
AMERICAN NATIONAL STANDARD

**TEST METHOD FOR THERMAL
TRANSMITTANCE AND
AIR INFILTRATION OF GARAGE DOORS**

ANSI/DASMA 105-1992 (R2004)

Door & Access Systems Manufacturers' Association, International

Sponsor:



1300 Sumner Ave
Cleveland, Ohio 44115-2851

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and Air Infiltration of Garage Doors**

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American National Standard

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**DOOR & ACCESS SYSTEMS MANUFACTURERS'
ASSOCIATION, INTERNATIONAL**

1300 Sumner Avenue

Cleveland, OH 44115-2851

Phn: 216/241-7333

Fax: 216/241-0105

E-Mail: dasma@dasma.com

URL: www.dasma.com

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Suggestions for improvement of this standard will be welcome. They should be sent to the Door & Access Systems Manufacturers' Association, International.

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Foreword (This foreword is included for information only and is not part of ANSI/DASMA 105, *Test Method for Transmittance and Air Infiltration of Garage Doors.*)

This standard was originally developed by the Technical Committee of the National Association of Garage Door Manufacturers and was approved as an American National Standard with the designation ANSI/NAGDM 105 - 1992. The Door & Access Systems Manufacturers' Association, International, (DASMA) was formed through the consolidation of two associations that served the garage door and operator industries for many years, NAGDM and the Door Operator & Remote Control Manufacturers Association (DORCMA).

The Technical Committee of the DASMA Commercial & Residential Garage Door Division reviewed the standard and determined that it is current and applicable; therefore, the committee has reaffirmed and redesignated this standard. DASMA employed the canvass method to demonstrate consensus and to gain approval as an American National Standard. The ANSI Board of Standards Review reaffirmed approval as an American National Standard on October 27, 2004.

DASMA recognizes the need to periodically review and update this standard. Suggestions for improvement should be forwarded to the Door & Access Systems Manufacturers' Association, International, 1300 Sumner Avenue, Cleveland, Ohio, 44115-2851.

ANSI/DASMA 105-1992 (R2004)

AMERICAN NATIONAL STANDARD

Test Method for Thermal Transmittance and Air Infiltration of Garage Doors

1.0 SCOPE

1.1 The purpose of this test method is to measure the thermal characteristics of garage doors under steady state conditions. Specifically, the measurements and calculations made will yield the thermal transmittance (U) and the air infiltration rate.

1.2 In this test method, a perpendicular air flow is directed toward the exterior of the test specimen. Cold side exterior surface coefficients are controlled by adjusting the test apparatus to specific performance conditions using a standard calibration panel.

1.3 Similarly, natural convection is simulated on the interior of the test specimen by the combined effects of the downward flow of air over the face of the specimen due to natural convective currents. The warm side interior heating apparatus is adjusted so that the resulting inside film coefficients of the standard calibration panel are within the established calibration limits.

1.4 Prior to beginning the tests to determine thermal transmittance, a measurement is made to determine the air infiltration rate at test conditions. The results of thermal testing will not include the effects of heat loss due to air infiltration because the dynamic wind pressure of the exterior will be balanced to a zero differential pressure with a static air pressure on the interior, thereby intending to eliminate infiltration during testing.

1.5 The test facilities must conform to the calibration specifications contained herein to achieve reproducibility and comparability of results. However, the details of the test apparatus necessary to achieve these conditions may vary.

1.6 Those applying this test method shall be trained in the techniques of temperature measurement, shall understand the theory of heat flow, and shall have experience in thermal testing. Since it is undesirable to specify the construction of the test facility in such detail that it would unnecessarily restrict the method to a single arrangement, those applying the method shall have the technical competency to determine the accuracy and the operating variables of their respective test facilities.

2.0 APPLICABLE DOCUMENTS

2.1 ASTM Standard C168 - Standard Definitions Of Terms Relating To Thermal Insulating Materials. (Applicable definitions from C168 are included in the Appendix.)

2.2 ASTM Standard E283 - Standard Test Method For Rate Of Air Leakage Through Exterior Windows, Curtain Walls, And Doors.

2.3 ASHRAE - Handbook Of Fundamentals

3.0 SUMMARY OF METHOD

3.1 To determine the thermal transmittance (U) of any specimen, it is necessary to know the area (A), the heat flux (q), the elapsed time (t), and the temperature differential (ΔT). The heat flux and the temperature differential shall be determined under conditions of steady state heat transfer. The test chamber shall establish and maintain the desired steady state temperature difference across the test specimen for a period of time necessary to assure stabilization of heat transfer and to accurately measure the heat transferred for a specified time.

3.2 To determine the heat flux (q), a five-sided metering box is placed around a test wall. A basic principle of the test method is to maintain a zero temperature difference across the metering box wall. Adequate temperature controls and monitoring capabilities are essential. It is recognized that small temperature gradients could occur across the metering box walls due to the limitations of controllers and the effect of the convection currents adjacent to all surfaces of the metering box. Since the total wall area of the metering box is considerably larger than the metering area of the test specimen, small temperature gradients across the walls may cause a significant heat exchange to the metering box. For this reason, the metering box walls should be instrumented so that the heat flow through them can be calculated and a correction can be applied to the test results.

3.3 Moisture migration, condensation, and freezing on or within the specimen can cause variations in heat flow. To avoid this, the relative humidity in the warm room must be maintained at or below 30%.

3.4 Garage door test specimens have irregular surfaces and, therefore, do not have single inside and outside surface coefficients. The utilization of a calibration panel and the selection of, and adjustment to, representative surface coefficients provides the means by which dissimilar construction of the same general type can be compared under uniform test conditions, wherein the heat flux (q) is the only unknown.

3.5 The intent of this procedure is to measure the thermal transmittance of test samples exposed to the same conditions. It is not intended to create uniform surface coefficients on the test specimens. Since many constructions have recesses that are not symmetrical, the use of parallel or angular air flows on the cold side of the test specimen could affect thermal transmittance and, in turn, affect the test reproducibility. A perpendicular air flow on the cold side is specified and very closely defined. The warm side surface coefficient is intended to be representative of natural convection, which generates a downward air flow parallel to the plane of the specimen on the warm side.

3.6 During the thermal test, this procedure neutralizes the effect of air infiltration by balancing the dynamic wind loading on the cold side with a static air pressure on the warm side. Therefore, thermal transmittance does not include heat loss due to air infiltration.

3.7 It is important to achieve precise calibration of cold side and warm side surface coefficients to insure consistent and reproducible test results. A pressure difference across the test specimen and variations in the water vapor content of the warm side air can cause errors in measuring heat flow; these variables must be reduced or eliminated to insure a reproducible test method.

4.0 SIGNIFICANCE AND USE

4.1 This test method applies only to vertically oriented constructions and is intended specifically for full sized garage doors.

4.2 The thermal transmittance (U) can be used to compare different products of the same test size. Due to changes in the ratio of materials for different sized specimens having the same construction, the thermal transmittance will vary with test specimen size. Air infiltration rates are measured directly from the test specimen. For these reasons, this standard test method sets forth specific sizes and mountings for test specimens.

4.3 The outside surface coefficient is based on the ASHRAE 15 mph wind for winter design conditions. The inside surface coefficient is based on natural convection on a vertical surface. The tested U value does not include the effects of lower or higher average wind speeds. Consequently, the test value should be appropriately adjusted when used in estimating seasonal product performance.

4.4 The U value determined by tests at the standard test conditions can be used in estimating design loads for heating and cooling equipment of most low-rise residential buildings, since the surface coefficients are intended to be the same as those recommended in the ASHRAE method of calculating residential loads. Applicability of the tested U values to other building types should be determined by a competent engineer.

5.0 TERMINOLOGY

5.1 Thermal conductivity (k): The time rate of heat flow through unit area and unit thickness of a homogeneous material under steady state conditions when a unit temperature gradient is maintained in the direction perpendicular to the area. Materials are considered homogeneous when the value of the thermal conductivity is not affected by variation in the thickness or in the size of the sample within the range normally used in construction. It is calculated as follows:

$$k = qL/A(T_1 - T_2) \quad (1)$$

5.2 Thermal conductance (C): The time rate of heat flow through a body per unit area from one of its bounding surfaces to the other for a unit temperature difference between the two surfaces, under steady conditions. It is calculated as follows:

$$C = qL/A(T_1 - T_2) \quad (2)$$

5.3 Surface coefficients (h): The ratio of the steady-state heat exchange between the surface and its external surroundings to the temperature difference between the surface and its surroundings. It is expressed in terms of time rate of heat flow per unit area of a particular surface by the combined effects of radiation, conduction, and convection for a unit temperature difference between the surface and the air. Subscripts (i) and (o) are used to differentiate between inside and outside surface coefficients respectively. Surface coefficients are calculated as follows:

$$h_i = q/A(T_h - T_i) \quad (3)$$

$$h_o = q/A(T_2 - T_c) \quad (4)$$

5.4 Thermal transmittance (U): The time rate of heat flow per unit area under steady state conditions from the air on the warm side of a body to the air on the cold side, per unit temperature difference between the warm and cold air. It is calculated as follows:

$$U = q/A(T_h - T_c) \quad (5)$$

U is referred to as the overall coefficient of heat transfer.

5.5 Symbols: The symbols used in the foregoing and subsequent paragraphs have the following significance:

- k = thermal conductivity, Btu in / hr sqft °F
- C = thermal conductance, Btu / hr sqft °F
- U = thermal transmittance, Btu / hr sqft °F
- t = time, hours
- q = time rate of heat flow through area A, Btu / hr
- A = area of test frame opening normal to heat flow, sqft
- L = length of path of heat flow, in
- T_h = temperature of warm side air, °F
- T₁ = temperature of warm surface, °F
- T₂ = temperature of cold surface, °F
- T_c = temperature of cold side air, °F
- i = inside surface coefficient, Btu / hr sqft °F
- o = outside surface coefficient, Btu / hr sqft °F
- d_{rms} = root-mean-square deviation of warm side heat transfer coefficients
- h_{ave} = average calculated warm side of heat transfer coefficients for elevation; x_i, Btu / hr sqft °F
- x_i = location of thermocouple row per Figure 4
- h_{si} = base warm side heat transfer coefficients for elevation x_i, Btu / hr sqft °F

6.0 APPARATUS

6.1 The thermal test facility is intended to subject a test specimen to differential interior and exterior temperatures and to accurately measure the thermal transmittance, air infiltration rate, and surface temperatures of that specimen.

6.2 Construction details, energy metering instrumentation, and controls are the responsibility of the test laboratory.

6.3 When the test facility is used to conduct air infiltration tests in accordance with ASTM E-283, the cold and warm chambers shall be capable of withstanding internal and external pressures required by the test program. All joints, corners, and other openings shall be carefully and completely sealed.

6.4 Cold Chamber

6.4.1 A refrigeration unit and controls are required to automatically maintain a temperature of 18° F ± 0.5° F.

6.4.2 A means of generating a uniform air flow of 15 mph and 25 mph shall be provided on the cold side. Air flow shall be perpendicular to the exterior surface of the test specimen. Horizontal centerline of discharge plenum shall coincide with the geometric horizontal centerline of the test specimen to insure a uniform air flow centered on the specimen.

6.5 Warm Chamber

6.5.1 A heating device and controls are required to automatically maintain a temperature of 68° F ± 0.5° F or higher.

6.5.2 A system for controlling the humidity of the warm room air shall be provided. Relative humidity of the warm room shall not exceed 30% at any time during the test. A hygrometer for indicating the relative humidity is required. The instrument shall indicate relative humidity to within 1%.

6.6 Temperature Measuring Equipment

6.6.1 All thermocouples shall be fabricated from the same lot of premium grade 30 gauge copper constantan type T thermocouple wire.

6.6.2 The cold room air temperature shall be determined by a thermocouple junction surrounded by a radiation shield as detailed in Figure 1. It shall be located at the intersection of the vertical and horizontal centerlines and 3" measured perpendicular to the test specimen.

6.6.3 The warm room air temperature shall be determined by thermocouple junctions surrounded by radiation shields as detailed in Figure 1. The center thermocouple shall be located at the intersection of the vertical and horizontal centerlines of the test specimen. One thermocouple shall be located 36" directly above and another 36" directly below the center thermocouple. These three thermocouples must be movable to maintain a distance of 6" ± 1/8" measured perpendicular to the plane of the warm side of the test specimen shown in Figure 2.

6.6.4 The instrumentation shall indicate temperature readings of the thermocouples within 0.1° F.

6.7 Pressure Measuring Equipment

6.7.1 Cold room air pressure detection shall be accomplished by locating the total pressure sensing element of the Pitot tube at the center and 6" inside the discharge plenum as shown in Figure 2.

6.7.2 When the thermal test facility is used to conduct air infiltration tests, instrumentation shall be provided to measure the air leakage through the test sample within 5%. The pressure differential across the separating wall shall be measured within 0.002" H₂O.

6.7.3 The warm room air pressure detection shall be representative of overall room conditions and not located near any known sources of air movement.

7.0 CALIBRATION

7.1 The thermal test facility shall be calibrated with a standard calibration panel of known conductance, constructed as shown in Figure 3, to establish cold and warm side surface coefficients. The test facility shall be calibrated prior to initial testing and periodically, at least semiannually, thereafter. The facility shall also be recalibrated if changes or adjustments are made to the equipment or if test data appears questionable.

7.2 Warm (Interior) Side Film Coefficient Locations

7.2.1 As shown in Figure 4, a column of thermocouples is to be placed 6" from each side of the calibration panel. Additional columns of thermocouples shall be equally spaced, but no closer than 18" nor greater than 36" apart. The first horizontal row of thermocouples shall be 6" below the top of the calibration panel; additional rows shall be placed at 12" increments.

7.3 Cold (Exterior) Side Film Coefficient Locations

7.3.1 Thermocouples are to be placed on the cold (exterior) side of the calibration panel directly opposite the warm (interior) side thermocouples per 7.2.1.

7.4 Pressure Stabilization

7.4.1 The plenum discharge shall be positioned and adjusted such that the average of the 15 mph cold side coefficients (h_o) is within the tolerance specified.

7.4.2 The pressure differential between the warm and the cold rooms shall be 0.000 ± 0.002 " H₂O during the stabilization and calibration runs.

7.5 Thermal Stabilization

7.5.1 The calibration panel shall be used for thermal stabilization measurements. As herein defined, stabilization is achieved when the individual thermocouple readings, obtained in five consecutive observations thirty minutes \pm 0.5 minutes apart, are within 0.5° F at each individual location.

7.6 Calibration Procedure

7.6.1 For this test method, standard conditions are defined as:

Cold room temperature:	18° F \pm 0.5° F
Warm room temperature:	68° F \pm 0.5° F
Cold room air flow:	15 mph perpendicular
Warm room air flow:	natural convection
Pressure difference across calibration panel:	0.000 ± 0.002 " H ₂ O

7.6.2 The calibration test shall consist of five sets of temperature readings, spaced 30 ± 0.5 minutes apart, over a two hour period. Heat loss through the calibration panel during each 30 minute \pm 5 second period must be within \pm 2% of the final average. Individual thermocouple readings must not deviate more than 0.5° F from the average temperature at each location.

7.6.3 Cold side surface coefficients (h_o) shall be calculated for each of the test points from data taken during the calibration run as follows:

$$h_o = 0.908 (T_1 - T_2) / (T_2 - T_c)$$

Where 0.908 = Conductance of the glass calibration panel assembly in Figure 3:

T_1 = Warm side surface temperature, °F
 T_2 = Cold side surface temperature, °F
 T_c = Cold side air temperature, °F

Average the heat transfer coefficients (h_o) at each location. The mean value of the averaged heat transfer coefficients shall be 5.8 ± 0.4 and the standard deviation shall not exceed 1.4.

7.6.4 Warm side surface coefficients (h_i) shall be calculated for each of the test points from data taken during the calibration run as follows:

$$h_i = 0.908 (T_1 - T_2) / (T_h - T_1)$$

Where 0.908 = Conductance of the glass calibration panel assembly in Figure 3:

T_1 = Warm side surface temperature, °F
 T_2 = Cold side surface temperature, °F
 T_h = Warm side air temperature, °F

Average the warm side heat transfer coefficients (h_i) at each location. These averaged coefficients are satisfactory if their standard deviation d_{rms} is less than 0.15 where:

$$d_{rms} = \sqrt{\frac{\sum_{i=1, \dots, n} (h_{ave} - h_{si})^2}{n}}$$

When:

n = number of rows
h = base warm side heat transfer coefficients
for elevation x as indicated in the
following chart:

x_i	h_{si} (BTU / HR SQ.FT. °F)
1	1.75
2	1.40
3	1.37
4	1.35
5	1.32
6	1.30
7	1.20

7.6.5 During the calibration test, the heat loss through the calibration panel shall be determined and shall be within 2% of the theoretical value calculated for the construction of the calibration panel per:

$$U = 1/h_o + 1/c + 1/h_i$$

Where h_i = Average of h_{si} values for n rows

The determination of q (time rate of heat flow through area A) must take into account extraneous heat losses or gains. These adjustments must include, but not limited to the test frame, separating wall or panel, metering box, chamber walls, fans, lights, pumps, dehumidifiers, and controls.

8.0 PREPARATION OF TEST SPECIMEN

8.1 These test specimens must comply with the following size requirements for the product categories into which they fall (width x height):

Residential:	9'-0" x 7'-0"
Commercial	10'-0" x 10'-0"

8.2 The commercial garage door test specimen shall be installed onto the wood frame per Figure 5. A mask shall be provided for installation of the residential test specimen per the details shown in Figure 6. Exposed surfaces of the mask shall be white.

8.3 All seals around the test specimen shall be of manufacturer's standard construction. All other joints between frame, mask, and other chamber components shall be sealed with duct tape.

8.4 The test specimen shall be representative of manufacturer's production unit or identified as a prototype design. The manufacturer shall provide a complete set of detail drawings and material descriptions to the testing laboratory.

8.5 The test specimen shall be installed in accordance with the manufacturer's standard installation instructions, in the closed position. In no case shall the door be caulked to the test frame. Horizontal track and balancing hardware are not required. See Figures 5 and 6.

9.0 TEST PROCEDURE

9.1 The standard test conditions required are:

Cold room temperature:	18° F ± 0.5 ° F
Warm room temperature:	68° F ± 0.5 ° F
Cold room air flow:	15 mph perpendicular
Warm room air flow:	natural convection
Pressure difference across specimen:	0.000 ± 0.002" H ₂ O
Interior Relative Humidity:	less than 30%

9.2 Inspect the test specimen for suitability for thermal testing. When it can be done satisfactorily, repair any damage incurred in shipment. Do not test a specimen if satisfactory repairs cannot be made.

9.3 Install the test specimen in the test wall with the outside face toward the cold room. Check the movable components to see that they are operational.

9.4 Air infiltration tests shall be performed on the specimen in accordance with ASTM E-283 at 15 mph and 25 mph.

9.5 Thermocouple locations shall be selected to determine stabilized heat flow conditions. The thermocouples should be carefully applied in the following manner:

- Use alcohol to clean the surface area where the thermocouples are attached.
- Preheat area, to which the thermocouple is to be affixed, with a portable heater-blower until all evidence of moisture is removed.
- Attach the thermocouple with the leadwires counted vertically at the desired location with a 1¼" long piece of Borden's 1" wide Mystic #7452 tape. Apply pressure to the tape with a small roller, back of finger, screwdriver, or other suitable tool, until it is evident the thermocouple is in direct contact with the surface.
- Lead wires should be arranged to minimize interference with natural convection on the warm side.

9.6 Adjust temperature controls for the warm room and the cold room to the standard test temperatures of 68° F and 18° F respectively. Adjust the relative humidity in the warm room to 30% or less. Turn on refrigeration, blower, and other necessary equipment. Adjust the pressure controls to provide a net total pressure difference across the test specimen of $0.000 \pm .002$ " H₂O.

9.7 Obtain stabilized temperature and heat flow conditions before beginning the tests. Stabilized conditions are obtained when three heat flow readings made at 30 minute \pm 5 second intervals are within 2% of the final average. Stabilized temperature conditions require that all readings be within 0.5° F. Warm side air temperature shall be $68^\circ \pm 0.5^\circ$ F and cold side air temperature shall be $18^\circ \pm 0.5^\circ$ F.

9.8 Begin the test to establish U value rating when stabilized conditions are obtained. Record all temperature points, warm room relative humidity, pressure difference, and power reading every 30 minutes \pm 5 seconds for two hours for a total of five sets of readings. Stabilized conditions must exist throughout the test.

9.9 When test is completed, shut the test chamber down, remove the test specimen and verify that the test specimen conforms to the drawings and specifications.

10.0 CALCULATIONS

10.1 Calculate U by means of equation (5), using the average values recorded during the entire test period.

10.2 Take into account all extraneous heat losses and gains.

11.0 REPORT

11.1 The test report shall include the following:

11.1.1 Name and location of testing laboratory, date when test was completed, date of issuance of the report, and names of individuals conducting and verifying the test.

11.1.2 Name of garage door manufacturer.

11.1.3 Series name, model number, and other identification of product tested.

11.1.4 Type, size, and description of seals.

11.1.5 "Inside" surface material and finish.

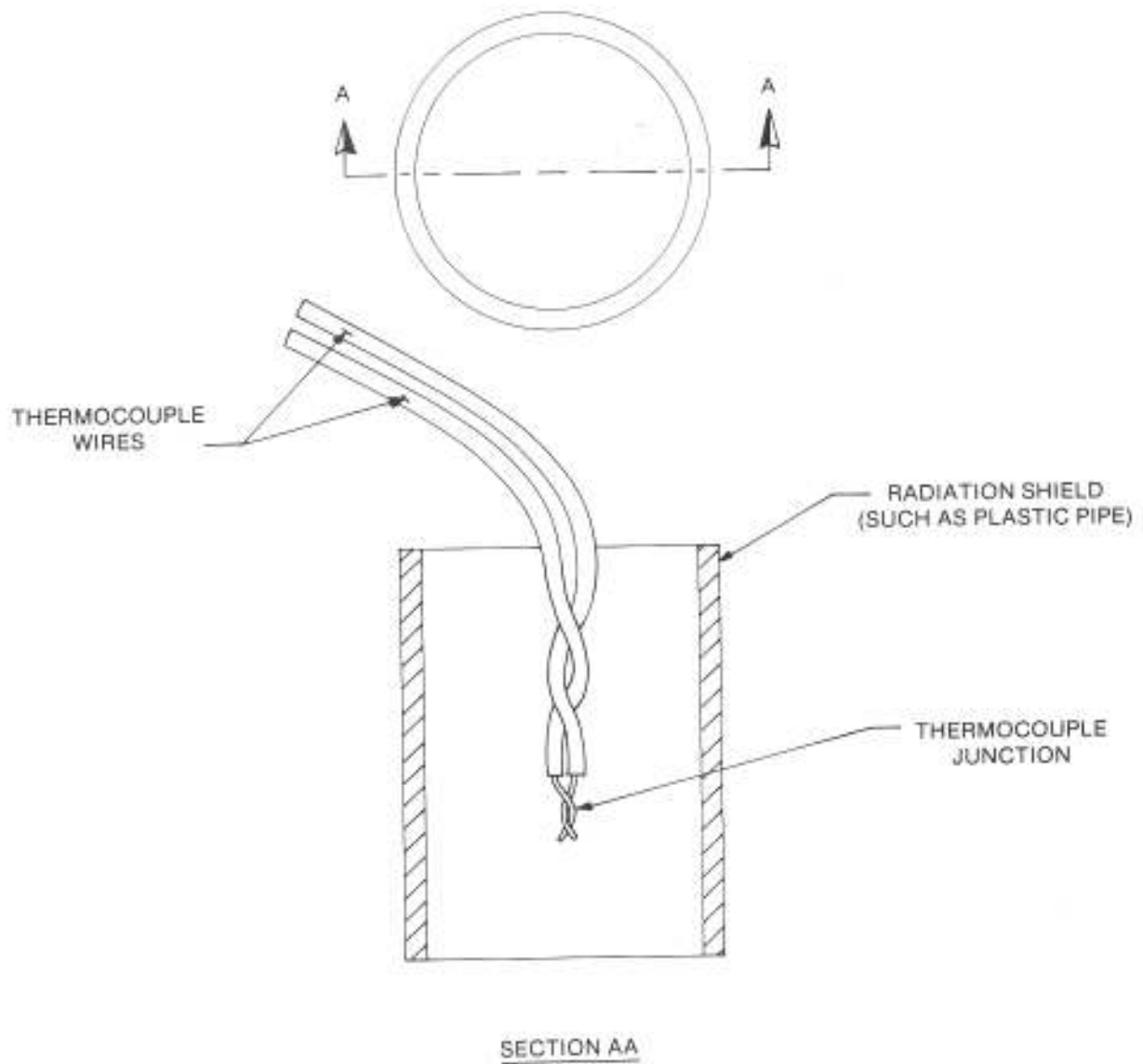
11.1.6 "Outside" surface material and finish.

11.1.7 Assembly and detail drawing(s) of components with material descriptions to be provided by the manufacturer and verified by the testing laboratory.

11.1.8 Thermal transmittance (U) of test specimen as calculated in section 10.1.

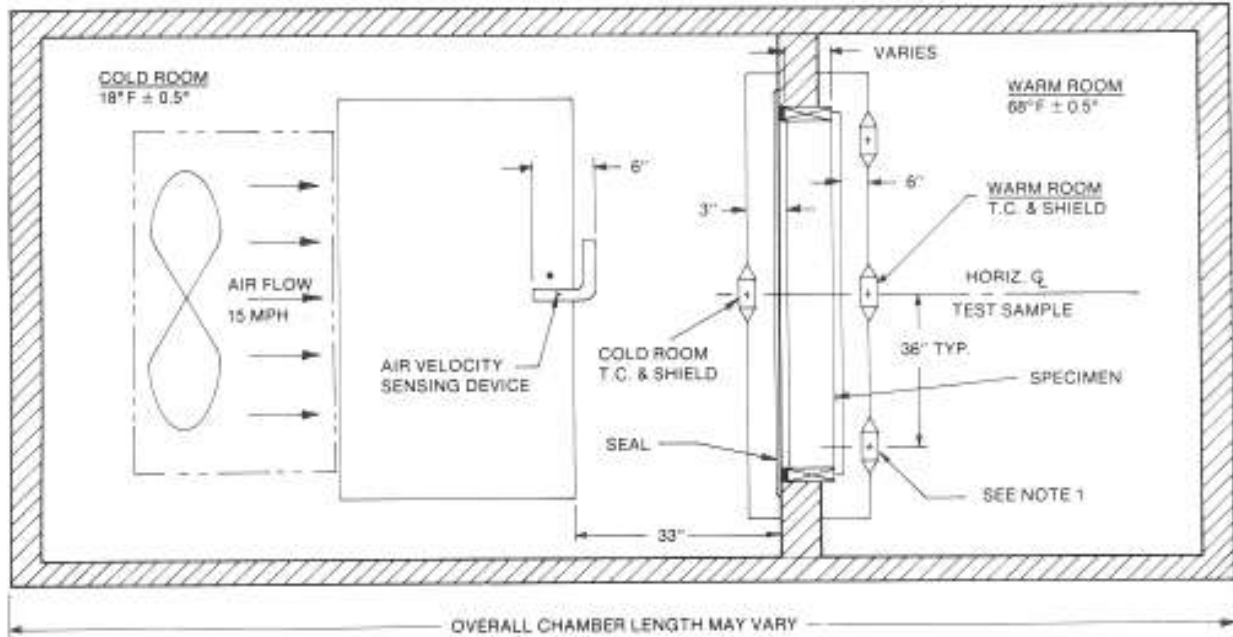
11.1.9 Air infiltration rate at 15 mph and 25 mph expressed in cu. ft/min/sq. ft. of test frame opening.

11.1.10 A statement that the tests were conducted in accordance with this Test Method and a list of any exceptions to standard conditions, sizes, or other specified criteria.



THERMOCOUPLE RADIATION SHIELD

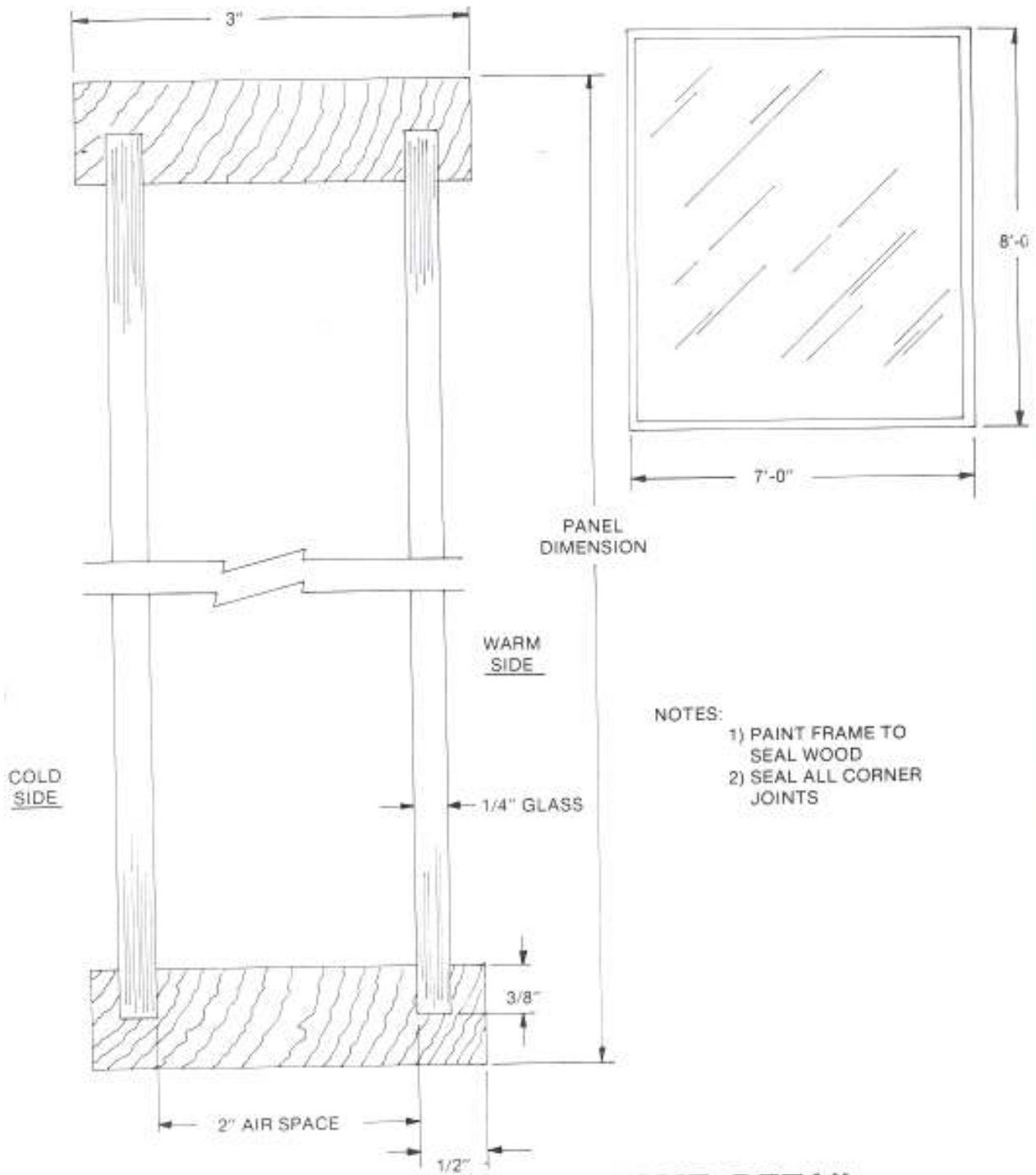
-- FIGURE 1 --



- NOTES:
- 1) THERMOCOUPLES AND SHIELDS ON WARM SIDE MOVABLE TO MAINTAIN 6" SPACING TO TEST SAMPLE

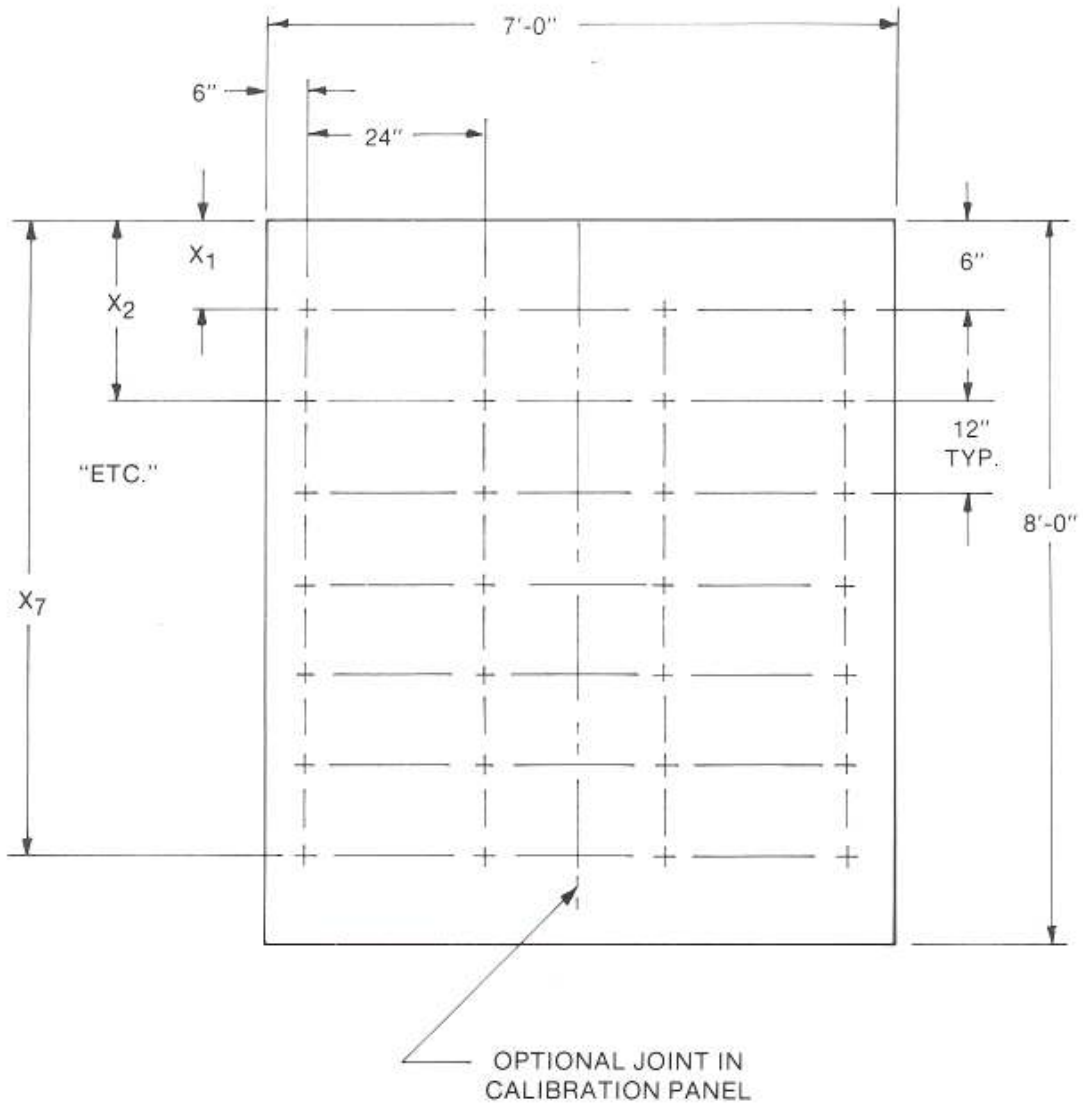
THERMAL CHAMBER DIAGRAM

-- FIGURE 2 --



CALIBRATION PANEL FRAME DETAIL

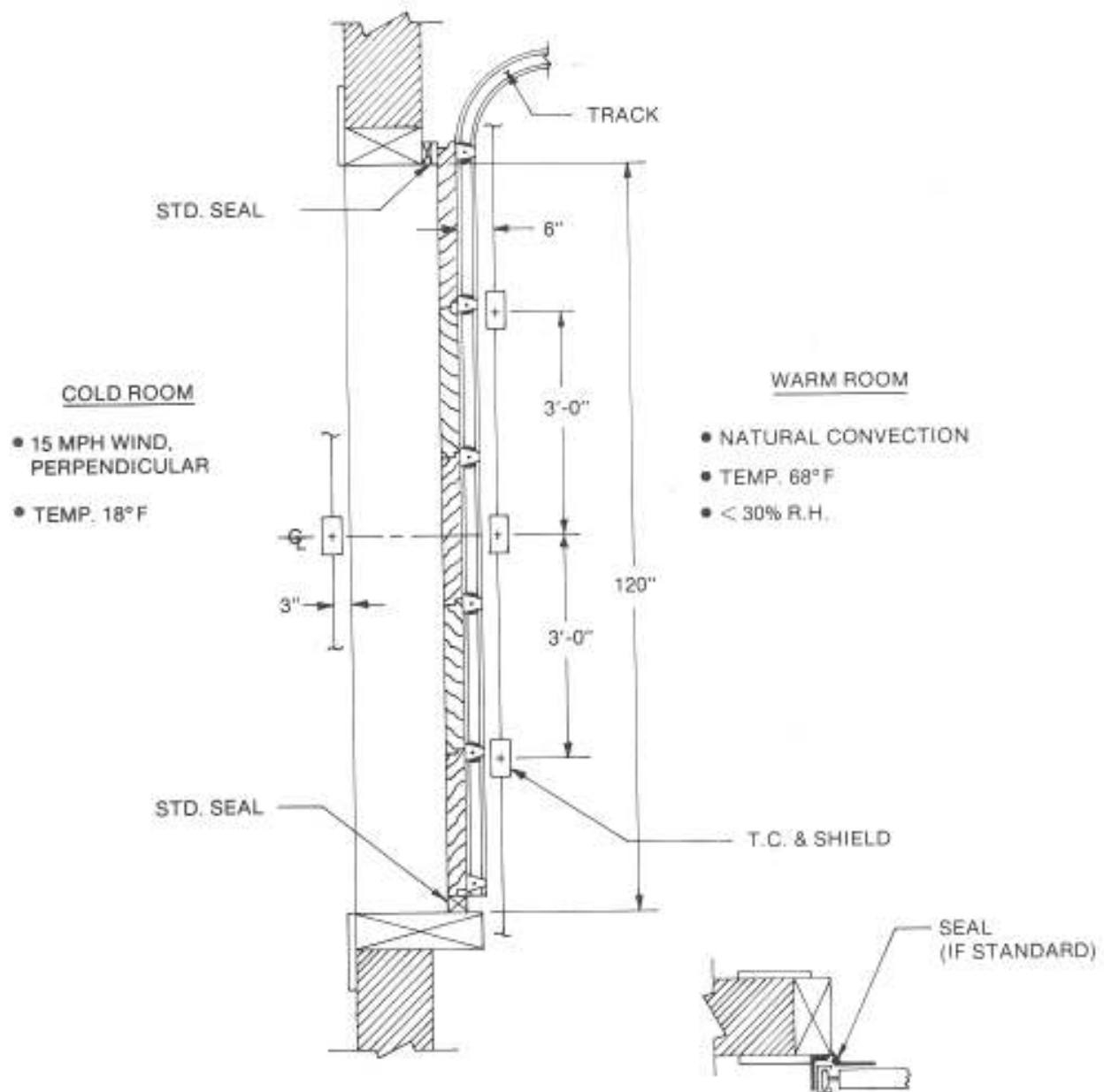
-- FIGURE 3 --



THERMOCOUPLE LOCATIONS
INSIDE & OUTSIDE

CALIBRATION PANEL

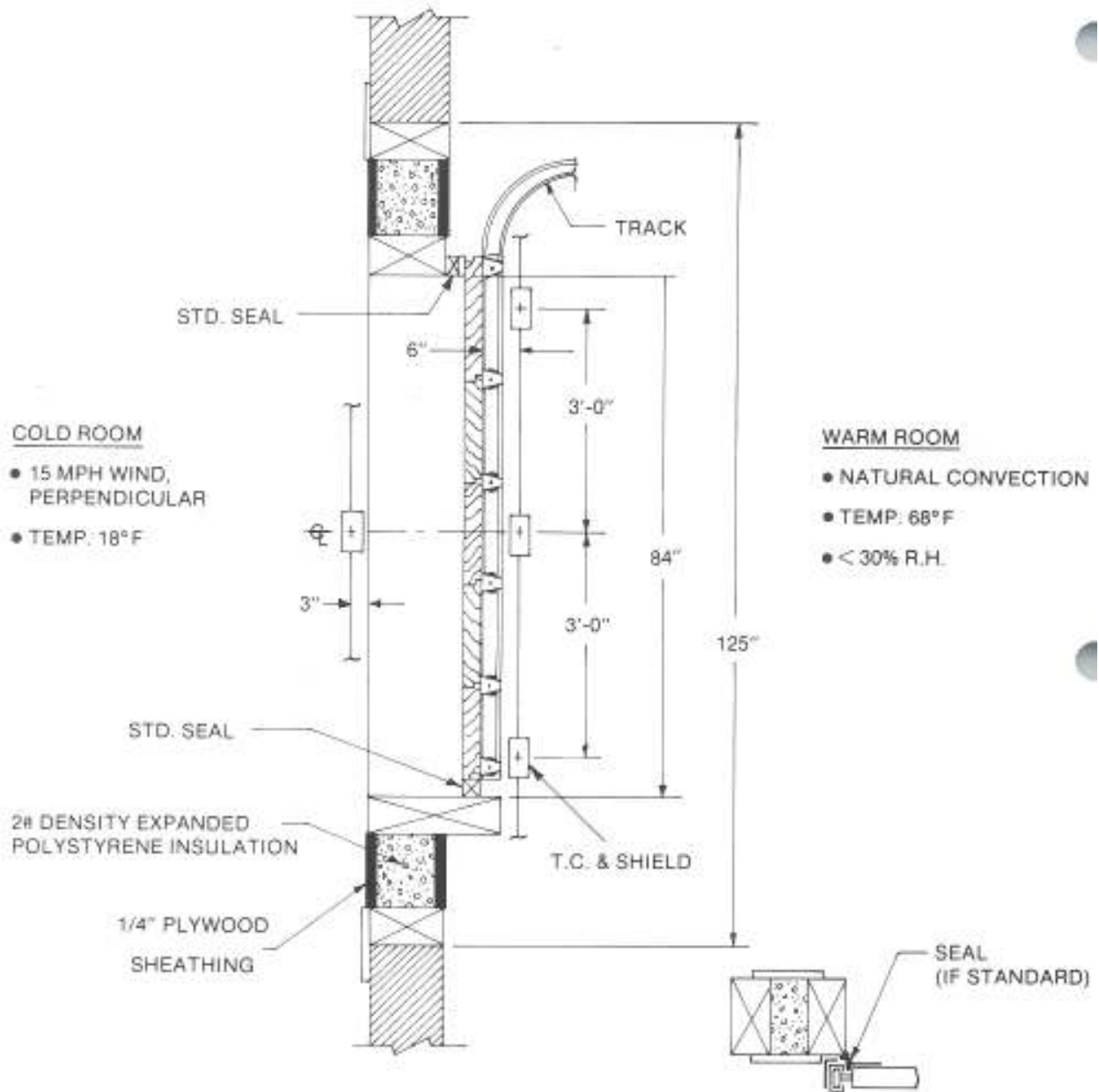
-- FIGURE 4 --



COMMERCIAL GARAGE DOOR

INSTALLATION 10' X 10'

-- FIGURE 5 --



RESIDENTIAL GARAGE DOOR

INSTALLATION 9' X 7'

-- FIGURE 6 --



DASMA – The Door & Access Systems Manufacturers Association, International – is North America’s leading trade association of manufacturers of garage doors, rolling doors, garage door operators, vehicular gate operators, and access control products. With Association headquarters based in Cleveland, Ohio, our 90 member companies manufacture products sold in virtually every county in America, in every U.S. state, every Canadian province, and in more than 50 countries worldwide. DASMA members’ products represent more than 95% of the U.S. market for our industry.

For more information about the Door & Access Systems Manufacturers Association, International, contact:

DASMA
1300 Sumner Avenue
Cleveland, OH 44115-2851
Phn: 216/241-7333
Fax: 216/241-0105
E-Mail: dasma@dasma.com
URL: www.dasma.com