

## FLAME RESISTANCE OF CLOTH; VERTICAL

## 1. SCOPE

1.1 This method is intended for use in determining the resistance of cloth to flame and glow propagation and tendency to char. It is designated primarily for flame resistant fabrics, but may be utilized in other applications as specified in applicable procurement documents. In addition to the vertical position of the sample and flame exposure conditions common to tests of this type, the method defines gas, burner, cabinet, temperature and humidity test conditions.

## 2. TEST SPECIMEN

2.1 The specimen shall be a rectangle of cloth 3 inches (76 mm) by 12 inches (305 mm) with the long dimension parallel to either the warp or filling direction of the cloth. No two warp specimens shall contain the same warp yarns, and no two filling specimens shall contain the same filling yarns.

## 3. NUMBER OF DETERMINATIONS

3.1 Unless otherwise specified in the procurement document, five specimens from each of the warp and filling directions shall be tested from each sample unit.

## 4. APPARATUS

4.1 Cabinet. A cabinet and accessories, fabricated in accordance with the requirements specified in figures 5903A, B, and C. Galvanized sheet metal or other suitable metal shall be used. The entire inside back wall of the cabinet shall be painted black to facilitate the viewing of the test specimen and pilot flame (see 7.1.2).

4.2 Burner. The burner shall be equipped with a needle valve to adjust the flame height, a barrel having a 3/8 inch (10 mm) inside diameter and a pilot light.

4.2.1 The burner may be constructed by combining a 3/8 inch (10 mm) inside diameter barrel  $3 \pm 1/4$  inches ( $76 \pm 6$  mm) long with a base from an adjustable valve burner. A tirrill burner is recommended but a bunsen burner modified to conform to this test method will also suffice.

4.2.2 The pilot light tube shall have an inside diameter of approximately 1/16 inch (2 mm) and shall be spaced 1/8 inch (3 mm) away from the burner edge.

## METHOD 5903.1

4.2.3 The necessary gas connections and the applicable plumbing shall be as specified in Figure 5903D except that a solenoid valve may be used in lieu of the stopcock valve to which the burner is attached. The solenoid valve shall be capable of being fully opened or fully closed in 0.1 second and activated by an adjustable timer.

4.2.4 On the side of the barrel of the burner, opposite the pilot light there shall be a metal rod of approximately 1/8 inch (3 mm) diameter spaced approximately 1/2 inch (13 mm) from the barrel and extending above the burner. The rod shall have two prongs (approximately 5/16 inch (8 mm)) marking the distances of 3/4 inch (19 mm) and 1-1/2 inches (38 mm) above the top of the burner.

4.2.5 The burner shall be movable when placed in the cabinet and capable of adjustment so that the center of the barrel of the burner is directly below the center of the specimen when performing the test.

4.3 Gas regulator valve system. A control valve system with a delivery rate designed to furnish gas to the burner under a pressure of 2-1/2 ± 1/4 pounds per square inch (17.2 kPa ± 1.7 kPa) at the burner inlet. The manufacturer's recommended delivery rate for the valve system shall include the required pressure (see 7.1.1).

4.4 Gas mixture. Methane 99% pure (see 7.1.1).

4.5 Metal hooks and weights. Metal hooks and weights to produce a series of total loads to determine length of char. The metal hooks shall consist of No. 19 gage steel wire or equivalent and shall be made from 3-inch (76 mm) lengths of the wire and bent 1/2 inch (13 mm) from one end to a 45-degree hook.

4.6 Stop watch. Stop watch or other device to measure the burning time to 0.2 second.

4.7 Measuring scale. Measuring scale graduated in increments of 1/8 inch (3 mm) to measure the length of char.

4.8 Specimen holder clamps. Spring steel clamps capable of holding the specimen firmly in its holder while subjected to the flame test.

## 5. PROCEDURE

5.1 The material undergoing test shall be evaluated for the characteristics specified in the applicable procurement document, i.e. after-flame time, after-glow time and char length on each specimen.

5.2 All specimens to be tested shall be at moisture equilibrium under standard atmospheric conditions in accordance with Section 4 of this standard. Each specimen to be tested shall be exposed to the test flame within 2 minutes after removal from the standard atmosphere.

5.3 The test cabinet can be set up in a laboratory hood. Precautions shall be taken to minimize the draft through the laboratory hood while testing. Open doors or windows are examples of unnecessary causes of drafts and shall be avoided. A ventilation smoke tube kit may be obtained to check for the presence of drafts (see 7.1.3).

5.4 Adjust gas pressure to  $2.5 \pm 0.25$  pounds per square inch (see 4.3). Ignite and adjust the pilot flame approximately 1/8 inch (3 mm) in height when measured from its lowest point to the tip so that it does not alter shape of the test flame during the 12 seconds ignition time. The burner flame shall be adjusted by means of the needle valve in the base of the burner to give a flame height of 1-1/2 inches (38 mm) with the solenoid fully open and the air supply to the burner shut off or taped so as not to allow air to enter. The 1-1/2 inch (38 mm) flame height is obtained by adjusting the needle valve so that the uppermost portion (tip) of the flame is level with the top of the metal prong. (It is important that the flame height be adjusted with the tip of the flame level with the tip of the metal prong. This may be more easily accomplished with nearby lights turned off.)

5.5 Adjust the timer to 12 seconds. This can be accomplished by timing the period between the opening and closing of the solenoid with an accurate laboratory timer or stopwatch.

5.6 The specimen shall be clamped in its holder in such a manner that the entire length of the specimen is exposed. Insert the holder containing a specimen into the test cabinet (with the laboratory hood ventilation off) and position the burner so that the middle of the lower edge of the specimen is centered 3/4 inch (19 mm) above the burner and level with the bottom metal prong. Open the solenoid by starting the timer thereby creating the test flame. At the end of the 12-second period, afterflame and afterglow shall be determined (see 5.7 and 5.8). Remove the specimen. If appropriate, turn on the laboratory hood fan (if available) until all smoke and fumes are removed, then shut off the fan and proceed with testing of additional specimens.

5.7 The afterflame time shall be the time the specimen continues to flame after the 12 second period (as indicated by the closing of the solenoid). Timing of afterflame shall be accomplished by means of a timer, stop watch or any timing device capable of recording to 0.2 second.

5.8 The afterglow time shall be the time the specimen continues to glow after it has ceased to flame (as a result of the 12 seconds flame impingement and afterflame). Timing of afterglow shall be accomplished by means of a timer, stop watch, or any timing device capable of recording to 0.2 seconds. The glow shall not be extinguished even when the afterglow time is not being evaluated because of the glow's effect on char length.

## METHOD 5903.1

5.9 After each specimen is removed, the test cabinet shall be cleared of fumes and smoke prior to testing the next specimen.

5.10 After removing the specimen from the cabinet the specimen shall be allowed to cool and the char length measured. The char length shall be the distance from the end of the specimen which was exposed to the flame to the top of the lengthwise tear made through the center of the charred area. The specimen shall be folded lengthwise and creased by hand along a line through the highest peak of the charred area. The hook shall be pierced into the specimen (or inserted into a hole, 1/4 inch (6 mm) diameter or less) at one side of the charred area 1/4 inch (6 mm) in from the lower end. A weight of sufficient size (such that the weight and hook together shall equal the total tearing load required in 5.1.1) shall be attached to the hook.

5.11 A tearing force shall be applied gently to the specimen by grasping the corner on the cloth at the opposite edge of the char from the load and raising the specimen and weight clear of the supporting surface. The specimen shall be raised in one smooth continuous motion, and shall not be jerked or pulled forcefully upward. The end of the tear shall be marked on the edge of the specimen and the char length measurement made along the undamaged edge.

5.11.1 Loads for determining char length. The specific load applicable to the weight of the test cloth shall be as follows:

<u>Specified weight per square yard of cloth before any fire retardent treatment or coating</u>		<u>The tearing weight for determining the charred length</u>	
<u>Ounces per square yard</u>	<u>g/m<sup>2</sup></u>	<u>Pounds</u>	<u>kg</u>
2.0 to 6.0	68 to 203	0.25	0.1
Over 6.0 to 15.0	Over 203 to 508	0.5	0.2
Over 15.0 to 23.0	Over 508 to 780	0.75	0.3
Over 23.0	Over 780	1.0	0.45

## 6. REPORT

6.1 The afterflame time, afterglow time and char length of the sample unit shall be the average of the results obtained from the individual specimens tested in each of the warp and filling directions. The averages for the warp and filling shall be reported separately. All values obtained from the individual warp and filling specimens shall be recorded in addition to the averages.

6.2 The averages of the afterflame time and afterglow time shall be reported to the nearest 0.5 second and the char length to the nearest 1/8 inch (3 mm).

7. NOTES

7.1 Suggested sources of materials and equipment.

7.1.1 Gas mixture (4.4) and regulator valve system (4.3) are available from:

- (a) Matheson Gas Products  
P.O. Box 85  
East Rutherford, NJ 07073
- (b) Air Products and Chemicals, Inc.  
P.O. Box 538  
Allentown, PA 18105

7.1.2 Test cabinet (4.1) is available from:

- (a) U.S. Testing Company  
1941 Park Avenue  
Hoboken, NJ 07030
- (b) The Govmark Organization, Inc.  
P.O. Box 807  
Bellmore, NY 11710
- (c) Custom Scientific Instruments, Inc.  
13 Wing Drive  
Cedar Knolls, NJ 07927

7.1.3 Ventilation Smoke Tube Kit (5.3) is available from:

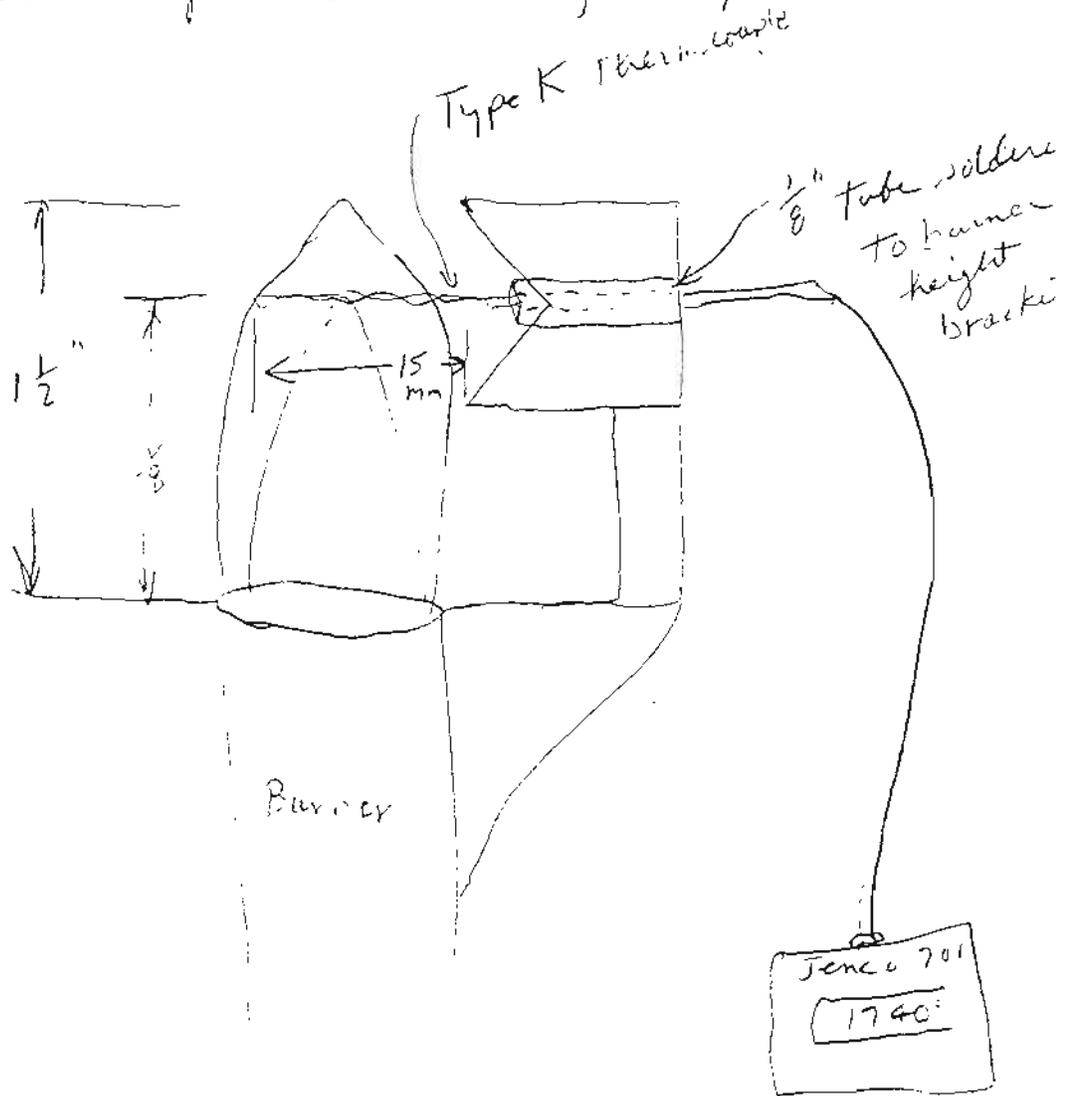
Mine Safety Appliances Co.  
Pittsburgh, PA 15230



Dept

3/7/90

5903 Temperature measuring technique





ESTABLISHED 1802

E. I. DU PONT DE NEMOURS & COMPANY  
INCORPORATED

FIBERS DEPARTMENT

LAUREL RUN BLDG.

P.O. Box 80, 705

WILMINGTON, DE 19880-0705

March 8, 1990

Ms. Patricia Cahill  
FAA Technical Center  
ACD 240 - Bldg. 203  
Atlantic City Airport  
N.J. 08405

Dear Pat:

Thanks so much for your time yesterday, we're looking forward to visiting with you on March 13, to further discuss your experiences with Federal Standard 191A - Test Method 5903, Flame Resistance Of Cloth; Vertical.

I'm enclosing a copy of the latest revision 5903.1 issued by the Army-Natick RD&E Center on December 28, 1989. As we discussed, the major change is substituting methane gas for the erratic Matheson B gas.

We have been working with flame temperature as a way of reducing the subjectivity of this test method. We have been reasonably successful in using a K type thermocouple connected to a Jenco Model 701 electronic thermometer (battery operated) positioned as shown in the attached sketch.

See you next Tuesday.

Best regards,

James W. Miller  
Military Account Manager  
(302) 999-3841



DEPARTMENT OF THE ARMY

U.S. ARMY TROOP SUPPORT COMMAND  
NATICK RESEARCH, DEVELOPMENT AND ENGINEERING CENTER  
NATICK, MA  
01760-5019

REPLY TO  
ATTENTION OF

Materials Research and  
Engineering Division

January 3, 1990

Ms. Laura Kinney  
E.I. duPont de Nemours & Co., Inc.  
Fibers Department  
Laurel Run  
P.O. Box 80, 705  
Wilmington, Delaware 19880-0705

Dear Ms. Kinney:

I have enclosed the new version of Federal Standard 191 Test Method 5903, Flame Resistance of Cloth; Vertical.

The method should include all of the modifications that we have discussed and hopefully we have produced a clear and concise product that will contribute to meaningful and reproducible results.

Thank you for your input and cooperation during this revision. Please contact me if you have any questions.

Sincerely,

A handwritten signature in cursive script, appearing to read "C. Heath".

Cleveland A. Heath  
Textile Technologist  
Process Technology Section

Enclosure