NBSIR 79-1596

Studies of Flammability Test Procedures for Curtains and Drapes

Donna E. Hopkins and John F. Krasny

Center for Fire Research
National Engineering Laboratory
National Bureau of Standards
Washington, DC 20234

March 1979

Final Report

Prepared for:
U.S. Coast Guard
Washington, DC 20590

NBSIR 79-1596

STUDIES OF FLAMMABILITY TEST PROCEDURES FOR CURTAINS AND DRAPES

Donna E. Hopkins and John F. Krasny

Center for Fire Research
National Engineering Laboratory
National Bureau of Standards
Washington, DC 20234

March 1979

Final Report

Prepared for:
U.S. Coast Guard
Washington, DC 20590

U.S. DEPARTMENT OF COMMERCE, Juanita M. Kreps, *Secretary*
Jordan J. Baruch, *Assistant Secretary for Science and Technology*
NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director*

TABLE OF CONTENTS

LIST OF TABLES

STUDIES OF FLAMMABILITY TEST PROCEDURES FOR CURTAINS AND DRAPES

Donna E. Hopkins and John F. Krasny

Abstract

The Intergovernmental Maritime Consultative Organization (IMCO) is in need of a simple, relevant flammability test method for the curtain and drapery fabrics used aboard ships. Two methods for measuring self-extinguishment of fabrics upon removal of the flame were compared. One was proposed by the United States' representative to IMCO, the other was an adaptation of a recently proposed method of the International Standards Organization (ISO). The effects of variations of the proposed test methods (changes in the ignition flame characteristics, bottom edge or surface ignition, and in the specimen suspension) were also investigated. In general, the relative ranking of the fabrics was not changed, though the individual afterflame time and char length results were affected by some of these variables. The advantages and disadvantages of the two proposed test methods are discussed and an improved method is recommended.

Key words: Curtains; drapes; fabrics; fire; flammability; international; self-extinguishment; ships; standards.

1. INTRODUCTION

A need for a generally acceptable method for testing the flammability of curtain and drapery fabrics to be used aboard ships has been recognized by the Intergovernmental Maritime Consultative Organization (IMCO). The U.S. Coast Guard (USCG), one of the agencies that could be affected by such a standard, decided that some background information and technical evaluation of the test methods being considered was necessary. With such information, the USCG will have a basis for a recommendation of a useful test to IMCO.

Two test methods have been proposed. One was suggested in an IMCO document (IMCO/FPXX/3 with amendments). The other was described in a letter from the United Kingdom Fire Research Station dated December 15, 1977. The latter involved a modification of a test recently proposed by the International Standards Organization (ISO). In this report, these tests will be referred to as the proposed IMCO and proposed ISO tests.

A comparison of the flammability performance of a number of fabrics deemed appropriate for use in ships' curtains was undertaken. The fabrics were tested according to the two proposed test methods, and variations thereof. The variations consisted of: three burner designs; variations of the flame height using one burner; bottom edge and surface ignition; and variations in the manner in which the specimens were suspended.

This report discusses the experimental findings, compares the advantages and disadvanatges of the two test methods, and makes certain recommendations as to an improved procedure.

2. TEST METHODS

Both proposed flammability test methods are small-scale methods for self-extinguishment[1] and do not fully simulate real-life curtain fires. The proposed IMCO method is based on current standards for flammability of textiles in use in Germany, Great Britain, and the U.S.A. It is very similar to DIN 53906, BS 3119, and the NFPA 701 small-scale tests. Use of char length and afterflame time as pass/fail criteria is proposed.

The proposed ISO method is basically a flame spread rate test which has been modified for identification of self-extinguishing fabrics. Again, char length and afterflame time are proposed as pass/fail criteria.

Table 1 summarizes the features of the two test methods. Table 4 summarizes the advantages and disadvantages of the proposed methods, based on the findings of this report. Both test methods test vertical fabric specimens, but specimen suspension methods differ. The IMCO proposal specifies a metal frame which supports the specimen on its two vertical edges. The two portions of the frame are clamped on each side with two clamps (four in all). The proposed ISO test uses a wider specimen, attached by six pins mounted on the vertical edges of the pin frame (12 in all). The specimen is pushed onto the pins so it is 2 cm (approximately 3/4 in) from the frame, and is held taut. This minimizes interaction of frame and burning specimen.

The IMCO specimen frame is mounted on a bar inside a cabinet. The ignition source can be moved from the outside of the closed cabinet so it contacts the exposed bottom edge of the specimen. The proposed ISO test

---

[1] The terms "self-extinguishing" or "self-extinguishment" used in this report indicate cessation of burning of a specimen soon after (within the "afterflame time") removal of the igniting flame, when tested under the conditions described in this paper. It does not imply that the fabric would not burn under other conditions of testing or in real-life fires.

does not require a cabinet but specifies location of the test equipment in a hood, with an air movement of less than 0.2 m/s during the test.

The proposed IMCO ignition source is a diffusion flame, essentially a tube through which natural gas is emitted. ISO proposes a small, precision machined burner, which provides a premixed flame. The specified fuel is propane or butane. Propane was used in the present work. Both flames are adjusted to 40 mm (approximately 1-3/4 in) length. The diffusion flame is broad and diffuse ("soft"); the ISO flame, relatively thin and concentrated ("hard"); and the Bunsen burner flame, intermediate. Both methods call for bottom edge ignition, but the ISO apparatus is designed to allow both bottom edge and surface ignition.

The time of exposure to the flame depends on the fabric weight in the proposed IMCO method, with heavier fabrics having longer ignition times, up to 12 seconds. The ISO method specifies a 5 or 15-second ignition time. The specimen must continue to burn for at least 5 seconds after the ignition source is removed when a 5-second ignition time is used. If this does not occur, the ignition time is 15 seconds.

3. VARIATIONS OF TEST METHODS

Variations in the two above test methods were introduced in order to determine optimum test conditions, in terms of differentiating between fabrics, reproducibility, ease of operation, and equipment cost.

Table 1 lists the parameters varied for each test method. Not all fabrics were tested under each of the listed variations.

3.1 Variations of the Proposed IMCO Method

The diffusion burner specified by the IMCO method was compared with a Bunsen burner, i.e., a similar but premixed flame. The diffusion burner was used with the flames adjusted to 30 and 50 mm, as well as the specified 40 mm, to establish the sensitivity of fabric behavior to flame height variations.

IMCO proposes bottom edge ignition, but this may not be the probable point of ignition in real-life accidents. Surface ignition with the diffusion (tube) burner and the Bunsen burner was attempted at approximately 5 cm (2 in) from the bottom edge of the specimens. The angle of the tube burner was fixed but that of the Bunsen burner was determined by experimentation. It was difficult to get good flame/specimen contact with the tube and Bunsen burner flames. However, some modification of the test procedure or apparatus may be needed to overcome this difficulty, but this could not be explored in the present study.

The manner in which the specimen was suspended inside the cabinet was also varied. In the proposed IMCO method, specimens are clamped between the two vertical edges of a hinged frame. Since draperies are not constrained in this manner, specimens were also tested free-hanging, supported by wire hooks attached to their top corners. In addition, they were tested in a common drapery configuration, arranged in folds. Bottom edge ignition with the tube and Bunsen burner was used on the free-hanging specimens, but only the tube burner was used on the folded specimens. As an intermediate condition between the clamp frame and free-hanging arrangement, the specimens were also exposed in the IMCO cabinet in a pin frame patterned after the ISO frame.

When testing in strict conformance with the proposed IMCO method, ten specimens, five in the warp and five in the filling direction, of each fabric were tested. In the study of the variations of test methods, four specimens, two in each direction, were used.

3.2 Variations of the Proposed ISO Method

The only variations in the ISO method were burner type and point of ignition. Either surface or bottom edge ignition was specified in the original ISO flame spread rate test method, and both were tried in the present study. The ignition source was also varied. In addition to the specified precision machined, premixed, hard flame burner[2], a Bunsen burner was used. The resulting flames differ greatly in terms of hardness of the flame, and its size at the base. The Rieber burner was used with and without a stabilizing disc. Previous reports indicated that such a disc was needed to obtain a stable flame, but no flame instability was observed in the present study even without a disc.

Six specimens were tested with the proposed version of the ISO test, and with each of the above variations, three each in warp and filling.

4. FABRICS

Manufacturers of fabrics who were reported to be suppliers of ships' curtains were contacted by phone, and candidate fabrics ordered. A total of seven fabrics were acquired from various manufacturers or distributors. One of the fabrics clearly was not self-extinguishing and was not used in the tests, while four appeared to be self-extinguishing. Two fabrics were borderline and were thus useful for the study of variations of test parameters. No uncoated nylon, polyester, or polypropylene (i.e., thermoplastic) material was included in the present series since they are not presently used as curtains on ships.

---

[2] This burner will henceforth be referred to as the "Rieber" burner for brevity. Dr. Rieber has been active in promoting the use of this type of ignition source at ISO meetings.

Table 2 describes the fabrics. Two of them were finished with flame retardants (FR); one was cotton; and one was wool. There were also two fiberglass fabrics, varying in weight; one aramid (Nomex^{R}) fabric; and a plastic coated nylon fabric. All fabrics were woven.

5. RESULTS AND DISCUSSION

The afterflame time and char length results are listed in table 3. In general, the average and standard deviations are shown. An asterisk indicates that some specimens of a fabric burned relatively little, although other specimens of the same fabric burned considerably more. The range of results is entered in the table (this will be called "bimodal distribution" throughout this report). The char length of the fabrics which were ignited on the surface was considered to be the length of the blackened area.

5.1 General Fabric Behavior

The aramid fabric, the FR cotton, and the two fiberglass fabrics were generally self-extinguishing under all test conditions. The afterflame time and char length of the coated nylon fabric and the supposedly FR treated wool fabrics used in these experiments depended greatly on the experimental conditions, such as burner type, flame height, ignition point, and specimen suspension method. These fabrics tended to show bimodal distribution of the results.

The aramid fabric was also somewhat sensitive to the specimen suspension method, as well as the ignition parameters. The longest char length was obtained with the IMCO frame, in which the specimen is held rigidly. The pin frame and the free-hanging specimens gave considerably shorter afterflame time and char length values. Surface ignition produced shorter times and chars than edge ignition, and the Bunsen burner generally produced shorter times and chars than the tube burner.

The FR treated cotton has been shown to be sensitive to ignition time by earlier investigators [1][3]. With bottom edge ignition for relatively long ignition times, e.g., 10-15 seconds, the flame tended to flash up the specimen, forming a char. Consequently, during the last seconds of such exposure, the flame impinged on a charred area.

The coated nylon fabric generally ignited with bottom edge ignition. The flame tended to travel up the center of the specimens, and produced large amounts of acrid smoke. With surface ignition, there was no visible flame on the fabric, only blackening of limited specimen areas, and some melting.

The fiberglass fabrics did not ignite, but sometimes they glowed after flame removal. The area exposed to the flame became silvery on the lighter weight fiberglass fabric, probably due to loss of the pigment. With edge ignition, the areas exposed to the flames tended to become brittle.

The wool fabric was reportedly RF treated but performed marginally in our tests. There were generally bimodal distributions of the results under any one condition, indicating, perhaps, uneven fabric properties or treatment. Other wool fabrics may be more effectively treated.

5.2 Effects of Experimental Conditions

5.2.1 IMCO vs ISO Proposed Methods

The afterflame times measured by the proposed IMCO and ISO methods were similar, but the ISO char length tended to be longer. Most important, the relative ranking of the fabrics was very similar. Thus, the

---

[3] Numbers in brackets refer to the literature references listed at the end of this report.

afterflame time and char length values obtained for the coated nylon and reportedly RF treated wool fabrics were considerably longer in both the proposed IMCO and ISO tests than for any of the other fabrics. The differences between the other four fabrics were small, often within the experimental error. Nevertheless, the fabrics ranked in almost the same order in both tests.

5.2.2 Effect of Variations of the IMCO Method

5.2.2.1 Tube vs Bunsen Burner

The proposed IMCO method specifies a diffusion tube burner, but Bunsen burners, which produce premixed flames, may be more readily available. The two burners were compared with the specimens in clamp frames and on pin frames, with bottom edge and surface ignition. The Bunsen burner gave generally similar or slightly lower results. Fabric rankings were not affected by burner choice.

5.2.2.2 Edge vs Surface Ignition

Ignition on a raw, unhemmed bottom edge of a vertically suspended specimen may be considered a "worst case" condition for most fabrics. In real-life, curtains and other textile items such as apparel usually have hemmed edges. The weight added by the hem generally makes ignition more difficult. The probability of surface ignition is probably larger than that of edge ignition in real-life exposure to small ignition sources. On the other hand, there are some fabrics (some acetate, nylon, and polyester fabrics) which burn primarily downward and sideward rather than upward. For these fabrics, bottom edge ignition is not a "worst case" condition, and they are not appropriately evaluated by bottom edge ignition. According to our brief survey, they are not used in ships' curtains, and such fabrics were not included in the present study.

For the fabrics included in the present study, surface ignition generally gave lower results than bottom edge ignition, and the char on them extended primarily upward.

5.2.2.3 Effect of Flame Height

Varying the height of the flame produced by the tube burner (30, 40, and 50 mm) had no major effect on the majority of the fabrics. For the aramid fabric, however, the longest afterflame time and char length averages and standard deviations were observed at the 40 mm flame height.

5.2.2.4 Effect of Specimen Suspension

Some industry representatives have reported that suspending specimens in relatively narrow, rigid frames is unrealistic, and puts some materials at a disadvantage [2]. Indeed, the less rigid suspension on the ISO pin frame, as compared to the IMCO clamp frame, improved the results for the aramid fabric but had little effect otherwise. Allowing a specimen to hang freely, by suspending it only at the top corners, reduced the afterflame time and char length results for the coated nylon fabric, and the char length results for the aramid fabric. These fabrics have a tendency to shrink and shrivel when heated under no or little constraint, and this increases their self-extinguishing propensity. On the other hand, arranging free-hanging specimens of the aramid, FR cotton, coated nylon and one fiberglass fabric in folds (a configuration often found in real-life situations, and considered in the NFPA 701 test as an option), tended to increase the char length over that of the free-hanging, flat specimens.

5.2.3 Effect of Variations of the Proposed ISO Method

5.2.3.1 Rieber vs Bunsen Burner

The ISO method specifies the Rieber burner which produces a small, hard flame. This flame was compared with that of a Bunsen burner. Both flames are premixed. When bottom edge ignition was used, the Bunsen burner results were similar to, or in some cases lower than, the Rieber burner results. Too few fabrics ignited on the surface in the ISO procedure to make a similar comparison for surface ignition. The use of the stabilizing disk for the Rieber burner did not affect the results.

5.3 Reproducibility

One of the reasons for varying the experimental conditions in this study was the expectation that conditions which would produce the best reproducibility could be identified. However, the results do not indicate that the variations investigated affected the reproducibility (as expressed by the standard deviation) in a major, systematic manner.

6. CONCLUSIONS AND RECOMMENDATIONS

The proposed IMCO and ISO methods rated the fabrics in approximately the same rank order. Both methods appear equally capable of identifying fabrics which self-extinguish after removal of the ignition flame. Both methods have certain advantages and disadvantages and these are described in some detail in table 4.

In addition to the advantages and disadvantages of the two methods listed in table 4, they have the following features in common:

- Both methods specify ignition at an unhemmed bottom edge of the specimen which is a "worst case" situation for most but not all fabric types.

- Neither method characterizes the behavior of curtain and drapery fabrics in a conflagration, i.e., whether the fabrics ignite when preheated and then are exposed to an ignition source. NFPA 701 addresses itself to this condition by requiring preheating of the specimens.

- Neither method addresses itself to the problem of release of smoke and toxic products when the fabrics are heated.

- Neither proposed method addresses itself to the hazard presented by fabrics which burn primarily sideward and downward rather than upward (e.g., some acetate, nylon, polyester, and other thermoplastic fabrics). Such fabrics are not properly evaluated by use of bottom edge ignition and char length criteria. Nor do such fabrics always produce flaming melt drip which would disqualify them under the IMCO proposal. It may, however, be possible to write a general provision against melting materials if this is considered desirable. This would cover the above named fabric types, which due to the fact that they melt and the molten material moves downward, do not burn primarily upward.

Based on these findings, we recommend that any future standard for the flammability of curtains and drapery fabrics used on ships contain the following provisions:

- Use of the IMCO cabinet, or cabinets of similar dimensions which are now in use in Germany, Great Britain, or in the U.S. NFPA 701 test. This is important to prevent operator exposure to toxic fumes.

- Use of the ISO pin frame, shortened to fit into the IMCO cabinet. This would overcome the objections to use of relatively narrow, clamp frames which seem to increase the char length of some materials, e.g., aramid fabrics.

- Use of the tube or a Bunsen burner. These are cheaper and simpler than the ISO Rieber burner, which appears to give roughly the same results. In addition, experience has shown that hard flames like those of the Rieber burner tend to burn holes into many thermoplastic fabrics without igniting them; the same fabrics may ignite with soft flames.

- In order to obtain a "worst case" ignition time condition, the following procedure is suggested: expose two specimens each in the warp and two each in the filling direction to 3, 9, and 15-second ignition (a total of 12 specimens). Test an additional three specimens in the direction and at the ignition time which produced the longest char length. The results of these five specimens would be used to pass or fail the fabric.

- In addition to bottom edge ignition, also expose two specimens cut in the warp and two specimens cut in the filling direction to a 15-second ignition on the surface of the fabric, 5 cm (2 in) from the bottom edge and in the center of the specimen. Determine afterflame time and char length in the direction of the longest diameter of the charred area, as well as occurrence of flaming melt drip. These determinations should help in the evaluation of materials which burn primarily sideward and downward rather than upward, as well as of materials which may cause secondary ignition because of flaming melt drip.

There appears to be no published method for determining char length of specimens which have been subjected to surface ignition. In the present work, the length of the blackened area was measured but this would not be rigorous enough for a standard. However, several possibilities similar to those used presently for specimens subjected to bottom edge ignition come to mind--one would be determining the longest diameter of the charred area visually and making a cut in the direction of this diameter from one fabric edge. Then the weights could be applied and the char length determined in the usual manner. A brief laboratory study would determine whether this procedure (or a few variants of it) are practical and reproducible. Char length of thermoplastic materials would be defined as the maximum diameter of the hole formed in the specimen.

Flaming melt drip can probably be best identified by placing a readily ignitable material, e.g., absorbent cotton used for medicinal purposes, on the bottom of the cabinet and observing secondary ignition.

This appears more rigorous than relying on visual determination of flames on the molten material, which is somewhat affected by the lighting conditions in the laboratory.

The other provisions of the proposed IMCO method were not investigated during this study but appear acceptable.

7. ACKNOWLEDGEMENTS

The sponsorship of the U.S. Coast Guard of this work is gratefully acknowledged. Thanks are also due to Dr. Alex Robertson of the Center for Fire Research for his many helpful suggestions.

8. REFERENCES

[1] McCarter, R. J., Textile Chemist and Colorist, Vol. 4, 21-23 (April 1974).

[2] Anderson, J. J., Textile Chemist and Colorist, Vol. 5, 27-33 (October 1973).

Table 1. Summary of test conditions

Parameter	IMCO Method	ISO Method
Enclosure	Cabinet	No enclosure
Specimen Size	76 x 254 mm (3 x 10 in)	170 x 560 mm (7 x 22 in)
Specimen Suspension		
Proposed	Clamp frame	Pin frame
Variations	Pin frame Free-hanging (suspended from upper corners) Free-hanging, arranged in folds	No variations
Fuel	Natural gas	Propane or butane
Burner		
Proposed	Tube, diffusion	Premixed, "Rieber"
Variations	Bunsen, premixed	Bunsen, premixed
Flame		
Proposed	40 mm	40 mm
Variations	30, 50 mm tube burner	40 mm with and without stabilizing disc
Ignition Point		
Proposed	Bottom edge	Bottom edge
Variations	Surface (tube and Bunsen burner)	Surface

Table 1. Summary of test conditions (continued)

Parameter	IMCO Method	ISO Method
Ignition Time		
Proposed	Increases with increasing fabric weight	5 or 15 seconds (15 unless afterflame time with 5 seconds ignition exceeds 5 seconds)
Criteria	Char length Afterflame time No burning melt drips on floor of cabinet	Char length and width Afterflame time

Table 2. Fabrics used in study

Fabric Weight	Fiber Content	Color	Construction	Weight g/m^2	Weight oz/sq yd	Ignition Time Seconds IMCO	Ignition Time Seconds ISO
1	Aramid	Yellow	Plain weave	197	5.9	6	15
2	FR Cotton	Green	Twill	314	9.4	10	15
3	Plastic coated nylon	White	Plain weave	653	19.6	12	15
4	Fiberglass	White	Plain weave	294	8.8	8	15
5	Fiberglass	Peach	Plain weave & twill	234	7.0	8	15
6	FR Wool	Brown	Plain weave	433	12.7	10	15

FR = Fire retardant

Table 3. Afterflame time and char length of curtain fabrics

Each entry in table indicates average/standard deviation, unless otherwise indicated.

Burner	Flame Height mm	Ignition Point	Specimen Suspension	Afterflame Time, seconds: Aramid 197 g/m^2	FR Cotton 314 g/m^2	Coated Nylon 653 g/m^2	Fiberglass 294 g/m^2	Fiberglass 234 g/m^2	FR Wool 433 g/m^2	Char Length, mm: Aramid 197 g/m^2	FR Cotton 314 g/m^2	Coated Nylon 653 g/m^2	Fiberglass 294 g/m^2	Fiberglass 234 g/m^2	FR Wool 433 g/m^2
A. IMCO METHOD AND VARIATIONS															
Proposed Method:															
Tube	40	BE	CF	21/21	.55/.40	17-107*	1.5/.30	1.2/.50	40/19	87/60	73/7.9	81-254*	9.8/2.5	8.1/1.9	52-254*
Variations:															
Bunsen	40	BE	CF	4.8/6.0	1.2/.10	2-119*	1.4/.22	1.5/.21	1.8-56*	65/17	74/15	53-254*	9.5/3.4	13/1.5	39-254*
Tube	40	Surf.	CF	.55/.40	1.1/.20	0/0	0/0	0/0	0/0	24/31	75/7.7	8.2/7.1	83/6.5	70/6.6	85/5.3
Bunsen	40	Surf.	CF	0/0	1.4/2.4	0/0	0/0	---	---	15/13	86/5.4	0/0	0/0	---	---
Tube	30	Surf.	CF	1.1-27*	.80/.10	41-114	1.9/.10	1.4/.50	11-54*	67/13	69/5.7	59-254*	9.5/7.1	8.5/.70	79-254*
Tube	40	Surf.	CF	21/21	.55/.40	17-107*	1.5/.30	1.2/.50	40/19	87/60	73/7.9	81-254*	9.8-2.5	8.1/1.9	52-254*
Tube	50	BE	CF	1.3/.50	1.3/.10	65/18	1.6/.10	1.7/.30	49/5.2	52/6.4	94/7.1	191/20	10/1.4	13/.70	254*
Tube	40	BE	Pin.Fr.	1.3/.30	.80/.30	23-112*	---	---	59/4.8	55/14	80/8.9	55-254	---	---	254*
Tube	40	BE	Freeh.	4.3/5.3	1.0/2.0	0-44*	1.6/2.0	1.4/.10	4.7/5.1	15/11	80/16	16/9.1	10/2.9	11/2.9	44/14
Tube	40	BE	Freeh., folds	2.4/1.2	0/0	4-42*	.90/.10	---	---	51/25	134/13	70/43	10/1.5	---	---
Bunsen	40	BE	Freeh.	.60/.40	---	.30/5.0	---	---	5.8/5.2	21/8.2	---	17/8.6	---	---	42/9.9
B. ISO METHOD AND VARIATIONS															
Proposed Method:															
Rieber	40	BE	Pin.Fr.	2.6/1.5	1.3/.23	2-156*	1.5/.30	1.7/.30	73/3.6	90/7.0	132/21	17-560*	30/10	36/7.1	560*
Variations:															
Bunsen	40	BE	Pin.Fr.	8.1/14	.95/.50	2-122*	1.1/2.0	1.1/2.0	8.5-78*	100/13	80/11	30-445*	13/3.1	19/3.8	42/560*
Rieber	40	Surf.	Pin.Fr.	0/0	0/0	.14/.30	0/0	0/0	76/52	43/5.1	84/9.3	49/2.6	53/1.7	52/5.1	560*
Bunsen	40	Surf.	Pin.Fr.	0/0	.70/.25	0/0	0/0	0/0	0/0	81/7.5	12/11	0/0	0/0	0/0	0/0
Rieber) with)	40	BE	Pin.Fr.	1.9/1.2	.90/.40	6-139*	1.9/.50	1.5/.20	82/4.9	93/16	98/15	64-472*	27/5.8	24/3.2	560*
disc)	40	Surf.	Pin.Fr.	0/0	0/0	0-32*	0/0	0/0	89/5.8	52/2.6	90/4.0	54/4.0	69/4.7	56/2.4	560*

*Range; char length of 254 is maximum possible for the IMCO method, char length of 560 mm is maximum possible for the ISO method.
Abbreviations: BE - bottom edge; CF - Clamp frame; Pin. Fr. - Pin frame; Freeh. - Free hanging: FR - Fire retardant.

Table 4. Advantages and disadvantages of proposed IMCO and ISO methods

	IMCO		ISO	
	Advantages	Disadvantages	Advantages	Disadvantages
Frames	Mounting on frames is quite easy, and if enough of the frames are available, can be done before testing.	The clamp frame holds the specimens quite tightly. For some fabrics, e.g., aramid, this can increase the char length (in a perhaps unrealistic manner) over that obtained with the ISO pin frame or especially free-hanging specimens.	Some fabrics are easily mounted on the pin frame, and a presser plate with holes corresponding to the pin locations may make mounting of dense fabrics easier.	Dense fabrics are somewhat difficult to mount.
Cabinet	Cabinet reduces operator exposure and expoaure of specimen to air currents.			Lack of cabinet exposes operator to smoke and fumes and makes protection of specimens from air currents difficult.
Burner	Burner is inexpensive and has a aoft flame.			Complex and expensive burner does not appear neceaaary for identifying self-extinguishing fabrica. Comparable reaults were obtained with a Bunaen burner. The hard flame of this burner may not ignite certain thermoplastic materials which may ignite with a softer flame.
Melt Drip	Haa provisions for eliminating fabrics on basis of burning melt drip which may cause secondary ignition.			Does not address problem of burning melt drip.

Table 4. Advantages and disadvantages of proposed IMCO and ISO methods (continued)

	IMCO		ISO	
	Advantages	Disadvantages	Advantages	Disadvantages
Ignition Time		Ignition time is based on fabric weight. This seems unrealistic in terms of real-life conditions. Also, some fabrics, e.g., FR cotton, have longer char length at short than long ignition time.		Ignition time is 5 seconds if this results in 5 second or more afterflame time. If afterflame time is shorter, ignition time is 15 seconds. Choice of a short <u>and</u> a long ignition time for <u>each</u> fabric may be more appropriate.
Specimen Size				Specimen size too large for self-extinguishing fabrics. Could be reduced (along with frame size for this purpose) to 25 cm.
Criteria (as presently proposed)	Specified afterflame time of 2 seconds eliminates fabrics which appear otherwise safe. A 5 second afterflame time would be more practical.			No definition of method to measure char length with either edge or surface ignition.

NBS-114A (REV. 9-78)

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET	1. PUBLICATION OR REPORT NO. NBSIR 79-1596	2. Gov't. Accession No.	3. Recipient's Accession No.

4. TITLE AND SUBTITLE

Studies of Flammability Test Procedures for Curtains and Drapes

5. Publication Date

March 1979

6. Performing Organization Code

7. AUTHOR(S)

Donna E. Hopkins and John F. Krasny

8. Performing Organ. Report No.

9. PERFORMING ORGANIZATION NAME AND ADDRESS

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, DC 20234

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS *(Street, City, State, ZIP)*

U.S. Coast Guard
Washington, D.C. 20590

13. Type of Report & Period Covered

Final

14. Sponsoring Agency Code

15. SUPPLEMENTARY NOTES

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

The Intergovernmental Maritime Consultative Organization (IMCO) is in need of a simple, relevant flammability test method for the curtain and drapery fabrics used aboard ships. Two methods for measuring self-extinguishment of fabrics upon removal of the flame were compared. One was proposed by the United States' representative to IMCO, the other was an adaptation of a recently proposed method of the International Standards Organization (ISO). The effects of variations of the proposed test methods (changes in the ignition flame characteristics, bottom edge or surface ignition, and in the specimen suspension) were also investigated. In general, the relative ranking of the fabrics was not changed, though the individual afterflame time and char length results were affected by some of these variables. The advantages and disadvantages of the two proposed test methods are discussed and an improved method is recommended.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

Curtains; drapes; fabrics; fire; flammability; international; self-extinguishment; ships; standards.

18. AVAILABILITY ☒ Unlimited

☐ For Official Distribution. Do Not Release to NTIS

☐ Order From Sup. of Doc., U.S. Government Printing Office, Washington, DC 20402, SD Stock No. SN003-003-

☒ Order From National Technical Information Service (NTIS), Springfield, VA. 22161

19. SECURITY CLASS (THIS REPORT)	21. NO. OF PRINTED PAGES
UNCLASSIFIED	
20. SECURITY CLASS (THIS PAGE)	**22. Price**
UNCLASSIFIED	

USCOMM-DC