

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
ASSISTANT SECRETARY FOR HOUSING -
FEDERAL HOUSING COMMISSIONER

To: REGIONAL ADMINISTRATORS, DIRECTORS,
OFFICES OF REGIONAL HOUSING, FIELD
OFFICE MANAGERS AND SUPERVISORS

Series and Series No.

Use of Materials
Bulletin No. 80

Date

October 31, 1979

SUBJECT: SPRAY APPLIED CELLULOSIC THERMAL INSULATION

Members of the HUD Staff processing cases and inspecting construction shall use this information in determining acceptability of the subject material for the uses indicated.

This bulletin should be filed with Bulletins on Special Methods of Construction and Materials as required by prescribed procedures. Additional copies may be requisitioned by the field offices.

The technical description, requirements and limitations expressed herein do not constitute an endorsement, approval or acceptance by the Department of Housing and Urban Development (HUD/FHA) of the subject matter, and any statement or representation, however made, indicating approval or endorsement by the Department of Housing and Urban Development is unauthorized and false, and will be considered a violation of the United States Criminal Code 18, U. S. C. 709.

Any reproduction of this Bulletin must be in its entirety and any use in sales promotion or advertising is not authorized.

Subject to good workmanship, compliance with applicable codes, and the methods of application listed herein, the materials described in this bulletin may be considered suitable for HUD Housing Programs including Housing for the Elderly and Care-Type Housing.

The eligibility of a property under these Programs is determined on the property as an entity and involves the consideration of underwriting and other factors not indicated herein. Thus, compliance with this bulletin should not be construed as qualifying the property as a whole, or any part thereof, as to its eligibility.

The methods of application for the materials listed herein are to be considered as part of the HUD Minimum Property Standards (MPS) and shall remain effective until this bulletin is cancelled or superseded.

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1. PURPOSE AND SCOPE

1.1 PURPOSE

This bulletin is issued as an interim standard to provide HUD field offices with a basis for accepting spray applied cellulosic thermal insulation.

1.2 SCOPE

This bulletin covers spray-applied cellulosic insulation (wood-fiber), specifically cellulosic fibers treated with chemicals and dry adhesives to be pneumatically conveyed and mixed with water at the spray nozzle; and cellulosic fibers treated with chemicals to be pneumatically conveyed and mixed with liquid adhesives at the spray nozzle. The spray-applied cellulosic insulation is intended for application in building construction with an ambient temperature range from -50 F to 180 F. Insulation densities of less than or equal to 4.5 lbs/ft³ are generally intended for application as thermal insulation. Densities greater than 4.5 lbs/ft³ are primarily used for acoustical insulation and can also provide thermal insulation. The acoustical use or function of this material is not covered by this Standard.

2. APPLICABLE DOCUMENTS (The test descriptions within this Standard are subject to pre-emptive revision by applicable Consumer Product Safety Commission regulations. Appropriate test revision will be issued as amendments to this Standard.)

2.1 ASTM Standards

C-168 Definition of Terms Relating to Thermal Insulating Materials.

C-177 Thermal Conductivity of Materials by Means of the Guarded Hot Plate.

C-236 Thermal Conductance and Transmittance of Built-up Sections by Means of the Guarded Hot Box.

C-518 Thermal Conductivity of Materials by Means of the Heat Flow Meter.

D-591 Methods of Test for Starch in Paper.

E-605 Methods of Test for Thickness and Density of Sprayed Fire-Resistive Material Applied to Structural Members.

E-84 Surface Burning Characteristics of Building Materials.

E-119 Fire Tests of Building Construction and Materials.

3. DEFINITIONS:

3.1 The applicable definitions in Definitions ASTM C-168 shall apply to the terms used in this bulletin.

3.2.1 Cured

The state or condition of the finished product after the liquid vehicle (water and/or solvents) has reached an equilibrium condition.

3.2.2 Curing

The process by which the liquid vehicle is allowed to evaporate. This is normally achieved at ambient building conditions, with or without mechanical convections of the air to hasten the curing process.

3.2.3 Sprayed Fiber Cellulosic

Sprayed Fiber Cellulosic base materials, chemically treated, which are conveyed pneumatically and mixed with water and/or adhesive at the spray nozzle.

3.2.4 Surface Finish Alterations

Changes in surface texture which may or may not result in changes to physical properties.

4. CLASSIFICATION:

4.1 The cellulosic fiber (wood-base) spray-on type thermal insulation covered by this bulletin is of two types.

4.1.1 Type IA Density (cured) of less than or equal to 4.5 lbs/ft³ with Flame Spread Classification of 0-25.

4.1.2 Type IB Density (cured) of more than 4.5 lbs/ft³ with Flame Spread Classification of 0-25.

5. MATERIALS AND USE

5.1 Materials

5.1.1 The basic material shall consist of virgin or recycled wood-based cellulosic fiber made from related paper or paperboard stock. Suitable chemicals may be introduced to provide improved properties such as flame retardation, processing, adhesive and cohesive qualities, and handling and application characteristics.

5.1.2 The basic material shall be processed into a form suitable for installation by pneumatic conveying equipment and simultaneous mixing with water and/or adhesive at the spray nozzle.

5.2 Use

5.2.1 This material is accepted for use in single and multifamily structures including Housing for the Elderly and Care-type Housing.

5.2.2 All installations shall comply with applicable requirements of HUD Minimum Property Standards, the applicable nationally recognized model building code, and local requirements.

5.2.3 All installations of this material should be covered with a suitable interior and exterior finish conforming to the MPS, where the material is adjacent to living, public or other occupied space.

5.2.4 Exterior walls of new construction, shall be firestopped at each floor level and at the ceiling of the uppermost story.

5.2.5 Adequate clearance between the insulation and heat sources shall be provided. Consult NFPA 90B, Warm Air Heating and Air Conditioning Systems. Protection of insulation at penetrations (heat sources) is critical.

6. PHYSICAL REQUIREMENTS:

6.1 Density

The density shall be determined in accordance with 9.1 and the insulation classified into one of the types listed in 4.1. All other tests included in this bulletin shall be conducted with insulation material within 10% of this measured density.

6.2 Thermal Resistance

The standard thermal resistance values are expressed in (degrees F-h-ft²)/BTU. The average thermal resistance, R, shall not be more than 5% below the listed and labeled R-value when tested in accordance with 9.2.

6.3 Surface Burning Characteristics

The insulation materials when tested in accordance with 9.3 shall be classified as indicated in 4.1.1 and 4.1.2.

6.4 Flame Resistance Permanency

The permanence of the flame retardants used shall be determined by subjecting the insulation to the conditions and testing in 9.4 and shall not result in an increase flame spread classification of 20% or more.

6.5 Moisture Absorption

Moisture gain in the insulation shall be no more than 15% when tested in accordance with 9.5.

6.6 Corrosiveness

The insulation shall be noncorrosive when tested in accordance with 9.6.

6.7 Fire Test of Building Partitions

The insulation shall be tested for fire rated building partitions in accordance with 9.10. The fire rating of the composite wall, including insulation, shall comply with requirements of the HUD Minimum Property Standards.

6.8 Odor Emission

A detectable odor of objectionable nature shall be cause for rejection of the insulation material when tested in accordance with 9.11 and detected by two or more of the panel members.

6.9 Fungi Resistance

The cured spray-applied cellulosic insulation material shall be tested for fungi resistance as specified in 9.12. The insulation material shall show no more fungal growth than the control material.

NOTE 1: Test procedures described in paragraphs 6.10, 6.11 and 6.12 are not required of products which are installed in such a manner that physical restrictions imposed by the construction elements preclude any possibility of subsequent delamination, erosion, or dusting and the product is identified only for such installations.

6.10 Bond Strength

The insulation shall be tested in accordance with 9.7 and the bond shall support 5 times the weight of the product for one minute.

6.11 Bond Deflection

The bond deflection of the material shall be tested in accordance with 9.8. After deflecting 1/60 of the span there shall be no evidence of spalling, delamination or similar deterioration.

6.12 Air Erosion

The insulation shall be tested in accordance with 9.9 and withstand an air flow of 800 ft./min.

7. WORKMANSHIP:

7.1 The product shall be free of extraneous foreign materials such as metals and glass which adversely affect the performance in service.

8. SAMPLING:

8.1 For purposes of standard tests, sampling shall be in accordance with Plan B of ASTM C 390.

9. TEST METHODS:

9.1 Density

9.1.1 Scope

This test method requires the application of sprayed cellulosic insulation material in accordance with manufacturer's published instructions.

The equipment, materials and procedure used to spray-apply the cellulosic insulation for laboratory tests shall be the same as is used for the construction of the ASTM E-84 test assembly, and also shall be representative of orientation (direction of application) as applied in in the field.

9.1.2 Apparatus

9.1.2.1 Steel Rule

Graduated to 1/16 of an inch, minimum 12" in length.

9.1.2.2 Polyethylene Sheet

Minimum 2 mil thickness and minimum area of 100 square feet.

9.1.2.3 Scale

Scale of sufficient sensitivity and capacity to weigh the specimen to an accuracy of at least 0.1 gram.

9.1.2.4 Drying Oven

Drying oven of sufficient dimensions to contain a specimen of 1' square area and 2" thickness. Oven temperature capability 80 F.

9.1.2.5 Power Saw

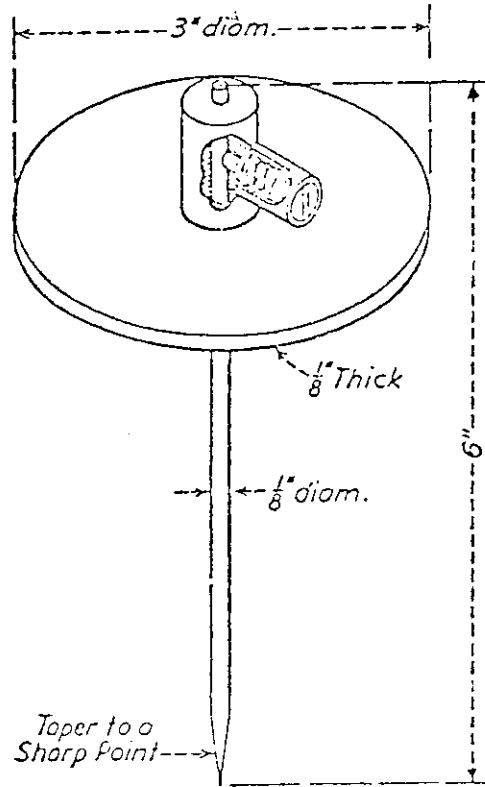
Power saw of sufficient size to cut the specimens to uniform dimensions.

9.1.2.6 Depth Gauge

The gauge of a 3" diameter disk with a 1/8" diameter probe. The probe is marked off in increments of 1/16" to facilitate accurate measurements. A spring loaded slide stop is attached to the disk to allow the operator to move the disk back and forth. The probe is inserted into the insulation until the substrate is reached and the disk is then moved to register the plane of the insulation surface. The probe is removed and the depth is read to the nearest 1/16" on the indicator.

CAUTION should be exercised to prevent compression of the insulation when moving the disk to register the plane of the insulation.

Insulation Thickness Indicator:



9.1.3.1 Method

The applicator shall spray-apply a test specimen to an area a minimum of 100 square feet at a thickness in accordance with the thermal conductivity test described in this Standard. (Thickness shall be a minimum of 2" unless the maximum design application thickness is less than 2", in such case the minimum thickness shall be 1" and the thermal resistance values shall be interpolated from this thickness). The applicator's assistant shall periodically gauge the depth or thickness of the spray-application with a depth gauge. The thickness should be such that the sample can be trimmed to the thicknesses described above, with uniform dimensions.

9.1.3.2 Test Specimen

The test specimen shall be sprayed cellulosic-based insulation applied to a polyethylene sheet against a suitable rigid and uniform substrate (plywood with the polyethylene sheet attached or tacked to the flat surface of the plywood). The specimen shall be allowed to condition at room temperature 70 F - 80 F and 40 - 50% humidity until constant weight is reached.

9.1.3.3 Thickness

After curing and conditioning to constant weight selected areas shall be removed from the polyethylene sheet and trimmed to appropriate dimensions. The dimensions shall be a minimum of 1 foot square and a minimum thickness of either 2" or 1" depending on the maximum design application thickness of the product being tested. These trimmed samples (a minimum of 3 samples from each 100 sq. ft. of test specimens sprayed) shall be conditioned to constant weight at 75 F and 50% relative humidity. The thickness of the cured and conditioned pretrimmed specimens shall be determined by placing the specimen on a suitable hard substrate and inserting the penetrating pin of the depth gauge perpendicular to and through the sprayed sample till it contacts the hard substrate. The sliding disc shall be moved with sufficient force to register the average plane of the surface. The pin shall be removed and the depth read to 1/16" increments as shown by the position of the sliding clip indicator. One measurement shall be taken at the center of the sample and one at each corner approximately 2" from the adjoining sides. The average of these measurements shall be taken as the thickness of the test specimen.

9.1.3.4 Length and Width

The dimensions of length and width shall be measured by the steel rule to increments of 1/16" and recorded. A minimum of 3 measurements for each dimension of length and width shall be taken. The average of these measurements shall be taken as the length and width.

9.1.4 Calculations of Density

The density in pounds per cubic foot shall be calculated as follows:

W = weight of specimen in pounds.
l = length of specimen in feet.
w = width of specimen in feet.
t = thickness of specimen in feet.
d = density of specimen in pounds per cubic foot.

$$d = \frac{W}{l \times w \times t}$$

9.1.5 Report

The density shall be determined for each of three samples and the density reported shall be an average of these three values.

9.2 Thermal Resistance:

Determination of the thermal resistance shall be in accordance with ASTM C-518 or C-236 at the thickness specified. In case of question, ASTM C-177 shall be used. The AVERAGE thermal resistance, R', shall be taken as the numerical average of three tests at the specified density and thickness, with evaluation performed and results reported at a 75 F mean temperature. All test specimens will be a minimum of 2" thick unless the maximum applied thickness is less than 2", and then it shall be tested at 1" thickness or at the maximum design thickness.

9.3 Surface Burning Characteristics:

Determine the surface burning characteristics of spray-on insulation in accordance with ASTM E-84 following the technical guidelines as outlined below. The inclusion of galvanized screening and the resultant correction factor are not to be applied because the spray-on insulation is self supporting. The spray-on insulation specimen shall be applied to 1/4" asbestos-cement board in accordance with manufacturer's published instruction. The equipment materials and procedure used to spray-apply the cellulosic insulation for laboratory tests shall be the same as is

used for the field application and shall be representative of orientation (direction of application) as applied in the field. The specimen shall be conditioned to constant mass at 70 ± 5 F and at a relative humidity of $40 \pm 5\%$. The specimen shall be evaluated at a minimum 1" thickness or at the maximum design thickness.

9.3.1 Test Equipment and Procedures for Flame Resistance

9.3.1.1 Fire Test Chamber

9.3.1.1.1 Duct of Chamber

The fire test chamber, Figures 1 and 2, shall consist of a horizontal duct having an inside width of $17\text{-}3/4" \pm 1/4"$ measured at the ledge location along the sidewalls and $17\text{-}5/8" \pm 3/8"$ at all other points; a depth of $12" \pm 1/2"$ measured from the bottom of the test chamber to the ledge of the inner walls on which the specimen is supported (including the $1/8" \pm 1/16"$ thickness of asbestos fabric gasketing tape); and a length of $25' \pm 3"$. The sides and base of the duct shall be lined with an insulating masonry material as illustrated in Figure 2, consisting of A.P. Green, G-26 refractory firebrick or equivalent. (This method is based on the use of G-26 firebrick manufactured by A.P. Green Refractories, Green Boulevard, Mexico, Mo. 65265.) One side of the chamber shall be provided with double observation heat-resistant windows with the inside pane flush mounted (see Figure 2). (Heat-resistant glass, Vycor, 100% silica glass, nominal $1/4"$ thick, has been found suitable for the interior pane; Pyrex glass, nominal $1/4"$ thick, has been found suitable for the exterior pane). Exposed inside glass shall be $2\text{-}3/4" \pm 3/8"$ by 11 plus 1, minus 2". The centerline of the exposed area of the inside glass shall be in the upper half of the furnace wall, with the upper edge not less than 2.5" below the furnace ledge. The windows shall be located such that not less than 12" of the specimen width can be observed. Multiple windows shall be located along the tunnel so that the entire length of the test sample may be observed from outside the fire chamber. The windows shall be pressure tight as described by 9.3.1.3.2.

FIG.1 - TEST FURNACE SHOWING SOME CRITICAL DIMENSIONS

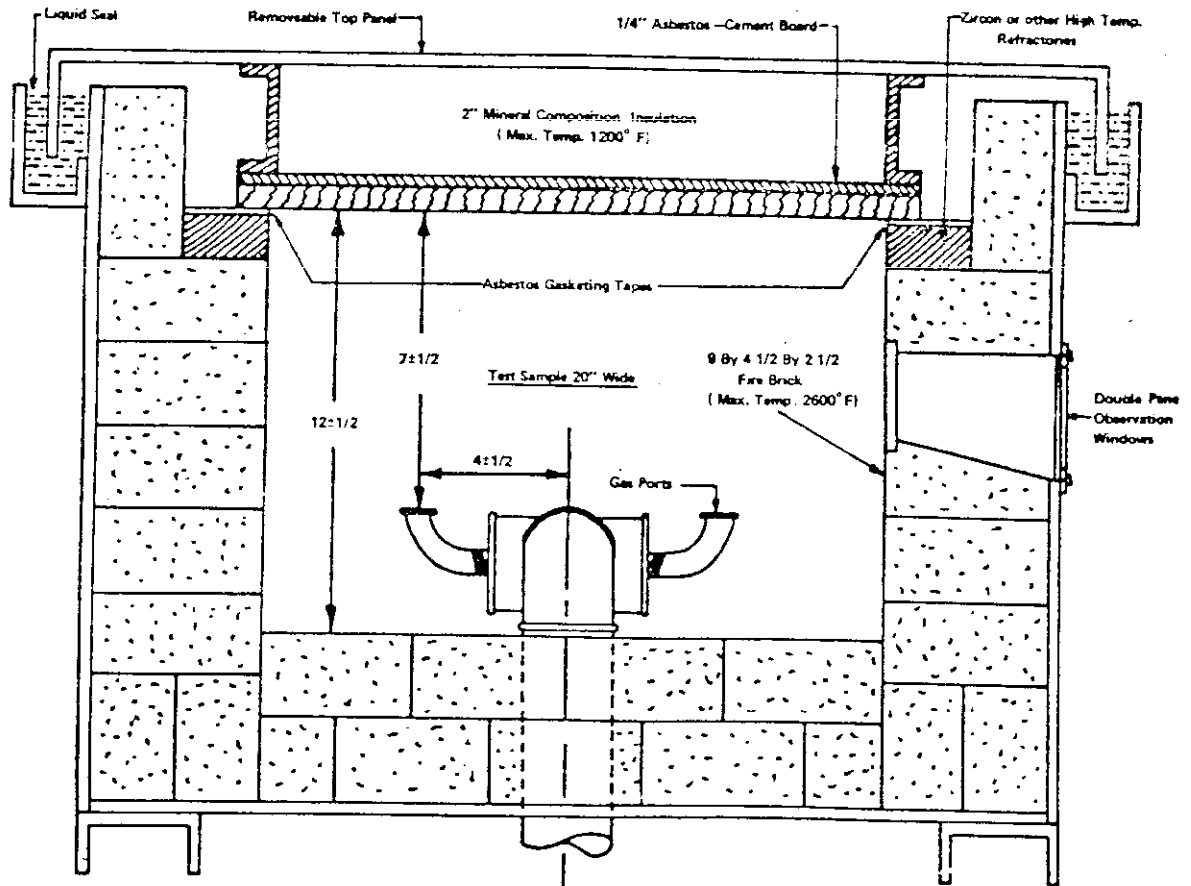
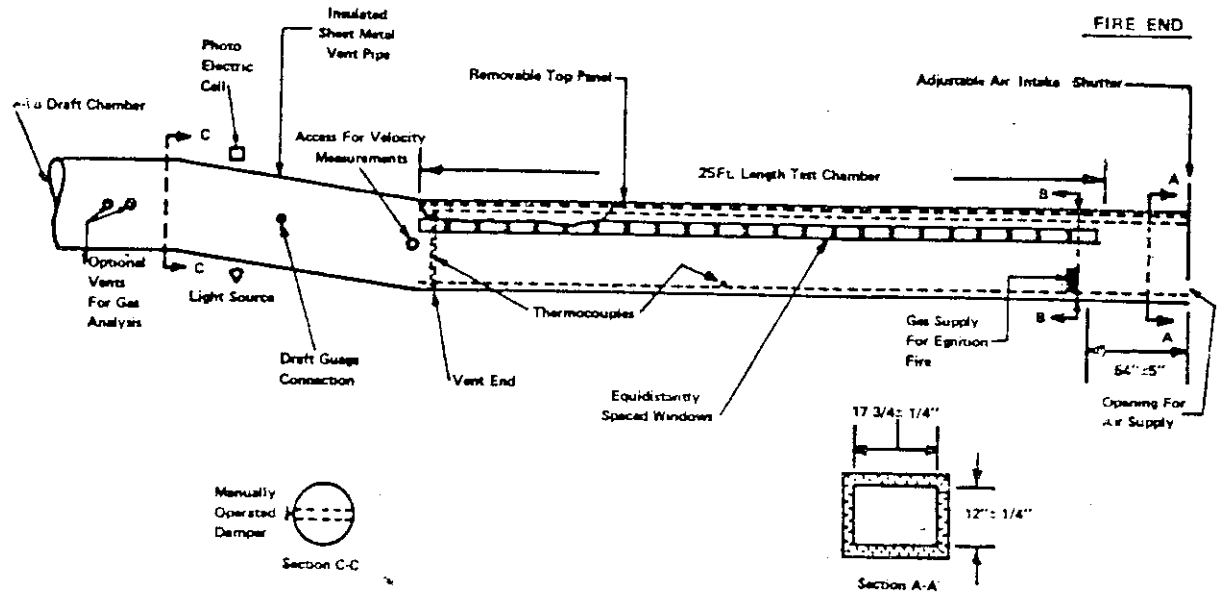


FIG.2- TEST FURNACE SHOWING SOME CRITICAL DIMENSIONS (Section B-B NOT A Construction Drawing)

9.3.1.1.2 Legdes in Chamber

The ledges shall be fabricated of structural materials capable of withstanding the abuse of continuous testing, level with respect to the length and width of the chamber and each other, and maintained in a state of repair commensurate with the frequency, volume, and severity of testing occurring at any time. (High temperature furnace refractory zircon has been found suitable for this purpose.)

9.3.1.1.3 Air Turbulence

To provide air turbulence for proper combustion, turbulence baffling shall be provided by position six A.P. Green, G-26 refractory firebricks or equivalent (long dimension vertical, 4-1/2" dimension along the wall) along the sidewalls of the chamber at distances of 7', 12', and 20 + 1/2' on the window side and 4-1/2', 9-1/2', and 16 + 1/2' on the opposite side.

9.3.1.1.4 Top of Chamber

The top shall consist of a removable noncombustible (metal and mineral composite) structure, insulated with nominal 3" + 1" thick mineral composition material as shown in Figure 2 and of a size necessary to cover completely the fire test chamber and the test samples. The lid shall be maintained in an unwarped and flat condition. The mineral composition material shall have physical characteristics comparable to the following:

Maximum effective temperature: 1200 F

Bulk density: 12.5 + 1.5 lb/ft³

Thermal conductivity at 300 to 700 F:
0.45 to 0.65 btu-ft/h-ft² F

The entire lid assembly shall be protected with flat sections of high-density (nominal 110 lb/ft³) 1/4" asbestos-cement board, maintained in an unwarped and uncracked condition through continued replacement. This protective board may or may not be secured to the furnace lid. When in place the top shall be completely sealed against the leakage of air into the fire test chamber during the the test.

9.3.1.1.5 Gas Burners and "Fire End" of Chamber

One end of the test chamber, designated as the "fire end", shall be provided with two gas burners delivering flames upward against the surface of the test sample. The burners shall be spaced $12" \pm 1"$ from the fire end of the test chamber, and $7\text{-}1/2" \pm 1/2"$ below the under surface of the test sample. The air intake shutter shall be located $54" \pm 5"$ upstream of the burner, as measured from the burner centerline to the outside surface of the shutter. Gas to the burners shall be provided through a single inlet pipe, distributed to each port burner through a tee-section. The burner outlet shall be nominal $3/4"$ elbow. The plane of the port shall be parallel to the furnace floor, such that the gas is directed upward toward the specimen. Each port shall be positioned with its center line $4" \pm 1/2"$ on each side of the centerline of the furnace so that the flame is evenly distributed over the width of the exposed specimen surface (see Figure 2). The controls used to assure constant flow of gas to the burners during periods of use shall consist of a pressure regulator, a gas meter calibrated to read in increments of not more than 0.1 ft^3 , a manometer to indicate gas pressure in inches of water, a quick-acting gas shut-off valve, a gas metering valve, and an orifice plate in combination with a water manometer to assist in maintaining uniform gas flow conditions. An air intake fitted with a vertically sliding shutter extending the entire width of the test chamber shall be provided at the fire end. The shutter shall be positioned so as to provide an air inlet port $3" \pm 1/16"$ high measured from the floor level of the test chamber at the air intake point. (A draft gage tap of the inlet section to indicate static pressure may be inserted through the top at the mid width of the tunnel $1" \pm 1/2"$ below the ceiling, $15" \pm 5"$ downstream from the inlet shutter. If the draft gage is installed in this location it is not necessary to have the draft gage installed in the "vent end" of the chamber described in §9.3.1.1.6 of this section.)

9.3.1.1.6 "Vent End" of Chamber

The other end of the test chamber, designated as the "vent end", shall be fitted with a gradual rectangular-to-round transition piece, not less than 20" in length, with a cross-sectional area of not less than 200 in. at any point. The

transition piece shall in turn be fitted to a 16" + 1/4" diameter flue pipe. The movement of air shall be by an induced draft system having a total draft capacity of at least 0.15" water column with the sample in place, the shutter at the fire end open the normal 3" + 1/16", and the damper in the wide open position. A draft gage to indicate static pressure shall be joined with the vent pipe using a surface mount connection upstream of the damper and photoelectric cell opening and at a point of minimum air turbulence, at least 16 diameters (approximately 21') from the vent end of the chamber.

9.3.1.1.7 Light Source

A light source shall be mounted on a horizontal section of the 16" diameter vent pipe at a point where it will be preceded by a straight run of pipe (at least 12 diameters or 16' and not more than 30 diameters (40') from the vent end of the chamber, and with the light beam directed upward along the vertical axis of the vent pipe. (A Weston Instruments No. 856BB Phototronic cell and 12-V sealed beam, clear lens, autho spot lamp, with an overall light to cell path length of 36" + 4" has been found suitable for this purpose.) The vent pipe shall be insulated with at least 2" of high-temperature mineral composition material, from the vent end of the chamber to the photometer location. A photoelectric cell of which the output is directly proportional to the amount of light received shall be mounted over the light source and connected to a recording device having a minimum operating chart width of 5" with an accuracy with + 1% of full scale, for indicating changes in the attenuation of incident light by the passing smoke, particulate, and other effluent. The distance between the light source lens and the photocell lens shall be 36" + 4". The cylindrical light beam shall pass through 3" diameter openings at the top and bottom of the 16" diameter duct, with the resultant light beam centered on the photocell. (The apparatus described in this section is used for determining smoke developed rating, a measurement that is not required by this interim standard. This equipment is normally used in conjunction with the Steiner Tunnel test apparatus. Although the apparatus described in this section is not used as part of the requirements of the interim standard, the apparatus is included since the removal of the equipment could conceivably cause variability of test results.)

9.3.1.1.8 Damper

An automatically controlled damper to regulate the draft pressure shall be installed in the vent pipe downstream of the smoke-indicating attachment. The damper shall be provided with a manual override.

9.3.1.1.9 Other Draft Regulation Devices

Other manual or automatic draft regulation devices or both may be incorporated to maintain fan characterization and air-flow control throughout test periods.

9.3.1.1.10 Exposed Thermocouple

A No. 18 AWG (1.02 mm) thermocouple, with $3/8" \pm 1/8"$ of the junction exposed in the air, shall be inserted through the floor of the test chamber so that the tip is $1" \pm 1/32"$ below the top surface of the asbestos gasketing tap and $23' \pm 1/2"$ from the centerline of its width.

9.3.1.1.11 Embedded thermocouple

A No. 18 AWG (1.02 mm) thermocouple embedded $1/8"$ minus 0" plus $1/16"$ below the floor surface of the test chamber shall be mounted in refractory or portland cement, carefully dried to avoid cracking, at distances of $13' \pm 1/2"$ and $23-1/4" \pm 1/2"$ from the centerline of the burner ports.

9.3.1.1.12 Maintaining Atmospheric Pressure

The room in which the test chamber is located shall have provision for a free inflow of air during the test to maintain the room at atmospheric pressure during the entire test run.

9.3.1.2 Test Specimens

9.3.1.2.1 Description

The test specimen shall be at least 2" wider (nominally $20-1/4" \pm 3/4"$) than the interior width of the tunnel and total $24' \pm 1/2"$ in length. The specimen may consist of a continuous, unbroken length, or of sections joined end to end. A $14" \pm 1/8"$ length of uncoated 16-gauge steel sheet shall be placed

on specimen mounting ledge in front of and under the specimen in the upstream end of the tunnel. Specimens shall be truly representative of the materials for which test results are desired. Properties adequate for identification of the materials or ingredients, or both, of which the test specimen is made shall be recorded.

9.3.1.2.2 Conditioning

The test specimen shall be conditioned to a constant weight at a temperature of 73.4 ± 5 F and at a relative humidity of $50 \pm 5\%$.

9.3.1.3 Calibration of Test Equipment

9.3.1.3.1 Placement of Asbestos-Cement Board

Place a $1/4 \pm 1/32$ " asbestos-cement board on the ledge of the furnace chamber, then place the removable lid of the test chamber in position. The asbestos-cement board shall be nominal $1/4$ " thick, high density (110 ± 5 lb/ft³) and uncoated. (In handling the asbestos-cement board, appropriate precautions should be taken to avoid unnecessary inhalation of dust from the asbestos-cement board.)

9.3.1.3.2 Controlling Air Leakage

With the $1/4$ " asbestos-cement board in position on top of the ledge of the furnace chamber and with the removable lid in place, establish a draft to produce a 0.15 " water-column reading on the draft manometer, with the fire-end shutter open $3 \pm 1/16$ ", by manually setting the damper as a characterization of fan performance. Then close and seal the fire-end shutter, without changing the damper position. The manometer reading shall increase to at least 0.375 ", indicating that no excessive air leakage exists. In addition, conduct a supplemental leakage test periodically with the fire shutter and exhaust duct beyond the differential manometer tube sealed, by placing a smoke bomb in the chamber. Ignite the bomb and pressurize the chamber to 0.375 ± 0.125 " water column. Seal all points of leakage observed in the form of escaping smoke particles.

9.3.1.3.3 Air Velocity

Establish a draft reading within the range 0.055 to 0.085" water column. (The draft reading shall be within the range of 0.85" to .100") water column if the draft gauge lap is inserted through the top at the "fire end" of the tunnel, as allowed by §9.3.1.1.5. The required draft gauge reading will be maintained throughout the test by the automatically controlled damper. Record the air velocity at seven points, 23' \pm 1" from the centerline of the burner ports, 6" \pm 1/4" below the plane of the specimen mounting ledge. Determine these seven points by dividing the width of the tunnel into seven equal sections and recording the velocity at the geometrical center of each section. During the measurement of velocity, remove the turbulence bricks (see §9.3.1.1.3) and exposed 23' thermocouple and place 24" \pm 1" long straightening vanes between 16 and 18' from the burner. The straightening vanes shall divide the furnace cross section into nine uniform sections. Determine the velocity with furnace air temperature at 73.4 \pm 5 F, using a velocity transducer. (A Thermo Systems, Inc. Model 1610 velocity transducer (thermal anemometer) using a readout device accurate to 0.001-V, has been found suitable for the purpose.). The velocity, determined as the arithmetic average of the seven readings, shall be 240' \pm 5'/min.

9.3.1.3.4 Temperature and Relative Humidity of Air Supply

Maintain the air supply at a temperature of 73.4 \pm 5 F, and a relative humidity of 50 \pm 5%.

9.3.1.3.5 Gas Supply

Supply the fire test chamber with natural (city) or methane (bottled) gas fuel of uniform quality with a heating value of nominally 1000 btu/ft³. Adjust the gas supply initially at approximately 5000 btu/min. Record the gas pressure, the pressure differential across the orifice plate, and the volume of gas used in each test. Unless otherwise corrected for, when bottle methane is employed, insert a length of coiled copper tubing into the gas line between the supply and metering connection to compensate for possible errors in the flow indicated due to reductions in gas temperature associated with the pressure drop and expansion across the regulator. With the draft and gas supply adjusted as indicated in 9.3.1.3.3 and 9.3.1.3.4, the test flame shall extend downstream to a distance of 4-1/2' \pm 6" over the specimen surface, with negligible upstream coverage.

9.3.1.3.6 Preheating of Test Chamber

Preheat the test chamber with the 1/4" asbestos-cement board and the removable lid in place and with the fuel supply adjusted to the required flow. Continue the preheating until the temperature indicated by the floor thermocouple at 23-1/4' reaches 150 ± 5 F. During the preheat test, record the temperatures indicated by the thermocouple at the vent end of the test chamber at intervals not longer than 15 s and compare these readings to the preheat temperature shown in the time-temperature curve in Figure 3. This preheating is for the purpose of establishing the conditions that will exist following successive tests and for indicating the control of the heat input into the test chamber. If appreciable variation from the temperatures shown in the representative preheat curve is observed, suitable adjustments in the fuel supply may be necessary based on red oak calibration tests.

9.3.1.3.7 Cooling

Allow the furnace to cool after each test. When the floor thermocouple at 13' shows a temperature of 105 ± 5 F, place the next specimen in position for test.

9.3.1.3.8 Tests With Red Oak Flooring

With the test equipment adjusted and conditioned as described in §§9.3.1.3, .4, .6, make a test or series of tests, using nominal 25/32" select-grade red oak flooring as a sample, conditioned to 6 to 8 percent moisture content as determined by the 221 F oven/dry method. Make observations at distance intervals not in excess of 2' + 6" and time intervals not in excess of 30 s, and record the time when the flame is 19-1/2' from the end of the ignition fire. The end of the ignition fire shall be considered as being 4-1/2' from the burners. The flame shall reach the end point in 5-1/2 min + 15s. Automatically record the temperatures measured by the thermocouple near the vent end at least every 15 s.

The flame may be judged to have reached the end point when the vent end thermocouple registers a temperature of 980 F.

9.3.1.3.9 Steel Screen Correction Factor

Prior to performing the surface burning test, the operator shall develop a correction factor for the select grade red oak flooring with the steel screening, as described in §9.3.1.4.1, in place. The placement and fastening of the screening to the select grade red oak flooring shall be as shown in Figure 4.

9.3.1.3.10 Recording Flame Spread Distance

Plot the flame spread distance and temperature readings separately on suitable coordinate paper. Figures 5 and 6 are representative curves for red oak flame spread distance and time temperature development. Flame spread distance shall be determined as the observed distance minus 4-1/2'.

9.3.1.3.11 Tests With Asbestos-Cement Board

Following the calibration test for red oak, conduct a similar test or tests on samples of 1/4" asbestos-cement board. These results shall be considered as representing a classification of 0. Plot the temperature readings separately on suitable coordinate paper. Figure 7 is a representative curve for time temperature development for asbestos-cement board. (In handling the asbestos-cement board, appropriate precautions should be taken to avoid unnecessary inhalation of dust from the asbestos-cement board.)

9.3.1.4 Procedures

9.3.1.4.1 Placement of Specimen

Loose fill insulation shall be placed on steel screening with wires nominally 0.01" + 0.001" in diameter with approximate 3/64" openings supported on a test frame 20" + 1/4" wide by 2" + 1/16" deep, made from nominally 2" by 3" by 3/16" steel angles. Three frames are required. See Figure 8. The insulation shall be packed to the density specified by the manufacturer. If the manufacturer fails to specify the density of the insulation, the Testing Agency shall determine the density of the insulation by using the blown in and/or poured density test method.

The Testing Agency shall then pack the insulation to the density obtained by using this test method. With the furnace draft operating, place the test specimen on the test chamber ledges which have been completely covered with nominal 1/8" thick by 1-1/2" wide woven asbestos tape. Place the specimen as quickly as is practical. Place the removable top in position over the specimen.

9.3.1.4.2 Furnace Draft

The completely mounted specimen shall remain in position in the chamber with the furnace draft operating for 120 s \pm 15 s prior to the application of the test flame.

9.3.1.4.3 Flame Front Distance

Ignite the burner gas. Observe and record the distance and time of maximum flame front travel with the room darkened. Continue the test for a 10 min. period \pm 2 s. The test may be terminated prior to 10 min. if the specimen is completely consumed in the fire area and no further progressive burning is evident.

9.3.1.4.4 Gas

Record the gas pressure, the pressure differential across the orifice plate, and the volume of gas used in each test.

9.3.1.4.5 Conclusion of Test

When the test is ended, shut off the gas supply, observe smoldering and other conditions within the test duct, and remove the specimen for further examination.

9.3.1.4.6 Recording Flame Spread

Plot the flame spread distance and temperature readings separately on the same type of coordinate paper as used in §9.3.1.3.10 for use in determining the flame spread classification as outlined in §9.3.1.5. The flame spread observations must be recorded at distance intervals not in excess of 2' or time intervals not in excess of 30 s. In addition, the peak must be noted with the time of occurrence.

Flame spread distance shall be determined as the observed distance minus 4-1/2'.

9.3.1.5 Classification

9.3.1.5.1 Method for Determining Flame Spread Classification (FSC)

(i) The total areas (A_T) under the flame spread time-distance curve shall be determined by ignoring any flame front recession. For example, in Figure 9 the flame spread 10' in 2-1/2 min. and then receded. The area is calculated as if the flame had spread to 10' in 2-1/2 min. and then remained at 10' for the remainder of the test or until the flame front again passed 10'. This is shown by the dashed line in Figure 9. The area (A_T) used for calculating the flame spread-classification is the sum of areas A_1 and A_2 in Figure 9.

(ii) If this total area (A_T) is less than or equal to 97.5 min ft², the flame spread classification shall be 0.564 times the total area (FSC = 0.564 A_T).

(iii) If the total area (A_T) is greater than 97.5 min. ft², the flame spread classification shall be 5363, divided by the difference of 195 minus the total area (A_T). (FSC = 5363/(195- A_T).)

(iv) The correction factor described in §9.3.1.3.9 shall be used in reporting the surface burning characteristics (flame spread classification) of cellulosic fiber insulation conforming to this Bulletin.

9.3.1.6 Report

The report shall include the following:

- 9.3.1.6.1 Description of the material being tested.
- 9.3.1.6.2 Test results as calculated in §9.3.1.5
- 9.3.1.6.3 Details of the method used in placing the specimen in the test chamber, and
- 9.3.1.6.4 Observations of the burning characteristics of the specimen during test exposure, such as sagging and fallout.

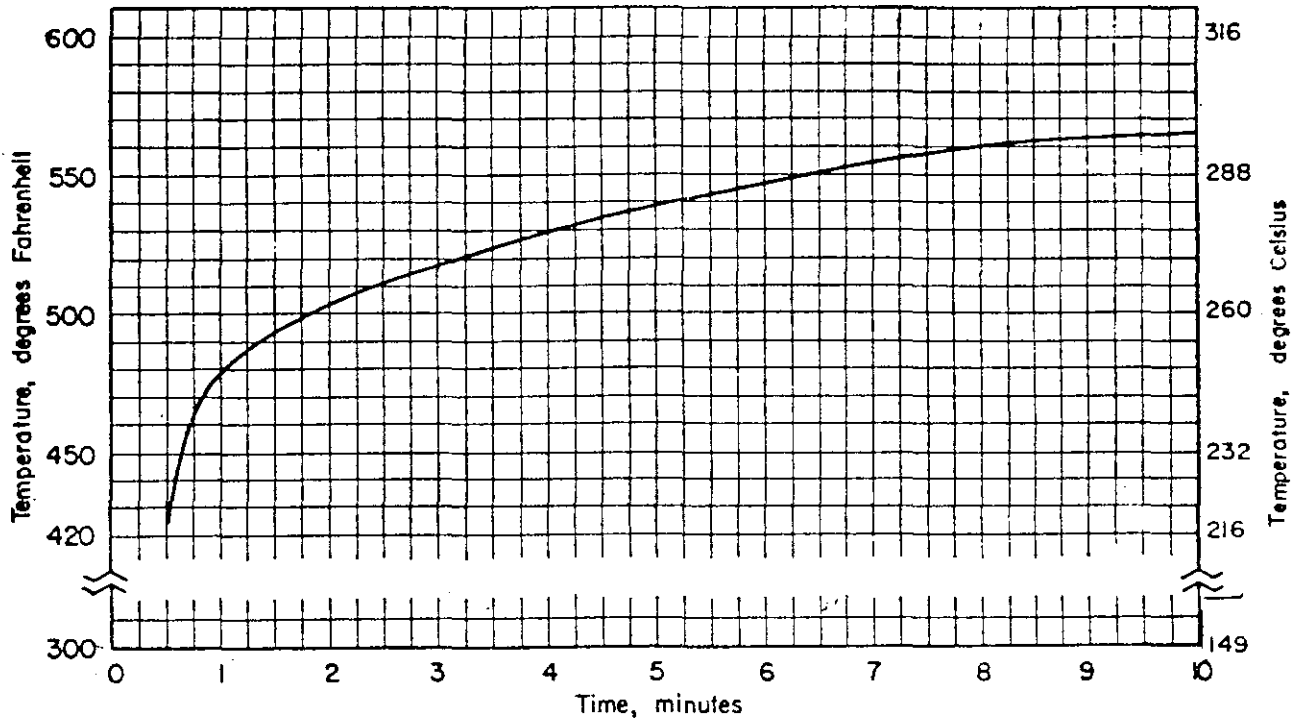


FIG.3 — TIME—TEMPERATURE CURVE FOR PREHEAT TEMPERATURE

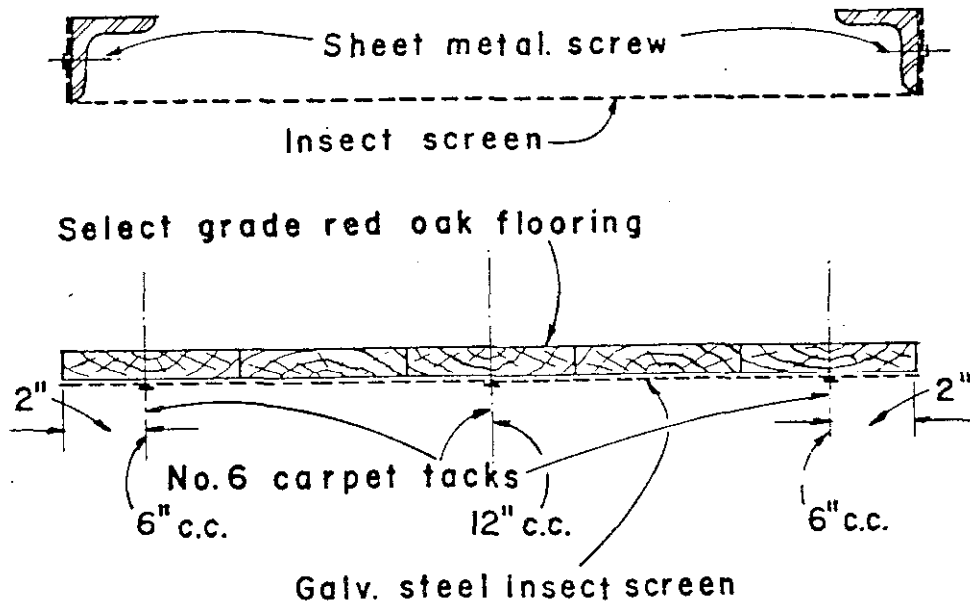


FIG.4 — PLACEMENT AND FASTENING OF SCREENING TO SELECT GRADE RED OAK FLOORING

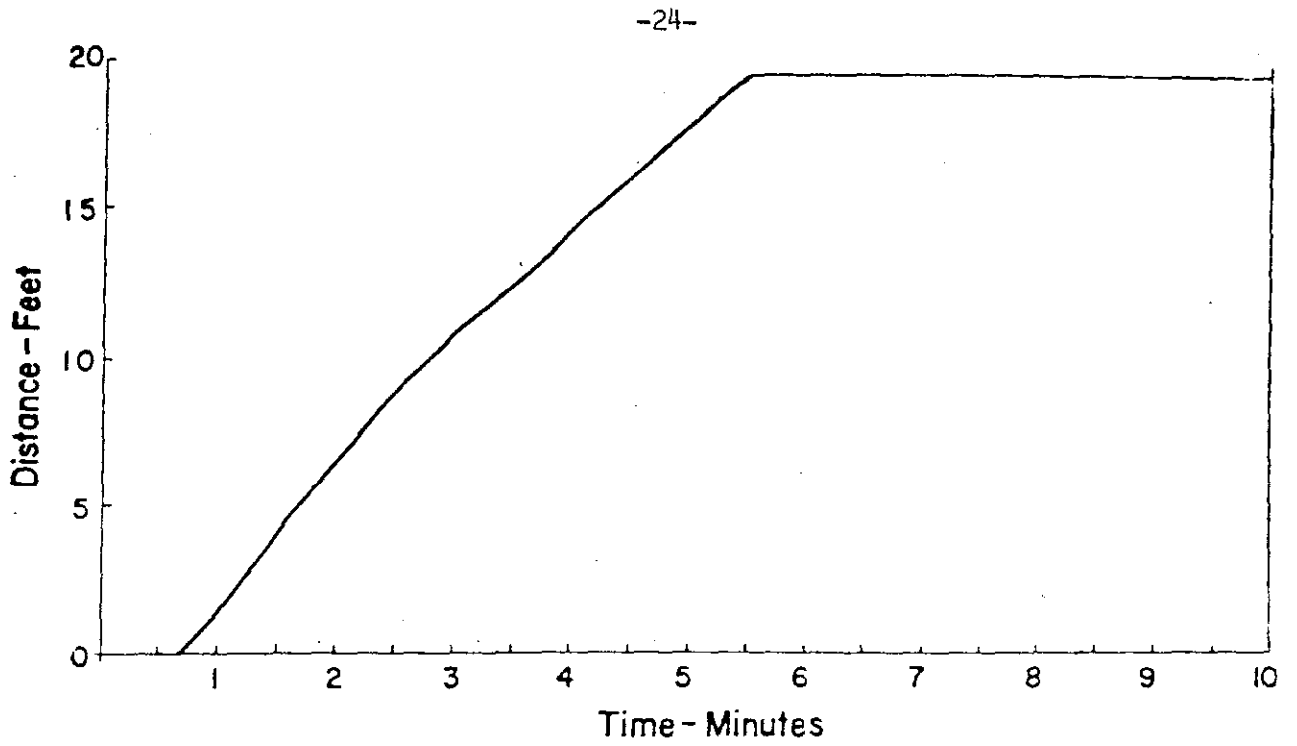


FIG. 5 — TIME—DISTANCE CURVE FOR FLAME SPREAD OF RED OAK

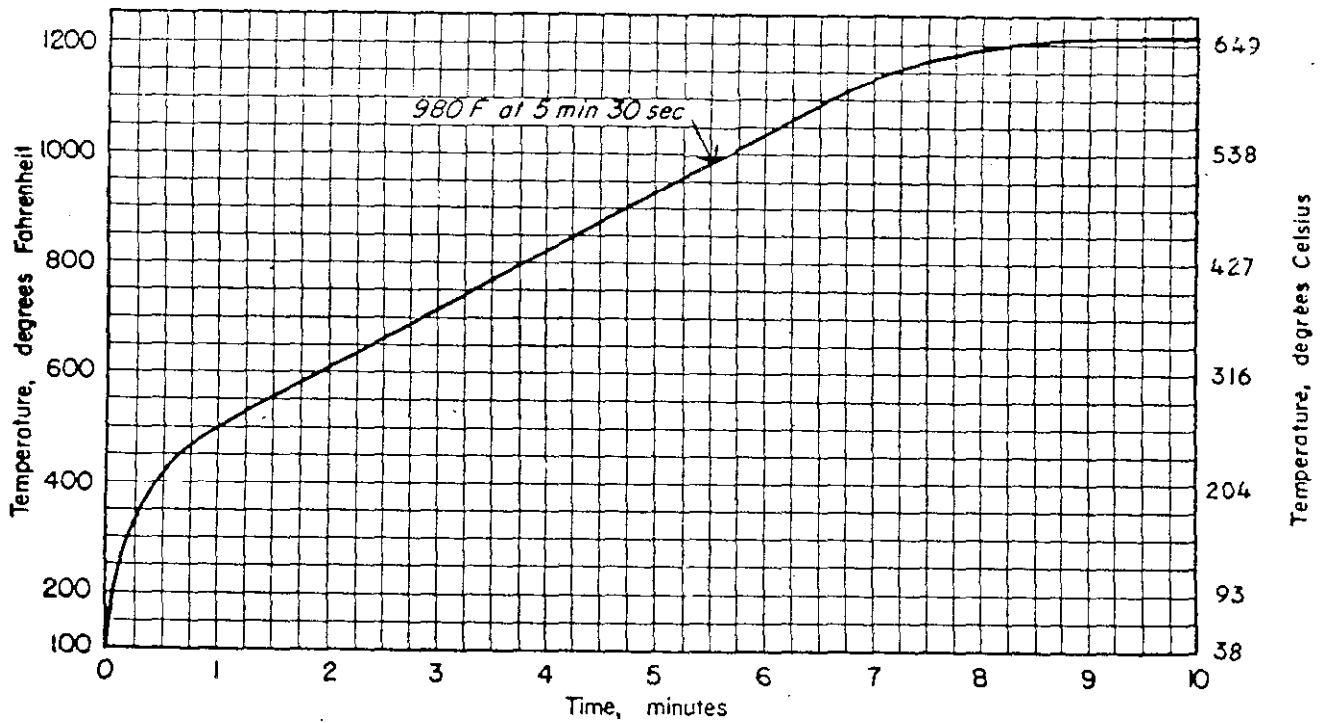


FIG. 6 — TIME—TEMPERATURE CURVE FOR FUEL CONTRIBUTION OF RED OAK

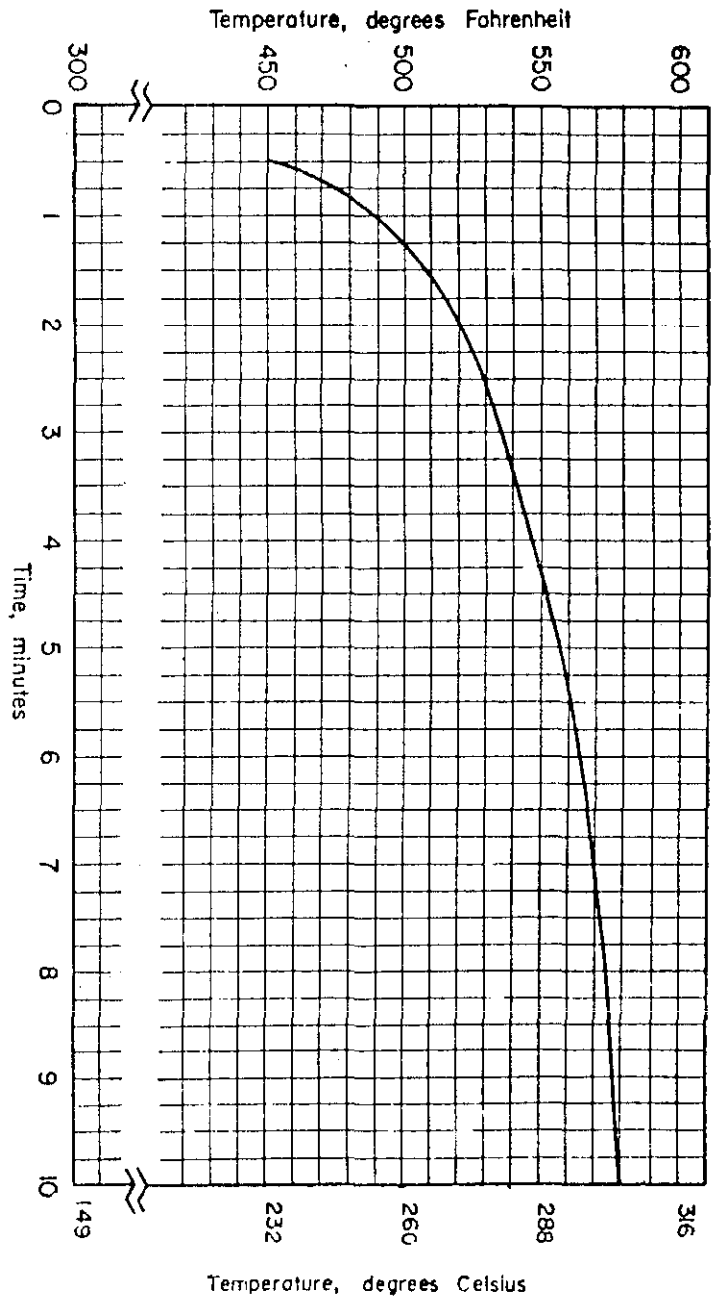


FIG.7 — TIME — TEMPERATURE CURVE FOR CONTRIBUTION OF ASBESTOS — CEMENT BOARD

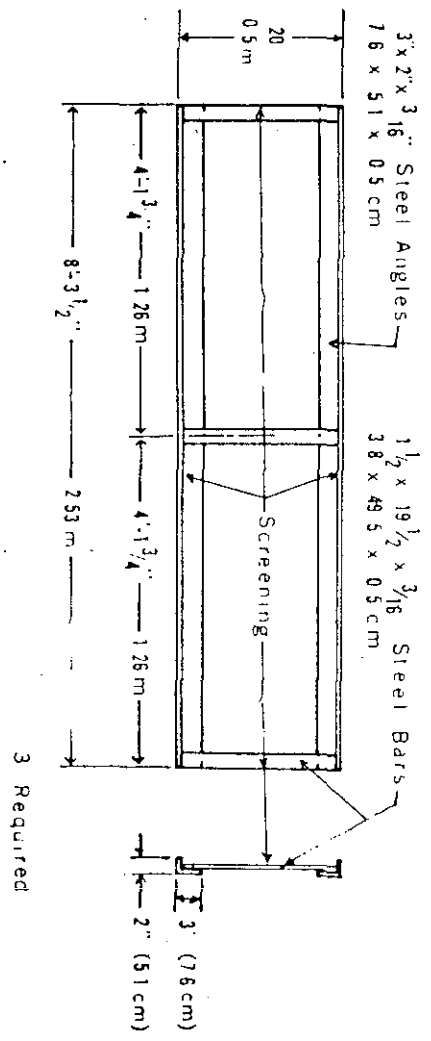


FIG.8

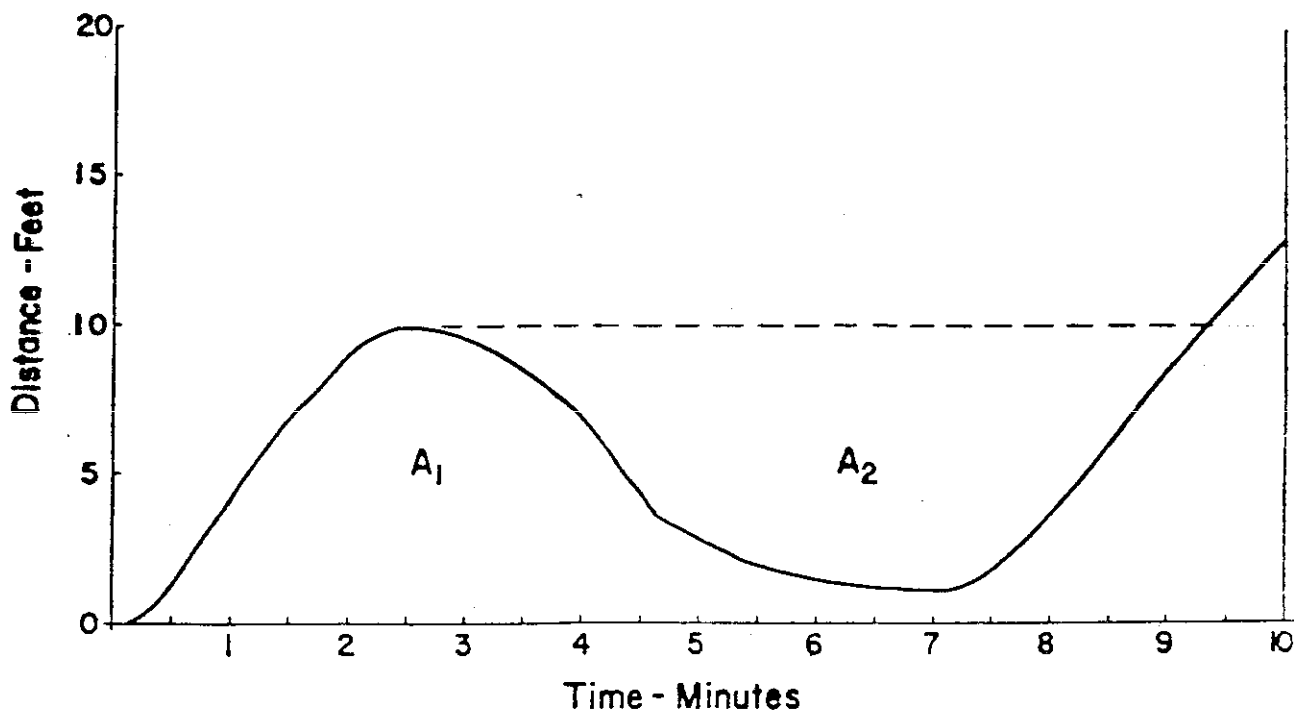


FIG.9 — EXAMPLE OF TIME—DISTANCE CURVE WITH FLAME FRONT RECESSION

9.4 Test Procedures for Flame Resistance Permanency

9.4.1 Apparatus

9.4.1.1 Humidity Chamber

Humidity chamber capable of maintain 180 ± 3 F with $96 \pm 3\%$ relative humidity for high-temperature conditioning and 80 ± 3 F with $50 \pm 3\%$ relative humidity for low-temperature conditioning.

9.4.1.2 Flame Spread Test Apparatus, 2 Feet

A Custom Scientific Instrument (CSI) 2' flame spread test tunnel (Model C-196 CL) has been found satisfactory for this purpose. When a material's flame spread rating as found in §9.3.1 is within 20% of a higher classification, a 25' tunnel must be used in place of the 2' apparatus.

9.4.1.3 Laboratory Scales

The scales must be capable of weighing to the nearest 0.1 g.

9.4.2 Procedure

9.4.2.1 Specimens

(i) Submit a representative sample of the insulation for test, portions of which shall be used for each test.

(ii) Prepare two specimens of at least 100 g each and not less than 2" thick.

(iii) Condition specimens for 24 hr at 80 ± 3 F and $50 \pm 3\%$ relative humidity.

(iv) Conduct a flame spread and fuel contribution test on one specimen in the 2' apparatus and record the results.

The screening used to support the specimen properly shall be in accordance with §9.3.1.4.1.

(v) Age the second specimen in the humidity chamber as follows:

24 hr at 180 ± 3 F and $96 \pm 3\%$ relative humidity

24 hr at 80 ± 3 F and $50 \pm 3\%$ relative humidity

24 hr at 180 ± 3 F and $96 \pm 3\%$ relative humidity

24 hr at 80 ± 3 F and $50 \pm 3\%$ relative humidity

(vi) Conduct a flame spread and fuel contribution test on the aged specimen.

9.4.3 Report

The report shall include the following:

9.4.3.1 Temperatures, relative humidity, and exposure times of aging procedure.

9.4.3.2 A numerical determination is made of the flame spread and fuel contribution of the aged specimen and the non-aged specimen. When there is an increase in flame spread of 20% or more of the aged specimen in the 2' apparatus, the flame resistance permanency test must be repeated using the test method specified in §9.3.1.

9.4.3.3 A change in flame spread classification in the 25' tunnel as modified in this standard shall constitute failure of the test.

9.5 Moisture Absorption

9.5.1 Scope

Subject the insulation specimen to the following test conditions to determine the moisture absorption of the product.

9.5.2 Apparatus

9.5.2.1 Humidity Chamber

Humidity chamber capable of maintaining 120 F \pm 3 F and 50 \pm 3% relative humidity and also 90 \pm 3% relative humidity.

9.5.2.2 Laboratory Scales

Laboratory scales capable of weighing to the nearest 0.1 g.

9.5.3 Specimen

Prepare the sample specimen in accordance with Section 9.1.3.3.

9.5.4 Procedure

Condition the test specimen at 50 \pm 3% relative humidity and 120 F to constant weight and record weight. Then increase the relative humidity to 90 \pm 3% and recondition for 24 hr. and record weight. Determine the hydration as moisture absorption by weight.

9.5.5 Calculations

Calculate the percentage moisture absorption by weight as follows:

$$\text{Moisture absorption, \%} = \frac{(W_1 - W_0)}{W_0} \times 100$$

Where: W_1 weight after test

W_2 weight of conditioned sample at 50% relative humidity.

9.5.6 Report

The report shall include all test conditions such as temperature, relative humidity, and exposure time. Moisture absorption in excess of 15% by weight shall constitute failure of test.

9.6 Test Procedures for Corrosiveness

9.6.1 Apparatus and Materials Required for the Test

9.6.1.1 Humidity Chamber

Humidity chamber capable of maintaining 120 ± 3 F and $96 \pm 3\%$ relative humidity.

9.6.1.2 Evaporating Dishes

Evaporating dishes, two 90 mm by 50 mm.

9.6.1.3 Test Specimens

Test specimens, two each 2" x 2" x 0.003" thick metal free of tears, punctures, or crimps as follows:

- (i) 3003 "0" Tamper Bare Aluminum
- (ii) ASTM B 152, Type ETP, Cabra No. 110, soft copper
- (iii) Low carbon, commercial quality, cold rolled, shim steel

9.6.1.4 Trichloroethylene or 1,1,1,-Trichloroethane

Analytical reagent trichloroethylene or 1,1,1,-trichloroethane.

9.6.2 Specimen

A representative sample of the insulation shall be submitted for test, portions of which shall be used for each test.

9.6.3 Test Procedure

9.6.3.1 Wash the metal specimens with 1,1,1,-trichloroethane to remove any oil or grease. Dry at room temperature.

- 9.6.3.2 Presaturate the insulation samples by mixing 20 g of insulation with 150 ml of distilled water at room temperature for each test specimen.
- 9.6.3.3 Place a 1/2" thick layer of saturated insulation into an evaporating dish, tamp level, and place metal specimen on the insulation. Cover the metal specimen with the remaining insulation and tamp to assure good contact with the metal plate. Cover with nonmetallic screen to prevent spilling during test.
- 9.6.3.4 Place the composite specimens and a control metal specimen into the humidity chamber, calibrated at 120 F and $96 \pm 3\%$ relative humidity for 336 hr.
- 9.6.3.5 Upon completion of the test, thoroughly wash the metal specimens under running water and lightly brush them to remove loose corrosion products. Remove the remaining corrosion products by immersing them in 10 parts distilled water and 1 part nitric acid, 15.9 N. Rinse the samples in water and dry.
- 9.6.3.6 Make two duplicate tests for each determination.
- 9.6.4 Report
- 9.6.4.1 Temperature, relative humidity, and exposure time.
- 9.6.4.2 Comparison of corrosion between insulated panel and control panel. When minor surface etching occurs on the insulated aluminum or copper panels, extended 30-day tests shall be conducted to determine additional corrosion effect. Extended 30-day tests shall be conducted on the steel panel only when corrosion of the insulated steel panel compares unfavorably with that of the control steel panel.
- 9.6.4.3 Noncorrosiveness shall be determined by the absence of any perforations when the metal specimen is observed over a chrome reflected 40-W appliance light bulb.

9.7 Bond Strength

9.7.1 Scope

This method of test covers a procedure for measuring the cohesion/adhesion or bond strength (tensile) perpendicular to surface of sprayed cellulosic insulation material applied to rigid backing.

9.7.2 Significance

The test measures the adhesive force required to separate the material from the base or the cohesive force within the material, and is an indication of the ability of sprayed material to remain in place and resist separation during anticipated service conditions.

9.7.3 Apparatus

9.7.3.1 A metal dish approximate 3-1/4" in diameter and 1/2" in depth. A hook shall be attached at the center on the outside of the dish.

9.7.3.2 A two component system of urethane resin to form a rigid foam.

9.7.3.3 Either a scale of spring-balanced type with capacity of approximately 25 lbs. or dead weights may be used. In either case, the accuracy shall be within 1/4 lb.

9.7.3.4 Galvanized steel sheet, 0.060" thick and 12" square.

9.7.3.5 Humidity Chamber capable of environmental control in all areas of the chamber to 120 ± 3 F and $90 \pm 3\%$ relative humidity.

9.7.4 Test Specimen

9.7.4.1 Test Specimen (laboratory)

The test specimen shall be sprayed cellulosic insulation material applied to the galvanized steel sheet. It shall be allowed to condition at room temperature and at atmospheric conditions until constant weight is reached.

9.7.4.2 Test Specimen (alternate)

The test specimen shall be the in-place sprayed cellulosic insulation material as applied to any field condition surface for which the product is intended. The specimen shall be conditioned at atmospheric conditions for a period sufficient to be considered cured in accordance with the manufacturer's recommendations.

9.7.5 Procedure:

9.7.5.1 The two component urethane resin system shall be mixed in the metal dish and the dish immediately placed against the surface of the sprayed cellulosic insulation which was pre-conditioned for 24 hr. at $80\text{ F} \pm 3\text{ F}$ and $50 \pm 3\%$ relative humidity.

9.7.5.2 The dish shall be supported at the surface until the resin has completely foamed and has become hard. Excess foam around the cap may be wiped away before the resin sets or cut away after set occurs.

9.7.5.3 (Alternate)

The sprayed material shall be cut completely through to the substrate of a 12" x 12" square centered at the specimen.

9.7.5.4 The scale or weight shall next be engaged with the hook and a uniform force exerted perpendicular to the surface.

9.7.5.5 The test specimen shall support weight or equivalent force equal to five-times the weight of the applied insulation for a minimum of 1 minute. Additional weights or force may be placed on the hook assembly and the adhesive or cohesive failure recorded. In each case the weights must remain for a minimum of one minute. A minimum of 4 separate tests shall be performed to determine the average bond strength of the insulation/substrate combination.

9.7.5.6 A second test specimen shall be prepared in accordance with Sections 9.7.5.1, 9.7.5.2, and 9.7.5.3. The specimen shall then be conditioned at $120\text{ F} \pm 3\text{ F}$ and $90 \pm 3\%$ relative humidity for 24 hr. The specimen shall be tested in accordance with Sections 9.7.5.4 and 9.7.5.5.

9.7.6 Calculations

The force in pounds shall be divided by the area of the metal dish in square feet to determine the cohesive/adhesive force in pounds per square foot.

9.7.7 Report

The report shall include the following:

9.7.7.1

Type of substrate, product description, temperature, relative humidity, and exposure time. Bond strength of less than five-times the weight of the applied insulation shall constitute failure. Reporting of values in excess of this force are to be agreed upon between manufacturer and purchaser. The report shall include a description of the type of failure. If separation occurred within the material the report shall indicate a cohesive failure. If separation occurred at the interface of the substrate and the sprayed cellulosic insulation material the report shall indicate an adhesive failure.

9.8

Bond Deflection

9.8.1

Scope

This method of test covers a procedure for determining the effect of deflection on sprayed cellulosic insulation material.

9.8.2

Significance

The test measures the behavior of sprayed cellulosic insulation material when subjected to deflection and evaluates such phenomena as spalling and delamination under bending stress.

9.8.3

Apparatus

9.8.3.1

Supports

Rigid base to provide at least 2" bearing and a clear span between supports of 5'.

9.8.3.2

Load

Any form of weights or testing machine capable of applying a load normal to the test surface and of developing a deflection of 1/60 of the clear span of the specimen.

9.8.3.3

Deflection Gauge

A dial micrometer graduated to 0.001".

9.8.4 Test Specimen

The specimen shall consist of cellular steel deck of the non-composite type, nominal 1-1/2" thick, 2' wide x 6' long, consisting of a 0.60" galvanized or painted steel fluted top section and a 0.048" galvanized steel flat bottom section welded together to form four cells 6" on center. The sprayed cellulosic insulation shall be applied to the underside of the steel deck at a minimum of 1" thickness or at the maximum design thickness. The sprayed fire-resistive material shall not be applied to the area 13" in from each end of the specimen, in order to permit the steel deck to bear directly on the supports of the test fixture. The prepared specimen shall be allowed to condition at room temperature and atmospheric conditions. The test shall not be conducted sooner than 28 days, after the completed application of the sprayed insulation material.

9.8.5 Procedure

The specimen shall be placed on the test fixture supports to simulate the field condition of a floor construction, with the sprayed material as the lower surface. The specimen shall have a clear span between supports of 5'. A vertical center load shall be applied to the upper face of the specimen to develop a deflection of 1/60 of the clear span; i.e., 1.0". To measure the deflection of the specimen, the initial reading of the dial micrometer shall be recorded prior to the application of the load and deformation recorded as the load is applied.

9.8.6 Report

The condition of the test specimen when it has deflected the required 1/60 of the span shall be indicated. Spalling, delamination, and the like shall be considered failure of the test. The thickness in inches and the density of the sprayed cellulosic fiber in pounds per cubic foot shall be reported.

9.9 Air Erosion:

9.9.1 Scope

This method of test covers a procedure for determining the effect of an air stream upon sprayed cellulosic insulation material.

9.9.2

Significance

Air erosion tests on floor and ceiling construction to which sprayed cellulosic insulation materials have been applied shall be conducted to evaluate the behavior of the material when the floor construction is subjected to tangential air streams. Such tests evaluate the resistance to dusting, flaking, spalling and delamination of the sprayed cellulosic insulation material.

9.9.3

Apparatus

9.9.3.1

Application Base

A suitable substrate to which the test specimens shall be applied.

9.9.3.2

Duct System

Galvanized steel, with one or more rectangular openings in the roof of the duct. The roof opening(s) shall have a total minimum area of 4 square feet.

9.9.3.3

Instruments

Either a standard vane anemometer, a heated-thermocouple anemometer, a hot-wire anemometer, or a pitot tube used in conjunction with a suitable manometer, as described in ASHRAE Guide under "Velocity Measurement", to measure air velocities in the duct.

9.9.3.4

Blower

A blower capable of moving air through the entire cross section of the duct at a velocity sufficient to handle the test requirement.

9.9.3.5

Filters

A filter upstream of the test specimen (at the blower end) and a collecting filter downstream of the test specimen. These filters shall be made of 30 denier nylon. The nominal construction of the fabric shall be 94 ends per inch and 82 picks per inch or finer.

9.9.4 Test Specimen (laboratory)

The total number of test specimens prepared shall be one more than the number of duct roof openings. All specimens shall be prepared identically and allowed to cure and dry until constant weight is reached and/or all free water is removed.

9.9.5 Procedure

- 9.9.5.1 The collecting filter shall be dried at 120 F for 1 hr. weighed, and placed in the apparatus.
- 9.9.5.2 The specimens shall be placed into the duct roof opening(s) so that the face of the specimen(s) and the inside face of the duct are in the same plane.
- 9.9.5.3 With both filters and the specimen(s) in position, the blower shall be maintained at a velocity of not less than 1200 feet per minute for 24 hr.
- 9.9.5.4 At intervals of 6 and 24 hours, the blower shall be stopped and the collecting filter carefully removed, folded, dried at 120 F and weighed until the weight is constant within the nearest 0.001 gram. The net difference in weight between the 6 hr purging and the 24 hr. purging shall constitute the dust removed from the insulation material. The weight of the dust removed shall not exceed 0.025 gram per square foot.
- 9.9.5.5 A duplicate and identically prepared specimen, not subjected to this testing procedure, shall be conditioned under identical conditions and used to determine the thickness and density as follows:

Using a rigid template of known area (minimum 1 foot square) and the depth gauge as specified in 9.1.2.5 measure the average depth of the sprayed cellulosic insulation material with the depth gauge taking a minimum of 6 measurements per square foot of area. Place the template over said area and carefully cut away the edges of the area around the template. Carefully remove the sprayed cellulosic insulation material within the area of the template and weigh this product to the nearest 0.01 g. Calculate the density of the sample as follows:

$$d = W/A \times h$$

Where: d is the density
W is the weight in pounds
A is the area of the template in square feet
h is the depth of the insulation in feet

9.9.6 Report

The report shall indicate the difference in weight of the collecting filter before and after each test interval in grams. The thickness in inches and the density in pounds per cubic foot shall be recorded.

NOTE: This test procedure is not applicable to products which are installed in such a manner that physical restrictions imposed by the construction elements preclude any adverse erosion or dusting.

9.10 Fire Test of Building Partitions

Fire testing of building partition shall be tested in accordance with ASTM E 119.

9.11 Odor Emission

Subject a minimum of 50 g of the cured spray-applied material as prepared in Section 9.6.3.2, to a soaking temperature of 150 F for 30 minutes in a closed container. The container shall be made of stainless steel or glass jars with all metallic lids. Take care to use containers that will not produce odor. A panel of five persons with normal odor perception shall examine for odor using the following questions:

- a. Was the odor perceptable?
- b. Was the odor objectionable, pleasant or otherwise?
- c. Was the odor weak, strong or very strong?

9.12 Fungi Resistance

Determination of fungi resistance shall be in accordance with MIL-STD-810, Method 508, except the spore suspensions shall be prepared using distilled water. The back side of 1/2" standard commercial grade gypsum board grayback paper surface shall be used as the control. After the test exposure the test samples shall be examined at 40X magnification for evidence of fungal growth (see 6.9).

10. General Guidelines for Application:

10.1 Scope

10.1.1 These general guidelines cover the application recommendations for spray-applied cellulosic fiber insulations consisting of uniform mixtures of binders and cellulosic fibrous materials.

10.2 Significance

10.2.1 The purpose of these general guidelines is to provide application procedures, specifically regarding substrate surface preparations, general sprayed fiber techniques, reinforcement and mechanical supports, application limitations, and common precautions necessary to avoid application and performance difficulties.

10.2.2 When thermal insulations are not applied in accordance with prescribed and proven procedures, performance failures such as poor adhesion may occur. The various sections of this recommended practice explain certain methods suitable for obtaining optimum results with sprayapplied cellulosic fiber insulation.

10.2.3 The requirements herein discussed are general in nature and considered practical. They are not intended as specific recommendations.

10.3 Apparatus, Utilities, and Operational Requirements

10.3.1 Application Machine and Related Spray Equipment

The insulation shall be applied with manufacturer-approved spray application machines, spray nozzles, and other necessary equipment, in strict accordance with manufacturer's instructions and recommendations.

10.3.2 Utilities and Operational Requirements

Unless otherwise specified, the following services may be required:

10.3.2.1 Electricity - 120v/15A. 240v/6A.

- 10.3.2.2 Water - 4 gallons/min. at 60 psig at the application level.
- 10.3.2.3 Illumination - sufficient illumination shall be provided for proper application.
- 10.3.2.4 Ventilation - sufficient ventilation shall be provided to reduce any accumulated dust during application and to allow proper curing of applied insulation after application.
- 10.3.2.5 Protective equipment - current OSHA regulations apply. As a guide, personnel working within 15' of the spraying or feeding operation should wear approved masks, and goggles or face shields.
- 10.3.2.6 Reinforcement - pins, studs, and other attachments, when used, shall be secured to substrate prior to application of insulation.
- 10.3.2.7 Windbreaks - as necessary, in order to minimize overspray, provide windbreaks within the application area.
- 10.3.2.8 Protective covers - as necessary, to minimize contamination and reduce clean-up. Protective covers and tape shall be provided to mask off areas not intended for insulation application and to minimize overspray.
- 10.4 Application
- 10.4.1 The application of spray-applied thermal insulating materials shall consist of:
 - 10.4.1.1 Fluffing the otherwise compacted fiber and metering it through an application machine.
 - 10.4.1.2 Pneumatically conveying this processed fiber through a flexible hose to the fiber spray nozzle.
 - 10.4.1.3 Introducing an atomized liquid as it reaches the spray nozzle, and
 - 10.4.1.4 Directing the wetted material to a substrate in an even, uninterrupted pattern.
- 10.5 Preconditions
- 10.5.1 Prior to commencing the application of spray-applied cellulosic fiber insulations, certain preconditions shall be observed:

10.5.1.1 Type of Spray Nozzle

The type of atomizing spray nozzle shall be as specified by the manufacturer. Atomization may be accomplished by direct water pressure or compressed air, as required by the insulation manufacturer.

10.5.1.2 Liquid/Fiber Ratio

Specific recommendations of the thermal insulation manufacturer must be followed. Liquid flow should be measured periodically to assure a proper ratio.

10.5.1.3 Prewetting Surfaces

Surfaces may require prewetting prior to application of insulation. Adhesives, when used, must be applied in accordance with insulation manufacturer's instructions.

10.6 Application Conditions and Limitations

10.6.1. Applicators

Only the applicator's properly trained and approved personnel shall be allowed to load and operate spraying equipment, or to apply the spray cellulosic fiber insulations. Unauthorized personnel shall not be allowed in the load or spraying area.

10.6.2 Surface Preparation

The surface to be treated shall be clean and free of loose paint, rust, oil, grease, or any other condition that would prevent good adhesion of the sprayed cellulosic fiber insulation to the substrate. Certain substrates may require surface sealing prior to application of the insulation to prevent bleed-thru. Certain substrates, such as painted surfaces and metal, may require etching or other preparation prior to application of the insulation to assure proper bonding.

10.6.3 Application Temperature

Insulation manufacturer's application temperature ranges must be observed and followed. Applications normally should not be made under conditions where freezing of adhesive, or ice formation within the insulation, or at the substrate interface can occur, and cause delamination, which may or may not be immediately apparent.

10.6.4 Application Environment

Environmental conditions shall be of such nature as to preclude development of moisture condensation problems within the insulation or at the substrate interface, which may reasonably be expected to result in eventual delamination or detract from the performance of the insulation. Recommendations of the insulation manufacturer concerning building design and climatic conditions as relating to insulation applications shall be followed.

10.6.5 Limitations on Maximum Thickness

A maximum thickness of 2" shall be applied without reinforcement in a single pass application. This limitation is directed at overhead horizontal applications and sloped applications where the gravitational force is directed perpendicular to the plane of the substrate. Applications to walls shall follow manufacturer's recommendations concerning thickness of initial pass. Applications in excess of 2" shall follow the manufacturer's recommendations for overhead applications.

10.6.6 Salt Corrosive Atmospheres

Where salt corrosive atmospheres, or otherwise hostile environments prevail, special attention may be needed for the following items:

- a. Special surface preparation.
- b. Type of insulation used.
- c. Type of reinforcement used.
- d. Need for protective coatings.
- e. Special liquid additive requirements.
- f. Long-term weathering provisions for outdoor exposure.

10.6.7 Heat Sources

Insulation manufacturer's application instructions for areas adjacent to potential or actual heat sources must be observed and followed. These include electrical outlets and heating ducts. Manufacturer's instructions shall contain specific fire safety installation details for these areas.

10.7 Certification

Each applicator shall certify to the purchaser that he/she is licensed as such and will furnish a copy of said certification upon request. The applicator also shall certify the type, amount, thickness and R-value of the insulation installed.

11. GENERAL GUIDELINES FOR ON-SITE QUALITY CONTROL INSPECTION

11.1 Scope

11.1.1 This section presents a general set of guidelines to assist contractors, inspectors and users in ascertaining that the proper application precautions are being followed. These general guidelines should be used in conjunction with the manufacturers' specific instructions for application.

11.1.2 It is not the intent of this procedure to determine the acceptance or rejection of any particular spray material, but rather to determine the acceptance or rejection of a particular job application based on methods of field inspection and quality control procedures for all materials.

11.2 Application

11.2.1 The application of spray-applied cellulosic insulation shall be the same as determined acceptable under a laboratory or field testing program. If adhesive, troweling, multiple coats, reinforcing or other procedures were utilized in the testing the same procedures shall be followed on the job site application.

11.2.2 These procedures shall be applicable to all direct contact spray applied cellulosic fiber materials.

11.3 Inspection Procedure

11.3.1 Check List

There are a number of physical and visual test procedures to be made as follows:

- a. Condition of substrates
- b. Thickness of application
- c. Density in pounds per cubic foot
- d. Bond strength - adhesion/cohesion.
- e. Inspection of patching work

11.3.2 Inspection

Inspection personnel shall be permitted to enter the premises as often as deemed necessary to observe the progress and application of the sprayed material and review the records of the applicator or manufacturer of the insulation.

11.3.3. Qualifications

Persons inspecting said spray applied cellulosic fiber insulation materials shall be adequately instructed in the use, application and capabilities of these products and shall be thoroughly familiar with the details of all procedures.

11.3.4 Materials and Design

All materials shall be properly labeled to allow appropriate identification for determining compliance with the accepted materials and design.

11.3.5 Test Reports

Testing laboratories shall perform the specified tests in this procedure and shall report promptly the findings, as appropriate to the Architect, General Contractor and insulation sub-contractor, etc., and to HUD. In any case, the report shall be no later than one week after each floor or 10,000 square feet is completed.

11.4 Method of Tests

The following tests shall be based on random samplings and are the responsibility of the insulation contractor or his representative. Substrate conditions shall be inspected before application, for proper preparation of substrate. All required tests shall be performed as the installation progresses, where practical.

11.4.1 Substrate Condition

All substrates shall be free of dirt, grease, release agents, loose scale, extensive rust and loose paint (primer) which in the judgement of the insulation sub-contractor will prevent adequate adhesion. Areas not in compliance shall be reported to the General Contractor for proper preparations.

11.4.2 Thickness Determination

Thickness of spray applied insulation shall be determined by use of a thickness gauge. One example of a thickness gauge is shown in Figure 1. The thickness measurements shall not be less than design thickness. Additional material shall be applied to those areas which have been rejected due to insufficient thickness.

11.4.2.1 Areas to be Measured for Thickness

Areas or bays which comprise at least 25% of each floor shall be preselected for testing as follows:

11.4.2.2 Floor/Ceiling Sections

Four random measurements per bay, or similar unit, shall be taken. To achieve random measurements it is suggested that a 12" x 12" square be laid out and a thickness measurement be taken at each corner.

11.4.2.3 Beams, Columns and Bar Joists

Measurements for thickness on beams, columns and bar joists shall be done on those adjoining the bays or similar units, tested for floor thickness. Four random measurements shall be taken for each. For each beam and each column tested, tests shall be made: two on the flange and two on the web section.

11.4.2.4 Special Floor/Ceiling Sections

In areas where additional thickness is required, such as under trench header ducts, etc., two additional measurements per bay, or similar units, tested, shall be taken.

Thickness Gauge

The gauge consists of a 3" diameter disk with a 1/8" diameter probe. The probe is marked off in increments of 1/16" to facilitate accurate measurements. A spring loaded slide stop is attached to the disk to allow the operator to move the disk back and forth. The probe is inserted into the insulation until the substrate is reached and the disk is then moved to register the plane of the insulation surface.

The probe is removed and the depth is read to the nearest 1/16" on the indicator. Caution should be exercised to prevent compression of the insulation when moving the disk to register the plane of the insulation.

11.4.3 Density Determination

11.4.3.1 Samples for density determination shall be one for each 10,000 square feet of floor/ceiling or wall area randomly selected, but shall be no less than two per floor. The average of all individual densities per floor shall not be less than the design criteria selected. No individual density shall be less than 90% of the required average density.

11.4.3.2 Density Test Method

- a. Mark off correct size of specimen using a suitable template.
- b. Test area for thickness before removal. Area size shall not be less than 36 square inches (6" x 6") if possible. The average thickness shall be determined from the measurements: For a 6" x 6" sample, take one measurement in center of 6" x 6" area and one at each corner approximately 1-1/2" from adjoining sides.
- c. Cut perimeter to substrate to allow removal.
- d. Remove insulation cleanly from substrate with 3" or 4" spatula.

11.4.3.2.1 Upon removal from the substrate, the density specimen shall be dried at 75 F and 50% relative humidity until constant weight, usually 24 hr to 48 hr. but for a minimum of 24 hr. A scale with an accuracy of 0.1 g shall be used to weight all specimens.

11.4.3.2.2 Density Calculations

Density shall be calculated in accordance with the following formula:

$$\text{Density in lbs. per cu. ft.} = \frac{W \times 1728}{l \times w \times t}$$

- a. Where W is weight of dry material in pounds; l is length of specimen in inches; w is width of specimen in inches; t is thickness of specimen in inches.

NOTE: For conversion of grams to pounds, divide gram weight of sample by 453.6 to obtain pounds.

11.4.4 Bond Strength (Adhesion and Cohesion)

11.4.4.1 Bond Strength of thoroughly dried and cured materials shall be at least five times the weight of insulation.

11.4.4.2 The test shall be conducted on areas adjoining the test section used for thickness and density determinations and shall be one test for beams and one test for walls (sloped) and one test for floor /ceiling decks for each 10,000 square feet of area, but a minimum of two tests per floor.

11.4.4.3 Method

a. Apparatus

1. A metal or plastic bottle cap, 3-1/4" in diameter and approximately 1/2" deep. A nail hook shall be attached at the outside center by pre-drilling a 1/8" center hole. The cap and nail hook shall weigh 1.2 ounces.
2. A two component adhesive system of urethane resin to form a quick set rigid foam.
3. A spring scale of sufficient capacity to measure the force five times the weight of the insulation being tested, with accuracy to 1/4 lb.

b. Procedure

1. A sufficient quantity of the two component urethane resin system shall be mixed in the cap, with hook attached and the cap immediately placed against the sprayed cellulosic fiber insulation material being used.

2. The cap is held in place until the resin has completely foamed and has set sufficiently to become self supporting.
3. After the foam becomes hard the spring scale is carefully engaged on the hook. This applies a uniform force perpendicular to the surface.
4. The material must support the weight for 1 min. in order to pass the test.
5. The bond strength in pounds per square feet is the force applied in pounds divided by the cap area in square feet as follows:

Force is that registered on the spring scale plus 1.2 ounce cap.

Area of the 3-1/4" diameter cap is 0.0578 square feet.

Therefore: $\frac{\text{Force (lbs) plus 1.2 oz}}{0.578} = \text{lbs. per square ft.}$

NOTE:

1. The adhered cap can be removed by carefully cutting the foam away from the fibrous insulation with a sharp knife or hacksaw blade.
2. Caps are available from laboratory supply houses or bottle suppliers.
3. The two component urethane foam resin system is available from Insta-Foam Products Company, 880 S. Fiene Drive, Addison, Illinois 60101 or a Sprayed Mineral Fiber Manufacturer's Association(SMFMA) member company.

11.4.5 Drying and Curing

- 11.4.5.1 Prior to any and all testing the Lab Technician shall determine that the spray applied cellulosic insulation is fully cured. This must be established before any tests for adhesion or cohesion are performed.

11.5.1 Upon complete drying or curing, sprayed insulation materials shall not show any cracks through which the substrate is exposed.

11.6 Patching

11.6.1 It is the responsibility of the insulation contractor (or representative) to note that corrective measures have been applied to all areas in need of respraying or patching where sprayed insulation has been deliberately removed for testing, damaged, or removed by other trades.