



Bell Laboratories

Subject: Protective Clothing Suitable For
Clean Room Use Providing Fire Resistance
Case 48100-1

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MEMORANDUM FOR RECORD

Introduction

Fires associated with metal alkyls, the most notable of which occurred when an MTS accidentally ignited methanol with trimethylaluminum melting a polyester lab coat, has focused attention on the need for fire resistant protective clothing. Traditionally, protective clothing worn in the clean room environment has been designed to protect product from particulate. Many of these garments also afford personal protection against chemical contact but new technologies requiring use of pyrophoric chemicals present new obstacles in personal protection. This Memorandum reviews the suitability of various fabrics in protecting against burn injuries and reviews data relative to particulate levels associated with various fabrics.

Recommendations

All persons directly handling pyrophoric materials should wear protective clothing consisting of face shield, safety glasses, flame retardant lab coat and heavy gloves if manual dexterity is not required. Nomex® gloves should be worn if manual dexterity is required.

Nomex is the choice material for construction of protective garments when handling pyrophoric materials. Nomex lab coats may be ordered from any lab safety supply catalogue (or consult with EHM&S Center).

PLAINTIFF'S EXHIBIT

ATT-384

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Method

Vendors were contacted and asked to provide information on garments that were both suitable for clean room use and exhibited fire resistance. Lab coats were also ordered from a safety supply house based on literature found in brochures that listed fabrics as fire retardant and suitable for clean room use. Fabrics assembled for testing included teflon coated Gore-tex[®], nomex, a monofilament nomex, modacrylic, and polyester, the cloth traditionally used to make clean room garments.

Fabrics were tested for fire resistance by subjecting them to an insult of metal alkyls. The decision to test the fabrics against the metal alkyls was based on the premise that the metal alkyls burn extremely hot and protection afforded against them is likely to be a good indicator that the fabric will protect against lower burning temperature materials. Testing of the fabric was conducted at Texas Alkyls.

To test for fire resistance the procedure normally used by Texas Alkyls to evaluate the fire retardancy of fabrics was used. A swatch of material (about 10" x 10") was exposed to 0.5ml of neat (undiluted) trimethylaluminum (TMAL). A temperature probe which was placed between the test fabric and a piece of filter paper was used to monitor the thermal increase around the area of exposure (see Figure 1.) The combination of the temperature rise and physical condition of the cloth and filter paper after the test are used as criteria for judging the utility of the fabric.

The following practices were followed (see Figure 1):

<u>OBJECTIVE</u>	<u>PROCEDURE</u>	<u>KEY POINTS</u>
1. Prepare cloth and testing apparatus.	a. Test material and filter paper are secured to the asbestos pad at each corner with ball joint clamps. This test stage is mounted in a horizontal plane with buret clamp at a height of 45 to 50 cm from the bench surfaces. See Figure 1 for details.	a. The asbestos pad serves as a non-combustible, nonconductive surface to rigidly suspend the test material. The filter paper enables the analyst to visually observe the effect of alkyl exposure to the area underneath the cloth due to seepage through the porous cloth. Any additional damage to the filter paper due to destruction of the cloth can be assessed in this manner.

	b. Position the temperature probe between the filter paper and test material with the probe tip 3 cm from the materials's edge. The probe is secured with a ball joint clamp.	b. The temperature probe must be positioned at this location to allow a large enough area for alkyl exposure. This location enables duplication of the test in order to increase confidence in the results.
4. Exposure of cloth to testing agents.	a. Withdraw 0.5 ml of metal alkyls into a 2 ml syringe assembly. b. With the needle tip at a height of 2 cm above the cloth (no more than 4 cm), deliver 0.5 ml of the testing agent on the cloth directly above the probe tip.	a. Lab coat and face shield must be worn during this part of the test. b. It is important not to exceed the 4 cm delivery distance so that the neat alkyls do not have time to build up heat and ignite. Make sure the fume hood is on.

After determining that nomex provided superior fire resistant qualities it was evaluated for clean room use. Visual inspection of the regular nomex showed that the material sheds a large amount of particulate. The monofilament nomex did not shed so it was evaluated for detachable particulate by Messrs. G. Helmke and D. Raver (52169) (see Appendix I). After being laundered by a commercial laundry (3 washes with water and detergent, 1 wash with perchloroethylene, 2 clear water rinses) the garment was tested in the automatic airborne particulate monitoring equipment at BTL-MR.

To determine if faceshields worn at BTL provide adequate protection against splashes of TMAL they were also evaluated. 0.5ml of TMAL was placed directly onto the face shield (see results).

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Results

The monofilament nomex garment when tested in the automatic counter had a particle density of (particles >0.5 microns) 1400 particles per cubic foot. This is considered suitable for clean room use. Other results are as follows:

Fabric Tested	Condition of Material After Application 0.5ml TMAH	Condition of Filter Paper	Highest Temp °C Under Fabric	Suitability For Clean Room Use	Attached Photo
Nomex	very good - no perforations	slight charring	242	No	1
Monofilament Nomex	good - slight perforation	slight charring	211	Yes	2
Clean Room Polyester	completely melted	very poor, burned through	266	Yes	3
Modacrylic	completely burned	very poor, burned through	196	No	4
Teflon coated Gore-tex	. 1st trial very good . 2nd trial completely burned	. slightly charred 1st trial . completely burned 2nd trial	. 162°C trial 1 . 457°C trial 2	Yes	5 and 6
.040" thick MSA Acetate Face Shield	excellent - no penetration	-----	45	---	7

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Discussion - Conclusion

Nomex fabric, other than being fire retardant, also inherently provides protection against acids and caustics. It is however being recommended only for special applications because of its high cost. Regular nomex lab coats cost about \$50.00, while monofilament coats cost about \$150.00. At the present time Vidaro (see Appendix II for ordering information) is the only known vendor selling this monofilament material. Vidaro will also manufacture gloves of monofilament nomex for individuals needing hand protection. The nomex should afford greater manual dexterity than other fire retardant gloves which are of heavier construction.

Use of nomex protective garments when handling pyrophoric materials or where there is danger of fire will significantly lessen the risk of personal injury from fire.


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MH-78691-DR-gap

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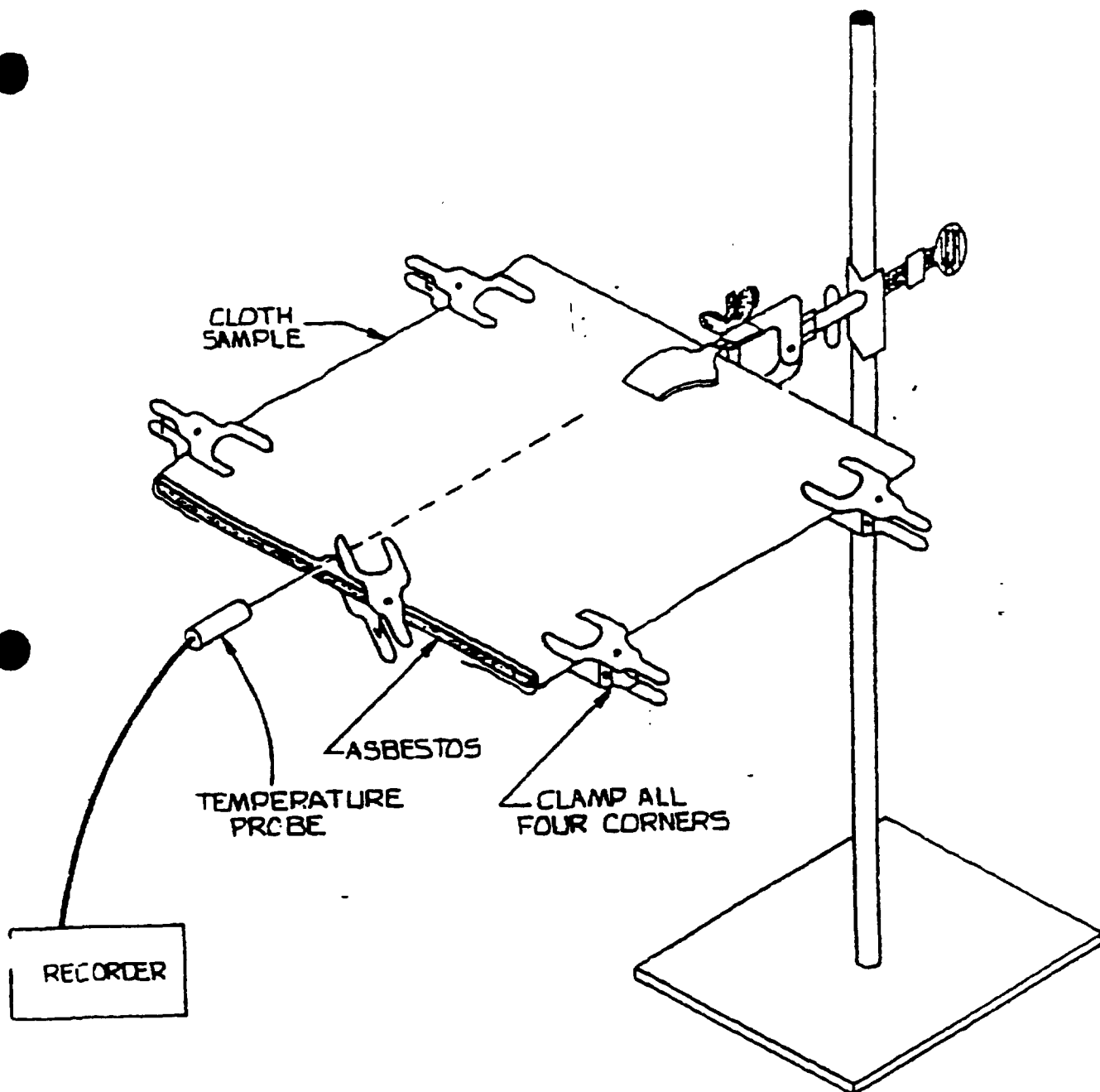


FIGURE 1
HORIZONTAL POSITION