NATIONAL BUREAU OF STANDARDS REPORT

1555

EVALUATION OF FOUR TEST METHODS FOR FIRE RETARDANT PAINTS

by

Marjorie W. Sandholzer,
E. W. Bender and
Catherine Rhodes

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

U. S. DEPARTMENT OF COMMERCE
Charles Sawyer, Secretary

NATIONAL BUREAU OF STANDARDS
A. V. Astin, Acting Director

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section is engaged in specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant reports and publications, appears on the inside of the back cover of this report.

1. ELECTRICITY. Resistance Measurements. Inductance and Capacitance. Electrical Instruments. Magnetic Measurements. Electrochemistry.

2. OPTICS AND METROLOGY. Photometry and Colorimetry. Optical Instruments. Photographic Technology. Length. Gage.

3. HEAT AND POWER. Temperature Measurements. Thermodynamics. Cryogenics. Engines and Lubrication. Engine Fuels.

4. ATOMIC AND RADIATION PHYSICS. Spectroscopy. Radiometry. Mass Spectrometry. Physical Electronics. Electron Physics. Atomic Physics. Neutron Measurements. Nuclear Physics. Radioactivity. X-Rays. Betatron. Nucleonic Instrumentation. Radiological Equipment. Atomic Energy Commission Instruments Branch.

5. CHEMISTRY. Organic Coatings. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Gas Chemistry. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

6. MECHANICS. Sound. Mechanical Instruments. Aerodynamics. Engineering Mechanics. Hydraulics. Mass. Capacity, Density, and Fluid Meters.

7. ORGANIC AND FIBROUS MATERIALS. Rubber. Textiles. Paper. Leather. Testing and Specifications. Organic Plastics. Dental Research.

8. METALLURGY. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion.

9. MINERAL PRODUCTS. Porcelain and Pottery. Glass. Refractories. Enameled Metals. Building Stone. Concreting Materials. Constitution and Microstructure. Chemistry of Mineral Products.

10. BUILDING TECHNOLOGY. Structural Engineering. Fire Protection. Heating and Air Conditioning. Exterior and Interior Coverings. Codes and Specifications.

11. APPLIED MATHEMATICS. Numerical Analysis. Computation. Statistical Engineering. Machine Development.

12. ELECTRONICS. Engineering Electronics. Electron Tubes. Electronic Computers. Electronic Instrumentation.

13. ORDNANCE DEVELOPMENT. Mechanical Research and Development. Electromechanical Fuzes. Technical Services. Missile Fuzing Research. Missile Fuzing Development. Projectile Fuzes. Ordnance Components. Ordnance Tests. Ordnance Research.

14. RADIO PROPAGATION. Upper Atmosphere Research. Ionospheric Research. Regular Propagation Services. Frequency Utilization Research. Tropospheric Propagation Research. High Frequency Standards. Microwave Standards.

15. MISSILE DEVELOPMENT. Missile Engineering. Missile Dynamics. Missile Intelligence. Missile Instrumentation. Technical Services. Combustion.

NBS PROJECT **NBS REPORT**

1002-43-1029 March 20, 1952 1555

EVALUATION OF FOUR TEST METHODS FOR FIRE RETARDANT PAINTS

by

Marjorie W. Sandholzer,
E. W. Bender and
Catherine Rhodes

EVALUATION OF FOUR TEST METHODS FOR FIRE RETARDANT PAINTS

ABSTRACT

Interlaboratory tests were arranged to study the reproducibility and usefulness of a proposed cabinet test method for determining the relative fire resistance of fire retardant paints. The National Bureau of Standards cooperated in the investigation and further expanded its program to include a comparison of the cabinet test with three other suggested test methods. The report covers only the work carried out at the National Bureau of Standards, an analysis of the interlaboratory results being in process at the Engineer Research and Development Laboratories. Results of the single laboratory indicate that the performance requirements imposed by the present cabinet method are less severe than can readily be met by a number of available paints. It is suggested that, with certain modifications, both the cabinet test and a standard British test for non-inflammability of materials offer promise as tests which might be satisfactory in sensitivity as well as severity.

1. INTRODUCTION

In connection with the preparation of specifications covering fire retardant paints, a test for fire retardancy which was judged appropriate to the requirements and facilities of paint factory laboratories was developed at the Engineer Research and Development Laboratories at Fort Belvoir, Va. After intensive study of the test at the ERDL, it was felt that organized cooperative tests to provide data

on the reproducibility and correlation of results obtained in different laboratories were an essential step in establishing the practical dependability of the method. Accordingly, a conference attended by representatives of the ERDL, the Office of the Chief of Engineers, and the National Bureau of Standards, was held on May 16, 1951 at the NBS, to plan and initiate such a cooperative testing program.

The following five laboratories had indicated willingness to participate and were equipped with or could obtain the necessary testing apparatus:

Albi Manufacturing Co., 29 Bartholomew Ave.,
Hartford, Conn.
Ocean Chemical Co., 8136 Dobson St., Chicago, Ill.
Vita Var Corp., Albert Ave., Newark, N. J.
Engineer Research and Development Laboratories,
Ft. Belvoir, Va.
National Bureau of Standards, Washington, D. C.

It was the general plan that each of these laboratories would use the proposed cabinet method in conducting tests of the same paints applied to the same base materials under conditions as closely similar as proved feasible. The results of the individual laboratories would be submitted to the ERDL for correlation and analysis.

Several factors were considered in an effort to establish reasonable uniformity in test procedures and test specimens. A check was to be made of the various laboratories to insure proper adjustment of the test equipments and full understanding of the stipulated procedure. Two base materials, poplar wood and insulating fiberboard, were selected, and it was arranged that all of the poplar wood panels would be procured and distributed to the participating laboratories by the ERDL while all of the fiberboard panels would be cut and distributed by the National Bureau of Standards. Furthermore, half of the panels, a set of ten for each test, were to be painted at the distributing laboratory, preferably by a single operator, and the other half, comprising duplicate sets of ten for each test, were to be supplied unpainted for preparation at the testing laboratory. This arrangement was designed to provide not only uniform specimens but also an indication of the effect on the results of differences in paint application. Three paints representing a range in fire retardancy, as indicated by earlier tests, were to be selected by, and distributed to the testing laboratories from the NBS. All samples of each paint were to be taken from a single

shipment of that paint and forwarded to the laboratories, identified only as Paints Nos. 1, 2, and 3. It was agreed that in all cases the paint would be applied to give a coverage of 250 ft^2/gal.

The following is a report of the work carried out at the National Bureau of Standards, where, in addition to the cooperative testing outlined above, the program was expanded to include tests by three other methods which have been used for comparison of fire retardancy in paints. These additional methods comprised the horizontal panel test described in paragraph F--3c(2) of Federal Specification SS-A-118a for Acoustical Units; Prefabricated, the Mild Schlyter Test described in Mimeo. No. 1443 entitled "Fire Test Methods Used in Research at the Forest Products Laboratory" and distributed by the Forest Products Laboratory, Madison, Wisconsin, and the "Test of Non-Inflammability of Materials" of Standard British Specification 476, modified as described in a Progress Report, Project 179-J8 on "Flame Spread Tests of Fiber Insulating Boards" prepared by the Forest Products Laboratory. The tests by these methods were conducted on specimens of the same fiberboard used in the cooperative tests by the cabinet method, using the same three paints applied at the same coverage of 250 ft^2/gal.

2. TEST MATERIALS

The following paints, under identification numbers assigned in the order of decreasing fire resistance (as indicated in previous tests by the method of Specification SS-A-118a on earlier shipments of the paints) were used in the tests:

No. 1 - "Duotex", manufactured by the Glidden Co. for the Celotex Corp.

No. 2 - "Fi-Re-Sist", manufactured by the Resistant Products Corp., Baltimore, Md.

No. 3 - a paint conforming to the military specification JAN-P-702, manufactured at the Navy Paint Factory, Philadelphia, Pa.

A bulk supply of each paint was procured by the NBS, from which the required smaller supplies were forwarded to each of the other testing laboratories. On all test specimens painted at the NBS, the specified coverage of 250 ft^2/gal

was applied in a single heavy brush coat.

Sheets of 1/2 in. "Insulite" taken from a single shipment were used in the preparation of all of the fiberboard test panels. Three hundred 6 in. by 12 in. panels were cut for the cabinet method tests, half of them being painted, fifty with each paint. The paint was applied on the edges as well as both surfaces. Thirty of the painted panels, ten coated with each paint, together with thirty unpainted panels to be similarly coated at the testing laboratory, were sent to each of the participating laboratories. In addition to the fiberboard panels prepared at the NBS, sixty poplar wood panels, 6 in. by 12 in. by 1/4 in., were received from the ERDL for tests by the cabinet method. Thirty of the wood panels had already been painted, ten with each paint, at the ERDL, and the remaining thirty were similarly coated after receipt at the NBS. All of the test panels, both poplar wood and fiberboard, were conditioned for one week prior to painting in an atmosphere controlled to 75° ±3°F and 50 to 60 percent relative humidity. After being coated they were similarly conditioned for two weeks before testing.

For tests by the horizontal panel method (Spec. SS-A-118a) and the Schlyter Test, three 8 by 4 ft sheets of the "Insulite" were painted, one with each paint, on the finished side only. Three of the 36 by 32 in. specimens required for the horizontal panel test, and two of the 31 by 12 in. specimens required for the Schlyter Test were then cut from each painted sheet. This provided sufficient test panels to make three determinations on each paint by the horizontal panel method, and one determination on each paint by the Schlyter Test, a set of two panels being required for each determination in the latter method. The specimens were conditioned, before and after painting, in the same manner as those prepared for the cabinet test.

Thirty 12 inch square fiberboard panels were painted on the finished side only, ten with each paint, for use in the British Non-Inflammability Test. These specimens were not specially conditioned before painting, and were tested after approximately three days of conditioning after painting.

3. TEST METHODS

3.1 Cabinet Method (Proposed Military Spec. MIL-P-CE for Paint, Fire Retardant, Interior)

Before testing, the panels are placed for 40 hours in an oven held at 120° ±3°F. Individual panels are then removed from the oven, cooled to room temperature, and weighed to the nearest 0.1 gram.

The test equipment is housed in a metal cabinet approximately 18 in. high by 14 in. wide and 10 in. deep, with a chimney vent in the top at the right hand side and a hinged, glass-paneled door in the front. Inside the cabinet, parallel supports of strap iron, set six inches apart and attached to the left side of the cabinet near the base, extend upward toward the vent at an angle of 45 degrees. The test panel is placed lengthwise on these supports, with the face to be tested downward and the lower end resting against an adjustable metal cross bar. To provide the test flame, 5 ml of absolute alcohol are drawn from a burette into a small brass cup supported on a metal pedestal insulated with asbestos paper. The cup has an outside diameter of 15/16 in., an outside height of 11/16 in., wall thickness of 1/32 in., and a capacity of 6 ml. The cup is moved into position under the test panel so that the lip of the cup is one inch vertically below the panel surface near its lower end. The alcohol is ignited with a match and the duration of the alcohol flame, the time at which flaming of the panel begins, and the duration of the panel flaming are noted with a stop watch.

After all flaming has ceased, the panel is cooled to room temperature and weighed to the nearest 0.1 gram. It is then cut into four sections along the lines of maximum length and width of flame attack by a fine-toothed saw. The charred paint film is scraped away, and the maximum length and width of char in the wood are determined along the longitudinal and lateral cuts, respectively. The maximum depth to which char penetrated at any point is also determined. From these values, the char area is calculated as the product of maximum char length and maximum char width, and char volume is taken as the product of char area and maximum char depth.

The specification proposes that the following requirements must be fulfilled by an acceptable paint. The average loss in weight of five specimens shall not exceed 15 grams and the average char volume, based on five specimens, shall not exceed 4.5 cu in. If the standard deviation in char volume among the specimens is greater than 0.9 cu in., five additional panels are tested and the average char volume of

the ten specimens shall not exceed 4.5 cu in.

The results of the tests made by this method are shown in Tables 1, 2, and 3.

3.2 Horizontal panel test (Spec. SS-A-118a)

The panels for this horizontal test were not dried in the oven but were taken directly from the conditioning room for testing.

The 36 in. by 32 in. specimen is mounted in a horizontal position, with the painted surface downward, on an angle iron frame which encloses an exposed area 30 inches square. The specimen is covered by an incombustible board, 1/2 in. thick, placed flat on its upper surface. The flame from a 7/8--in. gas-air burner set with the top of the burner 28-3/4 in. below the specimen, is directed against the center of the under surface of the specimen. The intensity of the fire exposure is gaged with a thermocouple placed one inch below the center of the specimen, and is adjusted to follow the "Standard" time-temperature curve shown in the specification. The duration of exposure is 20 minutes.

The specification defines as "Slow-Burning," materials which meet the following requirements: No flame from the specimen shall reach the angle iron frame during or after application of the test flame, nor shall glow progress to the edge of the specimen. All flaming shall cease within five minutes after the test flame is discontinued. Materials which do not fulfill these requirements are classified as "Combustible."

The time at which flames reached the iron frame and the corresponding classification of the panels tested are given in Table 4.

3.3 Mild Schlyter test

The two panels, each 12 by 31 in., comprising the test specimen are mounted vertically with the coated faces inward on an angle iron frame which spaces them 6 in. apart. The end of one panel rests on the floor while the bottom of the other is 4 in. above the floor. A wing-tipped gas burner having a right angle bend in the mixing tube is supported with its top between the panels and above the bottom of the

higher panel, the wing tip spreading the flame at right angles to the panel surfaces. The burner flame is applied for 3 minutes and the initial and subsequent flame heights are observed with the aid of a scale mounted beside the specimen.

Table 5 shows the results of the tests made by this method.

3.4 British Test of Non-Inflammability of Materials

In a study of flame spread tests several years ago, the Forest Products Laboratory found this method one of the more promising tests for distinguishing slight differences in flame behavior, and suggested several modifications which appeared to increase its sensitivity. These modifications, consisting primarily of the use of larger test specimens and a more severe flame exposure, have been adopted for the present work.

Before test, the 12 inch square panel is dried for 6 hours at 212°F, then cooled to room temperature and weighed to the nearest 0.1 gram.

The test equipment consists of a flat metal base in which four perpendicular metal rods are set in positions corresponding to the four corner areas of the specimen. The heights of the rods are so adjusted (one pair being longer than the other pair) that a specimen laid across them is inclined at an angle of 45 degrees, and hooks on the shorter rods serve as stops to prevent the specimen from sliding off. The test flame is provided by one milliliter of absolute alcohol burning in a flat-bottomed steel cup 11/16 in. in outside diameter, 9/32 in. high, and with a wall thickness of 1/32 in. The cup is set on a No. 11 cork fixed on the top of an adjustable metal support, and is placed so that the base of the cup is one inch vertically below the center of the under surface of the specimen.

The panel was mounted with the painted surface downward, and one milliliter of alcohol was pipetted into the cup and ignited with a match. The duration of the alcohol flame, the duration of flaming after the alcohol had burned out, and the time at which flame reached the upper edge of the panel were noted. If flaming persisted for one minute after the alcohol had been consumed, it was then manually extinguished. After the test, the panel was cooled to room temperature and

weighed to the nearest 0.1 gram. The charred paint was scraped away and measurements made of the maximum length and maximum width of char in the fiberboard. The product of these values was taken as the char area.

The results of the tests by this method are given in Table 6.

4. DISCUSSION OF RESULTS

Although the analysis of results from the several laboratories will provide more conclusive information on the cabinet test method, a number of interesting observations are suggested by the results obtained in this laboratory alone. To more conveniently show the relative performance of the paints and the effects of the varying conditions, the following condensed tabulation has been prepared from the more detailed Tables 1, 2 and 3.

Paint No.	Poplar Wood Panels				Fiberboard Panels	
	Coated at ERDL		Coated at NBS			
	avg wt loss grams	avg char vol in^3	avg wt loss grams	avg char vol in^3	avg wt loss grams	avg char vol in^3
1(Duotex)	10.6	5.7	10.0	5.3	3.8	3.1
2(Fi-Re-Sist)	19.3	8.5	17.4	7.0	8.3	5.4
3(Navy)	15.0	7.0	18.3	7.5	10.4	8.1

None of the three paints, applied to poplar wood, showed char volumes within the proposed limit of 4.5 cu in. Paint No. 1, however, fulfilled the requirement on weight loss, and Paint No. 3 also, on the panels coated at the ERDL, was just within the proposed 15 gram limit. On the fiberboard panels, Paint No. 1 satisfied both requirements for an acceptable paint, but Paints 2 and 3 exceeded the limit in char volume. Disregarding the proposed limits, however, the method appeared to provide reasonable differentiation among the three paints. In all of the tests the distinction between Paint No. 1 and the other two paints was decided and clear, which suggests that a superior paint could probably be selected consistently by this method. The differentiation between Paints 2 and 3 was less decided, but within each set of test conditions the weight loss and char volume agreed in determining the order of fire resistance, and, at least in weight

loss, a fair degree of sensitivity seems indicated.

It would appear that the method of paint application, even when a standard coverage is used, may have a bearing on the results of the test. Thus, the order of fire resistance of Paints 2 and 3 was reversed on the panels coated at the ERDL and those coated at the NBS. Furthermore, reference to the detailed tables will show that in weight loss there was consistently a greater variation among individual specimens in the groups coated at the NBS than in those coated at the ERDL. Whether these differences have any significance or may be related to variations in method of application (for example, the possible use of two light coats rather than one heavy coat) cannot be judged without further information from the other laboratories.

Regarding the base material used for the test panels, the three paints showed the same relative order of fire resistance on the poplar wood and on the fiberboard, although the wood evidently provided somewhat more severe test conditions. Coupled with this greater severity was a corresponding lesser sensitivity in the detection of differences in fire resistance. This is apparent with both the weight loss and char volume criteria, but is particularly notable with the char volume, which was of little value in distinguishing between the two less effective paints on the wood panels. The panels prepared from fiberboard were decidedly more uniform in weight, and probably in composition, than those prepared from the wood, and it should be noted that the facilities available at the time for cutting the fiberboard panels did not permit as great uniformity as could easily be achieved. The greater uniformity appeared to be reflected in a corresponding decrease in weight loss variation among the individual specimens of the fiberboard panels.

Apropos of the general operation of the test equipment, it was noted that the air supply within the cabinet is not sufficient for unrestricted burning of the alcohol and test panel. The suggestion is offered that a more satisfactory test exposure, and perhaps more reproducible results, could be obtained if this smothering effect were eliminated by modifying the cabinet to insure adequate ventilation. Such a modification could be expected to increase the severity of the test to some extent, which this laboratory feels would be a further improvement.

Comparing the results obtained by the different test methods, Paint No. 1 showed the greatest fire resistance in all cases. Except in the horizontal panel test, the difference between it and the other two paints was marked, and it seems evident that paints having a significant degree of fire resistance are available and the establishment of criteria for their selection is feasible.

The horizontal panel test is the most severe of the methods used and it does not determine relatively small differences in the flame behavior of less effective paints. Thus, the test panels of all three paints burned too readily to permit conclusive differentiation between them. However, the "Slow-Burning" classification of the test does offer a useful criterion for defining a class of more highly retardant paints, and there are paints on the market which have qualified in this "Slow-Burning" group. It is, therefore, strongly recommended that standards for an acceptable fire retardant paint should be no less severe than the "Slow-Burning" requirements of this test.

A more severe exposure in either the cabinet test or the British test for non-inflammability might provide a method in which the performance limits could be made adequately exacting and, at the same time, relative performance could be satisfactorily determined. Proper ventilation of the cabinet test would increase the severity of exposure in the one case, and a larger quantity of test fuel (perhaps 5 ml) would give a more severe exposure in the other, modifications which would, in fact, make the two tests closely similar. Reports of preliminary work using 5 ml of alcohol in the British test have shown promise of good comparative determinations. Although the mild Schlyter test differentiated between the three paints and could be modified to increase the severity of exposure, it is a more unwieldy test for laboratory use and development than the cabinet method or the British test.

5. SUMMARY

In connection with the development of a cabinet test method for the classification of fire retardant paints, a program of interlaboratory tests to investigate the reproducibility and correlation of results was arranged. The NBS cooperated in the interlaboratory tests and, in addition, expanded its program to include a comparison of the

cabinet method with three other test methods which have been used to determine fire retardancy in paints. The three additional tests comprised the horizontal panel test described in Federal Specification SS-A-118a, the mild Schlyter test, and a modification of the standard British "Test for Non-Inflammability of Materials," the latter two as described in publications of the Forest Products Laboratory. Three different paints were applied to both poplar wood and fiberboard panels for tests by the cabinet method, and to fiberboard panels only, for tests by the other methods.

Analysis of the interlaboratory results with the cabinet method will be made by the Engineer Research and Development Laboratories, to which the individual laboratories have submitted their findings. It is evident, however, from the results of tests at this laboratory alone, that test panels of considerably more uniform weight can be prepared from fiberboard than from poplar wood. With the use of fiberboard the test proved less severe but showed greater sensitivity, particularly with respect to the char volume criterion. In general, weight loss appeared the more sensitive criterion, the char volume providing little distinction between the less effective paints on wood panels.

Among the four test methods, there was consistent agreement in selecting one of the paints as definitely superior to the other two in fire resistance. The distinction between the two less effective paints was not as clear in most cases, and the order of relative fire resistance was not entirely consistent. Nevertheless, it would appear that the establishment of suitable criteria for the selection of acceptably fire retardant paints is readily feasible.

The horizontal panel test was the most severe of the methods used, and correspondingly ineffective in determining small differences in performance among paints of low fire resistance. There are paints available, however, which have met the requirements for the "Slow-Burning" classification of this test, and it is recommended that performance equivalent to these requirements should be specified for acceptable fire retardancy.

Both the cabinet test and the British test for non-inflammability offer promise as satisfactory laboratory methods for comparison and classification of fire resistance, if modified to increase the severity of flame exposure. It is suggested that this might be accomplished by providing adequate ventilation in the cabinet test, and by increasing the quantity of test fuel in the British test.

TG10210:1825-FP3117

Table 1 - CABINET TEST RESULTS ON PAINTS APPLIED TO POPLAR WOOD PANELS COATED AT E.R.D.L.

Paint and Test No.	Weight before test	Weight after test	Weight loss	Char length	Char width	Char depth	Char area	Char volume
Duotex	gram	gram	gram	in	in	in	in^2	in^3
1	152.6	143.9	8.7	8.6	4.8	.19	41.3	7.9
2	153.5	142.0	11.5	7.1	3.1	.19	22.0	4.2
3	152.5	142.2	10.3	8.1	3.0	.19	24.3	4.6
4	148.5	137.3	11.2	7.4	3.6	.19	26.6	5.1
5	129.9	119.7	10.2	8.3	3.1	.22	25.7	5.7
6	147.8	135.0	12.8	7.8	4.4	.19	34.3	6.5
7	140.3	131.0	9.3	7.3	3.0	.22	21.9	4.8
8	148.5	135.7	12.8	8.1	4.1	.19	33.2	6.3
9	144.9	135.6	9.3	7.6	3.6	.19	27.4	5.2
10	135.9	125.5	10.4	8.6	4.0	.19	34.4	6.5
Avg	145.4	134.8	10.6	7.9	3.7	.20	29.1	5.7
Fi-Re-Sist								
1	138.4	119.4	19.0	9.7	4.6	.22	44.6	9.8
2	163.9	141.7	22.2	9.8	4.3	.19	42.1	8.0
3	141.0	126.5	14.5	8.9	4.2	.22	37.4	8.2
4	143.4	128.1	15.3	8.9	3.8	.22	33.8	7.4
5	167.0	146.3	20.7	9.0	4.5	.19	40.5	7.7
6	169.1	150.5	18.6	8.8	3.9	.19	34.3	6.5
7	145.2	128.6	16.6	9.4	4.6	.22	43.2	9.5
8	150.0	126.6	23.4	9.7	4.6	.22	44.6	9.8
9	147.8	129.2	18.6	9.6	3.9	.22	37.4	8.2
10	143.2	118.9	24.3	9.6	4.8	.22	46.1	10.1
Avg	150.9	131.6	19.3	9.3	4.3	.21	40.4	8.5
Navy								
1	157.4	142.1	15.3	9.6	3.2	.19	30.7	5.8
2	146.2	131.5	14.7	6.6	4.8	.19	31.7	6.0
3	153.5	136.0	17.5	9.7	3.3	.22	32.0	7.0
4	158.4	145.7	12.7	6.6	4.1	.19	27.1	5.1
5	163.1	148.5	14.6	8.6	3.5	.19	30.1	5.7
6	140.9	125.4	15.5	9.7	4.9	.19	47.5	9.0
7	153.9	137.9	16.0	9.7	4.0	.19	38.8	7.4
8	146.3	131.1	15.2	9.2	3.8	.19	35.0	6.6
9	134.7	120.2	14.5	9.7	4.6	.22	44.6	9.8
10	138.1	124.4	13.7	9.7	4.3	.19	41.6	7.9
Avg	149.2	134.3	15.0	8.9	4.0	.20	35.9	7.0

Table 2 - CABINET TEST RESULTS ON POPLAR WOOD PANELS COATED AT THE N.B.S.

Paint and Test No.	Weight before test	Weight after test	Weight loss	Char length	Char width	Char depth	Char area	Char volume
Duotex	gram	gram	gram	in	in	in	in^2	in^3
1	141.6	136.0	5.6	6.6	2.8	.19	18.5	3.5
2	157.5	147.7	9.8	7.9	3.6	.19	28.4	5.4
3	161.5	148.4	13.1	9.3	3.9	.22	36.3	8.0
4	163.2	151.1	12.1	7.9	3.5	.19	27.6	5.2
5	151.5	140.6	10.9	7.9	3.3	.19	26.1	5.0
6	155.7	146.2	9.5	7.3	3.2	.19	23.4	4.4
7	135.7	128.1	7.6	8.2	3.2	.19	26.2	5.0
8	162.9	151.1	11.8	8.2	3.6	.19	29.5	5.6
9	156.5	145.9	10.6	7.9	3.2	.22	25.3	5.6
10	140.7	131.3	9.4	7.7	3.6	.19	27.7	5.3
Avg	152.7	142.6	10.0	7.9	3.4	.20	26.9	5.3
Fi-Re-Sist								
1	153.7	137.0	16.7	9.3	3.7	.19	34.4	6.5
2	152.1	135.2	16.9	8.3	3.8	.19	31.5	6.0
3	141.6	127.1	14.5	7.5	3.8	.19	28.5	5.4
4	161.4	142.3	19.1	9.0	3.8	.19	34.2	6.5
5	130.2	111.5	18.7	9.7	4.5	.19	43.6	8.3
6	160.3	141.3	19.0	9.8	3.8	.19	37.2	7.1
7	137.5	125.0	12.5	7.7	3.6	.19	27.7	5.3
8	146.8	123.2	23.6	9.8	4.6	.19	45.1	8.6
9	155.3	137.2	18.1	9.7	4.2	.19	40.7	7.7
10	132.2	117.5	14.7	8.8	4.3	.22	37.8	8.3
Avg	147.1	129.7	17.4	9.0	4.0	.19	36.1	7.0
Navy								
1	163.9	142.3	21.6	9.7	4.3	.19	41.7	7.9
2	156.9	141.2	15.7	9.9	4.0	.19	39.6	7.5
3	147.9	127.6	20.3	9.7	4.5	.22	43.6	9.6
4	132.6	121.5	11.1	8.0	2.9	.22	23.2	5.1
5	157.3	137.2	20.1	10.0	3.8	.19	38.0	7.2
6	168.3	148.7	19.6	9.6	3.8	.19	36.5	6.9
7	147.3	128.8	18.5	10.3	4.5	.19	46.4	8.8
8	140.9	119.8	21.1	9.3	4.6	.19	42.8	8.1
9	159.8	143.1	16.7	9.8	3.2	.19	31.4	6.0
Avg	152.8	134.5	18.3	9.6	4.0	.20	38.1	7.5

TABLE 3 - CABINET TEST RESULTS ON PAINTS APPLIED TO FIBERBOARD PANELS COATED AT THE N.B.S.

Paint and Test No.	Weight before test	Weight after test	Weight loss	Char length	Char width	Char depth	Char area	Char volume
Duotex	gram	gram	gram	in	in	in	in^2	in^3
1	199.6	196.8	2.8	5.9	3.1	.25	18.3	4.6
2	202.3	196.1	6.2	4.4	2.4	.28	10.6	3.0
3	200.3	198.1	2.2	4.6	2.4	.28	11.0	3.1
4	196.9	194.5	2.4	4.4	2.4	.28	10.6	3.0
5	206.3	204.4	1.9	4.6	2.4	.25	11.0	2.8
6	201.9	198.7	3.2	4.7	2.4	.28	11.3	3.2
7	207.2	201.6	5.6	4.3	2.4	.25	10.3	2.6
8	196.1	192.0	4.1	4.5	2.4	.31	10.8	3.3
9	209.5	204.6	4.9	4.5	2.6	.25	11.7	2.9
10	205.9	201.5	4.4	4.6	2.4	.25	11.0	2.8
Avg	202.6	198.8	3.8	4.6	2.5	.27	11.7	3.1
Fi-Re-Sist								
1	206.1	195.4	10.7	8.6	3.9	.25	33.5	8.4
2	211.2	201.3	9.9	5.8	4.0	.25	23.2	5.8
3	203.3	195.6	7.7	6.8	4.6	.25	31.3	7.8
4	202.7	195.9	6.8	6.3	3.3	.25	20.8	5.2
5	210.3	200.9	9.4	6.3	3.0	.25	18.9	4.7
6	202.8	193.5	9.3	6.3	3.3	.25	20.8	5.2
7	213.7	204.2	9.5	6.3	3.3	.25	20.8	5.2
8	204.7	200.2	4.5	5.5	2.7	.22	14.8	3.3
9	205.3	196.8	8.5	5.8	3.1	.25	18.0	4.5
10	204.3	197.7	6.6	5.9	2.6	.25	15.3	3.8
Avg	206.4	198.2	8.3	6.4	3.4	.25	21.7	5.4
Navy								
1	209.0	196.3	12.7	6.1	4.0	.41	24.4	10.0
2	208.5	196.3	12.2	5.9	4.0	.44	23.6	10.4
3	204.8	193.1	11.7	6.0	3.2	.38	19.2	7.3
4	212.3	204.0	8.3	6.6	3.0	.28	19.8	5.5
5	213.0	203.7	9.3	6.0	3.8	.25	22.8	5.7
6	211.2	204.2	7.0	5.4	3.2	.44	17.3	7.6
7	212.6	200.2	12.4	6.0	3.9	.28	23.4	6.6
8	204.7	195.2	9.5	7.5	3.2	.28	24.0	6.7
9	210.7	200.6	10.1	6.9	3.6	.44	24.8	10.9
10	211.2	200.5	10.7	6.4	4.2	.38	26.9	10.2
Avg	209.8	199.4	10.4	6.3	3.6	.36	22.6	8.1

Table 4 - RESULTS OF HORIZONTAL PANEL TEST (Spec. SS-A-118a)

Paint and Test No.	Time flame reached iron frame, min	Classification
Duotex 1	13.00	Combustible
2	6.00	do
3	9.00	do
Fi-Re-Sist 1	4.00	Combustible
2	6.00	do
3	5.00	do
Navy 1	4.55	Combustible
2	5.50	do
3	6.12	do

Table 5 - RESULTS OF MILD SCHLYTER TEST

Paint	Time of max. flame height, min	Flame height when burner removed, in	Duration of afterflaming, min
Duotex	2.30	20	3.45
Fi-Re-Sist	2.15	60	continued (manually extinguished)
Navy	2.15	72	continued (manually extinguished)

Table 6 - RESULTS OF BRITISH TEST FOR NON-INFLAMMABILITY

Paint and Test No.	Weight before test	Weight after test	Weight loss	Time flame at top of panel	Char length	Char width	Char area
	gram	gram	gram	min	in	in	in^2
Duotex							
1	349.3	349.0	0.3	not reached	5.1	1.9	9.7
2	347.0	346.6	0.4	do	5.0	1.8	9.0
3	353.8	353.4	0.4	do	5.5	1.8	9.9
4	345.9	345.4	0.5	do	5.0	1.9	9.5
5	346.9	346.4	0.5	do	4.9	1.9	9.3
6	352.5	352.1	0.4	do	5.1	2.2	11.2
7	350.5	349.9	0.6	do	5.0	2.0	10.0
8	348.3	347.5	0.8	do	4.9	1.9	9.3
9	355.7	355.0	0.7	do	5.0	1.9	9.5
10	354.7	353.9	0.8	do	4.8	2.0	9.6
Avg	350.5	349.9	0.5		5.0	1.9	9.7
Fi-Re-Sist							
1	349.0	343.4	5.6	0.70	9.2	3.8	35.0
2	353.5	344.1	9.4	1.17	9.4	5.6	52.6
3	348.3	342.4	5.9	0.96	9.2	4.8	44.2
4	355.0	351.6	3.4	not reached	5.9	3.6	21.2
5	351.9	349.6	2.3	do	6.4	3.0	19.2
6	350.6	347.3	3.3	0.87	8.4	2.7	22.7
7	347.0	338.6	8.4	1.59	9.6	6.6	63.4
8	349.3	345.7	3.6	1.63	7.3	3.8	27.7
9	354.3	347.7	6.6	1.17	8.5	5.6	47.6
10	351.2	347.8	3.4	not reached	6.4	3.8	24.3
Avg	351.0	345.8	5.2	1.16	8.0	4.3	35.8
Navy							
1	348.5	347.2	1.3	not reached	6.4	2.2	14.1
2	352.5	351.3	1.2	do	6.0	2.3	13.8
3	352.6	351.1	1.5	do	6.4	2.2	14.1
4	364.3	360.0	4.3	2.30	7.4	2.7	20.0
5	350.8	349.3	1.5	not reached	6.2	2.2	13.6
6	347.4	346.1	1.3	do	6.0	2.3	13.8
7	355.7	354.4	1.3	do	6.0	2.2	13.2
8	350.7	347.8	2.9	do	6.2	2.3	14.3
9	358.7	357.3	1.4	do	6.0	2.3	13.8
10	352.3	350.6	1.7	do	6.6	2.4	15.8
Avg	353.4	351.5	1.8		6.3	2.3	14.6

THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

The National Bureau of Standards is the principal agency of the Federal Government for fundamental and applied research in physics, mathematics, chemistry, and engineering. Its activities range from the determination of physical constants and properties of materials, the development and maintenance of the national standards of measurement in the physical sciences, and the development of methods and instruments of measurement, to the development of special devices for the military and civilian agencies of the Government. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various scientific and technical advisory services. A major portion of the NBS work is performed for other government agencies, particularly the Department of Defense and the Atomic Energy Commission. The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. The scope of activities is suggested in the listing of divisions and sections on the inside of the front cover.

Reports and Publications

The results of the Bureau's work take the form of either actual equipment and devices or published papers and reports. Reports are issued to the sponsoring agency of a particular project or program. Published papers appear either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three monthly periodicals, available from the Government Printing Office: the Journal of Research, which presents complete papers reporting technical investigations; the Technical News Bulletin, which presents summary and preliminary reports on work in progress; and Basic Radio Propagation Predictions, which provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: the Applied Mathematics Series, Circulars, Handbooks, Building Materials and Structures Reports, and Miscellaneous Publications.

Information on the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards ($1.00). Information on calibration services and fees can be found in NBS Circular 483, Testing by the National Bureau of Standards (25 cents). Both are available from the Government Printing Office. Inquiries regarding the Bureau's reports and publications should be addressed to the Office of Scientific Publications, National Bureau of Standards, Washington 25, D. C.


NBS