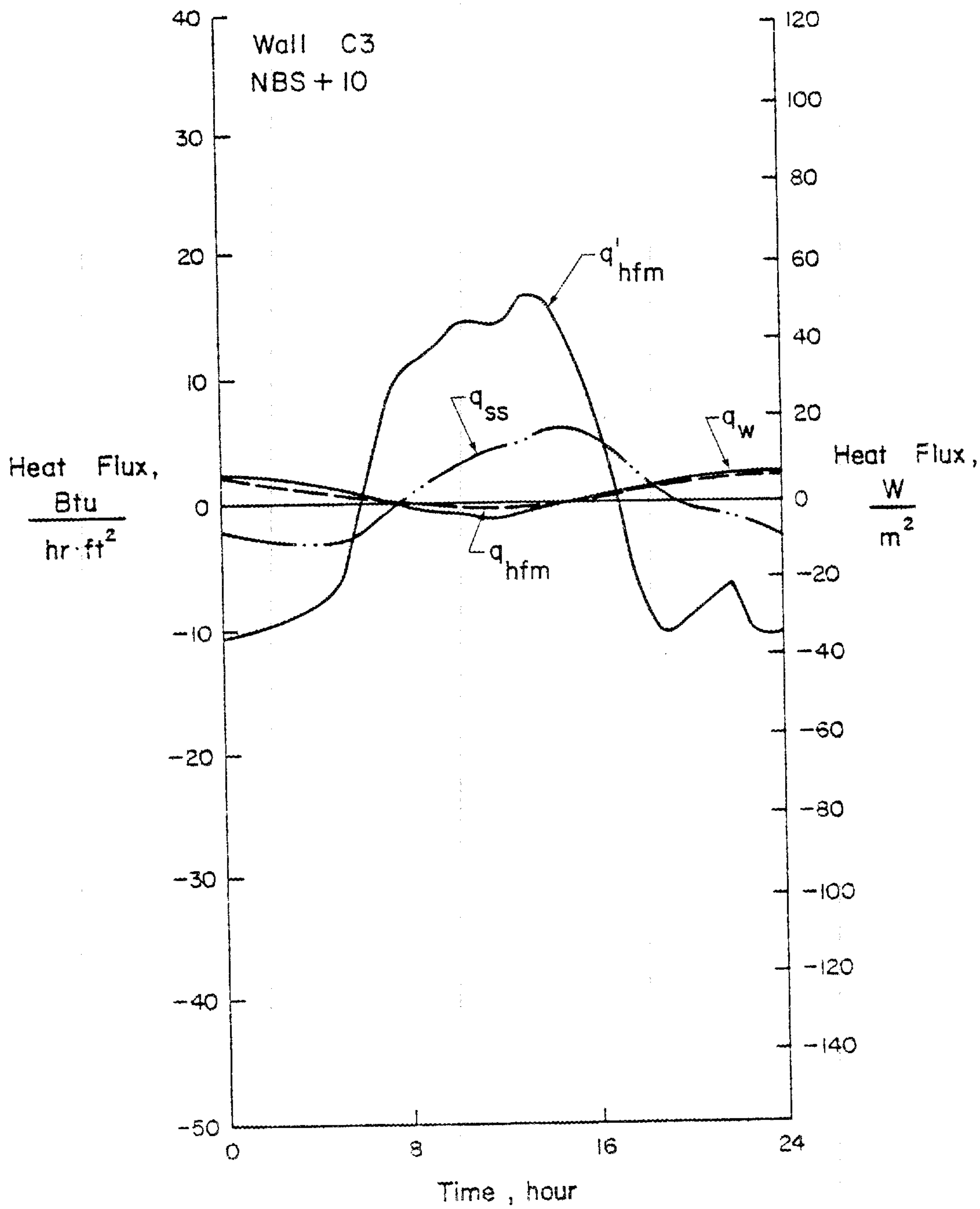


(a) Measured Temperatures



(b) Temperature Differentials

Fig. C3-3 Wall C3 Dynamic Test Results for NBS +10 Test Cycle



(c) Heat Flux

Fig. C3-3 Wall C3 Dynamic Test Results for NBS +10 Test Cycle

TABLE C3-8(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS+10 TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
1	52.1	56.8	75.3	73.5	72.7	2.41	1.82	-10.46		-2.78
2	50.2	54.8	74.4	73.4	72.7	2.17	1.67	-10.06		-3.10
3*	49.1	53.5	73.5	73.3	72.7	1.71	1.41	-9.43		-3.28
4	49.3	53.2	72.7	73.2	72.6	1.39	1.18	-8.05		-3.33
5	50.3	53.7	71.8	73.1	72.6	1.06	0.89	-6.81		-3.19
6	59.3	59.4	71.0	72.9	72.6	0.65	0.59	0.87		-2.27
7	72.9	70.3	70.3	72.8	72.6	0.09	0.31	8.68		-0.46
8	81.9	78.5	69.3	72.6	72.4	-0.46	-0.20	11.31		0.97
9	88.5	84.6	69.4	72.5	72.4	-0.74	-0.43	12.58		2.08
10	95.4	90.7	69.8	72.3	72.4	-0.79	-0.56	14.76		3.15
11*	99.7	95.3	70.2	72.3	72.3	-1.11	-0.71	14.43		4.02
12	102.6	98.2	71.3	72.4	72.4	-1.11	-0.60	14.10		4.49
13	108.6	103.3	72.2	72.4	72.3	-0.93	-0.49	17.11		5.41
14	112.0	107.2	73.3	72.5	72.4	-0.56	-0.33	16.59		6.11
15	110.0	106.6	74.5	72.6	72.5	-0.28	-0.09	12.24		5.97
16	105.8	103.7	75.6	72.7	72.5	0.19	0.25	7.99		5.46
17	97.3	97.4	76.7	72.9	72.5	0.42	0.59	1.49		4.26
18*	82.8	86.1	77.5	73.1	72.6	1.02	0.93	-7.49		2.27
19	71.9	76.4	78.0	73.3	72.7	1.34	1.22	-10.91		0.56
20	67.3	71.4	78.2	73.5	72.7	1.90	1.62	-9.84		-0.37
21	65.7	69.0	77.9	73.6	72.8	2.27	1.81	-7.86		-0.79
22	65.0	68.0	77.3	73.6	72.8	2.27	1.94	-6.59		-0.93
23	58.1	63.0	76.7	73.6	72.7	2.41	2.04	-11.01		-1.80
24	54.6	59.1	76.0	73.6	72.7	2.41	1.92	-10.66		-2.41
Mean	77.1	77.5	73.9	73.0	72.5	0.74	0.70	0.96		0.83

*Data for these hours are 2-day averages, not 3-day averages, of test results.
**Response factor analysis was not performed for this wall assembly.

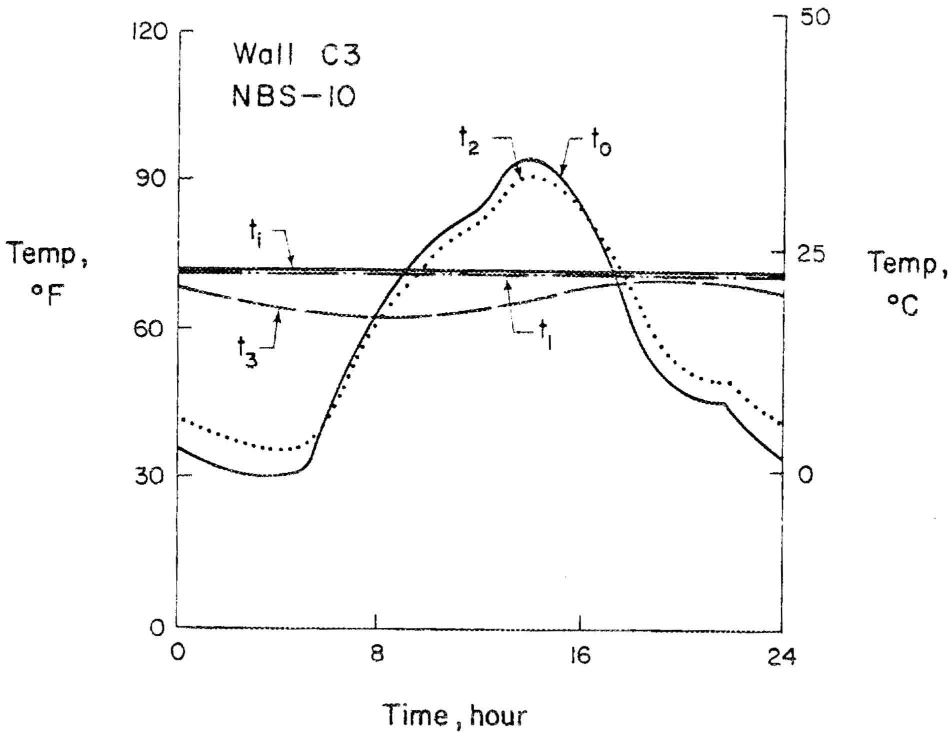
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 25%
Outdoor Chamber - 24%

Laboratory Air Temperature:
Max. - 72°F (22°C)
Min. - 70°F (21°C)

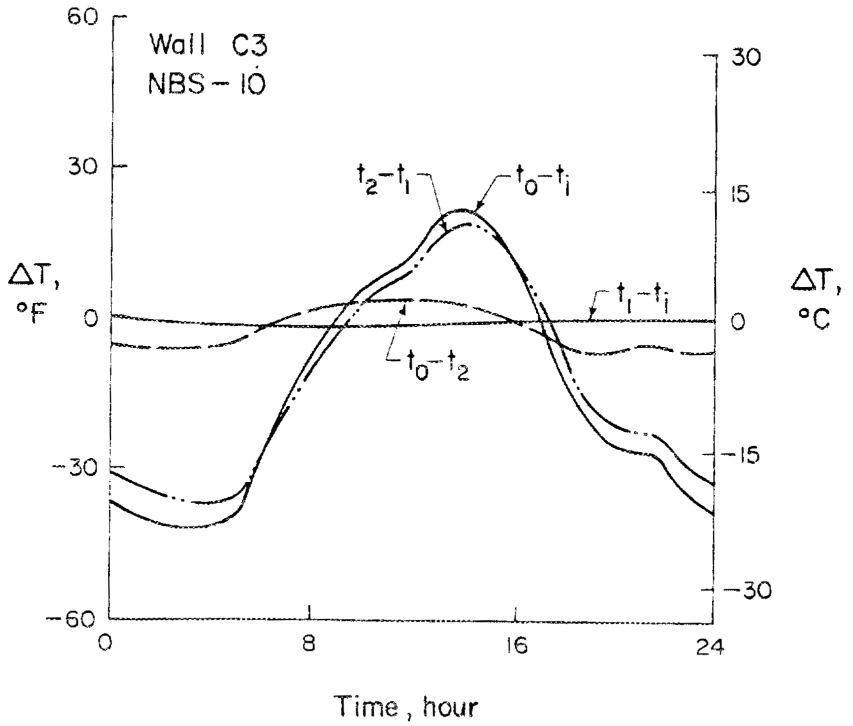
TABLE C3-8(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS+10 TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
1	11.2	13.8	24.0	23.0	22.6	7.59	5.73	-32.99		-8.75
2	10.1	12.7	23.6	23.0	22.6	6.86	5.26	-31.72		-9.77
3*	9.5	12.0	23.1	23.0	22.6	5.40	4.45	-29.76		-10.36
4	9.6	11.8	22.6	22.9	22.5	4.38	3.73	-25.41		-10.50
5	10.1	12.0	22.1	22.8	22.6	3.36	2.80	-21.49		-10.07
6	15.2	15.2	21.7	22.7	22.5	2.04	1.86	2.74		-7.15
7	22.7	21.3	21.3	22.7	22.5	0.29	0.99	27.38		-1.46
8	27.7	25.8	20.7	22.5	22.5	-1.46	-0.62	35.67		3.06
9	31.4	29.2	20.8	21.5	22.4	-2.33	-1.36	39.70		6.56
10	35.2	32.6	21.0	21.4	22.4	-2.48	-1.78	46.58		9.92
11*	37.6	35.2	21.2	22.4	22.4	-3.50	-2.23	45.51		12.69
12	39.2	36.8	21.8	22.4	22.4	-3.50	-1.90	44.46		14.15
13	42.5	39.6	22.3	22.5	22.4	-2.92	-1.54	53.97		17.07
14	44.5	41.8	22.9	22.5	22.5	-1.75	-1.04	52.34		19.26
15	43.3	41.4	23.6	22.6	22.5	-0.88	-0.30	38.61		18.82
16	41.0	39.8	24.2	22.6	22.5	0.58	0.80	25.21		17.21
17	36.3	36.4	24.8	22.7	22.5	1.31	1.85	4.69		13.42
18*	28.2	30.1	25.3	22.8	22.6	3.21	2.92	-23.63		7.15
19	22.2	24.7	25.5	22.9	22.6	4.23	3.85	-34.42		1.75
20	19.6	21.9	25.7	23.0	22.6	5.98	5.11	-31.04		-1.17
21	18.7	20.6	25.5	23.1	22.7	7.15	5.72	-24.81		-2.48
22	18.3	20.0	25.2	23.1	22.6	7.15	6.11	-20.80		-2.92
23	14.5	17.2	24.8	23.1	22.6	7.59	6.43	-34.74		-5.69
24	12.5	15.1	24.5	23.1	22.6	7.59	6.05	-33.62		-7.59
Mean	25.1	25.3	23.3	22.8	22.5	2.33	2.20	3.01		2.63

*Data for these hours are 2-day averages, not 3-day averages, of test results.
**Response factor analysis was not performed for this wall assembly.

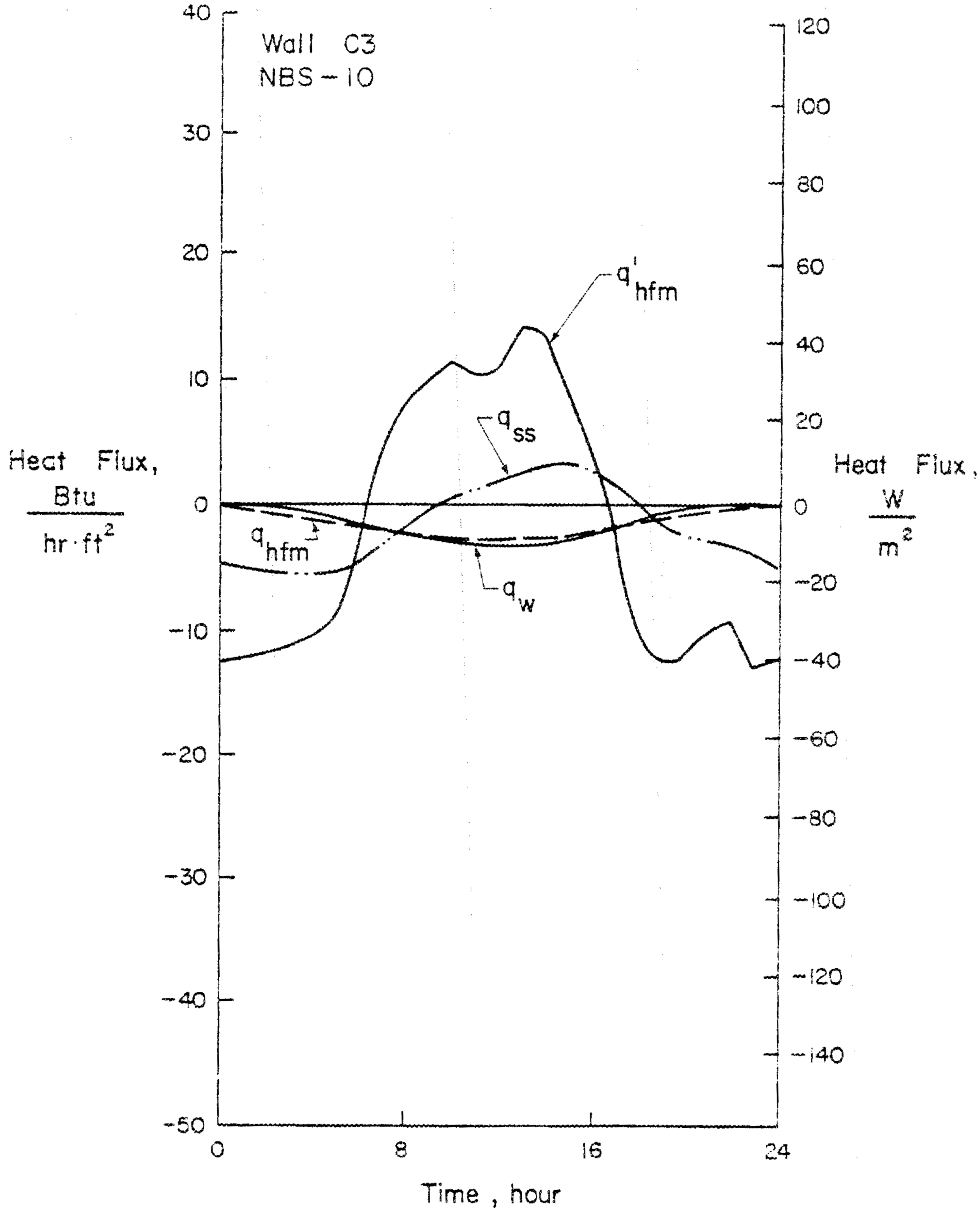


(a) Measured Temperatures



(b) Temperature Differentials

Fig. C3-4 Wall C3 Dynamic Test Results for NBS -10 Test Cycle



(c) Heat Flux

Fig. C3-4 Wall C3 Dynamic Test Results for NBS -10 Test Cycle

TABLE C3-9(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS-10 TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}* Response Factor	q_{ss} Steady-State
1	33.6	39.5	67.5	72.2	72.2	-0.28	-0.78	-12.68		-5.37
2	31.4	37.2	66.7	72.1	72.2	-0.56	-0.96	-12.59		-5.69
3	30.4	36.0	65.8	72.0	72.2	-0.69	-1.19	-11.80		-5.83
4	30.3	35.5	64.9	71.9	72.1	-1.02	-1.44	-10.85		-5.87
5	31.3	35.9	64.0	71.8	72.1	-1.48	-1.69	-9.35		-5.78
6	40.9	42.2	63.2	71.7	72.1	-2.04	-1.99	-1.82		-4.81
7	53.9	52.7	62.5	71.5	72.1	-2.36	-2.30	5.12		-3.10
8	63.2	60.9	62.1	71.4	72.0	-2.68	-2.58	8.07		-1.76
9	70.1	67.3	62.1	71.3	72.0	-3.15	-2.83	9.47		-0.69
10	77.5	74.0	62.6	71.3	72.1	-3.28	-2.96	11.45		0.46
11	81.1	78.0	63.2	71.2	72.1	-3.47	-3.06	10.65		1.11
12	84.3	80.9	64.0	71.3	72.1	-3.52	-3.05	10.81		1.67
13	91.3	86.7	64.8	71.3	72.1	-3.56	-2.96	14.40		2.64
14	94.5	90.5	65.9	71.4	72.1	-3.42	-2.79	13.31		3.28
15	92.6	90.0	66.9	71.5	72.1	-2.82	-2.56	9.34		3.19
16	87.1	86.2	68.1	71.6	72.1	-2.45	-2.29	4.37		2.50
17	79.1	80.3	69.2	71.7	72.2	-1.90	-1.96	-1.20		1.48
18	64.7	69.3	70.0	71.9	72.2	-1.39	-1.63	-10.18		-0.46
19	54.5	60.0	70.4	72.1	72.2	-0.88	-1.25	-12.92		-2.04
20	48.5	54.1	70.5	72.2	72.2	-0.51	-0.96	-12.84		-3.01
21	46.8	51.7	70.2	72.3	72.2	-0.28	-0.76	-10.67		-3.42
22	46.2	50.7	69.6	72.3	72.2	-0.09	-0.63	-9.32		-3.61
23	39.2	45.6	68.9	72.3	72.2	-0.05	-0.59	-13.37		-4.39
24	35.7	41.6	68.3	72.3	72.2	-0.19	-0.67	-13.03		-5.00
Mean	58.7	60.3	66.3	71.8	72.1	-1.75	-1.83	-1.90		-1.85

*Response factor analysis was not performed for this wall assembly.

Calibrated Hot Box Relative Humidity:
Indoor Chamber - 24%
Outdoor Chamber - 25%

Laboratory Air Temperature:
Max. - 73°F (23°C)
Min. - 69°F (21°C)

TABLE C3-9(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS-10 TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3 Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm} HFM @ Indoor Surf.	q'_{hfm} HFM @ Outdoor Surf.	q_{rf}* Response Factor	q_{ss} Steady-State
1	0.9	4.1	19.7	22.3	22.3	-0.88	-2.47	-40.01		-16.92
2	-0.3	2.9	19.3	22.3	22.3	-1.75	-3.04	-39.72		-17.94
3	-0.9	2.2	18.8	22.2	22.3	-2.19	-3.75	-37.23		-18.38
4	-0.9	2.0	18.3	22.2	22.3	-3.21	-4.55	-34.23		-18.53
5	-0.4	2.2	17.8	22.1	22.3	-4.67	-5.33	-29.49		-18.23
6	4.9	5.7	17.3	22.0	22.3	-6.42	-6.28	-5.75		-15.17
7	12.2	11.5	17.0	22.0	22.3	-7.44	-7.25	16.14		-9.77
8	17.3	16.1	16.7	21.9	22.2	-8.46	-8.13	25.47		-5.54
9	21.2	19.6	16.7	21.8	22.2	-9.92	-8.92	29.88		-2.19
10	25.3	23.3	17.0	21.8	22.3	-10.36	-9.33	36.12		1.46
11	27.3	25.5	17.3	21.8	22.3	-10.94	-9.66	33.59		3.50
12	29.0	27.2	17.8	21.8	22.3	-11.09	-9.63	34.10		5.25
13	33.0	30.4	18.2	21.8	22.3	-11.23	-9.33	45.43		8.32
14	34.7	32.5	18.8	21.9	22.3	-10.80	-8.80	42.00		10.36
15	33.6	32.2	19.4	21.9	22.3	-8.90	-8.08	29.48		10.07
16	30.6	30.1	20.0	22.0	22.3	-7.73	-7.22	13.78		7.88
17	26.2	26.9	20.6	22.1	22.3	-5.98	-6.17	-3.78		4.67
18	18.2	20.7	21.1	22.2	22.3	-4.38	-5.13	-32.13		-1.46
19	12.5	15.5	21.3	22.3	22.3	-2.77	-3.95	-40.75		-6.42
20	9.2	12.3	21.4	22.3	22.4	-1.60	-3.02	-40.50		-9.48
21	8.2	10.9	21.2	22.4	22.3	-0.88	-2.39	-33.67		-10.80
22	7.9	10.4	20.9	22.4	22.4	-0.29	-1.98	-29.39		-11.38
23	4.0	7.5	20.5	22.4	22.3	-0.15	-1.86	-42.19		-13.86
24	2.0	5.3	20.2	22.4	22.4	-0.58	-2.12	-41.12		-15.75
Mean	14.8	15.7	19.1	22.1	22.3	-5.53	-5.77	-6.00		-5.85

*Response factor analysis was not performed for this wall assembly.

TABLE C3-12 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), THERMAL LAG

Test Cycle	Thermal Lag, hrs											Calc. Time Constant, hrs
	Measured								Calculated			
	Calibrated Hot Box					Heat Flow Meter			Response Factor*			
	t_o vs t_1		q_{ss} vs q_w		Avg.	q_{ss} vs q_{hfm}		Avg.	q_{ss} vs q_{rf}		Avg.	
	@ Max.	@ Min.	@ Max.	@ Min.		@ Max.	@ Min.		@ Max.	@ Min.		
NBS	9	7	9	8	8.5	8	6.5	7.5				3.6
NBS+10	8	8	10	8	8.5	9	7	8				3.6
NBS-10	8.5	7	9	9	8.5	9	7.5	8.5				3.6

*Response factor analysis was not performed for this wall assembly.

TABLE C3-13 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), REDUCTION IN AMPLITUDE

Test Cycle	Measured, %						Calculated, %		
	Calibrated Hot Box			Heat Flow Meter			Response Factor*		
	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.
NBS	67	55	61	77	69	73			
NBS+10	68	56	62	75	66	71			
NBS-10	67	55	61	76	69	73			

*Response factor analysis was not performed for this wall assembly.

TABLE C3-14 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), ENERGY REQUIREMENTS

Test Cycle	Total Energy, Btu/ft^2 (W·hr/m^2)				Total Energy Comparisons, %			Net Energy, Btu/ft^2 (W·hr/m^2)				Net Energy Comparisons, %		
	Measured		Calculated					Measured		Calculated				
	q_w^T	q_{hfm}^T	q_{rf}^{T} *	q_{ss}^T	$\frac{q_w^T}{q_{ss}^T}$	$\frac{q_{hfm}^T}{q_{ss}^T}$	$\frac{q_{rf}^T}{q_{ss}^T}$	q_w^N	q_{hfm}^N	q_{rf}^{N} *	q_{ss}^N	$\frac{q_w^N}{q_{ss}^N}$	$\frac{q_{hfm}^N}{q_{ss}^N}$	$\frac{q_{rf}^N}{q_{ss}^N}$
NBS	27.8 (87.7)	20.6 (65.0)		71.1 (224.4)	39	29		-10.0 (-31.7)	-12.5 (-39.5)		-12.5 (-39.4)	80	100	
NBS+10	29.6 (93.5)	23.6 (74.5)		69.4 (219.0)	43	34		17.7 (55.9)	16.8 (53.0)		20.0 (63.2)	88	84	
NBS-10	42.0 (132.6)	43.9 (138.4)		77.1 (243.3)	55	57		-42.0 (-132.6)	-43.9 (-138.4)		-44.5 (-140.3)	95	99	

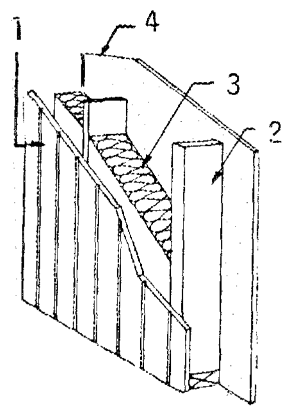
*Response factor analysis was not performed for this wall assembly.

WALL F3: 2x4-IN. (51x102-MM) WOOD FRAME WITH R-11 FIBERGLASS INSULATION AND CEDAR SIDING

DESCRIPTION: Wood frame wall with R-11 fiberglass blanket insulation between studs, gypsum wallboard on interior surface, and plywood cedar siding on exterior surface.

REFERENCE: Fiorato, A. E. and Cruz, C. R., "Thermal Performance of Masonry Walls," Research and Development Bulletin RD071, Portland Cement Association, Skokie, 1980, 17 pages.

COMPOSITION:



1. 5/8-in. (16-mm) Plywood Cedar Siding
2. 2x4-in. (51x102-mm) Wood Studs spaced 16 in. (406 mm) on centers
3. 3-1/2-in. (89-mm) R-11 Fiberglass Blanket Insulation faced with kraft paper
4. 1/2-in. (13-mm) Gypsum Wallboard

TABLE F3-1 - PHYSICAL PROPERTIES OF WALL AT TIME OF TEST

Property	Measured Value
Weight, psf (kg/m^2)	5.2 (25)
Average Thickness, in. (mm)	4.6 (117)
Area, ft^2 (m^2)	73.40 (6.82)
Estimated Moisture Content, % by ovendry weight	--

TABLE F3-3 - DESIGN HEAT TRANSMISSION COEFFICIENTS

Component	R, Thermal Resistance	
	Between Framing hr·ft^2·°F/Btu (m^2·K/W)	At Framing hr·ft^2·°F/Btu (m^2·K/W)
1. Outside Air Film	0.17 (0.03)	0.17 (0.03)
2. 5/8-in. (16-mm) Plywood Siding	0.78* (0.14)	0.78 (0.14)
3. 2x4-in. (51x102-mm) Wood Stud	--	4.35* (0.77)
4. 3-1/2-in. (89-mm) Fiberglass Blanket Insulation	11.00* (1.94)	--
5. 1/2-in. (13-mm) Gypsum Wallboard	0.45* (0.08)	0.45 (0.08)
6. Inside Air Film	0.68 (0.12)	0.68 (0.12)
Total R	13.08 (2.30)	6.43 (1.14)
Total U	0.08 (0.43)	0.16 (0.88)

*Source: ASHRAE Handbook of Fundamentals, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., New York, 1977, Chapter 22.

Adjust for Framing (15%):

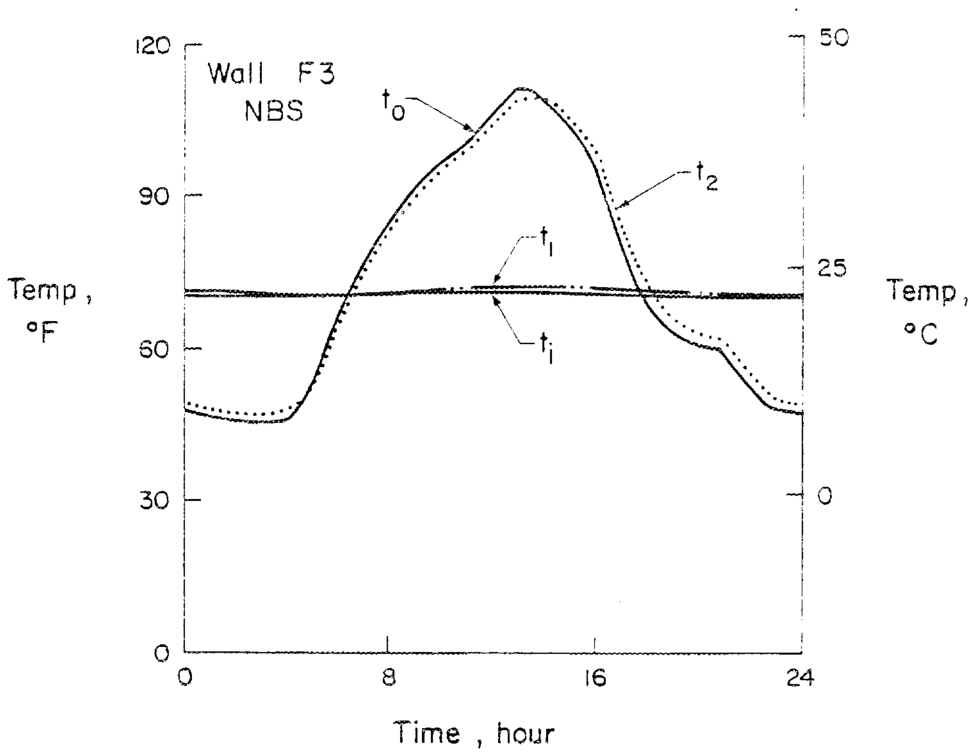
$U = (0.85)(0.08) + (0.15)(0.16) = 0.09$ Btu/hr·ft^2°F (0.50 W/m^2·K)

$R_T = 1/U = 11.36$ hr·ft^2·°F/Btu (2.01 m^2·K/W)

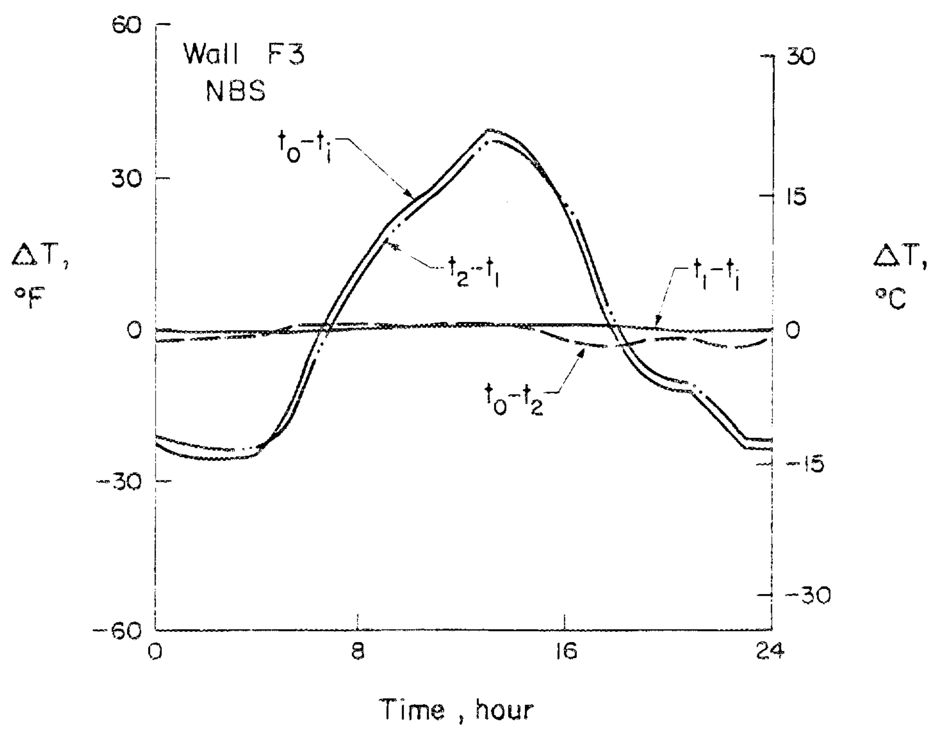
TABLE F3-4 - STEADY-STATE TEST RESULTS

Nominal Test Condition	q Heat Flux, Btu/hr·ft^2 (W/m^2)	R_T, hr·ft^2·°F/Btu (m^2·K/W)	U, Btu/hr·ft^2·°F (W/m^2·K)	Measured Temperatures, °F (°C)					Relative Humidity**		Laboratory Air Temperature	
				t_o Outdoor Air	t_2 Outdoor Surface	t_3* Internal	t_1 Indoor Surface	t_i Indoor Air	Indoor Chamber, %	Outdoor Chamber, %	Max. °F (°C)	Min. °F (°C)
t_m = 98°F (37°C)	3.8 (12.1)	13.57 (2.39)	0.07 (0.42)	124 (51)	123 (51)	-	74 (23)	72 (22)	-	-	72 (22)	71 (22)
t_m = 84°F (29°C)	1.2 (3.8)	18.70 (3.29)	0.05 (0.30)	95 (35)	94 (34)	-	73 (23)	72 (22)	-	-	70 (21)	70 (21)
t_m = 55°F (13°C)	-2.2 (-7.1)	15.22 (2.68)	0.07 (0.37)	37 (3)	39 (4)	-	71 (22)	72 (22)	-	-	71 (22)	71 (22)
t_m = 33°F (0°C)	-5.3 (-16.7)	15.91 (2.63)	0.07 (0.38)	-8 (22)	-5 (21)	-	70 (21)	71 (22)	-	-	74 (23)	71 (21)
Design Values	-	11.36 (2.01)	0.09 (0.50)	-	-	-	-	-	-	-	-	-

*Internal thermocouples were not used for this wall assembly.
**Relative humidity was not measured for this wall assembly.

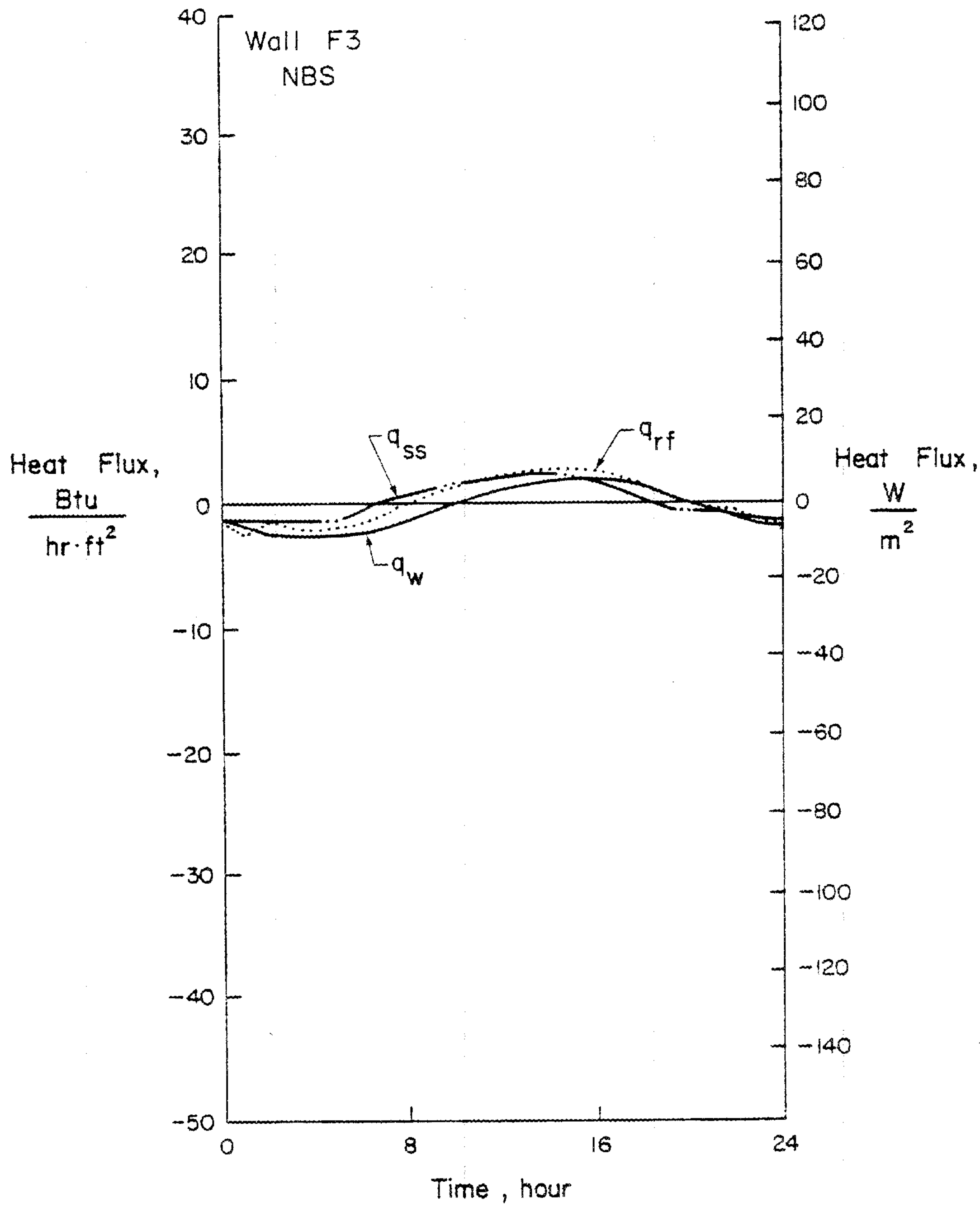


(a) Measured Temperatures



(b) Temperature Differentials

Fig. F3-2 Wall F3 Dynamic Test Results for NBS Test Cycle



(c) Heat Flux

Fig. F3-2 Wall F3 Dynamic Test Results for NBS Test Cycle

TABLE F3-7(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft²			Calculated Heat Flux, Btu/hr·ft²	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q'_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1	46.5	48.5		71.6	72.1	-1.91			-2.18	-1.66
2	45.8	47.6		71.4	71.6	-2.46			-1.73	-1.71
3	46.1	47.7		71.4	71.6	-2.42			-2.10	-1.70
4	46.4	48.0		71.3	71.4	-2.60			-2.04	-1.68
5	54.0	53.3		71.4	71.7	-2.42			-2.14	-1.30
6	69.5	67.9		71.5	71.7	-2.56			-1.42	-0.26
7	77.7	76.5		71.8	71.7	-1.86			-0.52	0.34
8	86.1	84.5		72.1	71.8	-1.35			0.05	0.89
9	93.3	91.7		72.4	71.7	-0.70			0.84	1.39
10	98.6	97.2		72.6	72.0	-0.09			1.23	1.77
11	101.7	100.5		72.8	71.9	0.33			1.96	2.00
12	107.1	105.2		72.9	71.8	1.02			2.36	2.33
13	113.2	111.5		73.2	72.1	1.21			2.60	2.76
14	111.4	110.9		73.4	72.1	1.67			3.16	2.70
15	105.0	105.6		73.4	72.3	1.86			2.91	2.32
16	97.1	98.7		73.3	72.0	2.09			2.91	1.83
17	83.2	86.3		73.0	71.8	1.86			2.30	0.96
18	70.1	73.4		72.7	71.9	1.53			1.17	0.05
19	63.4	65.7		72.4	72.0	0.46			0.33	-0.48
20	61.2	62.9		72.1	71.8	-0.14			0.01	-0.67
21*	60.4	61.8		72.0	72.0	-0.74			-0.58	-0.74
22*	54.7	57.5		71.9	71.7	-1.07			-0.54	-1.04
23*	48.3	50.8		71.7	71.6	-1.35			-1.19	-1.50
24*	47.8	49.5		71.5	71.5	-1.58			-1.56	-1.59
Mean	74.5	75.1		72.2	71.8	-0.46			0.24	0.21

*Data are 2-day averages, not 3-day averages, of test results.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor values supplied by Ken Childs, ORNL. Values calculated using NBS Response Factor Program by Peavy.

Calibrated Hot Box Relative Humidity:
Indoor Chamber - Not measured for this wall assembly
Outdoor Chamber - Not measured for this wall assembly

Laboratory Air Temperature:
Max. - 74°F (23°C)
Min. - 66°F (19°C)

TABLE F3-7(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q'_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1	8.1	9.1		22.0	22.3	-6.01			-6.88	-5.25
2	7.7	8.6		21.9	22.0	-7.77			-5.46	-5.41
3	7.8	8.7		21.9	22.0	-7.62			-6.63	-5.38
4	8.0	8.9		21.8	21.9	-8.21			-6.44	-5.28
5	12.2	11.8		21.9	22.0	-7.62			-6.75	-4.11
6	20.8	19.9		22.0	22.1	-8.06			-4.48	-0.82
7	25.4	24.7		22.1	22.0	-5.87			-1.64	1.06
8	30.0	29.2		22.3	22.1	-4.25			0.16	2.82
9	34.1	33.2		22.4	22.1	-2.20			2.65	4.40
10	37.0	36.2		22.6	22.2	0.29			3.88	5.59
11	38.7	38.1		22.6	22.1	1.03			6.18	6.31
12	41.7	40.7		22.7	22.1	3.23			7.45	7.33
13	45.1	44.1		22.9	22.3	3.81			8.20	8.69
14	44.1	43.8		23.0	22.3	5.28			9.97	8.52
15	40.5	40.9		23.0	22.4	5.87			9.18	7.32
16	36.2	37.1		22.9	22.2	6.60			9.18	5.78
17	28.4	30.2		22.8	22.1	5.87			7.26	3.02
18	21.2	23.0		22.6	22.2	4.84			3.69	0.15
19	17.4	18.7		22.4	22.2	1.47			1.04	-1.51
20	16.2	17.2		22.3	22.1	-0.44			0.03	-2.10
21*	15.8	16.5		22.2	22.2	-2.35			-1.83	-2.32
22*	12.6	14.1		22.1	22.0	-3.37			-1.70	-3.27
23*	9.1	10.4		22.0	22.0	-4.25			-3.75	-4.74
24*	8.8	9.7		22.0	22.2	-4.99			-4.92	-5.01
Mean	23.6	24.0		22.4	22.1	-1.45			0.77	0.66

*Data are 2-day averages, not 3-day averages, of test results.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor values supplied by Ken Childs, ORNL. Values calculated using NBS Response Factor Program by Peavy.

TABLE F3-12 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), THERMAL LAG

Test Cycle	Thermal Lag, hrs												Calc. Time Constant, hrs
	Measured									Calculated			
	Calibrated Hot Box					Heat Flow Meter*				Response Factor			
	t_o vs t_1		q_{ss} vs q_w		Avg.	q_{ss} vs q_{hfm}		Avg.		q_{ss} vs q_{rf}		Avg.	
	@ Max.	@ Min.	@ Max.	@ Min.		@ Max.	@ Min.			@ Max.	@ Min.		
NBS	1.5	2	3	3	2.5	-	-	-		1	0	0.5	0.6

*Heat flow meters were not used on this wall assembly.

TABLE F3-13 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), REDUCTION IN AMPLITUDE

Test Cycle	Measured, %						Calculated, %		
	Calibrated Hot Box			Heat Flow Meter*			Response Factor		
	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.
NBS	0	-11	-6	-	-	-	-15	-26	-21

*Heat flow meters were not used on this wall assembly.

TABLE F3-14 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), ENERGY REQUIREMENTS

Test Cycle	Total Energy, Btu/ft^2 (W·hr/m^2)				Total Energy Comparisons, %			Net Energy, Btu/ft^2 (W·hr/m^2)				Net Energy Comparisons, %		
	Measured		Calculated					Measured		Calculated				
	q_w^T	q_{hfm}^T *	q_{rf}^T	q_{ss}^T	$\frac{q_w^T}{q_{ss}^T}$	$\frac{q_{hfm}^T}{q_{ss}^T}$	$\frac{q_{rf}^T}{q_{ss}^T}$	q_w^N	q_{hfm}^N *	q_{rf}^N	q_{ss}^N	$\frac{q_w^N}{q_{ss}^N}$	$\frac{q_{hfm}^N}{q_{ss}^N}$	$\frac{q_{rf}^N}{q_{ss}^N}$
NBS	35.3 (111.3)		37.8 (119.4)	33.7 (106.2)	105		112	-11.0 (-34.8)		5.8 (18.4)	5.0 (15.8)	-220		116

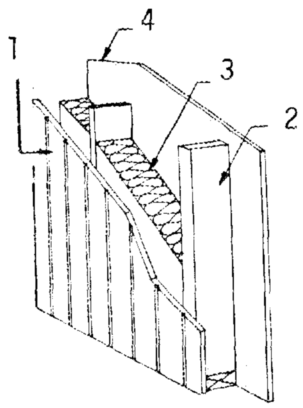
*Heat flow meters were not used on this wall assembly.

WALL F4: 2x4-IN. (51x102-MM) WOOD FRAME WITH R-11 FIBERGLASS INSULATION AND HARDBOARD SIDING

DESCRIPTION: Wood frame wall with R-11 fiberglass blanket insulation between studs, gypsum wallboard on interior surface, and plywood cedar siding on exterior surface.

REFERENCE: Fiorato, A. E., "Heat Transfer Characteristics of Walls Under Dynamic Temperature Conditions," Research and Development Bulletin RD075, Portland Cement Association, Skokie, 1981, 20 pages.

COMPOSITION:



1. 5/8-in. (16-mm) Plywood Cedar Siding with rough sawn surface and vertical gooves at 8-in. (203-mm) on centers
2. 2x4-in. (51x102-mm) Wood Studs at 16 in. (406 mm) center-to-center
3. 3-1/2-in. (89-mm) R-11 Kraft Paper Faced Fiberglass Insulation
4. 1/2-in. (13-mm) Gypsum Wallboard

TABLE F4-1 - PHYSICAL PROPERTIES OF WALL AT TIME OF TEST

Property	Measured Value
Weight, psf (kg/m^2)	5.3 (26)
Nominal Thickness, in. (mm)	4.75 (121)
Nominal Area, ft^2 (m^2)	73.67 (6.84)
Estimated Moisture Content, % by ovendry weight	--

TABLE F4-2 - MATERIAL PROPERTIES, R-11 FIBERGLASS INSULATION

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Nominal Installed Thickness, in. (mm)	--	--	--	3.625 (92)
Thickness, as received, in. (mm)	ASTM C167	--	--	3.44 (87)
Density, as received, pcf (kg/m^3)	ASTM C167	--	--	0.86 (14)

TABLE F4-3 - DESIGN HEAT TRANSMISSION COEFFICIENTS

Component	R, Thermal Resistance	
	Between Framing, $hr\cdot ft^2\cdot °F/Btu$ ($m^2\cdot K/W$)	At Framing, $hr\cdot ft^2\cdot °F/Btu$ ($m^2\cdot K/W$)
1. Outside Air Film	0.17 (0.03)	0.17 (0.03)
2. 5/8-in. (16-mm) Plywood Cedar Siding	0.77* (0.14)	0.77 (0.14)
3. 3-1/2-in. (89-mm) Wood Stud	--	4.38* (0.77)
4. 3-1/2-in. (89-mm) Fiberglass Insulation	11.00* (1.94)	--
5. 1/2-in. (13-mm) Gypsum Wallboard	0.45* (0.08)	0.45 (0.08)
6. Inside Air Film	0.68 (0.12)	0.68 (0.12)
Total R	13.07 (2.31)	6.45 (1.14)
Total U	0.08 (0.43)	0.16 (0.88)

*Source: ASHRAE Handbook of Fundamentals, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., New York, 1977, Chapter 22.

Adjust for Framing (17.3%):

$$U = 0.827\ (0.077) + 0.173\ (0.155)$$

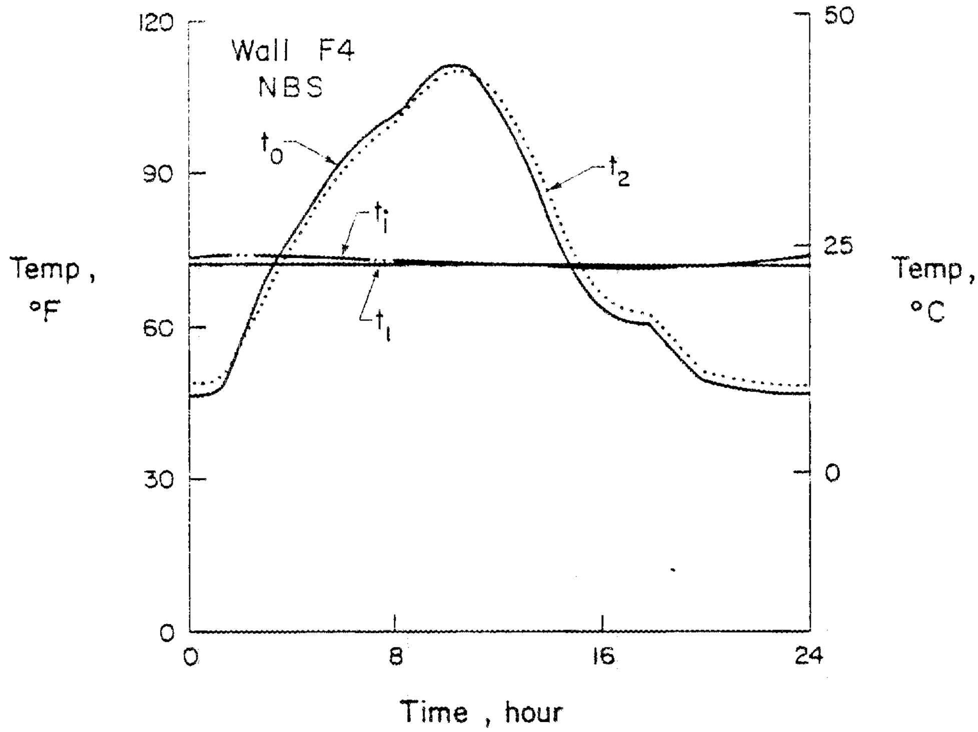
$$= 0.090\ Btu/hr\cdot ft^2\cdot °F\ (0.51\ W/m^2\cdot K)$$

$$R = 1/U = 11.05\ hr\cdot ft^2\cdot °F/Btu\ (1.95\ K\cdot m^2/W)$$

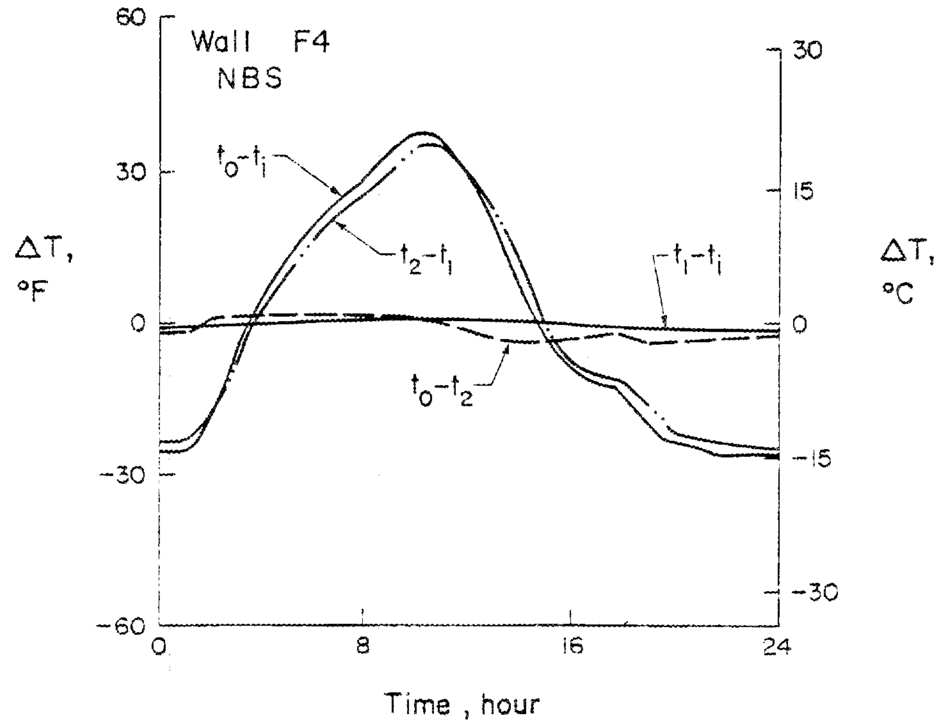
TABLE F4-4 - STEADY-STATE TEST RESULTS

Nominal Test Condition	q Heat Flux, Btu/hr·ft^2 (W/m^2)	R_T, hr·ft^2·°F/Btu (m^2·K/W)	U, Btu/hr·ft^2·°F (W/m^2·K)	Measured Temperatures, °F (°C)					Relative Humidity**		Laboratory Air Temperature	
				t_o Outdoor Air	t_2 Outdoor Surface	t_3* Internal	t_1 Indoor Surface	t_i Indoor Air	Indoor Chamber, %	Outdoor Chamber, %	Max. °F (°C)	Min. °F (°C)
t_m = 34°F (1°C)	-6.03 (-19.01)	13.02 (2.29)	0.08 (0.44)	-6 (-21)	-3 (-19)	-	70 (21)	72 (22)	-	-	72 (22)	70 (21)
t_m = 54°F (12°C)	-2.95 (-9.31)	12.97 (2.28)	(0.08) (0.44)	34 (1)	36 (2)	-	72 (22)	72 (22)	-	-	74 (23)	73 (23)
t_m = 100°F (38°C)	4.94 (15.59)	10.79 (1.90)	0.09 (0.53)	125 (52)	124 (51)	-	75 (24)	73 (23)	-	-	74 (23)	74 (23)
Design Values	--	11.05 (1.95)	0.09 (0.51)	-	-	-	-	-	-	-	-	-

*Internal thermocouples were not used for this wall assembly.
**Relative humidity was not measured for this wall assembly.

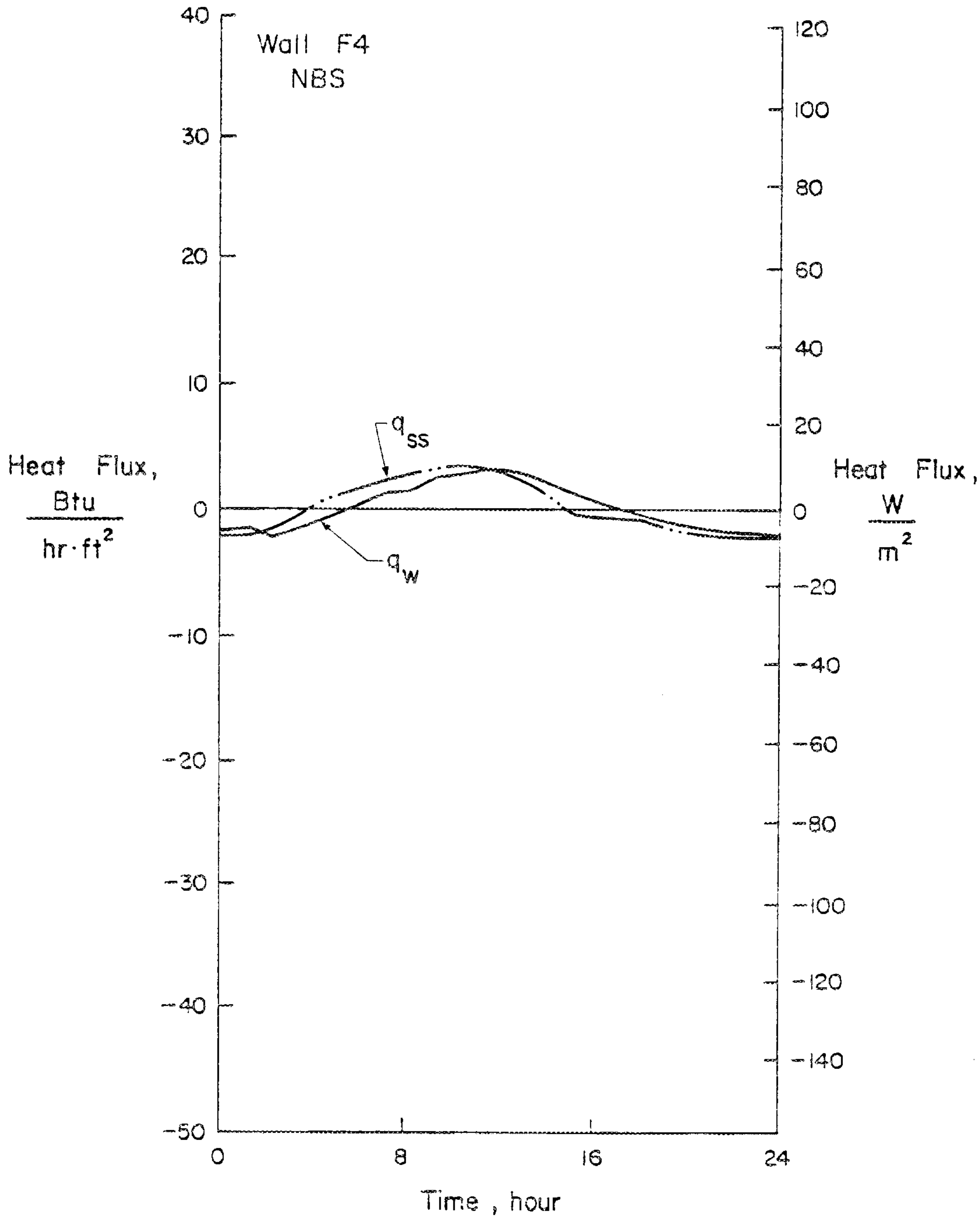


(a) Measured Temperatures



(b) Temperature Differentials

Fig. F4-2 Wall F4 Dynamic Test Results for NBS Test Cycle



(c) Heat Flux

Fig. F4-2 Wall F4 Dynamic Test Results for NBS Test Cycle

TABLE F4-7(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q'_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1*	47.1	48.7		72.2	72.7	-1.90				-2.11
2*	57.1	55.7		72.2	72.6	-2.11				-1.50
3*	70.4	68.6		72.5	72.7	-1.49				-0.36
4*	78.9	77.3		72.9	72.8	-1.05				0.41
5*	87.1	85.3		73.2	72.8	-0.24				1.15
6*	94.2	92.4		73.5	72.9	0.41				1.82
7*	99.1	97.7		73.8	72.9	1.32				2.32
8*	102.3	101.0		74.0	73.0	1.39				2.64
9*	108.7	106.5		74.2	73.0	2.52				3.18
10	112.7	111.0		74.4	73.1	2.71				3.63
11	110.6	110.3		74.6	73.1	3.15				3.54
12*	104.8	105.5		74.5	73.1	3.10				3.05
13*	95.4	97.5		74.3	73.1	2.98				2.25
14*	81.6	85.3		74.0	73.1	2.41				1.08
15*	69.6	73.2		73.6	72.9	1.36				-0.04
16*	63.9	66.2		73.2	72.9	0.88				-0.65
17*	61.8	63.5		73.0	72.8	0.04				-0.87
18*	60.7	62.2		72.8	72.8	-0.51				-0.97
19*	53.8	56.9		72.7	72.8	-0.72				-1.44
20*	49.3	51.7		72.5	72.7	-1.37				-1.88
21*	48.0	50.0		72.3	72.7	-1.39				-2.01
22*	47.1	49.0		72.3	72.7	-1.65				-2.09
23*	46.5	48.3		72.2	72.6	-1.77				-2.14
24*	46.8	48.4		72.2	72.6	-1.97				-2.13
Mean	74.9	75.5		73.2	72.9	0.25				0.29

*Data are 2-day averages, not 3-day averages, of test results.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

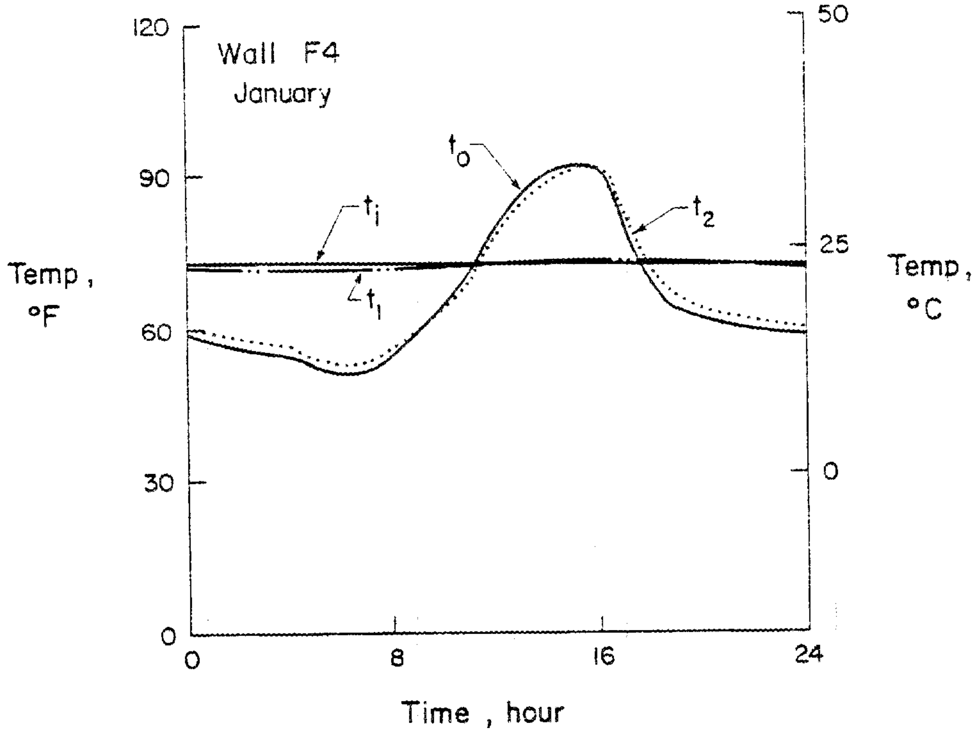
Calibrated Hot Box Relative Humidity:
Indoor Chamber - Not measured for this wall assembly
Outdoor Chamber - Not measured for this wall assembly

Laboratory Air Temperature:
Max. - 75°F (24°C)
Min. - 71°F (22°C)

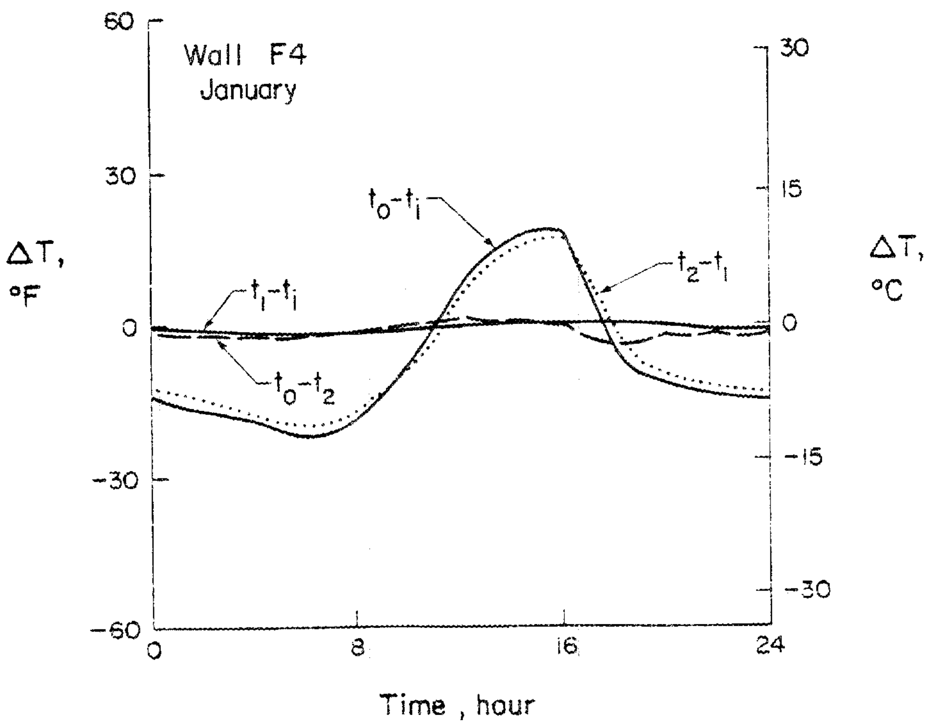
TABLE F4-7(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q'_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1*	8.4	9.3		22.3	22.6	-6.01				-6.65
2*	14.0	13.2		22.3	22.6	-6.67				-4.72
3*	21.4	20.3		22.5	22.6	-4.69				-1.14
4*	26.1	25.2		22.7	22.6	-3.30				1.31
5*	30.6	29.6		22.9	22.7	-0.75				3.64
6*	34.6	33.6		23.0	22.7	1.30				5.74
7*	37.3	36.5		23.2	22.7	4.15				7.32
8*	39.1	38.4		23.3	22.8	4.37				8.32
9*	42.6	41.4		23.4	22.8	7.95				10.03
10	44.8	43.9		23.6	22.8	8.54				11.45
11	43.7	43.5		23.6	22.9	9.95				11.16
12*	40.4	40.9		23.6	22.9	9.78				9.62
13*	35.2	36.4		23.5	22.8	9.42				7.11
14*	27.5	29.6		23.4	22.8	7.59				3.40
15*	20.9	22.9		23.1	22.7	4.30				-0.12
16*	17.7	19.0		22.9	22.7	2.76				-2.04
17*	16.6	17.5		22.8	22.7	0.13				-2.76
18*	15.9	16.8		22.7	22.7	-1.62				-3.07
19*	12.1	13.9		22.6	22.7	-2.28				-4.54
20*	9.6	10.9		22.5	22.6	-4.33				-5.92
21*	8.9	10.0		22.4	22.6	-4.40				-6.33
22*	8.4	9.4		22.4	22.6	-5.20				-6.60
23*	8.0	9.0		22.3	22.6	-5.57				-6.76
24*	8.2	9.1		22.3	22.6	-6.23				-6.73
Mean	23.8	24.2		22.9	22.7	0.80				0.90

*Data are 2-day averages, not 3-day averages, of test results.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

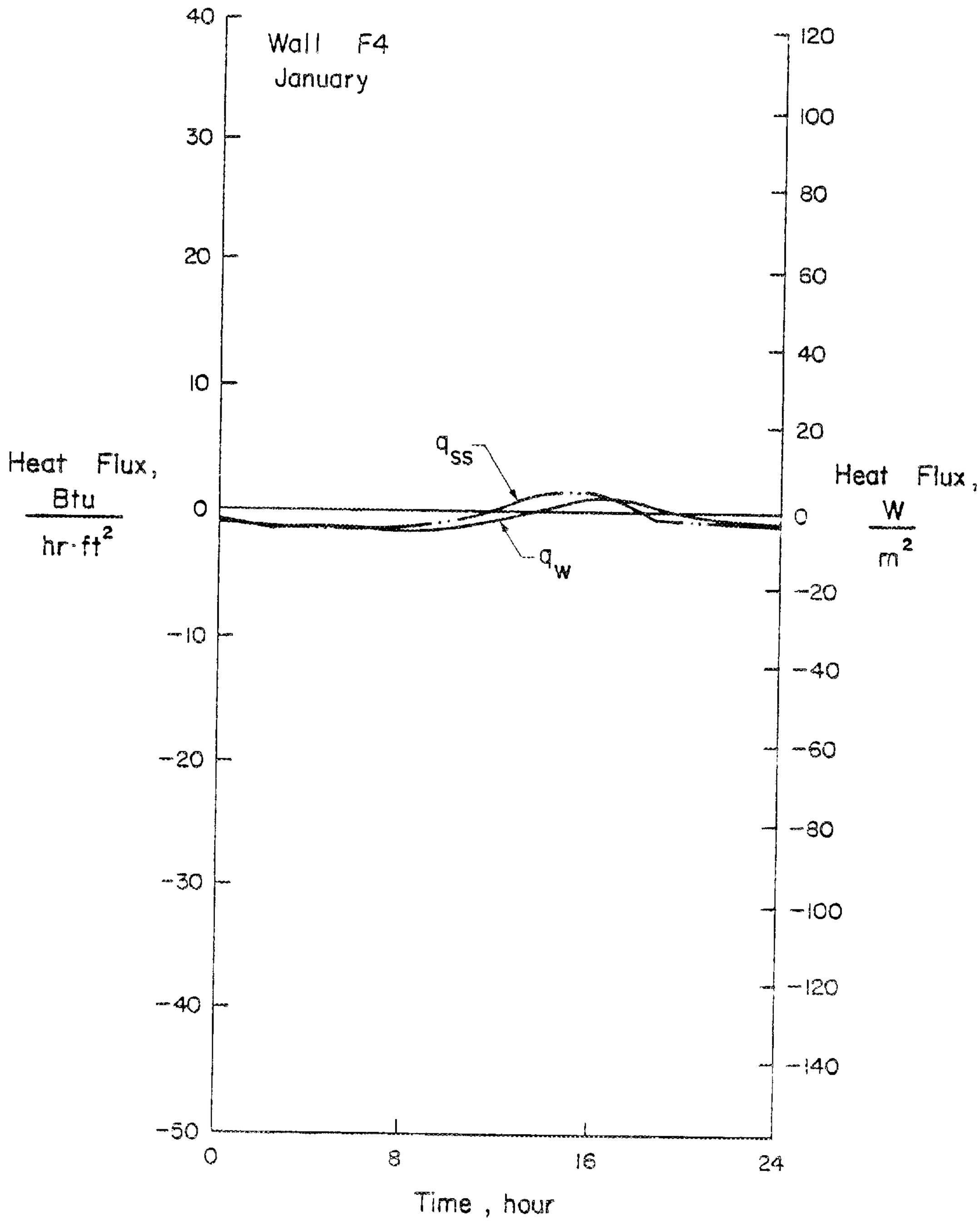


(a) Measured Temperatures



(b) Temperature Differentials

Fig. F4-3 Wall F4 Dynamic Test Results for Orlando January Test Cycle



(c) Heat Flux

Fig. F4-3 Wall F4 Dynamic Test Results for Orlando January Test Cycle

TABLE F4-8(a) - DYNAMIC TEST RESULTS (PERIODIC), ORLANDO JANUARY TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q'_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1	57.0	58.7		72.6	72.8	-1.25				-1.27
2	56.6	57.7		72.5	72.7	-1.44				-1.35
3	54.9	56.8		72.5	72.7	-1.39				-1.43
4	54.2	55.5		72.5	72.7	-1.53				-1.54
5	51.7	53.9		72.4	72.7	-1.62				-1.67
6	51.2	52.6		72.4	72.7	-1.73				-1.79
7	51.9	53.3		72.3	72.7	-1.79				-1.72
8	55.0	55.4		72.3	72.7	-1.91				-1.53
9	59.3	59.5		72.4	72.7	-1.84				-1.18
10	65.1	64.4		72.6	72.7	-1.48				-0.76
11	71.3	70.6		72.8	72.7	-1.06				-0.20
12	81.3	79.1		73.0	72.8	-0.68				0.58
13*	86.7	85.8		73.3	72.9	-0.41				1.19
14	90.4	89.1		73.5	72.9	0.26				1.49
15	92.9	92.6		73.7	73.0	0.82				1.82
16	92.4	92.2		73.8	73.0	1.13				1.77
17	83.1	85.9		73.8	73.0	1.24				1.15
18	70.8	74.0		73.5	73.0	0.71				0.05
19	63.8	66.5		73.2	72.9	0.11				-0.62
20	62.6	63.9		73.0	72.8	-0.32				-0.84
21	60.6	62.5		72.8	72.8	-0.54				-0.95
22	60.1	61.2		72.7	72.8	-0.83				-1.05
23	58.4	60.2		72.7	72.8	-0.85				-1.14
24	58.6	59.6		72.6	72.8	-1.03				-1.19
Mean	66.2	67.1		72.9	72.8	-0.73				-0.51

*Data are 2-day averages, not 3-day averages, of test results.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

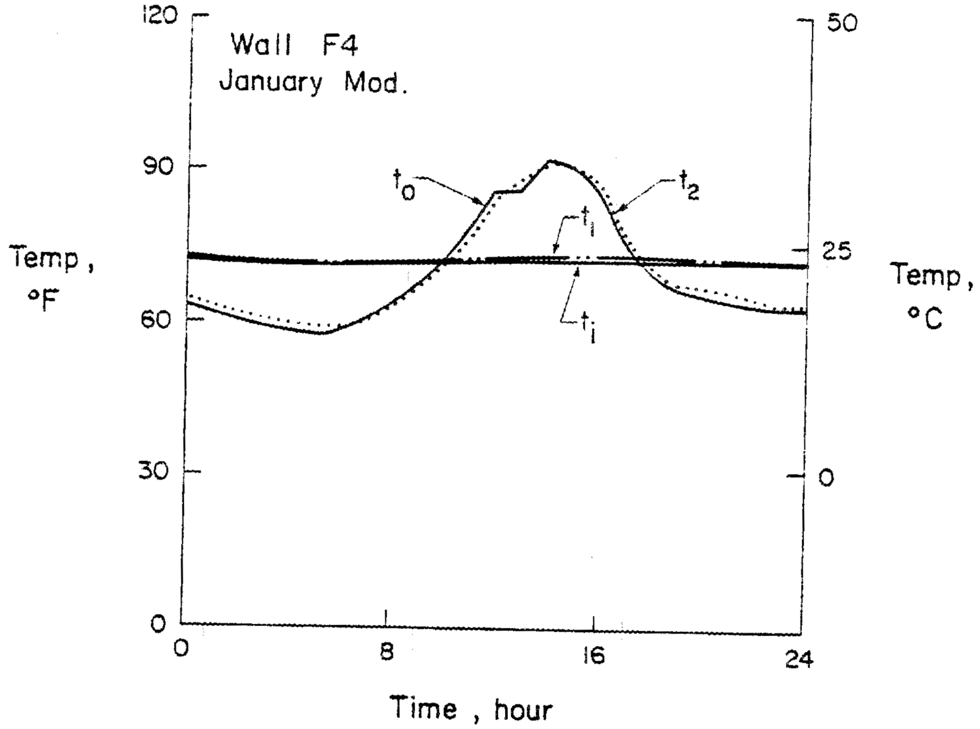
Calibrated Hot Box Relative Humidity:
Indoor Chamber - Not measured for this wall assembly
Outdoor Chamber - Not measured for this wall assembly

Laboratory Air Temperature:
Max. - 75°F (24°C)
Min. - 72°F (22°C)

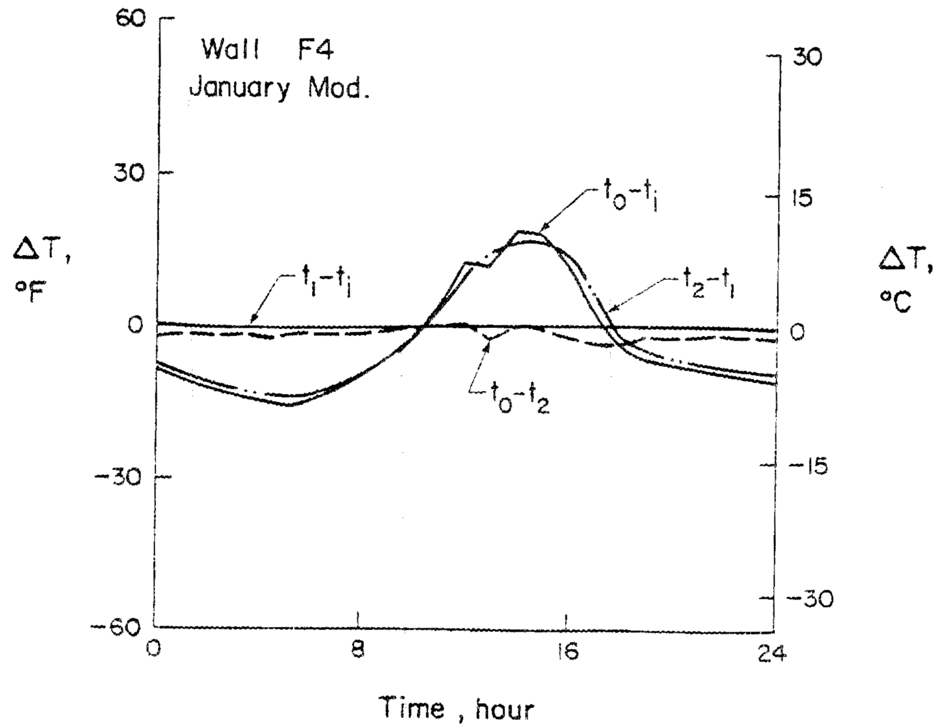
TABLE F4-8(b) - DYNAMIC TEST RESULTS (PERIODIC), ORLANDO JANUARY TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q'_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1	13.9	14.8		22.6	22.6	-3.94				-4.00
2	13.6	14.3		22.5	22.6	-4.53				-4.25
3	12.7	13.8		22.5	22.6	-4.38				-4.51
4	12.3	13.1		22.5	22.6	-4.82				-4.87
5	10.9	12.2		22.5	22.6	-5.11				-5.28
6	10.7	11.4		22.4	22.6	-5.45				-5.64
7	11.0	11.8		22.4	22.6	-5.65				-5.42
8	12.8	13.0		22.4	22.6	-6.04				-4.84
9	15.2	15.3		22.5	22.6	-5.79				-3.72
10	18.4	18.0		22.5	22.6	-4.67				-2.38
11	21.8	21.5		22.6	22.6	-3.36				-0.65
12	27.4	26.2		22.8	22.7	-2.14				1.81
13*	30.4	29.9		22.9	22.7	-1.29				3.76
14	32.5	31.7		23.1	22.7	0.83				4.72
15	33.9	33.7		23.2	22.8	2.59				5.75
16	33.5	33.4		23.2	22.8	3.56				5.59
17	28.4	30.0		23.2	22.8	3.90				3.64
18	21.5	23.3		23.1	22.8	2.25				0.15
19	17.7	19.2		22.9	22.7	0.35				-1.95
20	17.0	17.7		22.8	22.7	-1.02				-2.64
21	15.9	16.9		22.7	22.7	-1.70				-2.98
22	15.6	16.2		22.6	22.7	-2.63				-3.32
23	14.7	15.6		22.6	22.7	-2.68				-3.61
24	14.8	15.3		22.6	22.6	-3.26				-3.75
Mean	19.0	19.5		22.7	22.7	-2.29				-1.60

*Data are 2-day averages, not 3-day averages, of test results.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

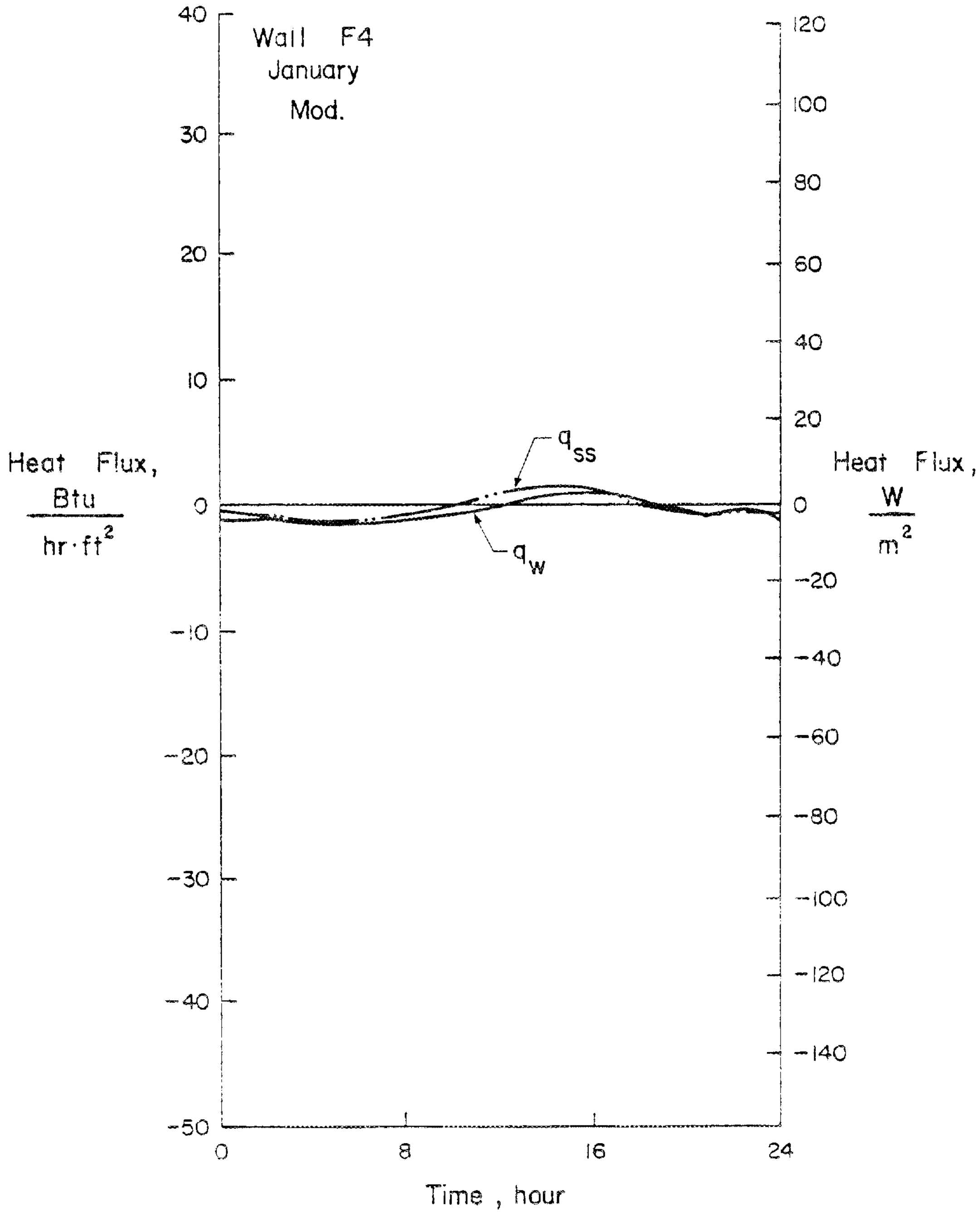


(a) Measured Temperatures



(b) Temperature Differentials

Fig. F4-4 Wall F4 Dynamic Test Results for Orlando January Modified Test Cycle



(c) Heat Flux

Fig. F4-4 Wall F4 Dynamic Test Results for Orlando January Modified Test Cycle

TABLE F4-9(a) - DYNAMIC TEST RESULTS (PERIODIC), ORLANDO JANUARY MODIFIED TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}* HFM @ Indoor Surf.	q'_{hfm}* HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
1	61.8	62.9		72.8	72.7	-1.08				-0.91
2	60.6	62.2		72.7	72.7	-1.00				-0.96
3	59.4	60.5		72.7	72.7	-1.23				-1.12
4	58.2	59.9		72.6	72.7	-1.39				-1.16
5	57.5	58.6		72.6	72.7	-1.31				-1.28
6	58.5	59.6		72.6	72.7	-1.34				-1.19
7	60.2	60.7		72.6	72.7	-1.26				-1.09
8	63.6	63.8		72.6	72.6	-1.19				-0.81
9	66.7	66.6		72.7	72.6	-1.03				-0.56
10	72.4	71.9		72.8	72.7	-0.71				-0.08
11	79.2	77.7		73.0	72.7	-0.58				0.44
12	86.9	85.6		73.3	72.8	-0.26				1.17
13	89.8	88.7		73.5	72.9	0.59				1.46
14	93.0	92.5		73.7	72.9	0.71				1.81
15	91.9	91.7		73.8	73.0	1.19				1.72
16	87.1	88.8		73.8	73.0	1.19				1.44
17	76.6	79.1		73.6	73.0	0.78				0.52
18	70.1	72.5		73.4	72.9	0.56				-0.08
19	67.6	68.8		73.1	72.8	-0.09				-0.40
20	66.5	68.0		73.0	72.8	-0.27				-0.46
21	65.3	66.2		72.9	72.8	-0.72				-0.62
22	64.6	66.0		72.9	72.8	-0.54				-0.64
23	63.7	64.6		72.8	72.7	-0.68				-0.76
24	63.2	64.5		72.8	72.7	-0.99				-0.76
Mean	70.2	70.9		73.0	72.8	-0.44				-0.18

*Internal thermocouples and heat flow meters were not used on this wall assembly.
**Response factor analysis was not performed for this wall assembly.

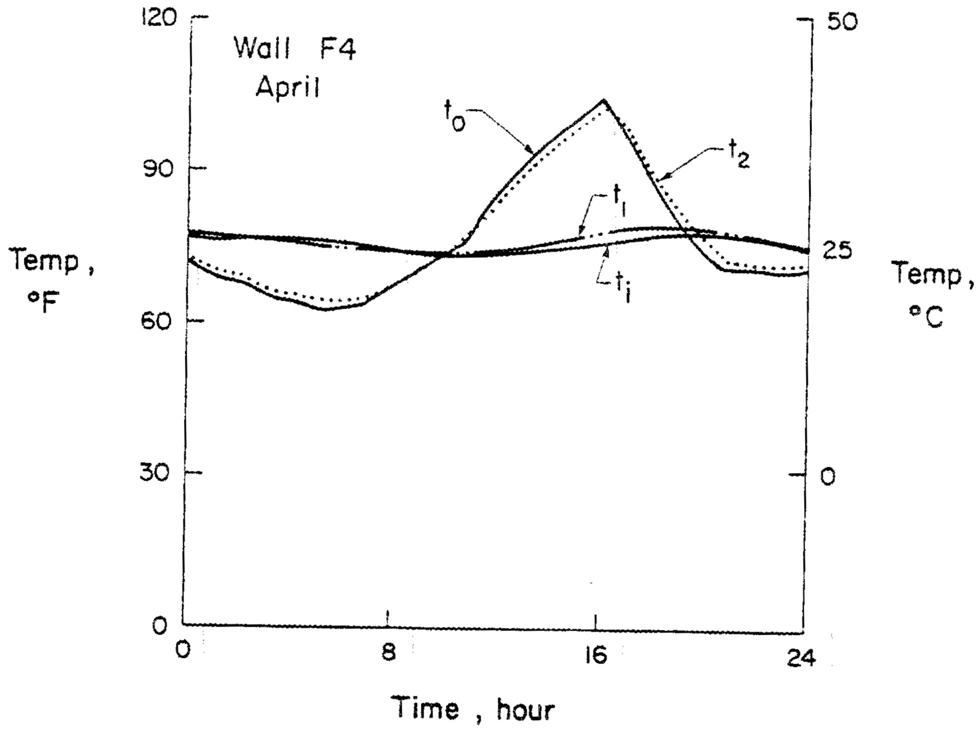
Calibrated Hot Box Relative Humidity:
Indoor Chamber - Not measured for this wall assembly
Outdoor Chamber - Not measured for this wall assembly

Laboratory Air Temperature:
Max. - 76°F (24°C)
Min. - 67°F (19°C)

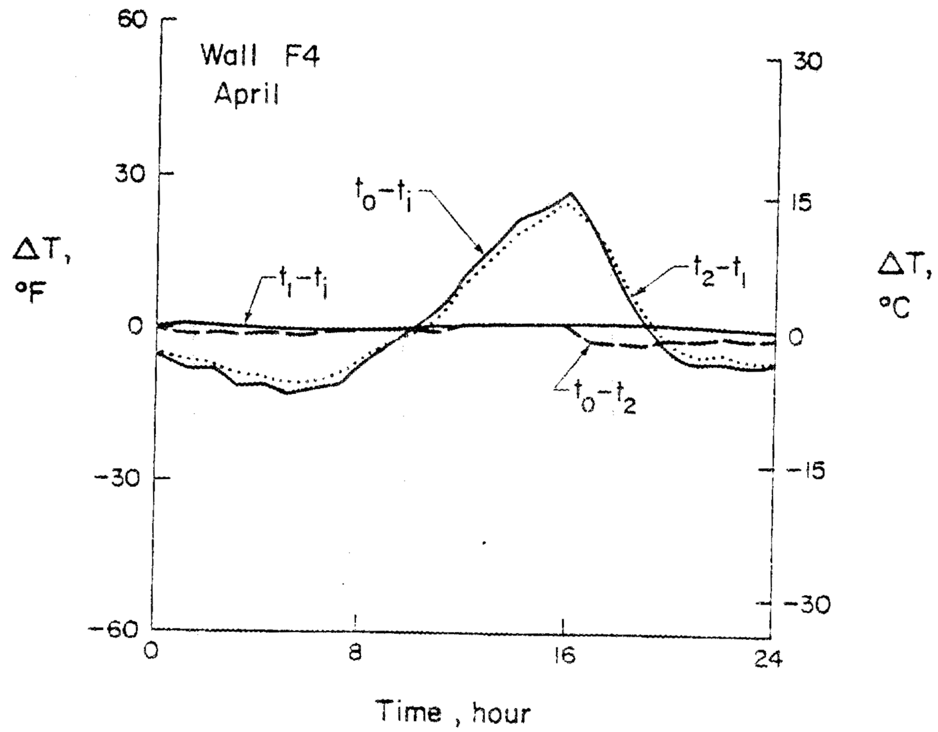
TABLE F4-9(b) - DYNAMIC TEST RESULTS (PERIODIC), ORLANDO JANUARY MODIFIED TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}* HFM @ Indoor Surf.	q'_{hfm}* HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
1	16.6	17.2		22.7	22.6	-3.40				-2.87
2	15.9	16.8		22.6	22.6	-3.16				-3.04
3	15.2	15.9		22.6	22.6	-3.89				-3.52
4	14.5	15.5		22.6	22.6	-4.38				-3.66
5	14.2	14.8		22.5	22.6	-4.13				-4.03
6	14.7	15.3		22.5	22.6	-4.23				-3.75
7	15.7	16.0		22.5	22.6	-3.99				-3.44
8	17.5	17.7		22.6	22.6	-3.74				-2.55
9	19.3	19.2		22.6	22.6	-3.26				-1.78
10	22.4	22.2		22.7	22.6	-2.23				-0.26
11	26.2	25.4		22.8	22.6	-1.84				1.40
12	30.5	29.8		22.9	22.7	-0.82				3.70
13	32.1	31.5		23.0	22.7	1.86				4.59
14	33.9	33.6		23.2	22.7	2.25				5.72
15	33.3	33.2		23.2	22.8	3.76				5.44
16	30.6	31.6		23.2	22.8	3.76				4.53
17	24.8	26.2		23.1	22.8	2.45				1.64
18	21.2	22.5		23.0	22.7	1.76				-0.27
19	19.8	20.5		22.9	22.7	-0.28				-1.26
20	19.2	20.0		22.8	22.7	-0.87				-1.46
21	18.5	19.0		22.7	22.7	-2.28				-1.95
22	18.1	18.9		22.7	22.6	-1.70				-2.01
23	17.6	18.1		22.7	22.6	-2.13				-2.38
24	17.3	18.1		22.7	22.6	-3.11				-2.41
Mean	21.2	21.6		22.8	22.7	-1.40				-0.57

**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

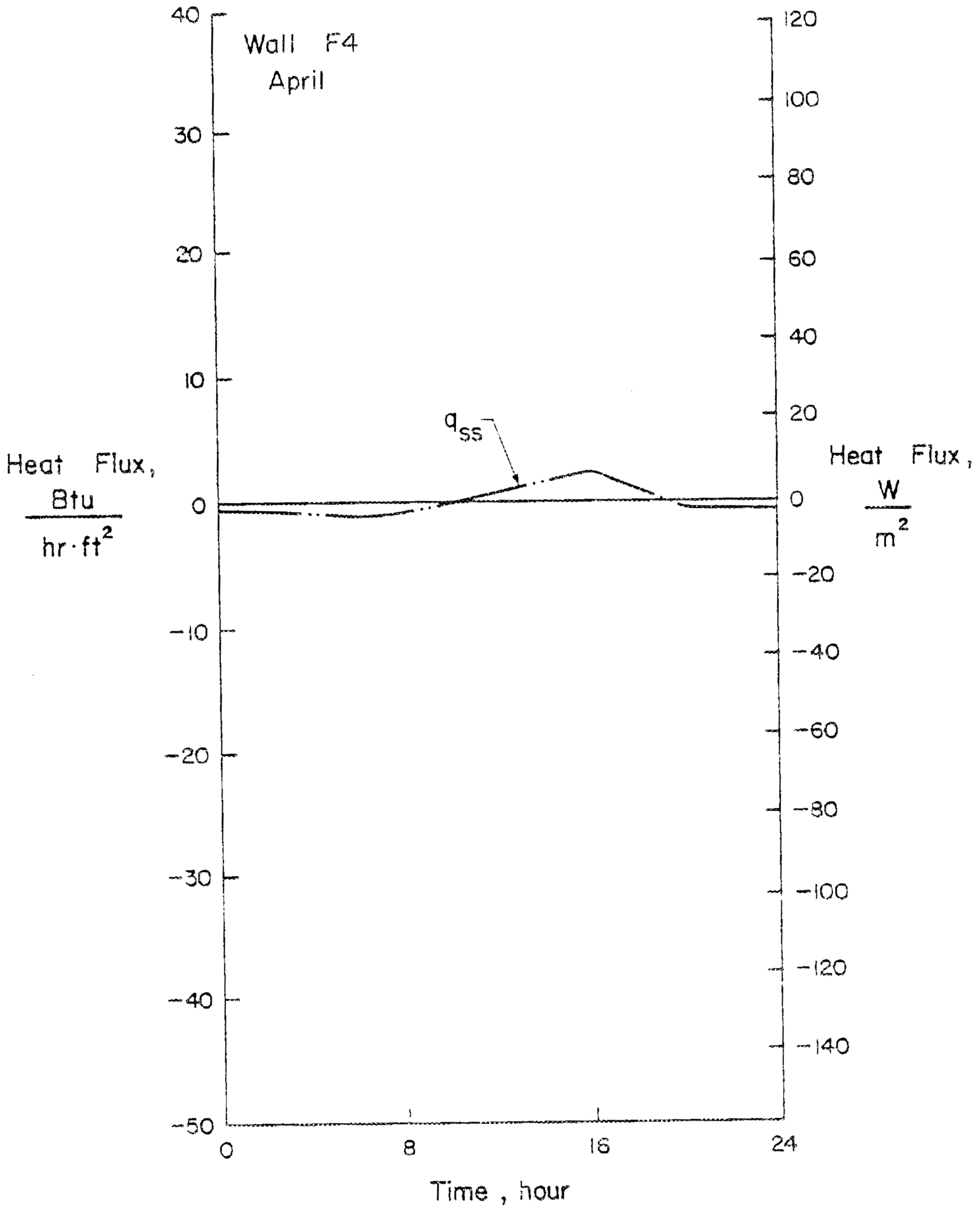


(a) Measured Temperatures



(b) Temperature Differentials

Fig. F4-5 Wall F4 Dynamic Test Results for Orlando April Test Cycle



(c) Heat Flux

Fig. F4-5 Wall F4 Dynamic Test Results for Orlando April Test Cycle

TABLE F4-10(a) - DYNAMIC TEST RESULTS (PERIODIC), ORLANDO APRIL TEST CYCLE*

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w* Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1	68.3	70.0		77.0	76.8					-0.65
2	68.1	69.1		76.5	76.5					-0.69
3	64.9	66.7		76.2	76.2					-0.88
4	64.8	65.8		75.7	75.8					-0.92
5	62.3	64.0		75.3	75.5					-1.04
6	63.4	64.2		74.9	75.1					-0.99
7	63.9	64.9		74.6	74.8					-0.90
8	67.6	67.6		74.3	74.5					-0.62
9	70.5	70.7		74.3	74.4					-0.34
10	74.7	74.2		74.3	74.2					-0.01
11	77.8	78.4		74.6	73.4					0.36
12	86.5	84.8		74.9	74.5					0.94
13	90.9	90.2		75.7	75.0					1.40
14	98.2	96.2		76.5	75.6					1.92
15	101.2	100.4		77.5	76.4					2.25
16	105.1	103.8		78.5	77.1					2.50
17	98.2	99.8		79.4	77.9					2.00
18	91.1	92.8		79.7	78.4					1.27
19	80.7	83.6		79.5	78.6					0.39
20	76.1	77.6		79.1	78.4					-0.14
21	71.8	73.7		78.5	78.1					-0.45
22	72.3	73.1		78.0	77.7					-0.46
23	70.5	71.9		77.6	77.4					-0.54
24	71.3	72.0		77.2	77.1					-0.49
Mean	77.5	78.1		76.7	76.2					0.16

*Test was conducted under floating conditions. Indoor surface and air temperatures were permitted to respond to outdoor temperature changes without heating, cooling, or forced air circulation on the indoor side. No heat flow through wall was measured.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

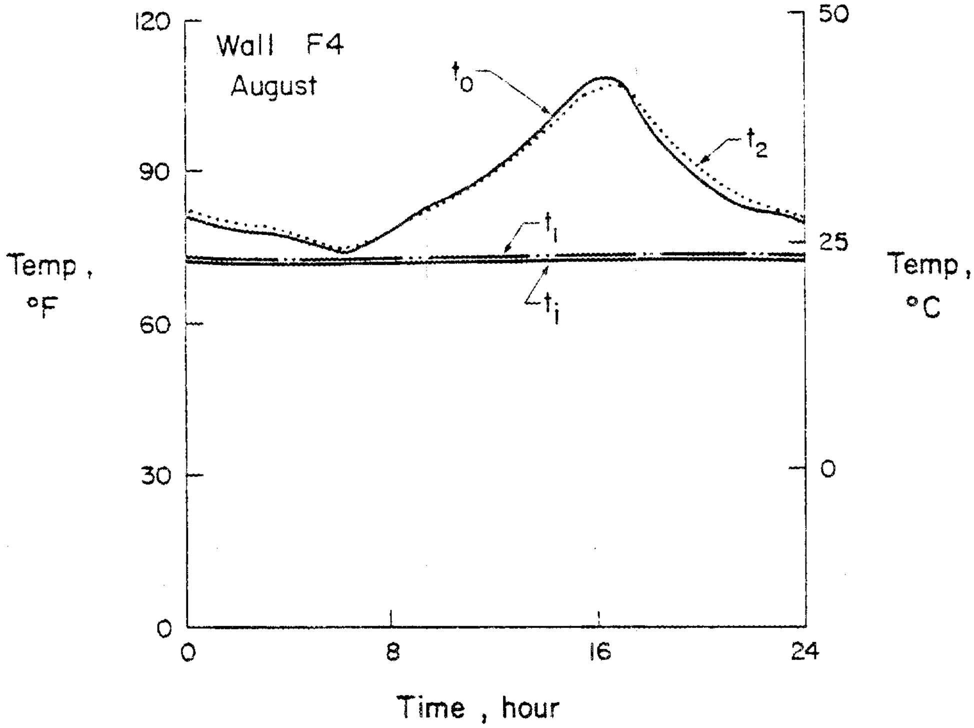
Calibrated Hot Box Relative Humidity:
Indoor Chamber - Not measured for this wall assembly
Outdoor Chamber - Not measured for this wall assembly

Laboratory Air Temperature:
Max. - 76°F (24°C)
Min. - 69°F (21°C)

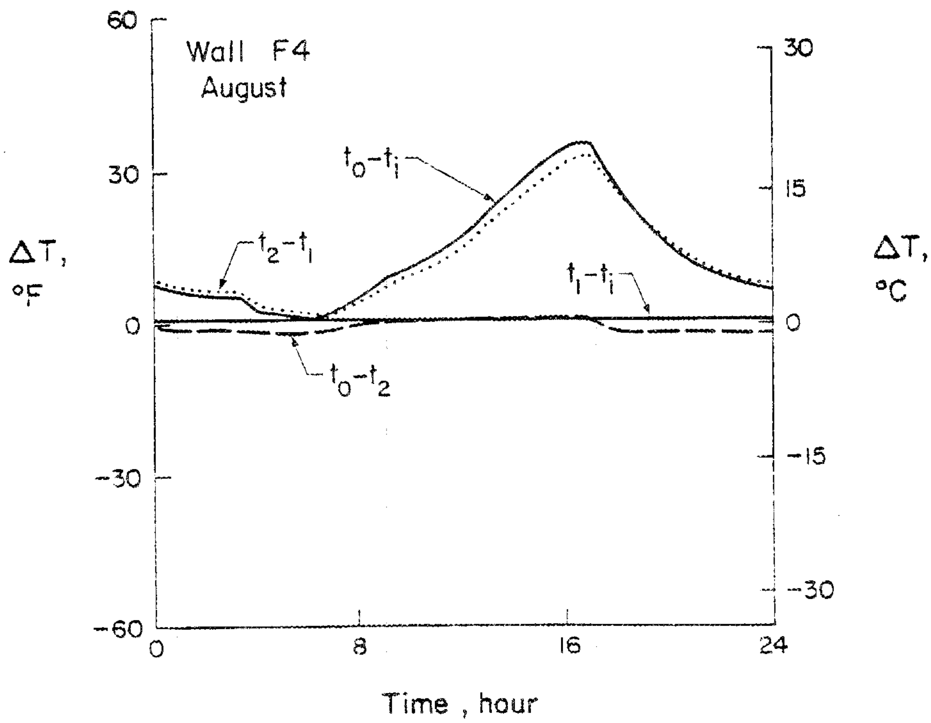
TABLE F4-10(b) - DYNAMIC TEST RESULTS (PERIODIC), ORLANDO APRIL TEST CYCLE, SI UNITS*

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w* Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q'_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1	20.1	21.1		25.0	24.9					-2.07
2	20.1	20.6		24.7	24.7					-2.18
3	18.3	19.3		24.6	24.6					-2.79
4	18.2	18.8		24.3	24.4					-2.90
5	16.8	17.8		24.1	24.2					-3.29
6	17.4	17.9		23.8	23.9					-3.12
7	17.7	18.3		23.6	23.8					-2.83
8	19.8	19.8		23.5	23.6					-1.96
9	21.4	21.5		23.5	23.5					-1.06
10	23.7	23.4		23.5	23.5					-0.03
11	25.5	25.8		23.6	23.0					1.13
12	30.3	29.3		23.9	23.6					2.98
13	32.7	32.3		24.3	23.9					4.41
14	36.8	35.7		24.7	24.2					6.05
15	38.5	38.0		25.3	24.6					7.08
16	40.6	39.9		25.8	25.1					7.88
17	36.8	37.7		26.3	25.5					6.32
18	32.8	33.8		26.5	25.8					4.02
19	27.1	28.7		26.4	25.9					1.24
20	24.5	25.3		26.1	25.8					-0.45
21	22.1	23.2		25.8	25.6					-1.43
22	22.4	22.8		25.5	25.4					-1.46
23	21.4	22.2		25.3	25.2					-1.69
24	21.8	22.2		25.1	25.0					-1.54
Mean	25.3	25.6		24.8	24.6					0.51

*Test was conducted under floating conditions. Indoor surface and air temperatures were permitted to respond to outdoor temperature changes without heating, cooling, or forced air circulation on the indoor side. No heat flow through wall was measured.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

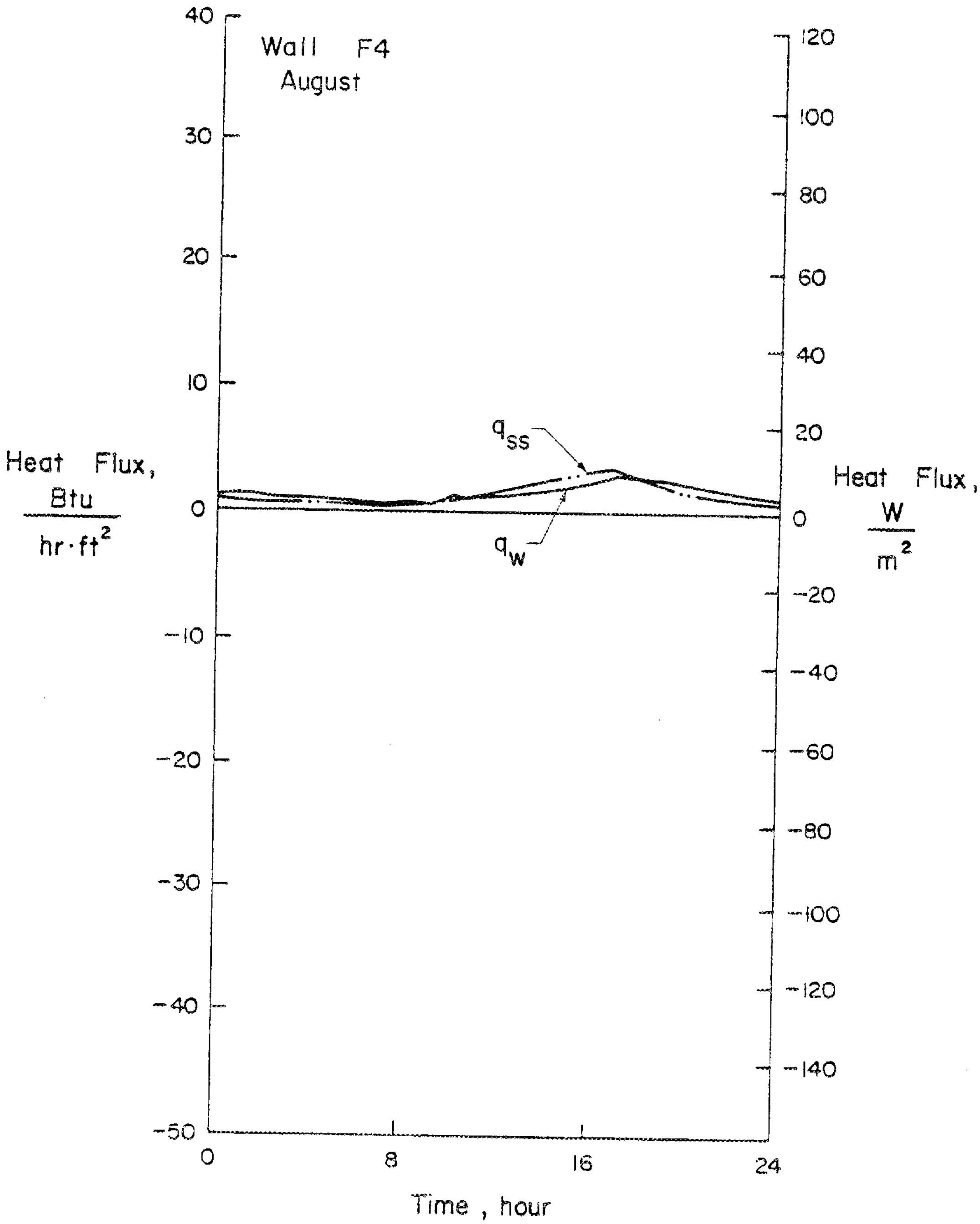


(a) Measured Temperatures



(b) Temperature Differentials

Fig. F4-6 Wall F4 Dynamic Test Results for Orlando August Test Cycle



(c) Heat Flux

Fig. F4-6 Wall F4 Dynamic Test Results for Orlando August Test Cycle

TABLE F4-11(a) - DYNAMIC TEST RESULTS (PERIODIC), ORLANDO AUGUST TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft²			Calculated Heat Flux, Btu/hr·ft²	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q'_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1	79.8	80.7		73.5	73.0	1.22				0.68
2	78.9	79.4		73.4	73.0	0.85				0.57
3	78.7	79.6		73.4	72.9	0.92				0.59
4	76.7	77.4		73.4	72.9	0.69				0.38
5	75.7	76.8		73.3	72.9	0.69				0.33
6	74.2	74.9		73.3	72.9	0.52				0.15
7	76.0	76.3		73.2	72.9	0.41				0.29
8	78.6	78.3		73.3	72.9	0.52				0.47
9	82.9	82.6		73.3	72.9	0.77				0.88
10	83.9	83.7		73.5	73.0	1.18				0.97
11	87.7	87.1		73.5	73.0	0.98				1.30
12*	90.5	89.6		73.7	73.0	1.27				1.53
13*	95.8	94.7		73.8	73.0	1.55				2.02
14*	99.8	98.2		73.9	73.1	1.76				2.36
15*	105.4	104.0		74.1	73.1	2.31				2.93
16	108.6	106.9		74.3	73.2	2.48				3.21
17	109.3	109.1		74.5	73.2	3.04				3.42
18	101.3	102.3		74.5	73.2	2.88				2.72
19	94.5	96.1		74.3	73.2	2.82				2.11
20	89.7	90.6		74.0	73.1	2.28				1.60
21	86.6	87.8		73.9	73.1	2.03				1.33
22	83.8	84.5		73.7	73.0	1.66				1.03
23	82.6	83.6		73.6	73.0	1.45				0.95
24	80.4	81.1		73.5	73.0	1.09				0.72
Mean	87.6	87.7		73.7	73.0	1.47				1.36

*Data are 2-day averages, not 3-day averages, of test results.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

Calibrated Hot Box Relative Humidity:
Indoor Chamber - Not Available
Outdoor Chamber - Not Available

Laboratory Air Temperature:
Max. - 78°F (26°C)
Min. - 75°F (24°C)

TABLE F4-11(b) - DYNAMIC TEST RESULTS (PERIODIC), ORLANDO AUGUST TEST CYCLE, SI UNITS*

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3** Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}** HFM @ Indoor Surf.	q'_{hfm}** HFM @ Outdoor Surf.	q_{rf}*** Response Factor	q_{ss} Steady-State
1	26.6	27.1		23.0	22.8	3.84				2.15
2	26.1	26.3		23.0	22.8	2.67				1.79
3	25.9	26.4		23.0	22.7	2.91				1.85
4	24.8	25.2		23.0	22.7	2.18				1.19
5	24.3	24.9		22.9	22.7	2.18				1.04
6	23.4	23.9		22.9	22.7	1.64				0.47
7	24.4	24.6		22.9	22.7	1.30				0.92
8	25.9	25.7		22.9	22.7	1.64				1.49
9	28.3	28.1		23.0	22.7	2.42				2.78
10	28.9	28.7		23.0	22.8	3.74				3.06
11	31.0	30.6		23.1	22.8	3.10				4.10
12*	32.5	32.0		23.1	22.8	4.01				4.81
13*	35.5	34.8		23.2	22.8	4.88				6.38
14*	37.7	36.8		23.3	22.8	5.54				7.45
15*	40.8	40.0		23.4	22.8	7.30				9.25
16	42.5	41.6		23.5	22.9	7.83				10.14
17	42.9	42.8		23.6	22.9	9.59				10.80
18	38.5	39.0		23.6	22.9	9.10				8.59
19	34.7	35.6		23.5	22.9	8.90				6.67
20	32.0	32.5		23.4	22.8	7.20				5.03
21	30.3	31.0		23.3	22.8	6.42				4.20
22	28.8	29.2		23.2	22.8	5.25				3.24
23	28.1	28.7		23.1	22.8	4.57				3.00
24	26.9	27.3		23.1	22.8	3.45				2.27
Mean	30.9	31.0		23.2	22.8	4.65				4.28

*Data are 2-day averages, not 3-day averages, of test results.
**Internal thermocouples and heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

TABLE F4-12 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), THERMAL LAG

Test Cycle	Thermal Lag, hrs											Calc. Time Constant, hrs
	Measured								Calculated			
	Calibrated Hot Box					Heat Flow Meter**			Response Factor***			
	t_o vs t_1		q_{ss} vs q_w		Avg.	q_{ss} vs q_{hfm}		Avg.	q_{ss} vs q_{rf}		Avg.	
	@ Max.	@ Min.	@ Max.	@ Min.		@ Max.	@ Min.		@ Max.	@ Min.		
NBS	1	1.5	1	3	1.5							0.7
Orlando January	1.5	1.5	2	2	2							0.7
Orlando Jan. Mod.	1.5	1	1.5	0	1							0.7
Orlando April	2	4	*	*	3							0.7
Orlando August	0.5	1	0	1	0.5							0.7

*Not available. See note beneath Table F4-10(a).

**Heat flow meters were not used on this wall assembly.

***Response factor analysis was not performed for this wall assembly.

TABLE F4-13 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), REDUCTION IN AMPLITUDE

Test Cycle	Measured, %						Calculated, %		
	Calibrated Hot Box			Heat Flow Meter**			Response Factor***		
	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.
NBS	13	3	7.5						
Orlando January	15	8	11.5						
Orlando Jan. Mod.	18	14	16						
Orlando April	*	*	*						
Orlando August	24	12	18						

*Not available. See note beneath Table F4-10(a).
**Heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

TABLE F4-14 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), ENERGY REQUIREMENTS

Test Cycle	Total Energy, Btu/ft^2 (W·hr/m^2)				Total Energy Comparisons, %			Net Energy, Btu/ft^2 (W·hr/m^2)				Net Energy Comparisons, %		
	Measured		Calculated					Measured		Calculated				
	q_w^T	q_{hfm}^T **	q_{rf}^T ***	q_{ss}^T	$\frac{q_w^T}{q_{ss}^T}$	$\frac{q_{hfm}^T}{q_{ss}^T}$	$\frac{q_{rf}^T}{q_{ss}^T}$	q_w^N	q_{hfm}^N **	q_{rf}^N ***	q_{ss}^N	$\frac{q_w^N}{q_{ss}^N}$	$\frac{q_{hfm}^N}{q_{ss}^N}$	$\frac{q_{rf}^N}{q_{ss}^N}$
NBS	38.4 (121.3)			43.3 (136.5)	89			6.1 (19.2)			6.9 (21.7)	88		
Orlando January	26.0 (81.9)			28.3 (89.2)	92			-17.4 (-55.0)			-12.2 (-38.4)	143		
Orlando Jan. Mod.	20.7 (65.3)			21.4 (67.7)	96			-10.6 (-33.6)			-4.3 (-13.6)	247		
Orlando April	*			22.2 (69.9)	*			*			3.9 (12.3)	*		
Orlando August	35.4 (111.7)			32.5 (102.7)	109			35.4 (111.7)			32.5 (102.7)	109		

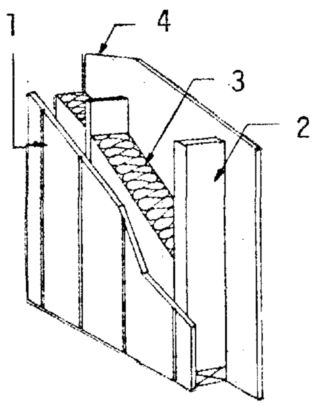
*Not available. See note beneath Table F4-10(a).
**Heat flow meters were not used on this wall assembly.
***Response factor analysis was not performed for this wall assembly.

WALL F5: 2x4-IN. (51x102-MM) WOOD FRAME WITH R-11 FIBERGLASS INSULATION AND HARDBOARD SIDING

DESCRIPTION: Wood frame wall with fiberglass insulation between studs, gypsum wallboard on interior surface, and hardboard siding on exterior surface.

REFERENCE: Fiorato, A. E. and Bravinsky, E., "Heat Transfer Characteristics of Walls Under Arizona Temperature Conditions," Construction Technology Laboratories, Portland Cement Association, Skokie, 1981, 61 pages.

COMPOSITION:



1. 7/16-in. (11-mm) Medium Density Hardboard Siding with vertical grooves spaced 8 in. (203 mm) on centers
2. 2x4-in. (51x102-mm) Wood Studs at 16-in. (406-mm) center-to-center
3. 3-1/2-in. (89-mm) R-11 Kraft Paper Faced Fiberglass Insulation
4. 1/2-in. (13-mm) Gypsum Wallboard

TABLE F5-1 - PHYSICAL PROPERTIES OF WALL AT TIME OF TEST

Property	Measured Value
Unit weight, psf (kg/m^2)	4.7 (23)
Average Thickness, in. (mm)	4.3 (109)
Area, ft^2 (m^2)	73.54 (6.83)
Estimated Moisture Content, % by ovendry weight	--

TABLE F5-2(a) - MATERIAL PROPERTIES, R-11 FIBERGLASS INSULATION

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Nominal Installed Thickness, in. (mm)	--	--	--	3.5 (89)
Thickness, as received, in. (mm)	ASTM C167	--	--	3.47 (88)
Density, as received, pcf (kg/m^3)	ASTM C167	--	--	0.81 (13)

TABLE F5-2(b) - MATERIAL PROPERTIES, HARDBOARD SIDING

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Nominal Thickness, in. (mm)	--	--	--	7/16 (11)
Measured Thickness, in. (mm)	--	--	--	0.29 (7)
Density, pcf (kg/m^3)	--	--	--	50 (801)

TABLE F5-3 - DESIGN HEAT TRANSMISSION COEFFICIENTS

Component	R, Thermal Resistance Between Framing $hr \cdot ft^2 \cdot °F/Btu$ $(m^2 \cdot K/W)$	R, Thermal Resistance At Framing $hr \cdot ft^2 \cdot °F/Btu$ $(m^2 \cdot K/W)$
1. Outside Air Film	0.17 (0.03)	0.17 (0.03)
2. 7/16-in. (11-mm) Medium Density Hardboard	0.60* (0.11)	0.60 (0.11)
3. 3-1/2-in. (89-mm) Wood Stud	-	4.38* (0.77)
4. 3-1/2-in. (89-mm) Fiberglass Insulation	11.00* (1.94)	-
5. 1/2-in. (13-mm) Gypsum Wallboard	0.45* (0.08)	0.45 (0.08)
6. Inside Air Film	0.68 (0.12)	0.68 (0.12)
Total R	12.90 (2.27)	6.28 (1.11)
Total U	0.08 (0.44)	0.16 (0.90)

Source: ASHRAE Handbook of Fundamentals, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., New York, 1977, Chapter 22.

Adjust for Framing (15.5%):

$$U = 0.845\ (0.078) + 0.155\ (0.159)$$

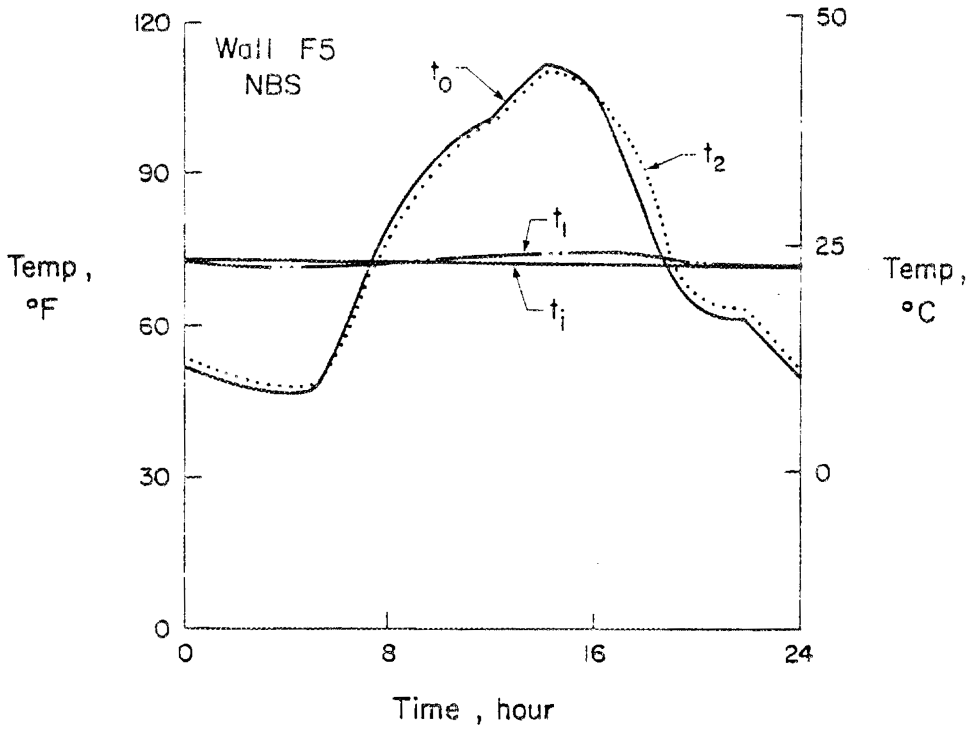
$$= 0.09\ Btu/hr \cdot ft^2 \cdot °F\ (0.52\ W/m^2 \cdot K)$$

$$R = 1/U = 11.04\ hr \cdot ft^2 \cdot °F/Btu\ (1.94\ K \cdot m^2/W)$$

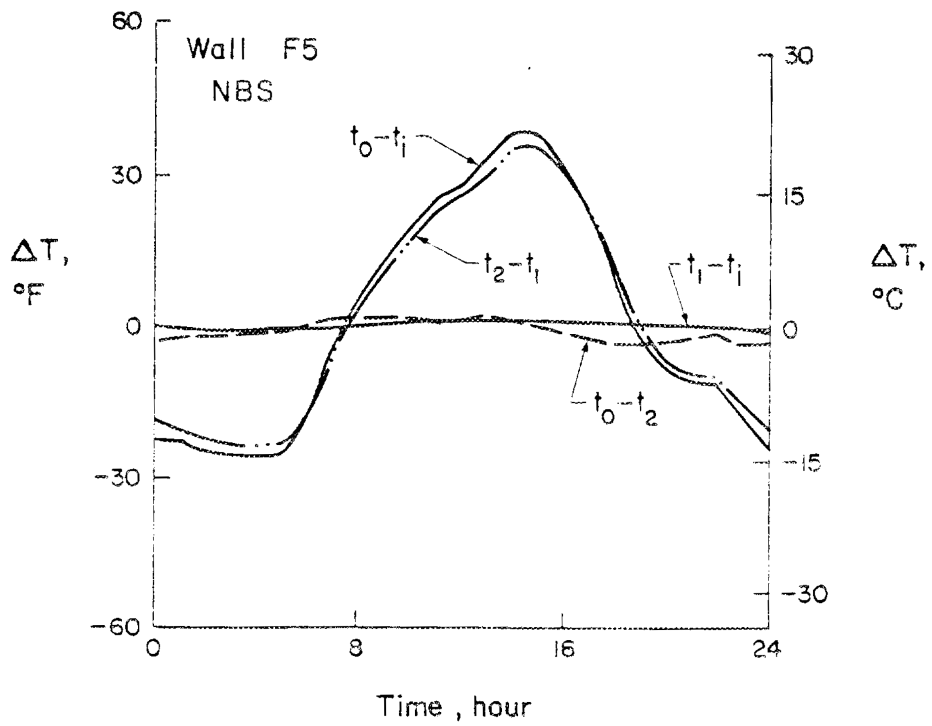
TABLE F5-4 - STEADY-STATE TEST RESULTS

Nominal Test Condition	q Heat Flux, Btu/hr·ft² (W/m²)	R_T, hr·ft²·°F/Btu (m²·K/W)	U, Btu/hr·ft²·°F (W/m²·K)	Measured Temperatures, °F (°C)					Relative Humidity		Laboratory Air Temperature	
				t_o Outdoor Air	t_2 Outdoor Surface	t_3* Internal	t_1 Indoor Surface	t_i Indoor Air	Indoor Chamber, %	Outdoor Chamber, %	Max. °F (°C)	Min. °F (°C)
t_m = 102°F (39°C)	5.68 (17.94)	10.04 (1.77)	0.10 (0.57)	130 (54)	128 (54)	-	76 (25)	74 (23)	33	**	74 (23)	72 (22)
t_m = 38°F (3°C)	-5.94 (-18.74)	11.98 (2.11)	0.08 (0.47)	2 (-17)	5 (-15)	-	71 (22)	73 (23)	29	**	74 (24)	70 (21)
Design Values	-	11.04 (1.94)	0.09 (0.52)	-	-	-	-	-	-	-	-	-

*Internal thermocouples were not used for this wall assembly.
**Outdoor chamber relative humidity was not measured for this wall assembly.

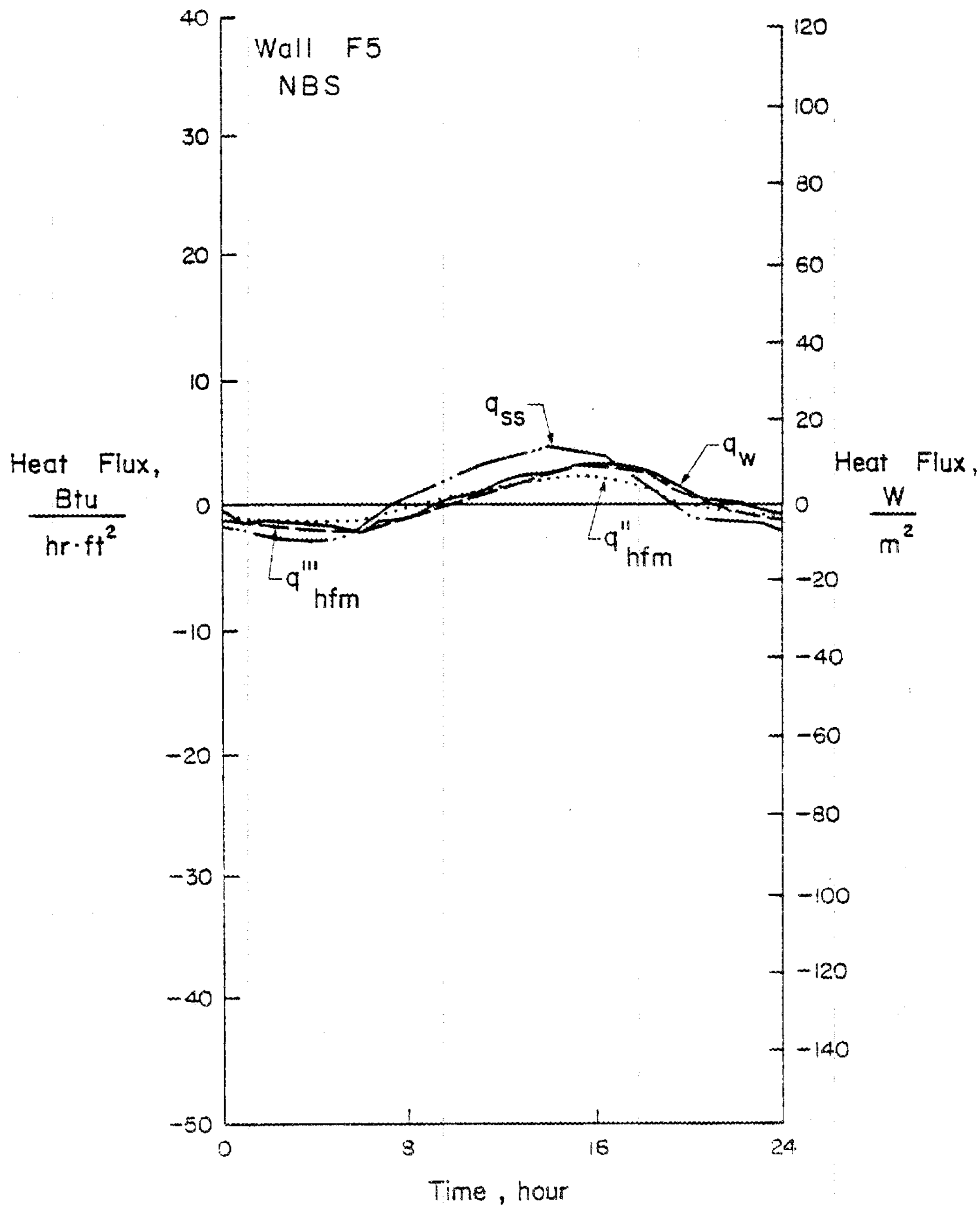


(a) Measured Temperatures



(b) Temperature Differentials

Fig. F5-2 Wall F5 Dynamic Test Results for NBS Test Cycle



(c) Heat Flux

Fig. F5-2 Wall F5 Dynamic Test Results for NBS Test Cycle

TABLE F5-7(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	49.8	51.7		72.9	73.1	-1.44	-1.26	-1.46		-2.06
2	47.7	49.8		72.9	73.1	-1.30	-1.40	-1.73		-2.24
3	46.8	48.6		72.8	73.1	-1.72	-1.45	-1.91		-2.34
4	46.7	48.4		72.7	73.1	-1.95	-1.51	-2.07		-2.35
5	47.4	48.8		72.7	73.1	-1.72	-1.53	-2.15		-2.31
6	56.7	55.3		72.8	73.1	-2.46	-1.38	-2.16		-1.71
7	70.7	68.6		73.1	73.1	-1.63	-0.80	-1.90		-0.45
8	80.0	78.1		73.5	73.3	-1.11	-0.06	-1.20		0.47
9	87.6	85.7		73.8	73.3	-0.14	0.48	-0.37		1.22
10	94.9	92.8		74.1	73.4	0.74	0.97	0.42		1.93
11	99.4	98.0		74.4	73.4	1.16	1.48	1.19		2.46
12	102.1	100.6		74.6	73.5	2.00	1.68	1.79		2.72
13	108.3	105.8		74.8	73.6	2.60	1.96	2.28		3.27
14	113.4	111.4		75.1	73.5	2.74	2.42	2.80		3.86
15	111.6	111.1		75.2	73.6	3.81	2.63	3.30		3.82
16	105.8	106.3		75.1	73.5	3.95	2.43	3.47		3.29
17	97.6	99.3		75.0	73.5	3.95	2.04	3.21		2.54
18	84.5	87.9		74.6	73.5	3.16	1.47	2.68		1.37
19	72.0	75.3		74.3	73.4	2.27	0.64	1.85		0.10
20	64.6	66.9		73.8	73.4	1.07	-0.09	0.83		-0.69
21	62.6	64.1		73.6	73.3	0.23	-0.45	0.05		-0.94
22	62.6	63.7		73.4	73.3	0.28	-0.58	-0.46		-0.96
23	56.7	59.6		73.3	73.2	-0.42	-0.66	-0.76		-1.35
24	50.9	53.3		73.1	73.2	-0.42	-1.06	-1.06		-1.93
Mean	75.9	76.3		73.8	73.3	0.57	0.25	0.28		0.32

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

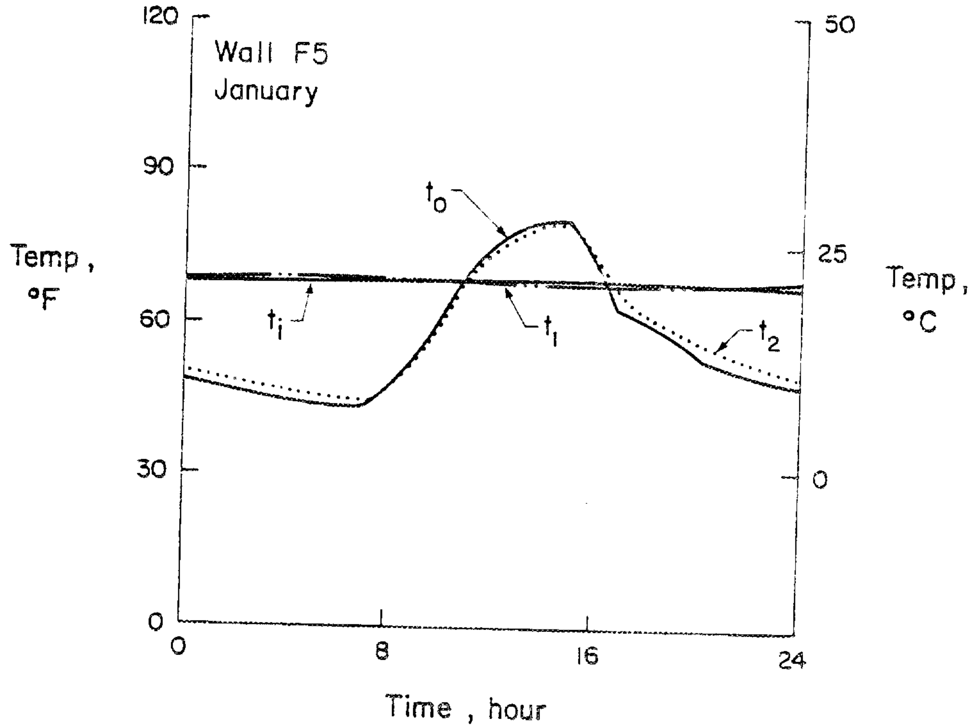
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 30%
Outdoor Chamber - Not measured for this wall assembly

Laboratory Air Temperature:
Max. - 74°F (23°C)
Min. - 71°F (22°C)

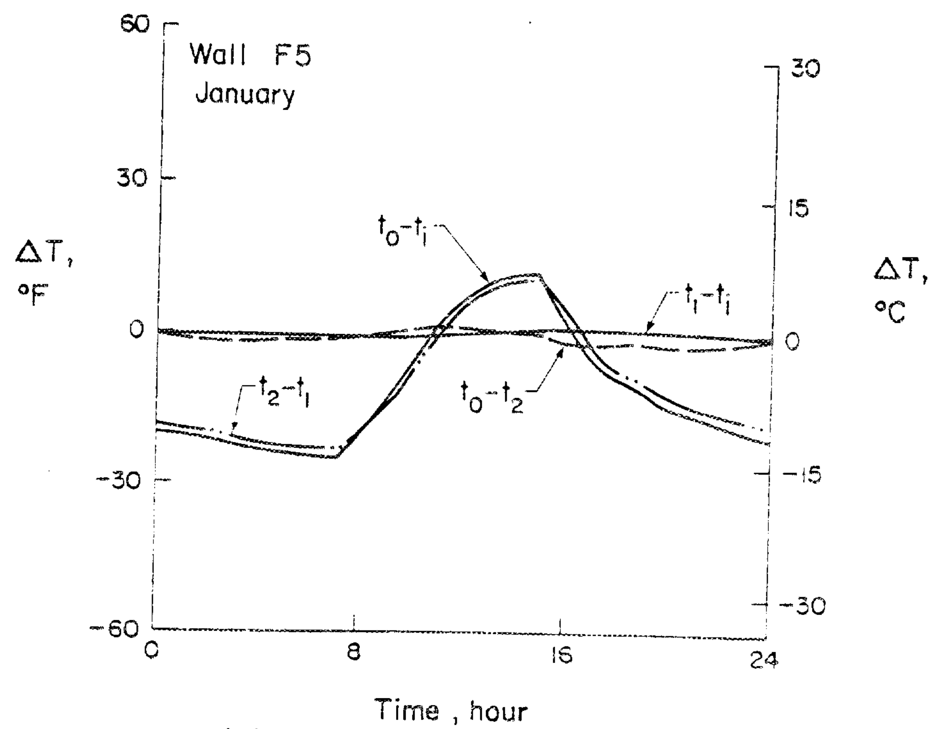
TABLE F5-7(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	9.9	10.9		22.7	22.8	-4.54	-3.98	-4.60		-6.50
2	8.7	9.9		22.7	22.8	-4.10	-4.41	-5.44		-7.06
3	8.2	9.2		22.7	22.8	-5.42	-4.58	-6.04		-7.38
4	8.2	9.1		22.6	22.8	-6.15	-4.75	-6.53		-7.41
5	8.6	9.3		22.6	22.8	-5.42	-4.82	-6.77		-7.29
6	13.7	12.9		22.7	22.8	-7.76	-4.36	-6.83		-5.39
7	21.5	20.3		22.8	22.8	-5.12	-2.52	-5.99		-1.41
8	26.7	25.6		23.1	22.9	-3.51	-0.20	-3.79		1.47
9	30.9	29.8		23.2	22.9	-0.44	1.51	-1.16		3.84
10	34.9	33.8		23.4	23.0	2.34	3.06	1.34		6.10
11	37.4	36.7		23.6	23.0	3.66	4.68	3.75		7.76
12	38.9	38.1		23.7	23.1	6.30	5.31	5.63		8.58
13	42.4	41.0		23.8	23.1	8.20	6.18	7.19		10.31
14	45.2	44.1		23.9	23.1	8.64	7.62	8.83		12.17
15	44.2	43.9		24.0	23.1	12.01	8.29	10.41		12.04
16	41.0	41.3		23.9	23.1	12.45	7.67	10.93		10.39
17	36.4	37.4		23.9	23.1	12.45	6.43	10.13		8.01
18	29.2	31.1		23.7	23.1	9.96	4.64	8.46		4.31
19	22.2	24.1		23.5	23.0	7.17	2.00	5.83		0.32
20	18.1	19.4		23.2	23.0	3.37	-0.30	2.62		-2.17
21	17.0	17.8		23.1	22.9	0.73	-1.43	0.17		-2.97
22	17.0	17.6		23.0	22.9	0.88	-1.84	-1.45		-3.03
23	13.7	15.3		22.9	22.9	-1.32	-2.07	-2.39		-4.25
24	10.5	11.8		22.8	22.9	-1.32	-3.33	-3.35		-6.08
Mean	24.4	24.6		23.2	23.0	1.79	0.78	0.87		1.02

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

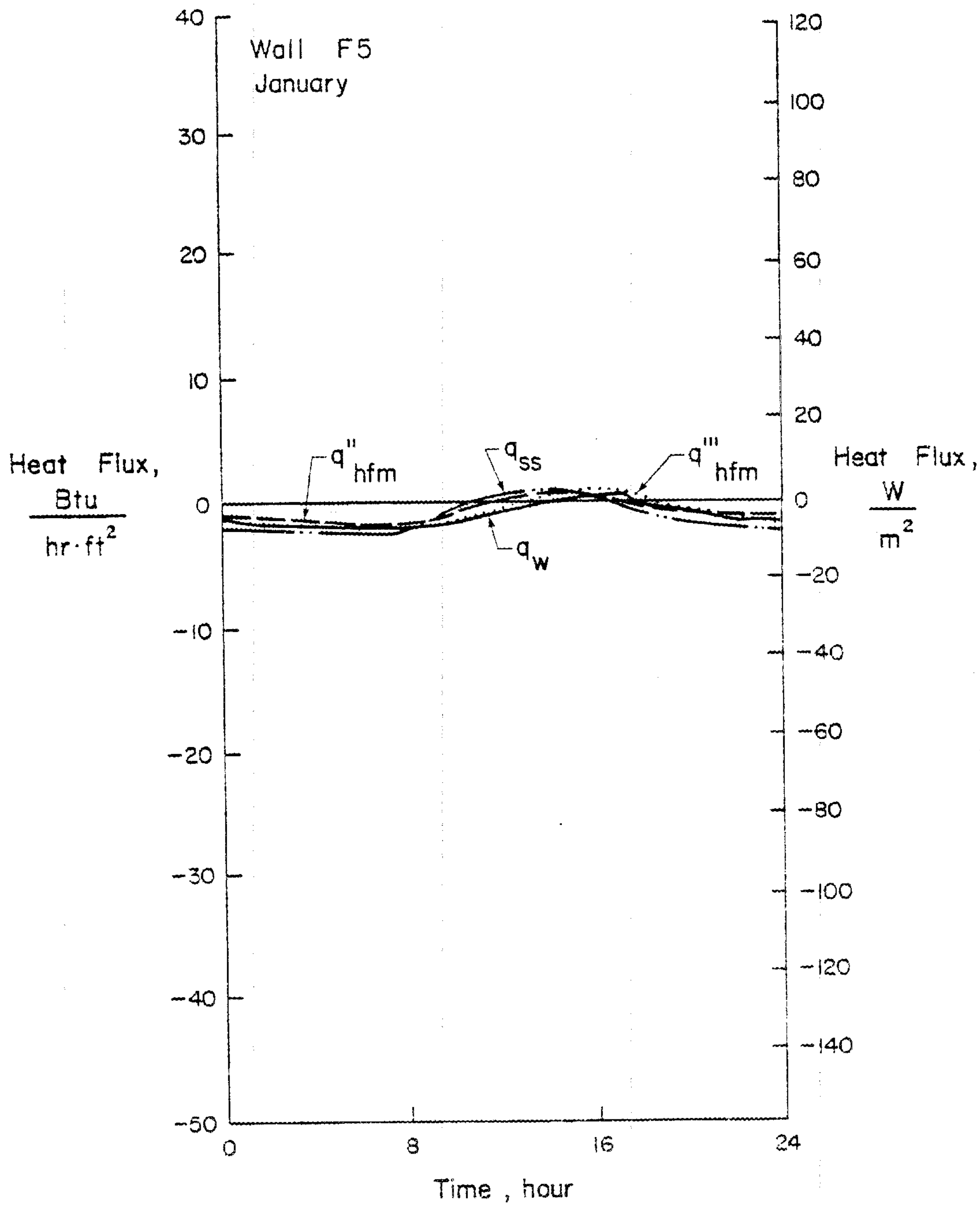


(a) Measured Temperatures



(b) Temperature Differentials

Fig. F5-3 Wall F5 Dynamic Test Results for Phoenix January Test Cycle



(c) Heat Flux

Fig. F5-3 Wall F5 Dynamic Test Results for Phoenix January Test Cycle

TABLE F5-8(a) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX JANUARY TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	$\dot{q}_{hfm}$ HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	47.6	49.2		68.1	68.3	-1.73	-1.14	-1.50		-1.82
2	46.7	48.4		68.1	68.3	-1.77	-1.19	-1.60		-1.89
3	45.2	47.1		68.0	68.3	-1.82	-1.25	-1.67		-2.00
4	44.3	46.0		68.0	68.3	-2.00	-1.32	-1.75		-2.10
5	43.9	45.5		67.9	68.3	-2.04	-1.35	-1.83		-2.14
6	43.3	45.0		67.9	68.3	-2.04	-1.40	-1.91		-2.19
7	43.1	44.7		67.9	68.3	-2.26	-1.42	-1.96		-2.21
8	48.4	48.5		67.9	68.3	-2.30	-1.36	-1.98		-1.86
9	54.3	54.2		68.0	68.3	-1.89	-1.07	-1.86		-1.34
10	62.4	61.3		68.2	68.3	-1.76	-0.72	-1.55		-0.68
11	70.8	69.5		68.5	68.4	-1.17	-0.25	-1.08		0.10
12	76.1	75.3		68.8	68.4	-0.62	0.21	-0.48		0.65
13	78.8	78.3		69.0	68.5	-0.07	0.52	0.11		0.93
14	80.9	80.5		69.2	68.5	0.35	0.70	0.55		1.14
15	80.8	81.1		69.3	68.5	0.52	0.82	0.87		1.19
16	72.7	75.0		69.2	68.5	0.70	0.70	1.01		0.58
17	63.7	66.4		69.0	68.5	0.51	0.22	0.80		-0.26
18	59.9	61.7		68.8	68.4	-0.14	-0.23	0.34		-0.70
19	57.5	59.2		68.6	68.4	-0.40	-0.45	-0.13		-0.92
20	54.2	56.2		68.5	68.4	-0.59	-0.65	-0.49		-1.20
21	52.1	53.8		68.3	68.4	-1.08	-0.81	-0.80		-1.40
22	50.4	52.1		68.2	68.3	-1.31	-0.93	-1.05		-1.55
23	49.3	50.9		68.2	68.4	-1.26	-1.03	-1.25		-1.67
24	48.2	49.8		68.1	68.4	-1.35	-1.11	-1.40		-1.76
Mean	57.3	58.3		68.4	68.4	-1.06	-0.60	-0.86		-0.96

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

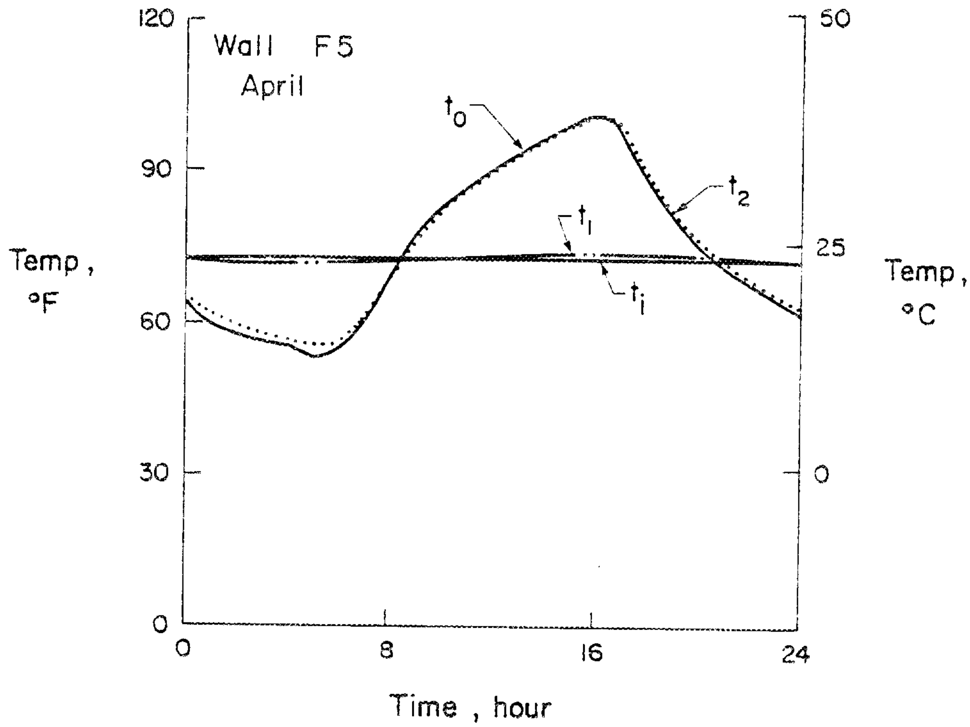
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 33%
Outdoor Chamber - Not measured for this wall assembly

Laboratory Air Temperature:
Max. - 73°F (23°C)
Min. - 71°F (22°C)

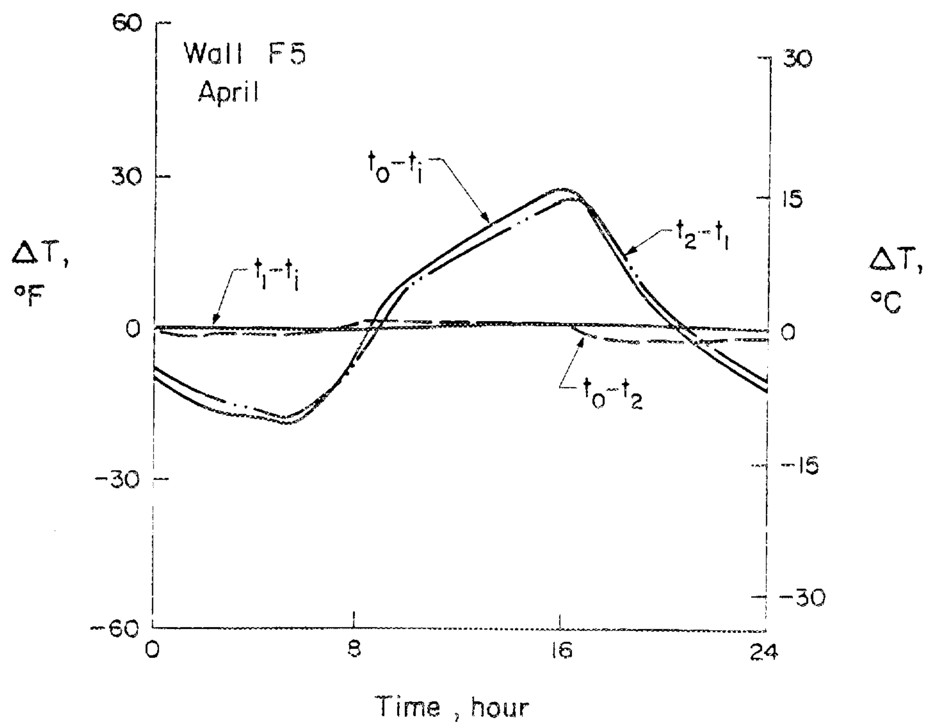
TABLE F5-8(b) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX JANUARY TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	8.7	9.6		20.1	20.2	-5.46	-3.60	-4.73		-5.73
2	8.2	9.1		20.1	20.2	-5.59	-3.76	-5.05		-5.96
3	7.3	8.4		20.0	20.2	-5.73	-3.94	-5.27		-6.31
4	6.8	7.8		20.0	20.2	-6.30	-4.16	-5.53		-6.63
5	6.6	7.5		19.9	20.2	-6.43	-4.27	-5.78		-6.75
6	6.3	7.2		19.9	20.2	-6.43	-4.41	-6.02		-6.89
7	6.2	7.1		19.9	20.2	-7.13	-4.47	-6.18		-6.98
8	9.1	9.2		19.9	20.2	-7.26	-4.28	-6.25		-5.87
9	12.4	12.3		20.0	20.2	-5.98	-3.38	-5.85		-4.21
10	16.9	16.3		20.1	20.2	-5.57	-2.28	-4.90		-2.13
11	21.6	20.8		20.3	20.2	-3.68	-0.80	-3.42		0.31
12	24.5	24.1		20.4	20.2	-1.95	0.65	-1.51		2.05
13	26.0	25.7		20.6	20.3	-0.21	1.64	0.36		2.95
14	27.2	26.9		20.7	20.3	1.10	2.22	1.75		3.59
15	27.1	27.3		20.7	20.3	1.64	2.60	2.76		3.76
16	22.6	23.9		20.7	20.3	2.19	2.20	3.18		1.83
17	17.6	19.1		20.6	20.3	1.62	0.68	2.53		-0.81
18	15.5	16.5		20.4	20.2	-0.43	-0.72	1.08		-2.19
19	14.2	15.1		20.3	20.2	-1.28	-1.42	-0.42		-2.89
20	12.3	13.4		20.3	20.2	-1.85	-2.05	-1.55		-3.77
21	11.2	12.1		20.2	20.2	-3.41	-2.57	-2.51		-4.43
22	10.2	11.2		20.1	20.2	-4.14	-2.92	-3.32		-4.90
23	9.6	10.5		20.1	20.2	-3.98	-3.24	-3.93		-5.26
24	9.0	9.9		20.1	20.2	-4.26	-3.50	-4.42		-5.55
Mean	14.0	14.6		20.2	20.2	-3.35	-1.91	-2.71		-3.03

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

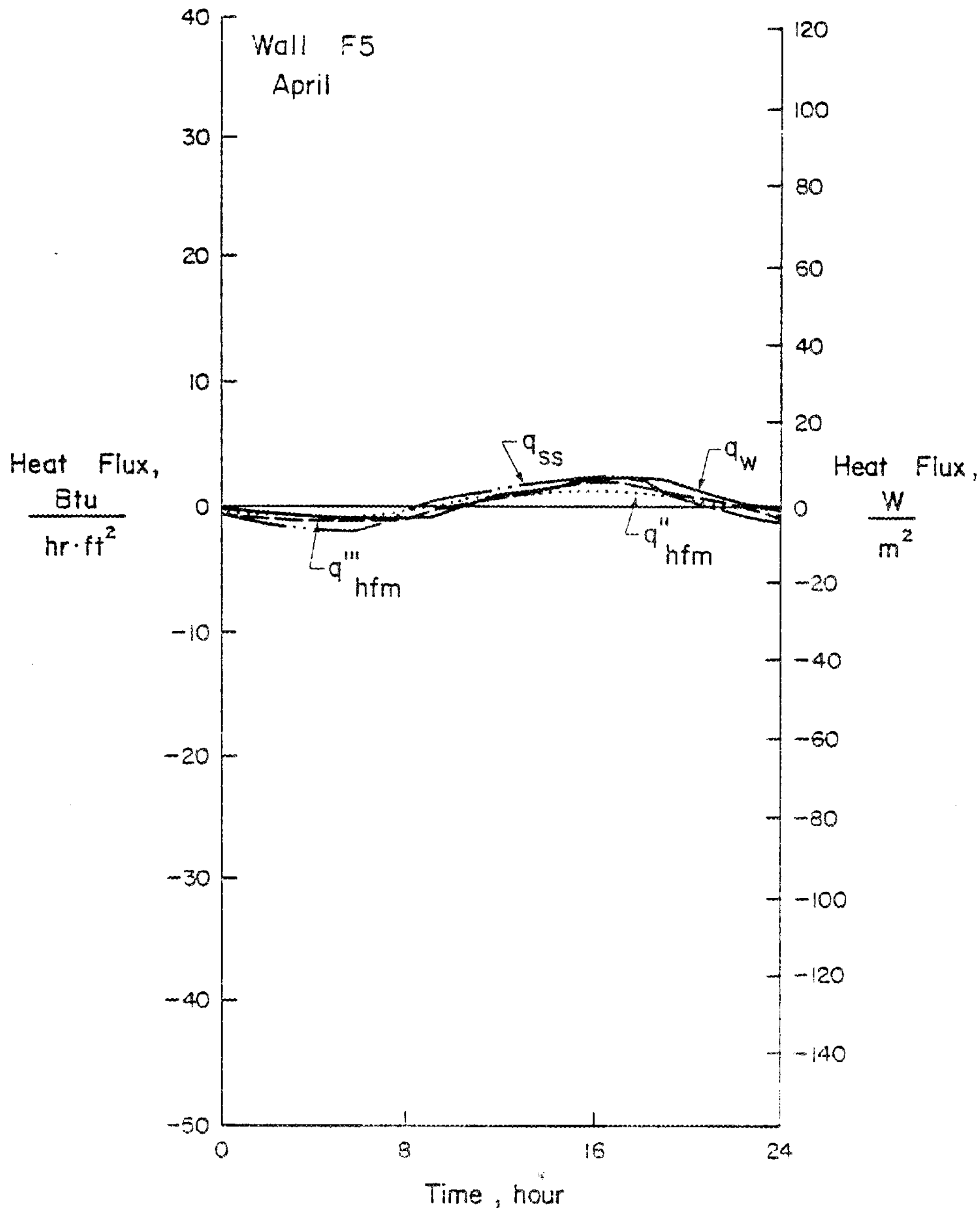


(a) Measured Temperatures



(b) Temperature Differentials

Fig. F5-4 Wall F5 Dynamic Test Results for Phoenix April Test Cycle



(c) Heat Flux

Fig. F5-4 Wall F5 Dynamic Test Results for Phoenix April Test Cycle

TABLE F5-9(a) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX APRIL TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	59.7	61.8		73.4	73.4	-0.17	-0.62	-0.63		-1.15
2	57.6	59.3		73.3	73.4	-0.34	-0.76	-0.87		-1.38
3	56.3	57.8		73.2	73.3	-0.86	-0.90	-1.09		-1.51
4	55.2	56.8		73.2	73.3	-0.81	-0.99	-1.28		-1.61
5	53.6	55.2		73.1	73.3	-1.32	-1.06	-1.41		-1.75
6	56.3	56.8		73.1	73.3	-1.27	-1.11	-1.53		-1.60
7	60.7	61.0		73.2	73.3	-1.64	-0.92	-1.53		-1.20
8	69.7	68.2		73.4	73.4	-1.08	-0.63	-1.34		-0.52
9	78.6	77.1		73.6	73.4	-0.71	-0.10	-0.90		0.35
10	84.4	83.3		73.9	73.5	-0.06	0.38	-0.31		0.96
11	87.8	86.9		74.1	73.5	0.63	0.73	0.31		1.31
12	90.9	89.9		74.3	73.5	1.00	0.96	0.81		1.61
13	94.5	93.3		74.5	73.6	1.45	1.16	1.19		1.95
14	97.2	96.2		74.6	73.6	1.82	1.39	1.55		2.25
15	99.8	98.4		74.7	73.5	2.23	1.56	1.86		2.47
16	102.8	101.5		74.9	73.7	2.59	1.76	2.13		2.79
17	100.5	100.8		74.9	73.7	3.06	1.88	2.39		2.71
18	91.8	93.6		74.8	73.6	2.83	1.64	2.39		1.95
19	82.8	85.1		74.5	73.6	2.59	1.12	2.05		1.08
20	77.0	78.8		74.3	73.5	1.75	0.62	1.49		0.46
21	72.2	74.0		74.1	73.5	1.39	0.25	0.91		-0.01
22	68.6	70.2		73.9	73.4	0.78	-0.03	0.42		-0.37
23	65.8	67.4		73.7	73.4	0.46	-0.25	0.00		-0.63
24	62.9	64.5		73.6	73.4	0.09	-0.43	-0.33		-0.90
Mean	76.1	76.6		73.9	73.5	0.60	0.24	0.26		0.30

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

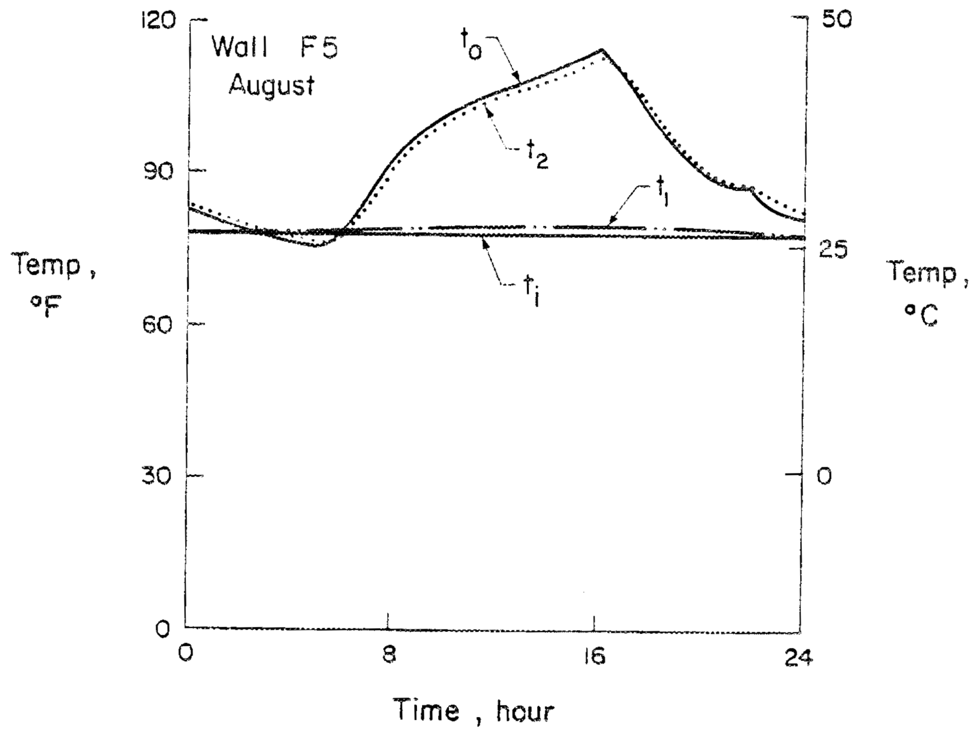
Calibrated Hot Box Relative Humidity:
Indoor Chamber - 30%
Outdoor Chamber - Not measured for this wall assembly

Laboratory Air Temperature:
Max. - 74°F (23°C)
Min. - 72°F (22°C)

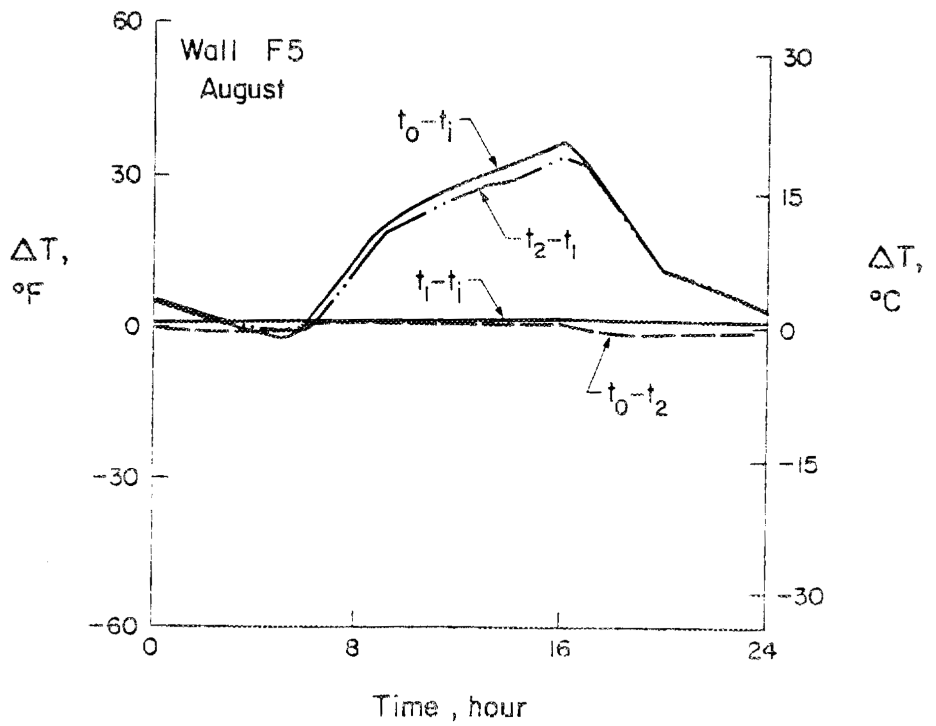
TABLE F5-9(b) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX APRIL TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}'' HFM @ Stud	q_{hfm}''' HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	15.4	16.6		23.0	23.0	-0.53	-1.97	-1.99		-3.61
2	14.2	15.2		22.9	23.0	-1.07	-2.41	-2.74		-4.34
3	13.5	14.3		22.9	22.9	-2.73	-2.84	-3.45		-4.76
4	12.9	13.8		22.9	22.9	-2.57	-3.12	-4.03		-5.07
5	12.0	12.9		22.8	22.9	-4.18	-3.34	-4.45		-5.52
6	13.5	13.8		22.8	22.9	-4.01	-3.49	-4.83		-5.03
7	15.9	16.1		22.9	22.9	-5.19	-2.90	-4.81		-3.79
8	20.9	20.1		23.0	23.0	-3.41	-1.99	-4.23		-1.63
9	25.9	25.1		23.1	23.0	-2.24	-0.32	-2.85		1.12
10	29.1	28.5		23.3	23.1	-0.19	1.20	-0.97		3.02
11	31.0	30.5		23.4	23.1	1.99	2.29	0.97		4.14
12	32.7	32.2		23.5	23.1	3.14	3.02	2.55		5.07
13	34.7	34.1		23.6	23.1	4.57	3.67	3.75		6.14
14	36.2	35.7		23.7	23.1	5.74	4.38	4.89		7.09
15	37.7	36.9		23.7	23.1	7.02	4.93	5.85		7.80
16	39.3	38.6		23.8	23.2	8.18	5.55	6.72		8.79
17	38.1	38.2		23.8	23.2	9.65	5.93	7.54		8.55
18	33.2	34.2		23.8	23.1	8.91	5.17	7.53		6.15
19	28.2	29.5		23.6	23.1	8.17	3.54	6.47		3.42
20	25.0	26.0		23.5	23.1	5.53	1.97	4.69		1.44
21	22.3	23.3		23.4	23.1	4.37	0.79	2.86		-0.03
22	20.3	21.2		23.3	23.0	2.47	-0.08	1.32		-1.17
23	18.8	19.7		23.2	23.0	1.45	-0.79	0.00		-1.98
24	17.2	18.1		23.1	23.0	0.28	-1.36	-1.06		-2.85
Mean	24.5	24.8		23.3	23.0	1.89	0.74	0.82		0.96

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

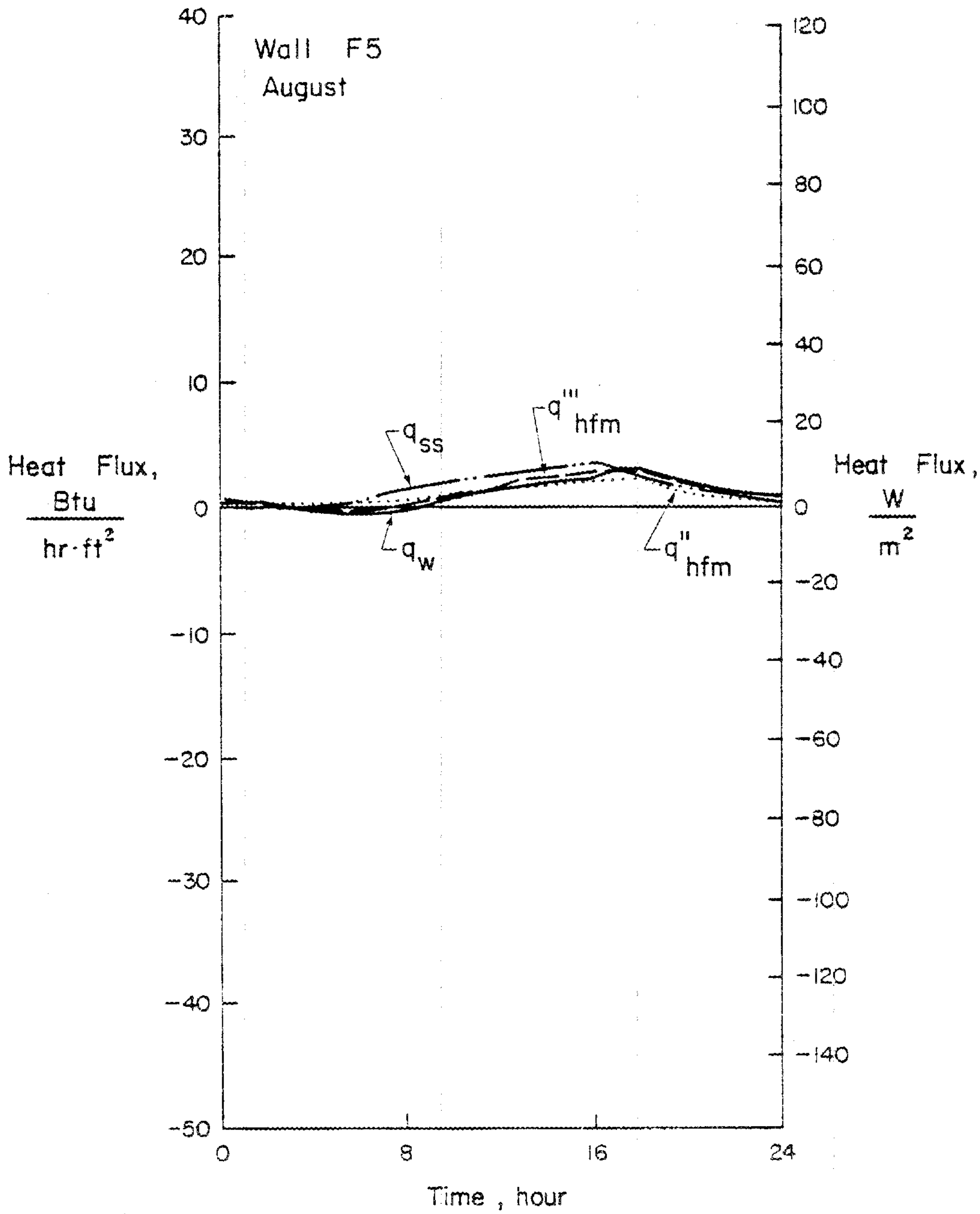


(a) Measured Temperatures



(b) Temperature Differentials

Fig. F5-5 Wall F5 Dynamic Test Results for Phoenix August Test Cycle



(c) Heat Flux

Fig. F5-5 Wall F5 Dynamic Test Results for Phoenix August Test Cycle

TABLE F5-10(a) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX AUGUST TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	80.9	81.9		78.6	78.1	0.38	0.29	0.48		0.34
2	79.4	80.4		78.6	78.1	0.34	0.20	0.32		0.18
3	78.0	79.0		78.5	78.1	-0.02	0.09	0.18		0.05
4	77.0	77.9		78.5	78.1	-0.25	0.02	0.05		-0.06
5	75.8	76.8		78.4	78.1	-0.48	-0.05	-0.06		-0.16
6	78.3	78.1		78.4	78.2	-0.66	-0.08	-0.17		-0.03
7	85.9	84.3		78.6	78.2	-0.66	0.12	-0.12		0.59
8	93.7	91.9		78.8	78.2	-0.28	0.57	0.21		1.36
9	99.0	97.6		79.1	78.2	0.27	1.03	0.75		1.94
10	102.1	100.9		79.2	78.3	1.05	1.32	1.39		2.29
11	104.5	103.5		79.3	78.3	1.37	1.54	1.73		2.56
12	106.5	105.4		79.5	78.3	1.55	1.71	2.05		2.75
13	108.6	107.5		79.6	78.3	1.92	1.86	2.32		2.97
14	110.4	109.2		79.7	78.3	2.41	1.99	2.55		3.15
15	113.2	111.6		79.8	78.3	2.49	2.15	2.76		3.40
16	115.6	114.2		79.9	78.4	2.68	2.36	2.99		3.69
17	112.0	112.2		80.0	78.3	3.61	2.43	3.27		3.45
18	104.0	105.4		79.7	78.3	3.33	2.09	3.15		2.73
19	96.5	98.1		79.5	78.3	2.77	1.61	2.68		1.95
20	91.1	92.3		79.3	78.2	1.93	1.16	2.11		1.35
21	88.4	89.2		79.1	78.2	1.38	0.84	1.55		1.05
22	86.7	87.5		78.9	78.2	1.01	0.68	1.17		0.89
23	84.4	85.3		78.9	78.2	0.88	0.53	0.88		0.66
24	82.6	83.5		78.8	78.2	0.42	0.41	0.65		0.48
Mean	93.9	93.9		79.1	78.2	1.14	1.04	1.37		1.57

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

Calibrated Hot Box Relative Humidity:
Indoor Chamber - 31%
Outdoor Chamber - Not measured for this wall assembly

Laboratory Air Temperature:
Max. - 73°F (23°C)
Min. - 71°F (21°C)

TABLE F5-10(b) - DYNAMIC TEST RESULTS (PERIODIC), PHOENIX AUGUST TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q''_{hfm} HFM @ Stud	q'''_{hfm} HFM Between Studs	q_{rf}** Response Factor	q_{ss} Steady-State
1	27.2	27.7		25.9	25.6	1.21	0.93	1.50		1.07
2	26.3	26.9		25.9	25.6	1.08	0.62	1.02		0.58
3	25.6	26.1		25.8	25.6	-0.07	0.29	0.56		0.16
4	25.0	25.5		25.8	25.6	-0.78	0.07	0.16		-0.19
5	24.3	24.9		25.8	25.6	-1.52	-0.16	-0.20		-0.51
6	25.7	25.6		25.8	25.7	-2.09	-0.25	-0.53		-0.10
7	29.9	29.1		25.9	25.7	-2.07	0.39	-0.39		1.85
8	34.3	33.3		26.0	25.7	-0.89	1.81	0.67		4.30
9	37.2	36.4		26.2	25.7	0.86	3.24	2.36		6.12
10	38.9	38.3		26.2	25.7	3.32	4.18	4.40		7.21
11	40.3	39.7		26.3	25.7	4.31	4.86	5.47		8.07
12	41.4	40.8		26.4	25.7	4.88	5.40	6.46		8.67
13	42.6	41.9		26.4	25.7	6.04	5.88	7.32		9.36
14	43.6	42.9		26.5	25.7	7.61	6.29	8.03		9.93
15	45.1	44.2		26.6	25.7	7.86	6.77	8.69		10.74
16	46.4	45.7		26.6	25.8	8.44	7.46	9.44		11.62
17	44.4	44.6		26.7	25.7	11.38	7.67	10.31		10.88
18	40.0	40.8		26.5	25.7	10.51	6.58	9.92		8.60
19	35.8	36.7		26.4	25.7	8.73	5.06	8.46		6.16
20	32.8	33.5		26.3	25.7	6.10	3.67	6.65		4.27
21	31.3	31.8		26.2	25.7	4.36	2.66	4.90		3.30
22	30.4	30.8		26.1	25.7	3.20	2.15	3.69		2.80
23	29.1	29.6		26.1	25.7	2.79	1.66	2.77		2.08
24	28.1	28.6		26.0	25.7	1.34	1.30	2.06		1.52
Mean	34.4	34.4		26.2	25.7	3.61	3.27	4.32		4.94

*Internal thermocouples were not used for this wall assembly.
**Response factor analysis was not performed for this wall assembly.

TABLE F5-12 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), THERMAL LAG

Test Cycle	Thermal Lag, hrs												Calc. Time Constant, hrs
	Measured												
	Calibrated Hot Box					Heat Flow Meter @ Stud			Heat Flow Meter Between Studs				
	t_o vs t_1		q_{ss} vs q_w		Avg.	q_{ss} vs q''_{hfm}		Avg.	q_{ss} vs q'''_{hfm}		Avg.	
	@ Max.	@ Min.	@ Max.	@ Min.		@ Max.	@ Min.		@ Max.	@ Min.		
NBS	1	0.5	2.5	2.5	1.5	1	1	1	2	2	2	0.5
Phoenix January	0.5	0	1	1.5	0.5	0	0	0	1	1	1	0.5
Phoenix April	0.5	0.5	1	2	1	1	1	1	1.5	1.5	1.5	0.5
Phoenix August	1	0.5	1	1.5	1	1	1	1	1	1	1	0.5

TABLE F5-13 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), REDUCTION IN AMPLITUDE

Test Cycle	Reduction in Amplitude, %								
	Calibrated Hot Box			Heat Flow Meter @ Stud			Heat Flow Meter Between Studs		
	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.
NBS	5	-13	-4	33	33	33	10	9	10
Phoenix January	18	1	10	34	34	34	13	10	12
Phoenix April	1	-9	-4	34	34	34	14	13	14
Phoenix August	-17	-4	-11	34	35	35	10	10	10

TABLE F5-14 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), ENERGY REQUIREMENTS

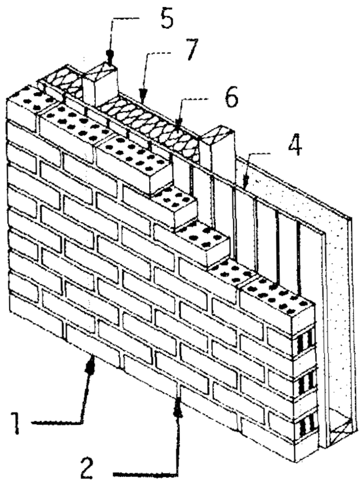
Test Cycle	Total Energy, Btu/ft^2 (W·hr/m^2)				Total Energy Comparisons, %			Net Energy, Btu/ft^2 (W·hr/m^2)				Net Energy Comparisons, %		
	Measured			Calc.				Measured			Calc.			
	q_w^T	$q_{hfm}^{T\,''}$	$q_{hfm}^{T\,'''}$	q_{ss}^T	$\frac{q_w^T}{q_{ss}^T}$	$\frac{q_{hfm}^{T\,''}}{q_{ss}^T}$	$\frac{q_{hfm}^{T\,'''}}{q_{ss}^T}$	q_w^N	$q_{hfm}^{N\,''}$	$q_{hfm}^{N\,'''}$	q_{ss}^N	$\frac{q_w^N}{q_{ss}^N}$	$\frac{q_{hfm}^{N\,''}}{q_{ss}^N}$	$\frac{q_{hfm}^{N\,'''}}{q_{ss}^N}$
NBS	42.3 (133.3)	30.4 (96.0)	41.1 (129.7)	46.4 (146.3)	91	66	89	13.7 (43.1)	6.0 (18.8)	6.6 (20.9)	7.7 (24.4)	178	78	86
Phoenix January	29.7 (93.6)	20.9 (65.8)	28.0 (88.2)	32.3 (101.8)	92	65	87	-25.5 (-80.5)	-14.5 (-45.8)	-20.6 (-65.0)	-23.1 (-72.9)	110	63	89
Phoenix April	30.9 (97.6)	21.3 (67.0)	28.7 (90.6)	32.5 (102.6)	95	66	88	14.4 (45.5)	5.7 (17.8)	6.3 (19.8)	7.3 (22.9)	197	78	86
Phoenix August	32.1 (101.4)	25.1 (79.3)	33.6 (106.0)	38.1 (120.1)	84	66	88	27.4 (86.6)	24.9 (78.5)	32.9 (103.8)	37.6 (118.6)	73	66	88

WALL V1: 10-IN. (254-MM) BRICK VENEER

DESCRIPTION: Wood frame with insulation between studs, gypsum wallboard on interior surface, and plywood cedar siding on exterior surface; with a clay brick veneer applied 1-in. (25-mm) from the cedar siding.

REFERENCE: Fiorato, A. E. and Cruz, C. R., "Thermal Performance of Masonry Walls," Research and Development Bulletin RD071, Portland Cement Association, Skokie, 1980, 17 pages.

COMPOSITION:



1. 4x2-1/2x8-in. (102x64x203-mm) Clay Brick - 10 cores per brick
2. Type M Mortar: one part portland cement, one-quarter part lime, and three parts masonry sand by volume
3. Corrugated Metal Ties
4. 5/8-in. (16-mm) Plywood Cedar Siding
5. 2x4-in. (51x102-mm) Wood Studs spaced 16 in. (406 mm) on centers
6. 3-1/2-in. (89-mm) R-11 Fiberglass Blanket Insulation faced with kraft paper
7. 1/2-in. (13-mm) Gypsum Wallboard painted

TABLE V1-1 - PHYSICAL PROPERTIES OF WALL AT TIME OF TEST

Property	Measured Value
Unit Weight, psf (kg/m^2)	45.1 (220)
Average Thickness, in. (mm)	9.2 (234)
Air Space Thickness, in. (mm)	1.0 (25)
Area*, ft^2 (m^2)	73.78 (6.85)
Moisture Content,** % by ovendry weight	1.8

*Area is average of brick and wood frame surface areas.
**Measured on masonry, including mortar joints, after test.

TABLE VI-2 - MATERIAL PROPERTIES, CLAY BRICK

Property	Test Method	Specimen Condition	Mean Temperature, °F (°C)	Measured Value
Standard Dimensions, in. (mm)	--	--	--	3-3/4x2-1/4x8 (95x57x203)
Measured Dimensions, in. (mm)	ASTM C67	--	--	--
Percent Solid Volume	--	--	--	75
Ovendry Unit Weight, pcf (kg/m^3)	--	--	--	151 (2419)
Moisture Content, % ovendry weight	ASTM C67	--	--	0
Absorption, % ovendry weight	ASTM C67	--	--	1.8

TABLE VI-3 - DESIGN HEAT TRANSMISSION COEFFICIENTS

Component	R, Thermal Resistance hr·ft²·°F/Btu (m²·K/W)
1. Outside Air Film	0.17 (0.03)
2. 4x2-1/2x8-in. (102x64x203-mm) Clay Brick	0.44* (0.08)
3. 1-in. (25-mm) Air Space	0.97** (0.17)
4. Wood Stud Wall F3, adjusted for framing	10.51 (1.85)
5. Inside Air Film	0.68 (0.12)
Total R	12.77 (2.25)
Total U	0.08 (0.44)

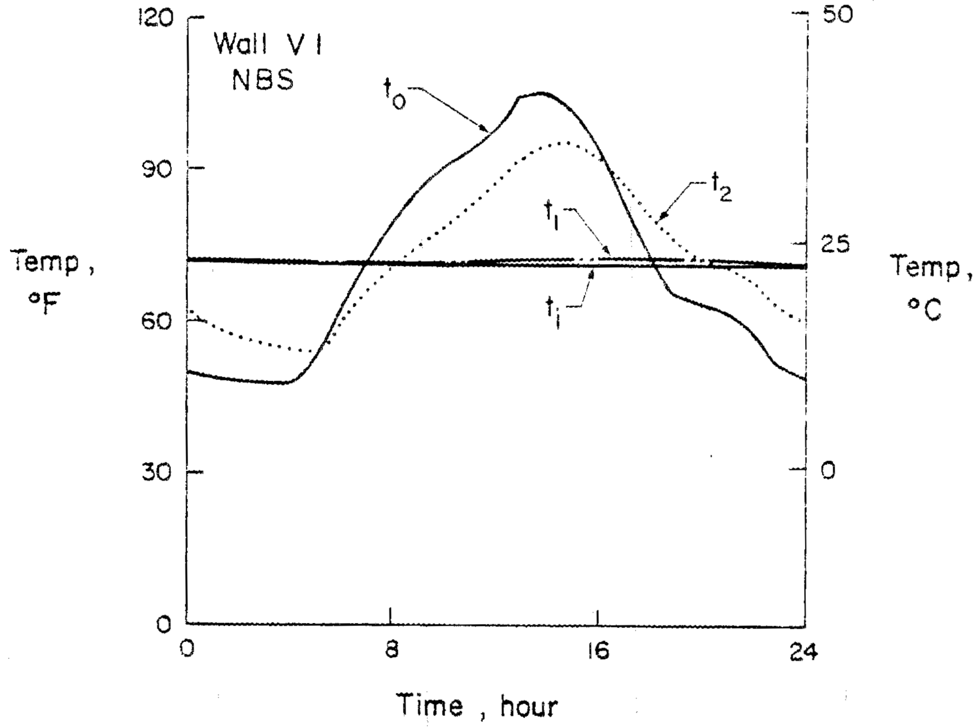
*Source: Heat Transmission Coefficients of Brick Masonry Walls, Technical Notes on Brick Construction No. 4, Brick Institute of America, McLean, Virginia, August/September 1974.

**Source: ASHRAE Handbook of Fundamentals, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., New York, 1977, Chapter 22.

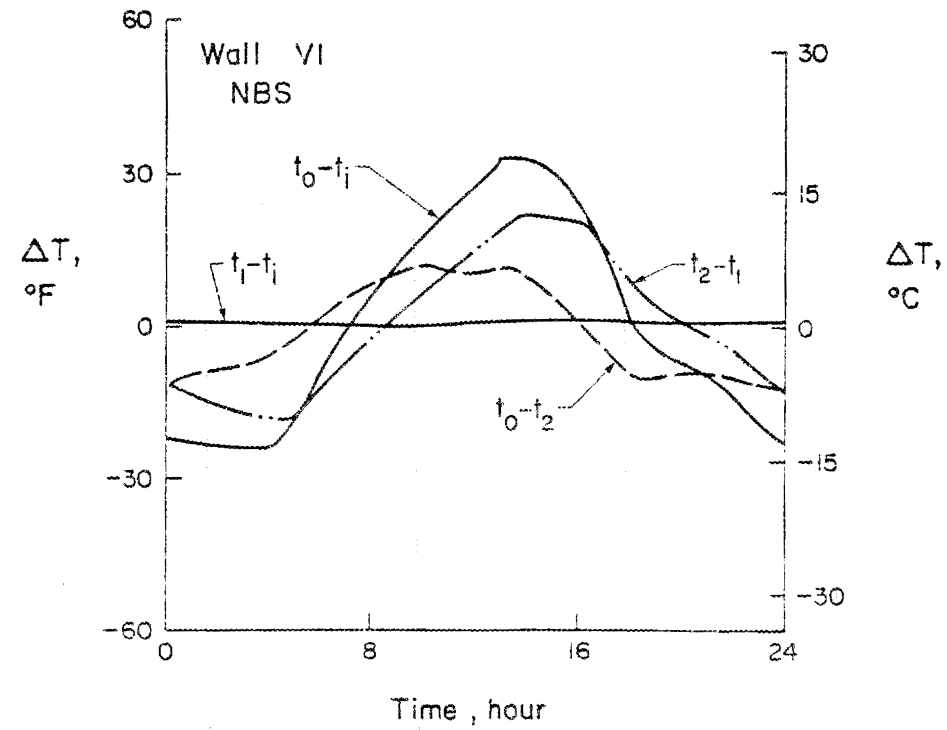
TABLE V1-4 - STEADY-STATE TEST RESULTS

Nominal Test Condition	q Heat Flux, Btu/hr·ft^2 (W/m^2)	R_T, hr·ft^2·°F/Btu (m^2·K/W)	U, Btu/hr·ft^2·°F (W/m^2·K)	Measured Temperatures, °F (°C)					Relative Humidity**		Laboratory Air Temperature	
				t_o Outdoor Air	t_2 Outdoor Surface	t_3* Internal	t_1 Indoor Surface	t_i Indoor Air	Indoor Chamber, %	Outdoor Chamber, %	Max. °F (°C)	Min. °F (°C)
t_m = 99°F (37°C)	3.7 (11.6)	14.29 (2.52)	0.07 (0.40)	125 (52)	123 (51)	-	74 (23)	72 (22)	-	-	78 (26)	78 (26)
t_m = 84°F (29°C)	1.4 (4.4)	16.32 (2.87)	0.06 (0.35)	95 (35)	95 (35)	-	74 (23)	72 (22)	-	-	79 (26)	78 (26)
t_m = 55°F (13°C)	-2.4 (-7.7)	13.86 (2.44)	0.07 (0.41)	37 (3)	39 (4)	-	71 (22)	71 (22)	-	-	78 (26)	76 (24)
t_m = 33°F (0°C)	-4.6 (-14.6)	16.96 (2.99)	0.06 (0.33)	-8 (-22)	-3 (-21)	-	70 (21)	71 (22)	-	-	82 (28)	81 (27)
Design Values	-	12.77 (2.25)	0.08 (0.44)	-	-	-	-	-	-	-	-	-

*Internal thermocouples were not used for this wall assembly.
**Relative humidity was not measured for this wall assembly.

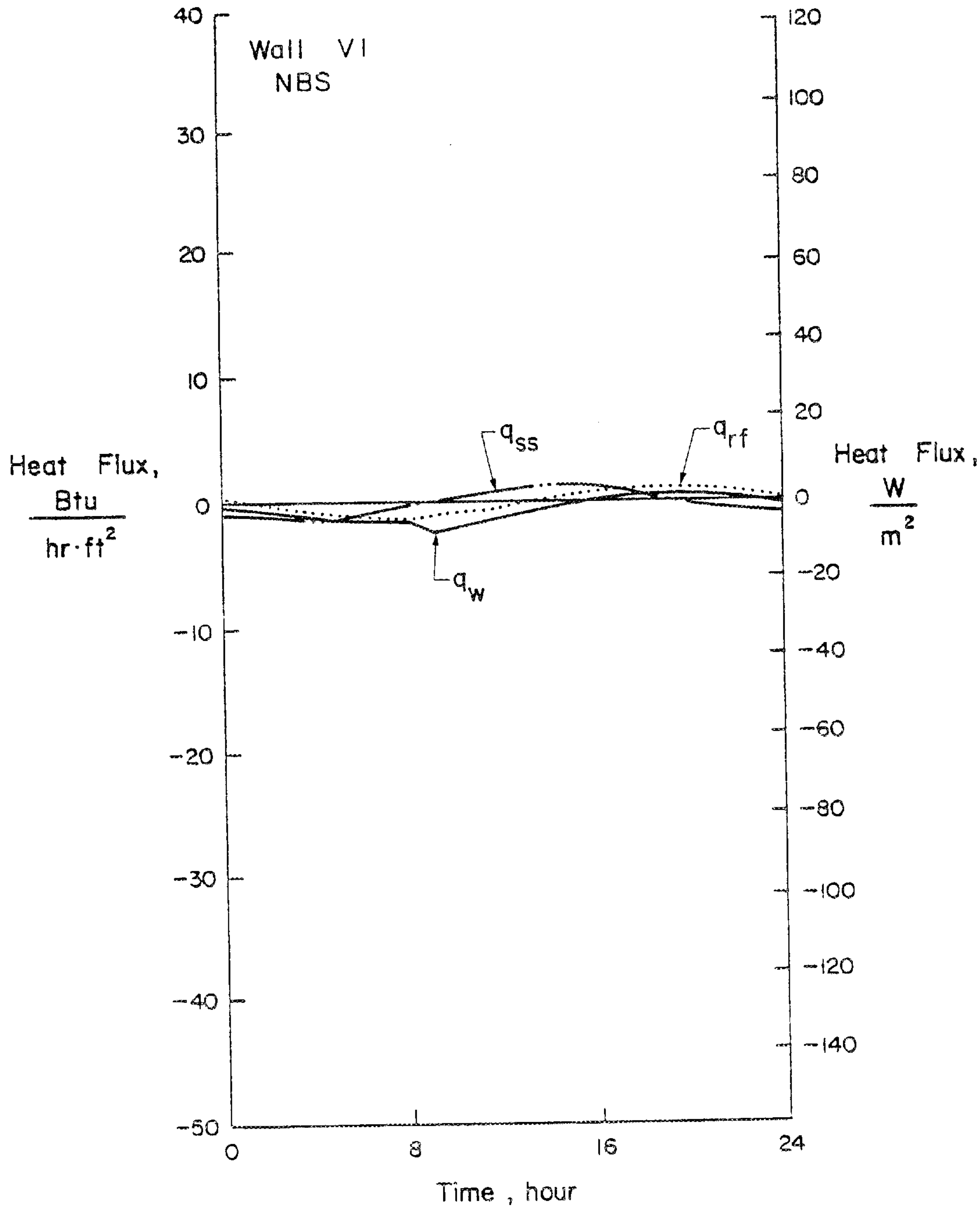


(a) Measured Temperatures



(b) Temperature Differentials

Fig. V1-2 Wall V1 Dynamic Test Results for NBS Test Cycle



(c) Heat Flux

Fig. V1-2 Wall V1 Dynamic Test Results for NBS Test Cycle

TABLE VI-7(a) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE

Time, hr	Measured Temperatures, °F					Measured Heat Flux, Btu/hr·ft^2			Calculated Heat Flux, Btu/hr·ft^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}* HFM @ Indoor Surf.	q'_{hfm}* HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
1	48.6	58.3		72.1	71.6	-0.37			0.06	-0.92
2	47.4	56.4		72.0	71.5	-0.56			-0.03	-1.04
3	47.3	55.1		71.7	71.6	-0.74			-0.44	-1.11
4	47.5	54.1		71.8	71.5	-1.06			-0.56	-1.18
5	52.1	54.3		71.7	71.2	-1.48			-0.61	-1.17
6	64.6	61.0		71.6	71.5	-1.34			-1.16	-0.71
7	71.7	65.5		71.6	71.5	-1.48			-1.00	-0.41
8	79.3	70.6		71.8	71.8	-1.48			-1.22	-0.08
9	85.2	74.6		71.6	71.6	-2.17			-0.84	0.20
10	91.1	79.5		71.6	71.3	-2.04			-0.52	0.53
11	94.6	83.4		71.8	71.6	-1.53			-0.60	0.78
12	98.9	87.3		71.9	71.6	-1.25			-0.22	1.03
13	105.9	92.8		72.0	71.7	-0.69			0.02	1.40
14	106.2	95.5		72.2	71.8	-0.46			0.29	1.56
15	102.6	95.5		72.3	71.8	-0.09			0.67	1.55
16	97.0	93.9		72.4	71.7	0.09			0.99	1.44
17	86.5	89.3		72.7	71.5	0.18			1.37	1.11
18	73.9	82.3		72.6	71.5	0.56			1.29	0.65
19	66.6	76.9		72.6	71.7	0.69			1.27	0.29
20	64.6	73.7		72.6	71.6	0.51			1.27	0.07
21	62.6	70.7		72.6	72.0	0.51			0.76	-0.13
22	58.9	68.5		72.5	71.9	0.51			0.86	-0.27
23	52.1	63.1		72.3	71.8	0.00			0.63	-0.62
24	49.1	60.5		72.1	71.5	-0.14			0.58	-0.78
Mean	73.1	73.4		72.1	71.6	-0.58			0.12	0.09

*Internal thermocouples and heat flow meters were not used on this wall assembly.
**Response factor values supplied by Ken Childs, ORNL. Values calculated using NBS Reponse Factor Program by Peavy.

Calibrated Hot Box Relative Humidity:
Indoor Chamber - Not measured for this wall assembly
Outdoor Chamber - Not measured for this wall assembly

Laboratory Air Temperature:
Max. - 81°F (27°C)
Min. - 63°F (17°C)

TABLE VI-7(b) - DYNAMIC TEST RESULTS (PERIODIC), NBS TEST CYCLE, SI UNITS

Time, hr	Measured Temperatures, °C					Measured Heat Flux, W/m^2			Calculated Heat Flux, W/m^2	
	t_o Outdoor Air	t_2 Outdoor Surf.	t_3* Internal	t_1 Indoor Surf.	t_i Indoor Air	q_w Calib. Hot Box	q_{hfm}* HFM @ Indoor Surf.	q'_{hfm}* HFM @ Outdoor Surf.	q_{rf}** Response Factor	q_{ss} Steady-State
1	9.2	14.6		22.3	22.0	-1.17			0.19	-2.90
2	8.6	13.6		22.2	21.9	-1.75			-0.09	-3.29
3	8.5	12.8		22.1	22.0	-2.34			-1.39	-3.51
4	8.6	12.3		22.1	21.9	-3.36			-1.77	-3.74
5	11.2	12.4		22.0	21.8	-4.67			-1.92	-3.67
6	18.1	16.1		22.0	21.9	-4.23			-3.66	-2.24
7	22.1	18.6		22.0	21.9	-4.67			-3.16	-1.28
8	26.3	21.4		22.1	22.1	-4.67			-3.85	-0.25
9	29.6	23.7		22.0	22.0	-6.86			-2.65	0.63
10	32.9	26.4		22.0	21.8	-6.42			-1.64	1.67
11	34.8	28.5		22.1	22.0	-4.82			-1.89	2.45
12	37.2	30.7		22.2	22.0	-3.94			-0.69	3.25
13	41.1	33.8		22.2	22.0	-2.19			0.06	4.40
14	41.2	35.3		22.3	22.1	-1.46			0.91	4.93
15	39.2	35.3		22.4	22.1	-0.29			2.11	4.89
16	36.1	34.4		22.4	22.1	0.29			3.12	4.53
17	30.3	31.8		22.6	21.9	0.58			4.32	3.51
18	23.3	27.9		22.6	22.0	1.75			4.07	2.04
19	19.2	24.9		22.6	22.0	2.19			4.01	0.90
20	18.1	23.1		22.5	22.0	1.61			4.01	0.23
21	17.0	21.5		22.6	22.2	1.61			2.40	-0.40
22	15.0	20.3		22.5	22.2	1.61			2.71	-0.85
23	11.2	17.3		22.4	22.1	0.00			1.99	-1.95
24	9.5	15.8		22.3	21.9	-0.44			1.83	-2.46
Mean	22.8	23.0		22.3	22.0	-1.82			0.38	0.29

*Internal thermocouples and heat flow meters were not used on this wall assembly.
**Response factor values supplied by Ken Childs, ORNL. Values calculated using NBS Response Factor Program by Peavy.

TABLE VI-12 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), THERMAL LAG

Test Cycle	Thermal Lag, hrs											Calc. Time Constant, hrs
	Measured								Calculated			
	Calibrated Hot Box					Heat Flow Meter*			Response Factor			
	t_o vs t_1		q_{ss} vs q_w		Avg.	q_{ss} vs q_{hfm}		Avg.	q_{ss} vs q_{rf}		Avg.	
	@ Max.	@ Min.	@ Max.	@ Min.		@ Max.	@ Min.		@ Max.	@ Min.		
NBS	3	3.5	4.5	5	4	-	-	-	2.5	3	3	1.7

*Heat flow meters were not used on this wall assembly.

TABLE VI-13 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), REDUCTION IN AMPLITUDE

Test Cycle	Measured, %						Calculated, %		
	Calibrated Hot Box			Heat Flow Meter*			Response Factor		
	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.	@ Max.	@ Min.	Avg.
NBS	14	-25	-6	-	-	-	15	-6	5

*Heat flow meters were not used on this wall assembly.

TABLE VI-14 - SUMMARY OF DYNAMIC TEST RESULTS (PERIODIC), ENERGY REQUIREMENTS

Test Cycle	Total Energy, Btu/ft^2 (W·hr/m^2)				Total Energy Comparisons, %			Net Energy, Btu/ft^2 (W·hr/m^2)				Net Energy Comparisons, %		
	Measured		Calculated					Measured		Calculated				
	q_w^T	q_{hfm}^T *	q_{rf}^T	q_{ss}^T	$\frac{q_w^T}{q_{ss}^T}$	$\frac{q_{hfm}^T}{q_{ss}^T}$	$\frac{q_{rf}^T}{q_{ss}^T}$	q_w^N	q_{hfm}^N *	q_{rf}^N	q_{ss}^N	$\frac{q_w^N}{q_{ss}^N}$	$\frac{q_{hfm}^N}{q_{ss}^N}$	$\frac{q_{rf}^N}{q_{ss}^N}$
NBS	19.9 (62.9)		17.3 (54.5)	19.0 (60.0)	105		91	-13.8 (-43.6)		2.9 (9.0)	2.2 (6.9)	-630		132

*Heat flow meters were not used on this wall assembly.