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NATIONAL BUREAU OF STANDARDS REPORT

5822

PERFORMANCE TESTS OF CAMBRIDGE
"AEROSOLVE" AIR FILTERS
(TYPES 3A-95 & 3A-35)

by

Thomas W. Watson and Henry E. Robinson

Report to
General Services Administration
Public Buildings Service
Washington 25, D. C.

NBS

U. S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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Heat Transfer Section
Building Technology Division

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PERFORMANCE TESTS OF TYPES 3A-95 AND 3A-35 CAMBRIDGE "AEROSOLVE" AIR FILTERS

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1. INTRODUCTION*

At the request of the Public Buildings Service, General Services Administration, the performance characteristics of dry-type air filters were determined to provide information to assist in the preparation of air filter specifications.

The test results presented herein were obtained on specimen dry-type air filters submitted by the manufacturer at the request of the Public Buildings Service, and included determinations of dust-arresting efficiency with two aerosols (atmospheric air and Cottrell precipitate), pressure drop, and dirt loading performance.

2. DESCRIPTION OF THE FILTER SPECIMENS

The two filters submitted were manufactured by the Cambridge Filter Corporation of Syracuse, New York, and were dry-type, replaceable cartridge, air filters, 24x24x12 inches in nominal size. They were identified by the manufacturer as Aerosolve Model 3A-95 and Aerosolve Model 3A-35 cartridges.

A permanent steel frame (Cambridge Model 4A-1000) was furnished for holding the replaceable cartridges during use. This frame had overall dimensions of 23 15/16 x 23 15/16 x 12 inches.

The Model 3A-95 replaceable air filter cartridge had overall dimensions of 23 3/8 x 23 3/8 x 12 inches. The filtering media consisted of a mat or blanket about 3/8 inch thick of apparently un-oiled fine glass fibers, reportedly approximately one micron in diameter. In the cartridge, the blanket was arranged in pleats or vee-folds over wires at the end of the vees, and its edges were glued to the surrounding frame of fire-resistant two-ply corrugated paperboard.

*This report is submitted for information only, and is not released for use in connection with advertising or sales promotion.

The downstream face of the media was supported by a thin glass fiber sheet. Insertion of the replacement cartridge in the permanent steel frame additionally reinforces and supports the filter media by means of wire vees permanently installed in the steel frame. The inside edge of the replacement cartridge is pressed against a felt gasket in the steel frame to effect a dust-tight seal. The net face area of the filter was 3.60 sq. ft., and the area of the blanket effective for filtering was approximately 43 sq. ft.

The Model 3A-35 air filter cartridge was identical in size and design, except that the glass fiber blanket was of coarser texture, the glass fibers having a diameter of approximately 3 microns.

3. TEST METHOD AND PROCEDURE

Efficiency determinations were made by the NBS "Dust-Spot Method" using the following aerosols: (a) outdoor atmospheric air drawn through the laboratory without addition of other dust or contaminant; and (b) Cottrell precipitate dispersed in the outdoor atmospheric air. The test method is described in a paper "A Test Method for Air Filters" by R. S. Dill (ASHVE Transactions, Vol. 44, p. 379, 1938).

For these tests, the filter was installed in the apparatus and the desired rate of air flow through the cleaner was established. Samples of air were drawn from the center of the test duct, at points one foot upstream and eight feet downstream of the filter and passed through known areas of Whatman No. 41 filter paper. The areas of the filter paper used upstream and downstream and the times during which the air was sampled upstream and downstream were selected experimentally so that the change in transmission of light through the two filter paper spots would be about the same. The filter efficiency was calculated by means of the formula

$$\text{Efficiency, percent} = 100 \left[1 - \frac{A_2}{A_1} \cdot \frac{O_2}{O_1} \cdot \frac{T_1}{T_2} \right]$$

where A represents the dust spot area, O the change in light transmittance of the filter paper as measured before and after the deposition of dust, and T the time during which the air sample was drawn. Subscripts 1 and 2 refer to the upstream and downstream positions, respectively.

Two efficiency-measuring techniques, or modifications based on the above formula, were used, depending on the apparent efficiency of the filter with the different aerosols.

For the tests made, techniques L and N were used, as indicated in Table 2.

All light transmission measurements were made with the photometer illumination at a constant intensity, as determined by measurement on a reference of constant transmission characteristics. The filter papers used upstream and downstream were selected to have equal light transmissions when clean.

The efficiency of the filter in arresting particulate matter in atmospheric air was determined by means of tests of the L type, as described in Table 2, with the filter clean. Following these, the efficiency of the filter in arresting Cottrell precipitate was measured by means of two N-type tests, after which was begun the process of loading the filter with a mixture of 4 percent cotton lint and 96 percent of Cottrell precipitate, by weight, separately dispersed in the air stream. The lint used for this purpose was No. 7 cotton linters previously ground in a Wiley mill with a 4-millimeter screen. At suitable periods, as the loading progressed, the efficiency of the filter was determined using Cottrell precipitate in outdoor air. Pressure drops were recorded at intervals during the test. The dirt-loading was continued until the pressure drop increased to approximately 0.90 inch W.G. for the 3A-95 filter, and 0.57 inch W.G. for the 3A-35 filter. The efficiency was again determined with Cottrell precipitate and then with atmospheric air as the aerosols.

4. TEST RESULTS

Table 1 presents data as to the pressure drops of the clean filters at several rates of air flow.

The performance of the filters at 1000 cfm is summarized in Table 2, and is also shown graphically in Figures 1 and 2 for both aerosols A and C.

Observation of the filters at the end of the dirt-loading tests showed that the lint fraction of the dirt-load was uniformly deposited on the upstream faces, and had not penetrated appreciably into the media. In the case of the 3A-95 filter, the bulk of the dust fraction of the dirt load was found on the upstream face and had not penetrated into the media beyond about 1/16-inch. The downstream face of this filter was observed to be clean and not discolored. In the case of the 3A-35 filter, the downstream face of the media was uniformly darkened at the end of the dirt-loading test. No lint was visible on the downstream face of either filter.

TABLE 1

PRESSURE DROP OF CLEAN FILTERS

Air Flow cfm	Face Velocity fpm	Pressure Drop inch W.G.
	3A-95	
1200	28	0.507
1000	23	.414
800	19	.322
600	14	.234
	3A-35	
1200	28	0.172
1000	23	.133
800	19	.094
600	14	.063

TABLE 2

PERFORMANCE OF FILTERS AT 1000 CFM

Filter	Aerosol(1)	Total Dirt Load(2) grams	Pressure Drop inch W.G.	Eff. Meas. Technique(3)	Efficiency percent
3A-95	A	-	0.422	L	92.0
		-	.423	L	91.4
		-	.428	L	90.8
		-	.438	L	91.2
					Avg. 91.4
	C	10	.438	N	99.7
		19	.438	N	99.7
		306	.503	N	99.9
		415	.543	-	-
		533	.603	N	99.9
		692	.705	-	-
		811	.797	-	-
		909	.865	N	99.8
	A	909	.910	L	98.8
		909	.918	L	97.7
3A-35	A	-	.130	L	24.0
		-	.130	L	23.4
			.130	L	23.8
	C	10	.132	N	85.1
		19	.133	N	90.5
		29	.136	N	93.9
		38	.137	N	94.7
	A	59	.140	L	37.7
		59	.140	L	38.4
	C	257	.160	-	-
		374	.176	-	-
		542	.200	N	94.1
		790	.242	-	-
		956	.299	N	95.7
		1145	.372	-	-
		1235	.406	N	96.2
		1384	.450	-	-
		1453	.503	N	97.8
		1684	.558	-	-
		1813	.605	N	96.9
		1822	.612	N	96.9
	A	1822	.580	L	63.1
		1822	.570	L	62.8

(Cont'd)

TABLE 2 (Cont'd)

(1) Aerosol A: Particulate matter in atmospheric air at NBS
Aerosol C: Cottrell precipitate in atmospheric air (1 gram per 1000 cf).

(2) Average mixture: 3.9 percent lint, 96.1 percent Cottrell precipitate, by weight.

(3) Efficiency measuring technique:

L: Air sampled at equal rates through equal areas; upstream sampling time selected to yield approximately equal dust-spot opacities of the upstream and downstream filter papers.

N: Air sampled at equal rates for equal times; downstream areas selected to yield approximately equal dust-spot opacities of the upstream and downstream filter papers.

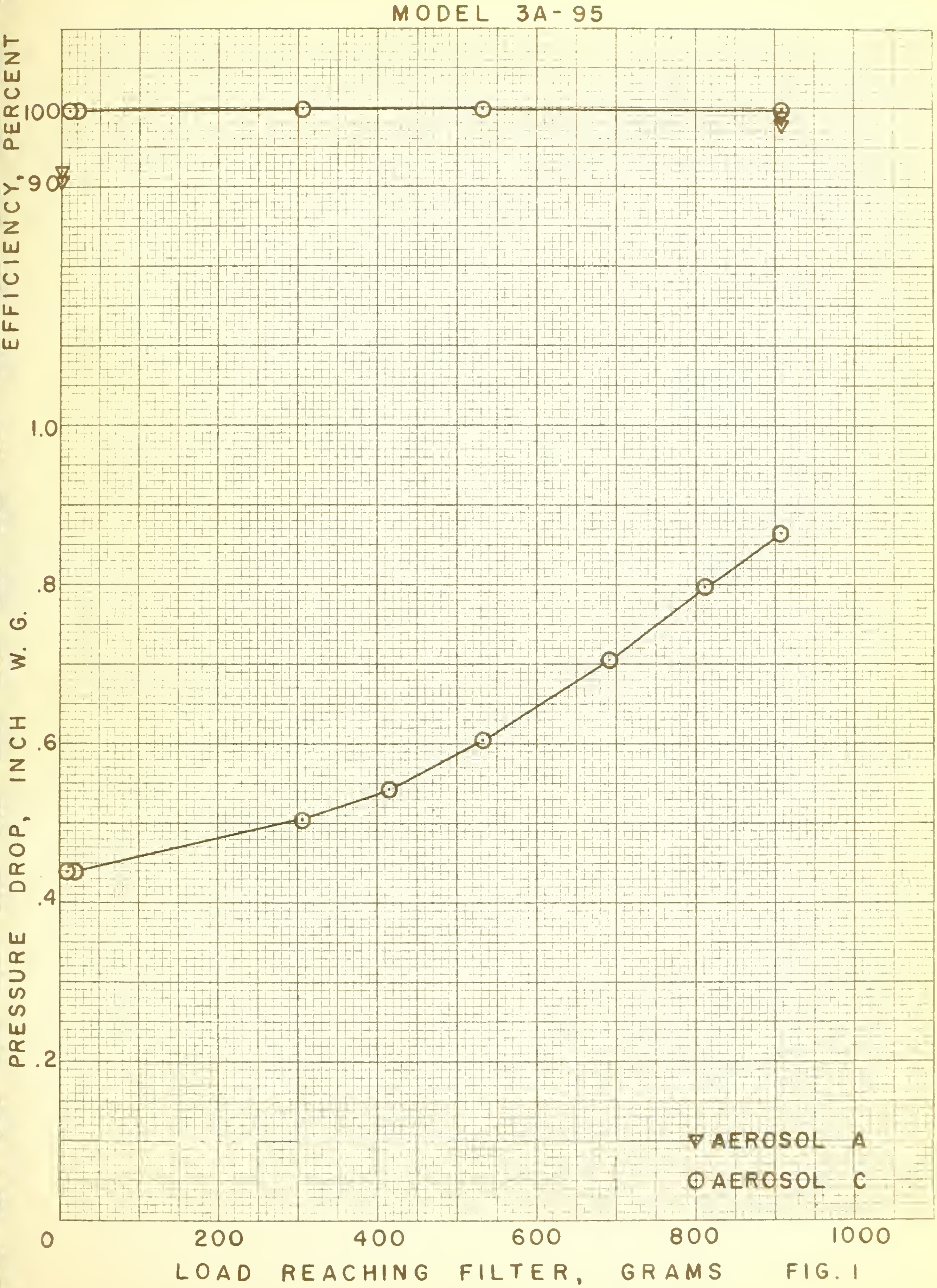
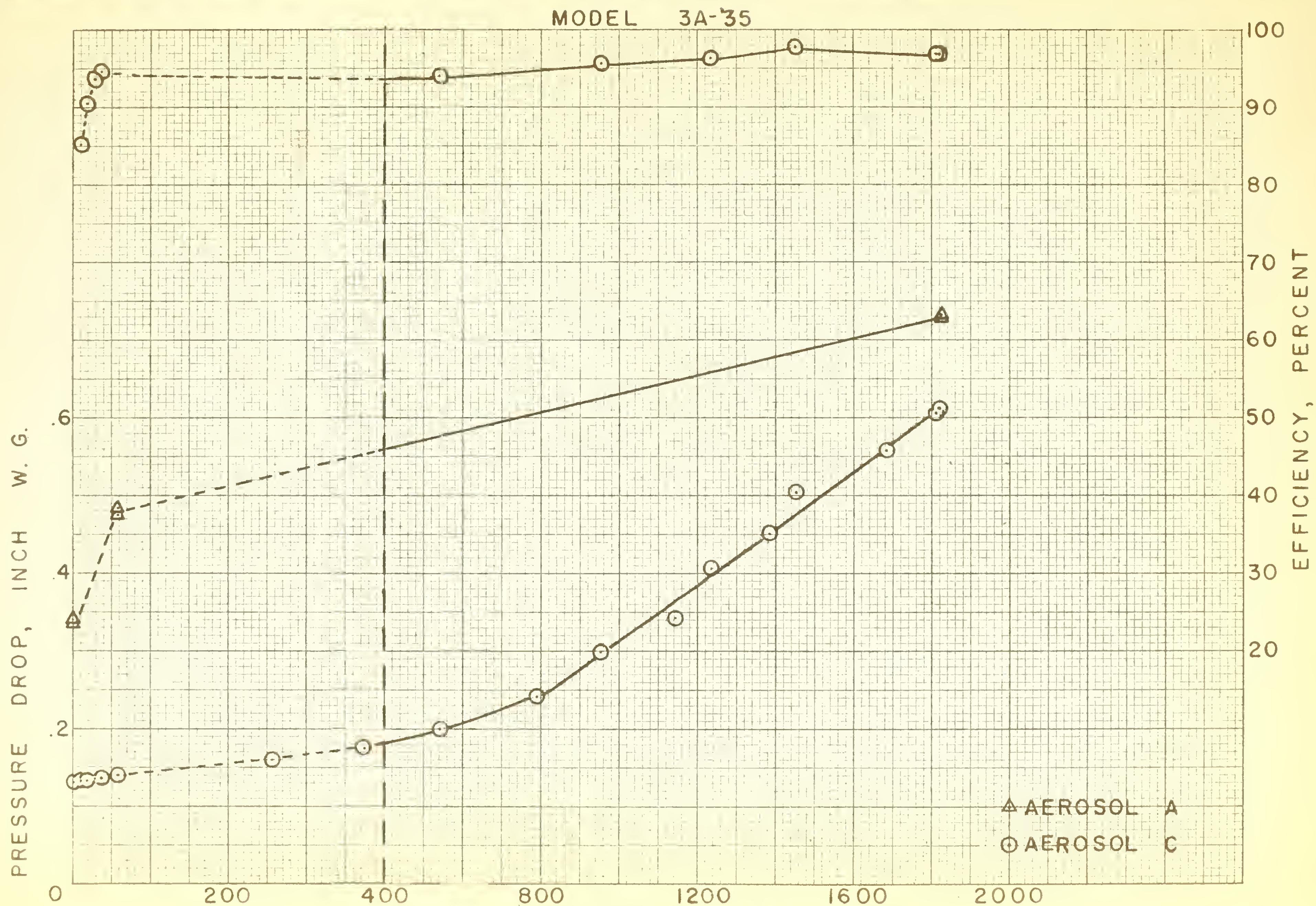

MODEL 3A-95
EFFICIENCY, PERCENT
100
90
PRESSURE DROP, INCH W. G.
1.0
.8
.6
.4
.2
0
200
400
600
800
1000
LOAD REACHING FILTER, GRAMS
AEROSOL A
AEROSOL C

FIG. I



LOAD REACHING FILTER, GRAMS FIG. 2

U. S. DEPARTMENT OF COMMERCE
Sinclair Weeks, *Secretary*

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

THE NATIONAL BUREAU OF STANDARDS

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WASHINGTON, D. C.

Electricity and Electronics. Resistance and Reactance. Electron Devices. Electrical Instruments. Magnetic Measurements. Dielectrics. Engineering Electronics. Electronic Instrumentation. Electrochemistry.

Optics and Metrology. Photometry and Colorimetry. Optical Instruments. Photographic Technology. Length. Engineering Metrology.

Heat. Temperature Physics. Thermodynamics. Cryogenic Physics. Rheology. Engine Fuels. Free Radicals Research.

Atomic and Radiation Physics. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics. Neutron Physics. Nuclear Physics. Radioactivity. X-rays. Betatron. Nucleonic Instrumentation. Radiological Equipment.

Chemistry. Organic Coatings. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Molecular Structure and Properties of Gases. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

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Mineral Products. Engineering Ceramics. Glass. Refractories. Enameled Metals. Concreting Materials. Constitution and Microstructure.

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BOULDER, COLORADO

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