

**TITLE:** Standard Test Procedure for Acceptance of Materials used as Welding and Cutting Curtains and Thermal Barriers in Underground Coal Mines

---

**1.0 PURPOSE**

This document establishes the Mine Safety and Health Administration's (MSHA) standard test procedure for accepting materials used as welding and cutting curtains and thermal barriers in underground coal mines.

**2.0 SCOPE**

- 2.1. This procedure applies to all materials used a welding and cutting curtains and thermal barriers in underground coal mines.
- 2.2. This procedure may involve hazardous materials, operations, and equipment. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

**3.0 REFERENCES**

None

**4.0 DEFINITIONS**

- 4.1. Thermal Barrier - a material used to provide separation of coal or other combustible materials from equipment as defined in Title 30, Code of Federal Regulations, Part 75.1107-1(a)(3) that specifically lists unattended enclosed motors, controls, transformers, rectifiers, and other similar noncombustible electrically-powered equipment containing no flammable fluid.
- 4.2. Welding and Cutting Curtains - materials used as horizontal or vertical barriers designed to resist the passage of hot sparks or molten metal generated from welding and cutting operations.

**5.0 TEST EQUIPMENT**

**Thermal Barrier Test Equipment - Section 5.1**

**Welding and Cutting Curtain Test Equipment - Section 5.2**

### 5.1. Equipment for the Testing of Thermal Barriers

- 5.1.1. A calibration is performed on each piece of equipment as often as necessary to ensure accuracy to within at least 0.5 percent of the Celsius temperatures recorded during a test.
- 5.1.2. Appropriate safety equipment should be utilized to minimize the exposure of personnel that are conducting these tests to the fumes emitted during testing and to provide protection against heat when handling hot test specimens.
- 5.1.3. Ambient air temperature during all testing shall be  $26^{\circ}\text{C} \pm 5^{\circ}\text{C}$  ( $79^{\circ}\text{F} \pm 9^{\circ}\text{F}$ ).
- 5.1.4. Temperature measuring and recording instrumentation adequate for measuring and recording the temperature as specified at intervals not exceeding 10 seconds. The temperature measuring and recording equipment is accurate to within at least 0.5 percent of the Celsius temperatures recorded during any test.
  - 5.1.4.1. A furnace thermocouple to measure the furnace temperature during the test.
  - 5.1.4.2. A surface thermocouple to measure the temperature at the surface of a specimen during the test.
  - 5.1.4.3. A specimen thermocouple to measure the temperature at the geometric center of the specimen during the test.
- 5.1.5. Timing instrumentation for timing the length of tests.
- 5.1.6. A hot-air vertical tube ignition furnace adequate for providing the uniform heating of the test specimen at the required test temperature (see descriptive arrangement in Figure 1). MSHA's test procedures and criteria are modified from those outlined in the ASTM E-136 Test: Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C.
- 5.1.7. A weighing balance accurate to 0.1 gram.
- 5.1.8. A desiccator.

**TITLE:** Standard Test Procedure for Acceptance of Materials used as Welding and Cutting Curtains and Thermal Barriers in Underground Coal Mines

---

5.1.9. Five (5) specimen weighing dishes sized to accommodate sizes 38mm (+ 2mm, - 0mm) by 38 mm (+ 2mm, - 0mm) for testing. The maximum depth of the dishes should not exceed 7mm.

5.2. Equipment for the Testing of Welding and Cutting Curtains

5.2.1. Appropriate protective safety apparel for use when cutting 12.4mm diameter holes in 7mm thick cold rolled steel with an electric welder.

5.2.2. A confining enclosure and support stand assembly (see Figure 2).

5.2.3. The confining enclosure shall be assembled from four Marinite® plates or equivalent noncombustible material having dimensions of 305mm ( $\pm$  3mm) by 305mm ( $\pm$  3mm) by 12.7mm ( $\pm$  1mm). The enclosure is reinforced around the top and bottom with flame retardant painted plywood of nominal dimensions of 320mm by 38mm by 12.7 mm.

5.2.4. A barrier support stand, Figure 2, constructed of nominal 25mm angle iron or similar material measuring 356mm by 356mm (nominal) supported by four legs 152mm (nominal) in length.

5.2.5. Three (3) cold-rolled steel plates for each thickness material manufactured measuring 371mm ( $\pm$  3mm) square by 7mm ( $\pm$  1mm) thick.

5.2.6. Three (3) sheets of brown Kraft® paper or equivalent for each thickness of material manufactured measuring 432mm ( $\pm$  3mm) square.

5.2.7. An electric welder with adequate power for cutting 7mm thick cold rolled steel with 3.2mm diameter Number 7014 or equivalent welding rods.

5.2.8. Welding rods, Number 7014, 3.2mm diameter or equivalent.

## 6.0 TEST SAMPLES

### Thermal Barrier Test Samples - Section 6.1

### Welding and Cutting Curtain Test Samples - Section 6.2

#### 6.1. Thermal Barrier Test Samples

6.1.1. Appropriate protective safety equipment and apparel should be utilized while test specimens are being prepared.

**TITLE:** Standard Test Procedure for Acceptance of Materials used as Welding and Cutting Curtains and Thermal Barriers in Underground Coal Mines

---

- 6.1.2. Prepare five (5) specimens representative of the properties of the sample designated for testing. The dimensions of the specimens shall be 38mm (+ 2mm, - 0mm) by 38 mm (+ 2mm, - 0mm) by 50mm (+ 3mm). If the finished material is coated to improve moisture and abrasion resistance, the specimens for this test shall be taken from material that has not been coated.
- 6.1.3. If the height of a material, except a composite material, is less than 47mm, the specimens prepared shall consist of layers of the sample.
- 6.1.3.1. The specimens must be held firmly together during testing.
- 6.1.4. If the sample is a composite material and has a height that is not 50mm ( $\pm$  3mm), the layers of the specimen shall be proportional in thickness to the layers of the sample.
- 6.1.5. The top and bottom faces of each specimen prepared shall be the faces of the material as manufactured.
- 6.1.6. If it is not practical to prepare a specimen by the procedures described in paragraphs 6.1.2, 6.1.3, and 6.1.4, the test shall be performed on five specimens of each component of the sample made to the dimensions prescribed in paragraph 6.1.2.
- 6.1.7. A vertical hole shall be made in the top center of each specimen to a depth of one half the height of the specimen. The hole diameter should be sized to accept the thermocouple used in testing.
- 6.1.8. Each specimen shall be conditioned for at least 20 hours in a ventilated oven at  $60^{\circ}\text{C} \pm 5^{\circ}\text{C}$  ( $140^{\circ}\text{F} \pm 9^{\circ}\text{F}$ ). The specimens shall be cooled to ambient room temperature in a desiccator prior to testing.
- 6.2. Welding and Cutting Curtain Test Samples
- 6.2.1. Appropriate protective safety equipment and apparel should be utilized while test specimens are being prepared.
- 6.2.2. The specimens for the welding and cutting curtain evaluation tests need only come from nominal laboratory storage and be dry without any accumulations of condensation. If the finished product is coated to

improve moisture and abrasion resistance, the specimens for this test must be taken from material that has been coated.

- 6.2.3. The welding and cutting curtain evaluation test requires three (3) test specimens measuring 406mm ( $\pm 3$ mm) square by the thickness as manufactured to be cut from a larger sheet of material. The test specimens may be further trimmed on the corners to accommodate the support stand (see Figure 2). If more than one thickness is manufactured, three specimens of each thickness of material shall be tested.

## 7.0 PROCEDURES

### Thermal Barrier Test Procedures - Sections 7.1 & 7.2

### Welding and Cutting Curtain Test Procedures - Section 7.3

#### 7.1. Test Procedures for Thermal Barriers

- 7.1.1. Appropriate protective safety equipment and apparel should be utilized while specimens are being tested.
- 7.1.2. The furnace thermocouple,  $T_2$ , is located in the furnace approximately 10mm from the furnace wall at a height of approximately 75mm above the bottom of the furnace until the furnace is stabilized (see Figure 1).
- 7.1.3. The furnace shall be turned on and permitted to stabilize for at least 10 minutes at  $750^{\circ}\text{C} \pm 10^{\circ}\text{C}$  ( $1382^{\circ}\text{F} \pm 18^{\circ}\text{F}$ ) and maintained at the stabilized temperature for the duration of the test.
- 7.1.4. The temperature recording equipment shall be turned on and a temperature measurement made at each thermocouple as designated not less than once each 10 second period.
- 7.1.5. Specimens shall be removed from the desiccator one at a time, weighed and placed onto the furnace's specimen holder, thermocouples attached, and then inserted into the furnace.
- 7.1.6. Two thermocouples are attached to the test specimen as shown in Figure 1. The specimen thermocouple,  $T_4$ , is inserted into the hole in the top center of the specimen to a depth approximately equal to one-half the depth of the specimen.

**TITLE:** Standard Test Procedure for Acceptance of Materials used as Welding and Cutting Curtains and Thermal Barriers in Underground Coal Mines

---

- 7.1.7. The surface thermocouple,  $T_3$ , is placed in contact with the side of the specimen at the approximate mid-height of the specimen.
- 7.1.8. Note that the furnace thermocouple,  $T_2$ , is located between the furnace wall and the specimen diametrically opposite thermocouple  $T_3$ . The furnace, specimen, and surface thermocouples should now be located in approximately the same horizontal plane.
- 7.1.9. The specimen is inserted into the furnace such that the approximate center of the test specimen is at the furnace thermocouple's hot junction.
- 7.1.10. The test specimen must be placed into the furnace within five seconds of opening the furnace.
- 7.1.11. The initiation of the timing apparatus shall coincide with the placement of the test specimen into the furnace.
- 7.1.12. The duration of the test period shall be 20 minutes, or until peak temperatures for all thermocouples have passed. The duration and occurrence of any flaming shall be recorded.
- 7.1.13. At the end of the test period, the test specimen shall be removed from the furnace and weighed while it is still hot.
- 7.1.14. The testing sequence shall be repeated until all the specimens have been tested.
- 7.2. Additional Tests for Fiberglass and Other Materials That Melt at  $750^{\circ}\text{C} \pm 10^{\circ}\text{C}$ :
- 7.2.1. If the material submitted for testing is fiberglass or other material that melts at  $750^{\circ}\text{C} \pm 10^{\circ}\text{C}$  ( $1382^{\circ}\text{F} \pm 18^{\circ}\text{F}$ ), it is tested as described in sections 7.1.1 through 7.1.14, except the average weight loss of the specimens are determined as follows:
- 7.2.2. Prepare five additional specimens as described in Section 6.1.2.
- 7.2.3. Each of the additional specimens is placed on a weighing dish and both the specimen and the weighing dish are conditioned as described in Section 6.1.8.

**TITLE:** Standard Test Procedure for Acceptance of Materials used as Welding and Cutting Curtains and Thermal Barriers in Underground Coal Mines

---

- 7.2.4. Each specimen and its weighing dish is removed from the desiccator after cooling and immediately prior to testing. The specimen and its weighing dish are weighed to the nearest 0.1 gram.
- 7.2.5. Each specimen and its weighing dish is placed in the furnace specimen holder one at a time and tested in the stabilized furnace at  $750^{\circ}\text{C} \pm 10^{\circ}\text{C}$  ( $1382^{\circ}\text{F} \pm 18^{\circ}\text{F}$ ) for 20 minutes or until peak temperatures have passed. No specimen thermocouple or surface thermocouple is attached to the specimen.
- 7.2.6. At the end of the heating period, the specimen and weighing dish are removed from the furnace and weighed while still hot.
- 7.2.7. The testing sequence shall be repeated until the additional specimens have been tested.

7.3. Test Procedures for Welding and Cutting Curtains

- 7.3.1. Appropriate protective safety equipment and apparel should be utilized while specimens are being tested.
- 7.3.2. The support stand is placed on a solid nonflammable surface and a sheet of brown Kraft® paper is placed directly beneath the support stand and held in place by the support stand legs. No intentional air space is to be created beneath the Kraft® paper.
- 7.3.3. A test specimen is draped over the support stand and the confining enclosure lowered into the support stand to secure the material in place.
- 7.3.4. A sheet of the cold-rolled steel is centered (approximately) on top of the confining enclosure.
- 7.3.5. Appropriate safety apparel for welding is donned and the welder is then used to cut three nominal 12.7mm diameter holds spaced approximately 152mm apart at points representing an equilateral triangle in the approximate center of the plate with respect to the exposed test specimen. No intentional time delay shall occur between the cutting of the holes.

## 8.0 TEST DATA

**Thermal Barriers - refer to Section 9.1.1.1, 9.1.1.2 and 9.1.3**

**Welding and Cutting Curtains - refer to Section 9.2.1 and 9.2.2**

## 9.0 PASS/FAIL CRITERIA

**Thermal Barriers Pass/Fail Criteria - Section 9.1**

**Welding and Cutting Curtains Pass/Fail Criteria - Section 9.2**

### 9.1. Criteria for Thermal Barriers

9.1.1. For acceptance, the test results of the material submitted shall fall within the following limits:

9.1.1.1. The highest temperature recorded for each specimen by the furnace thermocouple,  $T_2$ , when averaged with the highest temperatures recorded for all other specimens, is not more than 50°C (122°F) above the stabilized furnace temperature.

9.1.1.2. The highest temperature recorded for each specimen by the surface thermocouple,  $T_3$ , when averaged with the highest temperatures recorded for all other specimens, is not more than 50°C (122°F) above the stabilized furnace temperature.

9.1.2. The duration of flaming of each specimen during testing, when averaged with the duration of flaming recorded for all other specimens, shall not be greater than 10 seconds.

9.1.3. The average weight loss of the specimens after heating shall not be greater than 50 percent of their average weight after conditioning.

9.1.4. For acceptance of fiberglass and materials that melt at 750°C ± 10°C (1382°F ± 18°F), the average weight loss of the specimens after heating shall not be more than 50 percent of their average weight before heating.

### 9.2. Criteria for Welding and Cutting Curtains

9.2.1. The material is acceptable if the hot sparks and molten steel drippings from the welding and cutting process do not penetrate and ignite the brown Kraft® paper sheets beneath the support stand in any of the three tests.

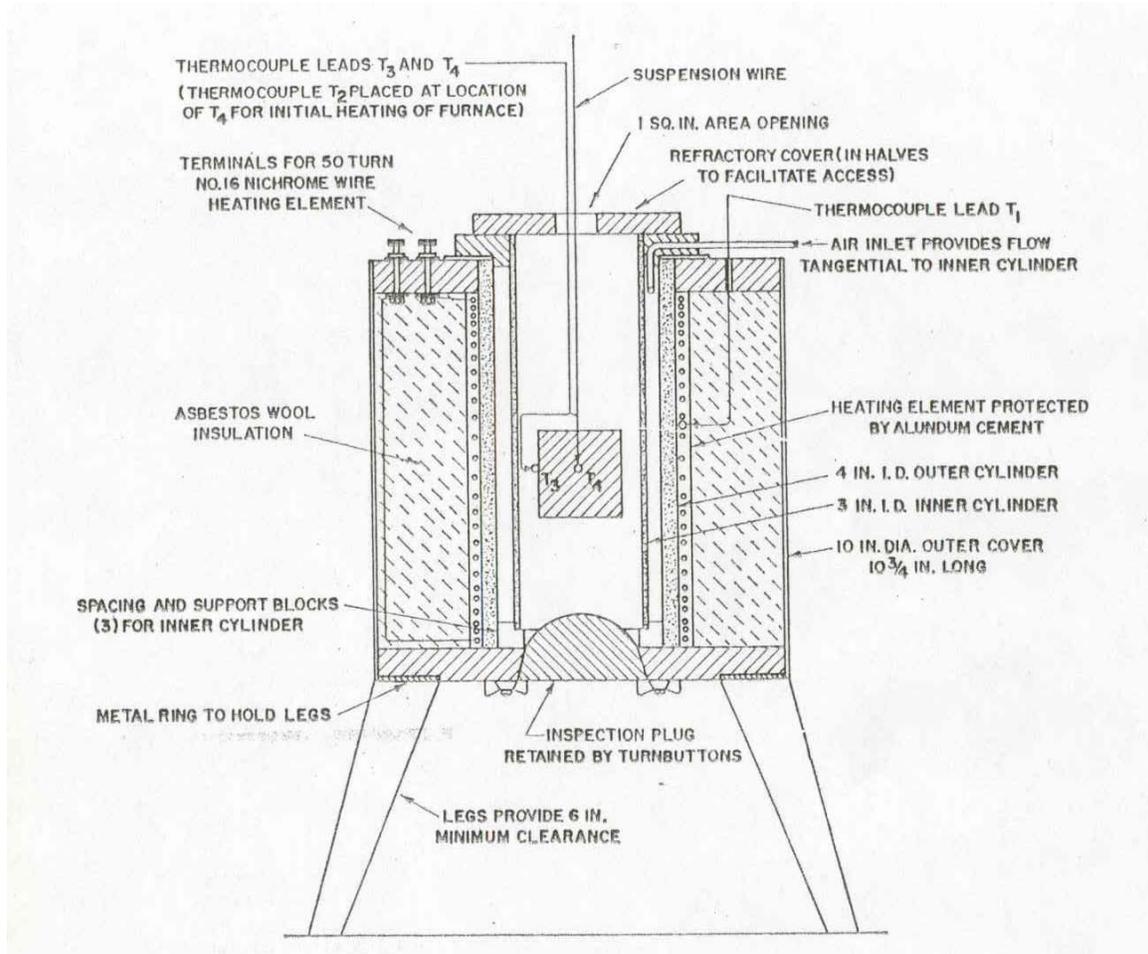
TITLE: Standard Test Procedure for Acceptance of Materials used as Welding and Cutting Curtains and Thermal Barriers in Underground Coal Mines

---

9.2.2. Supplementary Test for Determining the Flame Spread Index of Coated Materials:

In addition to the tests defined in Sections 7.0 and 8.0, welding and cutting curtains and thermal barriers that are coated to improve moisture and abrasion resistance properties shall exhibit a flame spread index less than or equal to 25 when tested in accordance with ASTM Standard E 162-87, Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source. Specimens used for this test must be cut from material that has been coated.

TITLE: Standard Test Procedure for Acceptance of Materials used as Welding and Cutting Curtains and Thermal Barriers in Underground Coal Mines

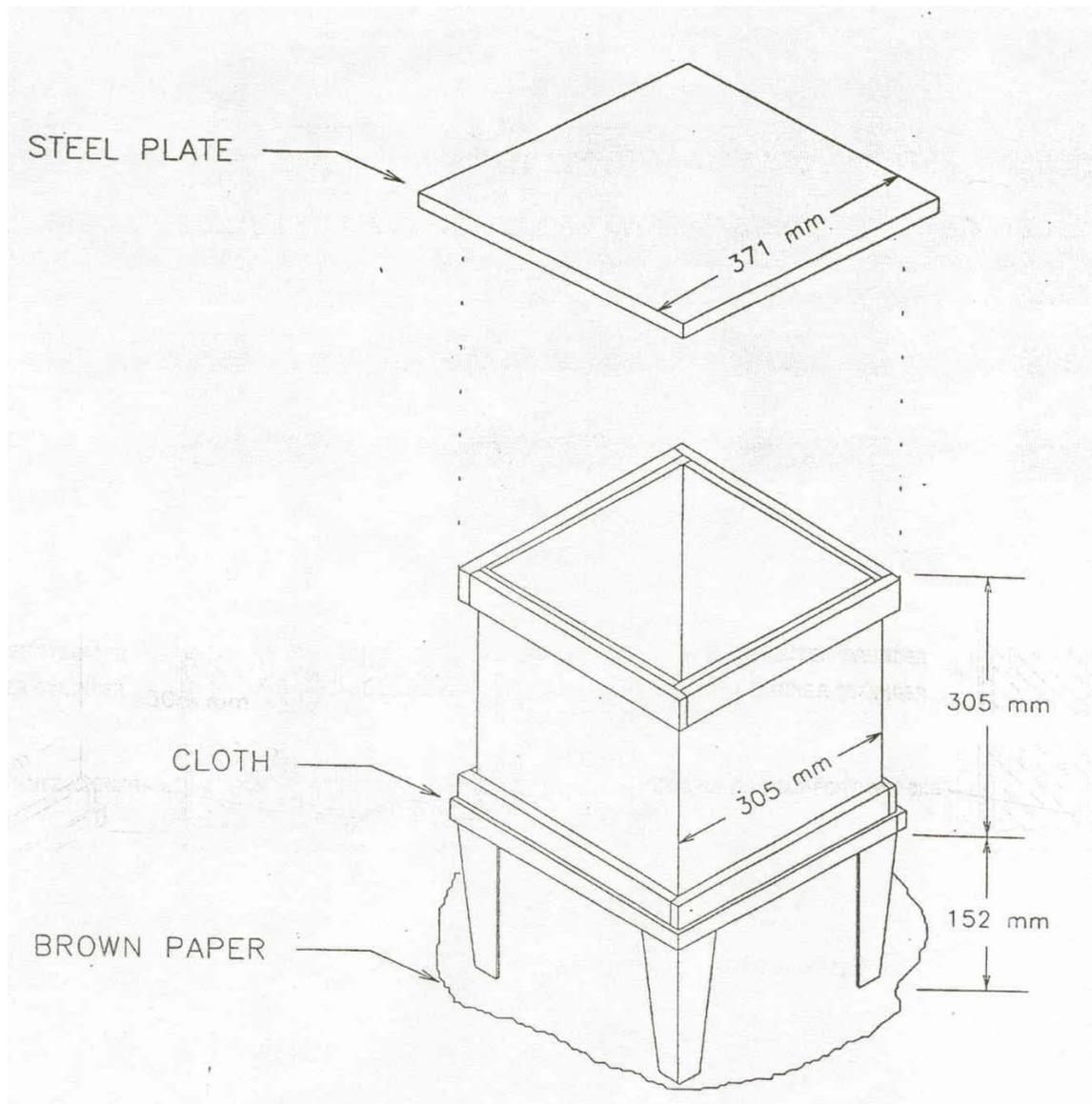


FURNACE ASSEMBLY CROSS SECTION

Figure 1

TITLE: Standard Test Procedure for Acceptance of Materials used as Welding and Cutting Curtains and Thermal Barriers in Underground Coal Mines

---



TESTING UNIT  
WELDING AND CUTTING CURTAIN THERMAL PERFORMANCE TEST

Figure 2