NATIONAL BUREAU OF STANDARDS REPORT

2285

PERFORMANCE TESTS OF CLEANABLE IMPINGEMENT TYPE AIR FILTERS TYPE HV-2 AND TYPE HV-2-16

manufactured by
American Air Filter Company, Inc.
Louisville, Kentucky.

by

Henry E. Robinson
Thomas W. Watson

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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NBS PROJECT **NBS REPORT**

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Henry E. Robinson
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Heating and Air Conditioning Section
Building Technology Division

To

Bureau of Ships, Code 327
Department of the Navy

Reference: NPO - 15479 Index No. NSM 130-001

Performance Tests of American Type HV-2 and HV-2-16 Air Filters

I. INTRODUCTION

At the request of the Bureau of Ships, Code 327, Navy Department (NPO-15479, Index No. NSM 130-001) qualification tests were made to determine the performance of cleanable viscid-impingement type air filters in accordance with Section 4.5 of Military Specification MIL-F-16552 (Ships) dated 1 October 1951 as modified by Amendment 1 dated 15 April 1952.

The tests were performed on specimen filters submitted by the manufacturer at the request of the Bureau of Ships, and included determinations of the dust-arresting efficiency, pressure drop, specific dirt load and cleanability of the specimens at three face air velocities, namely 300, 600 and 900 feet per minute.

II. DESCRIPTION OF THE FILTER SPECIMENS

The two filters submitted were manufactured by the American Air Filter Company, Inc. of Louisville, Kentucky, and were of the cleanable viscid type, 20x20x2 inches in nominal size. They were identified by their nameplates as Type HV-2 and Type HV-2-16 air filters.

The Type HV-2 filter media was composed of V-crimped, and flat, strips of 12-mesh screen wire, assembled by piling one alternately on the other. The resulting media, seen in the direction of air-flow, appeared to consist of pyramidal pockets each converging to a point at the other face of the media, with each square pyramid bisected along a diagonal by the flat screen. There were approximately four V-crimped layers per inch of pile. The filter had actual outside dimensions of 19-1/2x19-1/2x1-7/8 inches, leaving a free opening 18-3/16x18-1/4 inches (2.31 ft^2 net face area) and weighed 10.2 lb. when clean, without oil.

The Type HV-2-16 air filter was similar in construction to the Type HV-2 except that 16-mesh screen wire was used throughout as media and there was an average of 3.6 V-crimped layers per inch of pile. The filter had actual outside dimensions of 19-1/2x19-9/16x 1-7/8 inches, leaving a free opening 18-1/4 inches square (2.31 ft^2 net face area) and weighed 11.9 lb. when clean, without oil.

The manufacturer submitted an adhesive designated as "BA Viscosine" for oiling both filters. This was done in preparation for the test by immersing the filters in the liquid and letting the excess oil drain off with the filters standing on edge for a minimum of 16 hours prior to the test.

III. TEST METHOD AND PROCEDURE

The dust-arresting efficiency of the filter was determined by the NBS "Dust Spot Method" using as a test dust Cottrell precipitate at a concentration of one gram per thousand cubic feet of air. The test method is described in the paper "A Test Method for Air Filters" by R. S. Dill (ASHVE Transactions, Vol. 44, p. 379, 1938).

Dirt-holding capacity was determined by supplying to the filter air in which were dispersed cotton lint and Cottrell precipitate in the approximate proportions of 4% and 96% by weight, respectively. The average rate of feed of the contaminants was not more than 25 grams per hour per square foot of net filter face area at each face velocity. The lint used for this purpose was No. 7 cotton linters ground in a Wiley mill with 4 mm screen.

The efficiency and dirt-loading tests were made at three different air velocities, namely, 300, 600 and 900 fpm.

In the tests at each velocity, the following uniform procedure was employed. The clean filter, after oiling and draining as described above, was installed in the test duct and its initial pressure drop was measured at 300, 600 and 900 fpm air velocity. The initial efficiency of the filter at the test velocity was then determined, following which the process of loading the filter with a mixture of 4 percent lint and 96 percent Cottrell precipitate by weight was started. At intervals the increasing pressure drop of the filter was recorded. At suitable periods as loading progressed, the efficiency of the filter was determined using 100 percent Cottrell precipitate. In addition, the efficiency of the filter was determined at the end of a day of loading, and at the start of the next day, to ascertain whether the rate of dirt loading was overtaxing the wetting rate of the filter adhesive. The dirt loading was continued, in general, until the rate of pressure drop rise increased to approximately 0.004 inch W.G. per gram of dirt mixture fed per square foot of filter face area.

The filter was then removed from the test duct and cleaned by means of a stream of cold water from a high-pressure hose nozzle, directed at and into the filter media. After drying, the filter was re-oiled for subsequent tests or for measurement of its initial pressure drop after the final cleaning.

IV. TEST RESULTS

The pressure drop of the clean oiled filters, in inch W.G., at 300, 600 and 900 fpm face air velocity, was measured at the start of each of the tests, and after the 900 fpm test, as shown in Table 1.

TABLE 1

Face Velocity, fpm	300	600	900
HV-2			
At start of 300 fpm test	0.042	.138	.282
At start of 600 fpm test	.043	.141	.289
At start of 900 fpm test	.042	.139	.282
After 900 fpm test	.041	.133	.280
Increase in P.D. after 3 cleanings,%	-	-	-
HV-2-16			
At start of 300 fpm test	.050	.158	.322
At start of 600 fpm test	.049	.158	.323
At start of 900 fpm test	.050	.163	.342
After 900 fpm test	.049	.161	.343
Increase in P.D. after 3 cleanings,%	-	2	7

A summary of the test data obtained in dirt-loading tests conducted at 300, 600 and 900 fpm face velocity is given in Table 2, for each of the filters.

TABLE 2

Filter	Face Air Velocity fpm	Dirt Load* grams/sq.ft.	Pressure Drop inch WG	Efficiency percent
HV-2	300	0	.042	-
		10	.046	44
		52	.057	50
		90	.069	49(P)
		92	.068	51(A)
		133	.084	-
		182	.103	56
		204	.117	55(P)
		207	.115	59(A)
		250	.151	61
		304	.203	63
		332	.243	65(P)
		335	.242	69(A)
		388	.363	68
		427	.483	75(P)
		429	.463	77(A)
		434	.508	80
HV-2	600	0	.141	-
		30	.147	52
		75	.202	56
		102	.220	59(P)
		108	.224	60(A)
		150	.253	59
		247	.327	65(P)
		253	.336	63(A)
		269	.353	65
		334	.436	-
		393	.527	68(P)
		399	.564	69(A)
		441	.683	73
		469	.839	75
HV-2	900	0	.282	-
		26	.302	59
		63	.392	60
		108	.443	60(P)
		117	.455	63(A)
		162	.518	64
		234	.609	65(P)
		243	.618	67(A)
		325	.762	69
		370	.852	75(P)
		379	.884	74(A)
		460	1.153	74
		478	1.234	76

* Average mixture: 4.2% lint, 95.8% Cottrell precipitate by weight.
Average rate of dirt loading: 15.6 grams per square foot per hour.

* Average mixture: 4.1% lint, 95.9% Cottrell precipitate by weight.
Average rate of dirt loading: 19.9 grams per square foot per hour.

* Average mixture: 4.0% lint, 96% Cottrell precipitate by weight.
Average rate of dirt loading: 22.5 grams per square foot per hour.

TABLE 2 - continued

Filter	Face Air Velocity fpm	Dirt Load* grams/sq.ft.	Pressure Drop inch WG	Efficiency percent
HV-2-16	300	0	.050	-
		3	.050	47
		6	.050	48
		9	.050	47
		69	.072	52(P)
		72	.070	50(A)
		136	.100	57
		165	.115	59(P)
		168	.114	59(A)
		209	.150	62
		254	.200	64
		270	.225	68(P)
		273	.220	65(A)
		290	.262	72
		327	.375	77
		357	.520	78

* Average mixture: 4.2% lint, 95.8% Cottrell precipitate by weight.
Average rate of dirt loading: 15.0 grams per square foot per hour.

HV-2-16	600	0	.158	-
		6	.158	57
		12	.162	59
		63	.204	57
		81	.217	57(P)
		87	.224	61(A)
		129	.258	61
		176	.303	-
		221	.347	65(P)
		227	.349	63(A)
		307	.503	67
		363	.718	72(P)
		369	.719	77(A)
		387	.833	77

* Average mixture: 4.0% lint, 96% Cottrell precipitate by weight.
Average rate of dirt loading: 20.4 grams per square foot per hour.

HV-2-16	900	0	.342	-
		9	.350	65
		18	.357	65
		72	.452	-
		126	.522	67(P)
		135	.540	67(A)
		189	.631	-
		252	.749	70
		279	.810	75(P)
		288	.830	76(A)
		333	.985	-
		361	1.103	78

* Average mixture: 4% lint, 96% Cottrell precipitate by weight.
Average rate of dirt loading: 24.8 grams per square foot per hour.
NOTE: Efficiencies marked (P) or (A) were determinations made at the end of a day of loading, and at the start of the next day of loading, respectively.

V. SUMMARY OF RESULTS

A. Performance

The test data are plotted in Figure 1 and Figure 2, which show the variation of the pressure drop and of the efficiency of the filters as they were subjected to increasing specific dirt loading at face velocities of 300, 600 and 900 feet per minute.

Table 3 presents values of the pressure drop (P.D.), in inches of water, and of the approximate efficiency (Eff.), in percent, as taken from the curves of Figure 1 and Figure 2, at various specific dirt loadings.

TABLE 3

Spec.Dirt Ldg. grams/sq.ft.	0 (Initial)		100		200		300		400	
Face Vel.fpm	P.D.	Eff.	P.D.	Eff.	P.D.	Eff.	P.D.	Eff.	P.D.	Eff.
					HV-2					
300	0.04	44	.07	51	.11	55	.20	63	.40	70
600	.14	52	.22	59	.29	63	.39	66	.56	69
900	.28	59	.43	60	.57	64	.72	67	.96	74
					HV-2-16					
300	0.05	47	.08	53	.14	61	.29	73	-	-
600	.16	57	.23	61	.32	64	.49	67	-	-
900	.34	65	.48	67	.65	69	.87	76	-	-

B. Cleanability

The pressure drops of the clean oiled filters at 300,600 and 900 fpm face velocity recorded in Table 1 under Test Results indicate that, after the filter had been subjected to three loadings with the dust-lint mixture and three cleanings and oilings, the pressure drop of the Type HV-2 filter was substantially the same as it had been at the start of the tests. The Type HV-2-16 filter showed a slight increase in pressure drop at 900 fpm after its last cleaning, over its original measurement. This change is within the uncertainty with which the cleaning opera-

tion, which is necessarily involved in the process of ascertaining cleanability, could be performed. It is believed both filters can be considered as satisfactorily cleanable.

C. General

The fact that efficiencies determined at the end of a day of loading of the filters (those marked (P) in Table 2) were approximately the same as those made at the start of the next day of loading (those marked (A)) indicates that the dirt loading rates to which the filters were subjected did not overtax the wetting-rate of the filter adhesive and cause the filter surfaces to become "dry".

tion, which is necessarily involved in the process of ascertaining cleanability, could be performed. It is believed both filters can be considered as satisfactorily cleanable.

C. General

The fact that efficiencies determined at the end of a day of loading of the filters (those marked (P) in Table 2) were approximately the same as those made at the start of the next day of loading (those marked (A)) indicates that the dirt loading rates to which the filters were subjected did not overtax the wetting-rate of the filter adhesive and cause the filter surfaces to become "dry".

AMERICAN HV-2

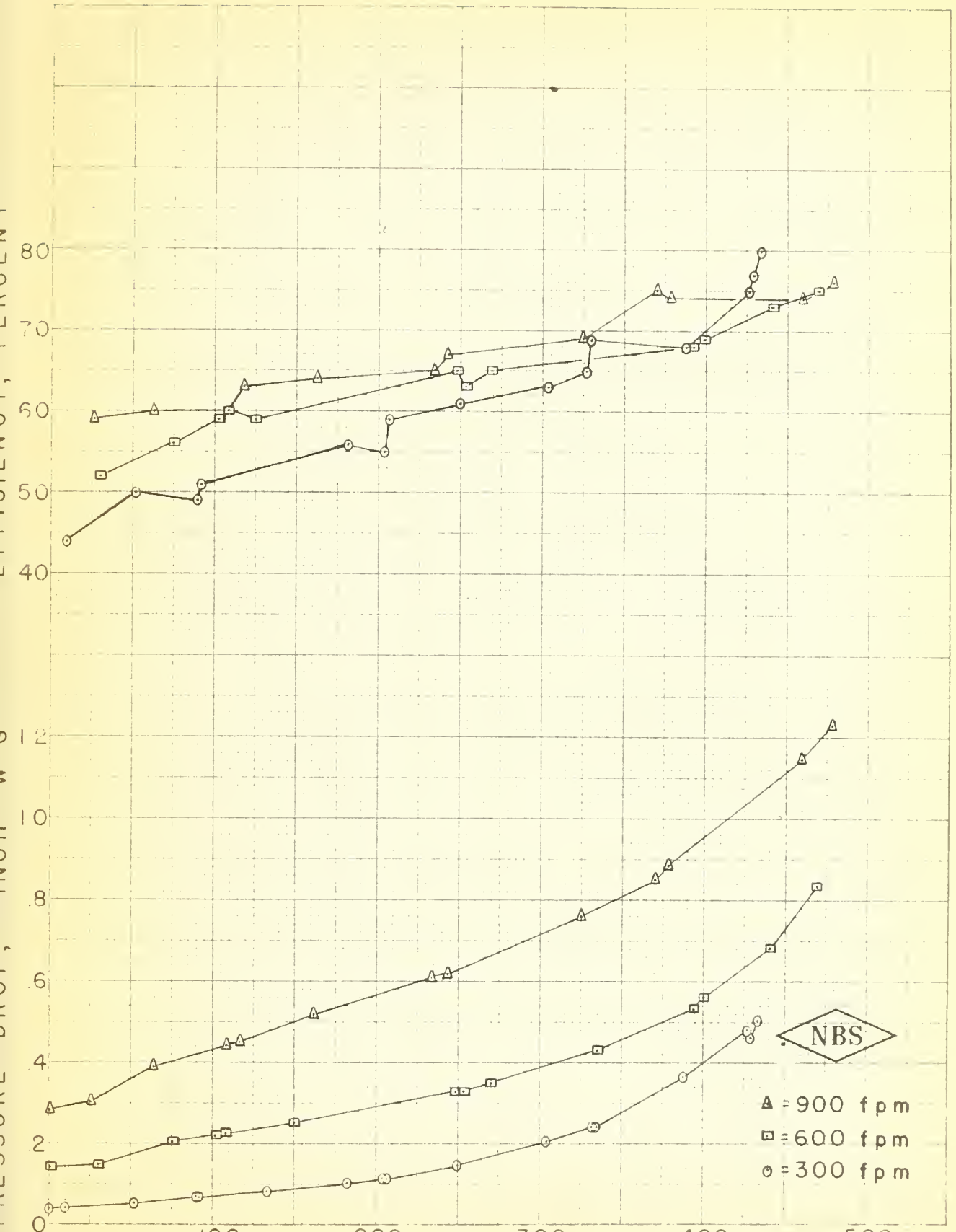

FIG 1

AMERICAN HV-2 -16

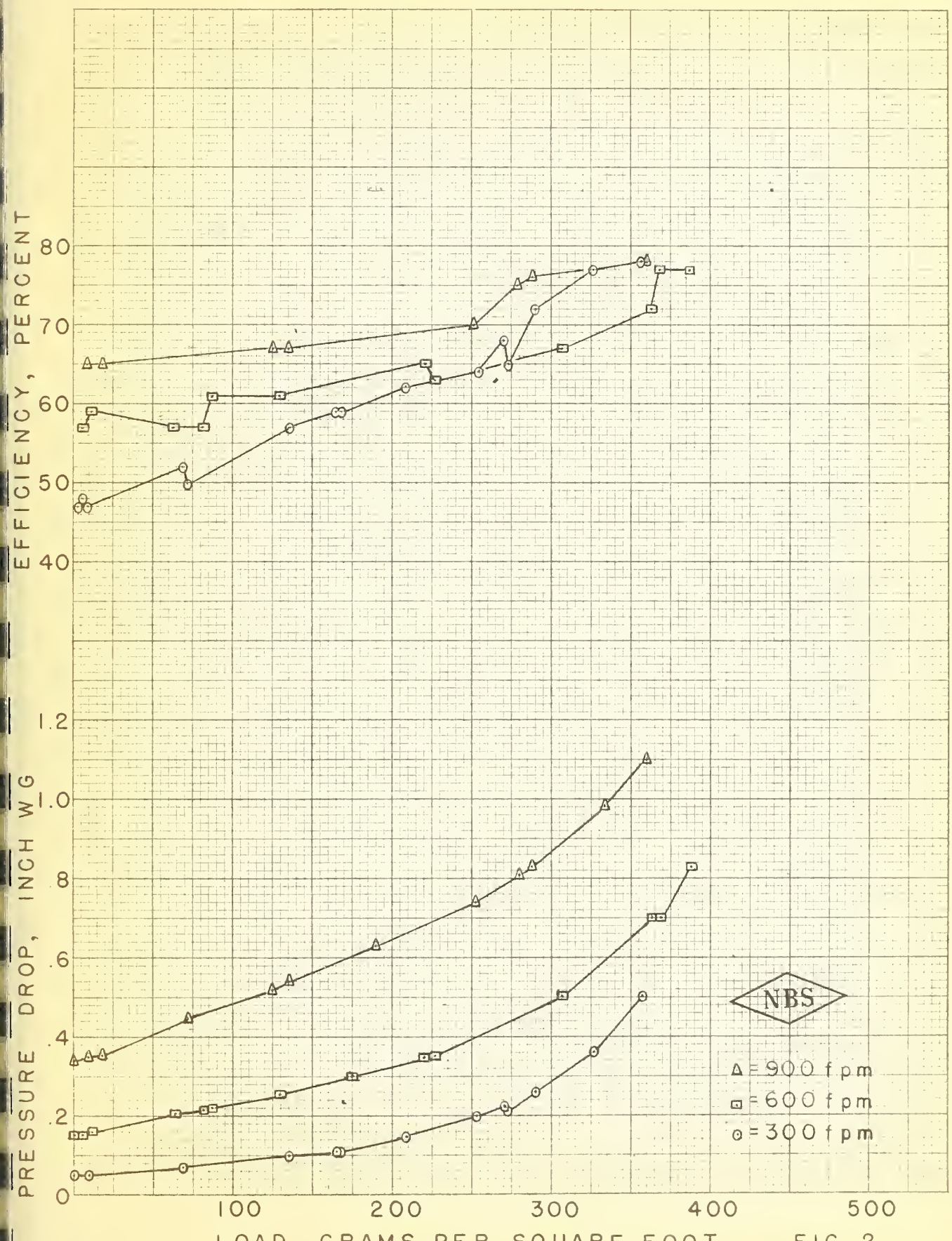

FIG. 2

THE NATIONAL BUREAU OF STANDARDS

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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. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to Government Agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services and various consultation and information services. A major portion of the Bureau's work is performed for other Government Agencies, particularly the Department of Defense and the Atomic Energy Commission. The scope of activities is suggested by 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.


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