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NATIONAL BUREAU OF STANDARDS REPORT

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PERFORMANCE TESTS OF CLEANABLE IMPINGEMENT TYPE AIR FILTERS TYPE EWA AND TYPE EWAP (CONTINENTAL)

by

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to

Bureau of Ships
Department of the Navy

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT **NBS REPORT**

1003-20-4715 July 29, 1953 2699

PERFORMANCE TESTS OF CLEANABLE IMPINGEMENT TYPE AIR FILTERS TYPE EWA AND TYPE EWAP

Manufactured by
Continental Air Filters, Inc.
Louisville, Kentucky

by

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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 CLEANABLE IMPINGEMENT TYPE AIR FILTERS TYPE EWA AND TYPE EWAP

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 Continental Air Filters, Incorporated, of Louisville, Kentucky, and were of the cleanable viscid type, 20 x 20 x 2 inches in nominal size. They were identified as Type EWA and Type EWAP air filters.

The media of the filters consisted of formed strips of aluminum about 2 inches wide which had been intricately corrugated with double compound curves. The strips were placed on edge in non-nesting relationship, thus forming many honeycomb openings and were held together at the edges by a steel retaining frame.

The Type EWA filter had approximately 5.5 layers of metal per inch of pile. The filter had actual outside dimensions of 19 1/2 x 19 1/2 x 2 inches, leaving a free opening 18 inches square (2.25 ft^2 net face area) and weighed 9.2 lb when clean.

The Type EWAP filter was similar in construction to the Type EWA filter except that the layers of metal had been indented forming small dimples about 3/16 inch apart. Some of these dimples were perforated, and some were not. The filter had actual outside dimensions of 19 1/2 x 19 1/2 x 2 inches, leaving a free opening 18 1/16 inches square (2.27 ft^2 net face area) and weighed 9.4 lb when clean. There were approximately 5.7 layers of metal per inch of pile.

The manufacturer submitted an adhesive designated as "C-1" oil for oiling both filters. This was done in preparation for 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 drops of the clean oiled filters, in inch W.G., at 300, 600, and 900 fpm face air velocity, were 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
Type EWA			
At start of 300 fpm test	0.042	.144	.310
At start of 600 fpm test	.043	.144	.305
At start of 900 fpm test	.042	.144	.310
After 900 fpm test	.043	.143	.305
Increase in P.D. after 3 cleanings, percent	2	0	0
Type EWAP			
At start of 300 fpm test	0.045	.152	.330
At start of 600 fpm test	.043	.150	.326
At start of 900 fpm test	.044	.150	.322
After 900 fpm test	.043	.148	.320
Increase in P.D. after 3 cleanings, percent	0	0	0

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 Velocity fpm	Dirt Load* grams/sq ft	Pressure Drop inch WG	Efficiency percent
EWA	300	0	0.042	-
		3	.042	37
		5	.042	34
		8	.042	39
		59	.048	43
		62	.046	38
		70	.046	44

TABLE 2 - continued

Filter	Face Velocity fpm	Dirt Load* grams/sq ft	Pressure Drop inch WG	Efficiency percent
EWA	300	75	0.047	41
		78	.048	40
		107	.052	42(P)
		110	.049	41(A)
		196	.070	48
		257	.093	50(P)
		265	.097	49(A)
		276	.103	54
		325	.149	60
		370	.203	61
		394	.250	64(P)
		397	.264	65(A)
		429	.348	73
		459	.520	76

*Average mixture: 3.9% lint, 96.1% Cottrell precipitate by weight.
Average rate of dirt loading: 17.3 grams per square foot per hour.

Filter	Face Velocity fpm	Dirt Load* grams/sq ft	Pressure Drop inch WG	Efficiency percent
EWA	600	0	0.144	-
		5	.144	44
		11	.144	40
		17	.144	43
		24	.150	47
		82	.185	47(P)
		87	.170	52(A)
		133	.200	48
		182	.250	54
		215	.300	57
		236	.330	64(P)
		242	.340	59(A)
		251	.360	60
		297	.510	62
		334	.675	66
		352	.805	72

*Average mixture: 4.0% lint, 96% Cottrell precipitate by weight.
Average rate of dirt loading: 21.4 grams per square foot per hour.

TABLE 2 - continued

Filter	Face Velocity fpm	Dirt Load* grams/sq ft	Pressure Drop inch WG	Efficiency percent
EWA	900	0	0.310	-
		6	.310	53
		12	.305	52
		52	.340	55(P)
		5[illegible]	.315	48(A)
		64	.315	51
		79	.345	54
		117	.363	53
		210	.510	60
		274	.6[illegible]5	65(P)
		283	.713	60(A)
		302	.795	60
		339	.990	64
		348	1.050	68

*Average mixture: 4.0% lint, 96% Cottrell precipitate by weight.
Average rate of dirt loading: 20.2 grams per square foot per hour.

Filter	Face Velocity fpm	Dirt Load* grams/sq ft	Pressure Drop inch WG	Efficiency percent
EWAP	300	0	0.045	-
		3	.045	38
		8	.045	41
		34	.048	45
		52	.050	42
		65	.050	43
		152	.075	39
		188	.093	48(P)
		191	.090	51(A)
		207	.102	50
		256	.15[illegible]	60
		277	.195	61
		290	.212	62(P)
		293	.210	60(A)
		335	.385	70
		353	.528	77

*Average mixture: 4.0% lint, 96% Cottrell precipitate by weight.
Average rate of dirt loading: 21.0 grams per square foot per hour.

TABLE 2 - continued

Filter	Face Velocity fpm	Dirt Load* grams/sq ft	Pressure Drop inch WG	Efficiency percent
EWAP	600	0	0.150	-
		6	.150	42
		11	.150	45
		97	.204	44
		127	.250	48(P)
		133	.220	50(A)
		160	.250	54
		215	.363	64
		251	.490	65
		273	.615	63(P)
		278	.610	68(A)
		300	.840	69

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

Filter	Face Velocity fpm	Dirt Load* grams/sq ft	Pressure Drop inch WG	Efficiency percent
EWAP	900	0	0.322	-
		18	.322	54
		27	.322	53
		74	.388	57
		120	.455	61(P)
		129	.416	60(A)
		184	.536	61
		240	.729	69
		285	.925	75

*Average mixture: 4.0% lint, 96% Cottrell precipitate by weight.
Average rate of dirt loading: 25.4 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

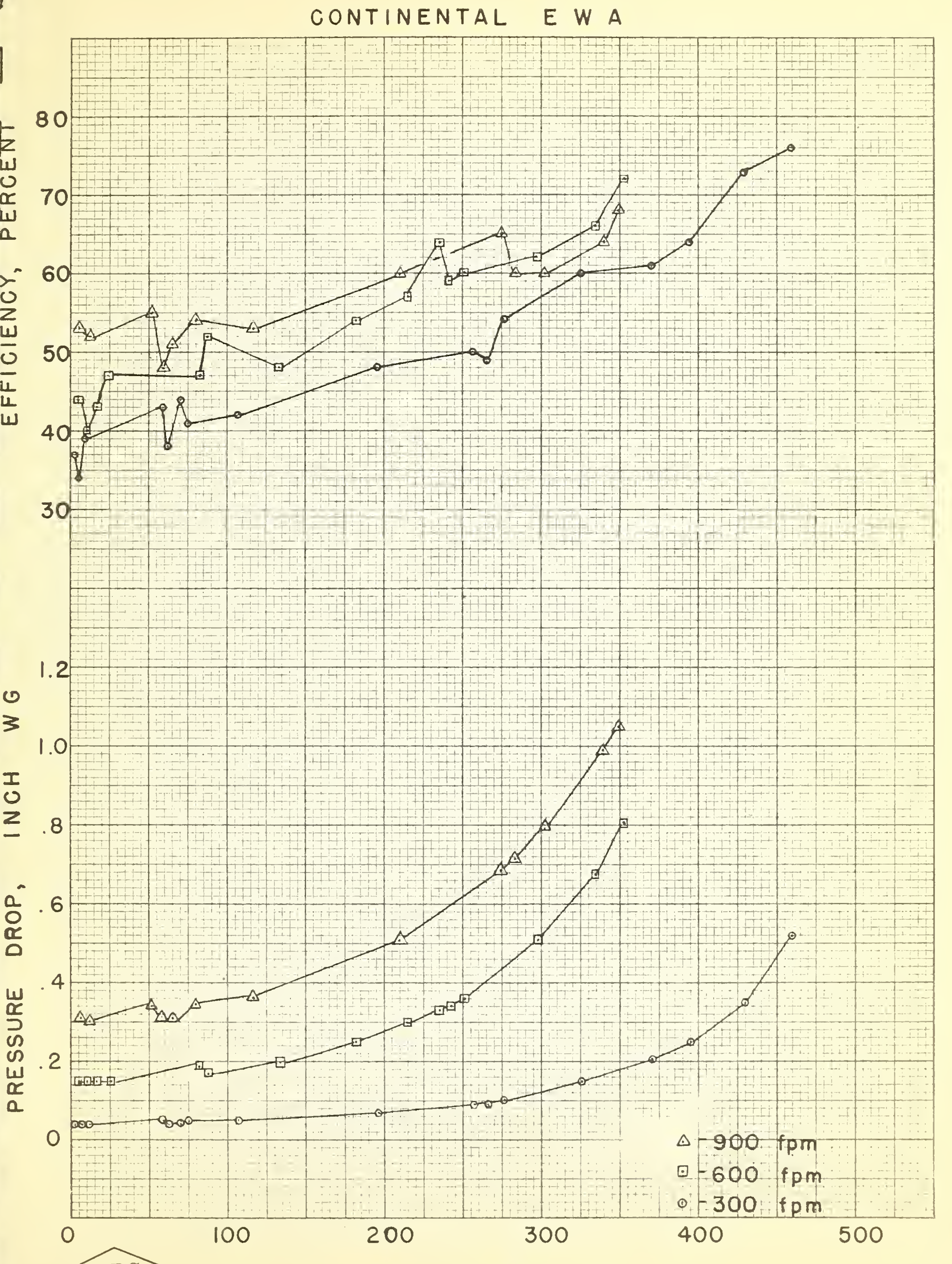
Spec. Dirt Ldg. grams/sq ft	0 (Initial)		100		200		300		400	
Face Vel., fpm	P.D.	Eff.	P.D.	Eff.	P.D.	Eff.	P.D.	Eff.	P.D.	Eff.
				EWA						
300	0.04	37	.05	42	.07	48	.12	47	.26	66
600	.14	44	.18	51	.28	56	.52	62	-	-
900	.31	53	.36	53	.49	59	.79	60	-	-
				EWAP						
300	0.05	38	.06	41	.09	50	.23	61	-	-
600	.15	42	.21	44	.33	61	.84	69	-	-
900	.32	54	.43	59	.59	63	-	-	-	-

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 filters had been subjected to three loadings with the dust-lint mixture and three cleanings and re-oilings, their average pressure drops remained substantially the same. It is believed that 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.



CONTINENTAL E W A
EFFICIENCY, PERCENT
80
70
60
50
40
30
PRESSURE DROP, INCH WG
1.2
1.0
.8
.6
.4
.2
0
900 fpm
600 fpm
300 fpm
0
100
200
300
400
500
LOAD, GRAMS PER SQUARE FOOT

NBS

FIG. 1

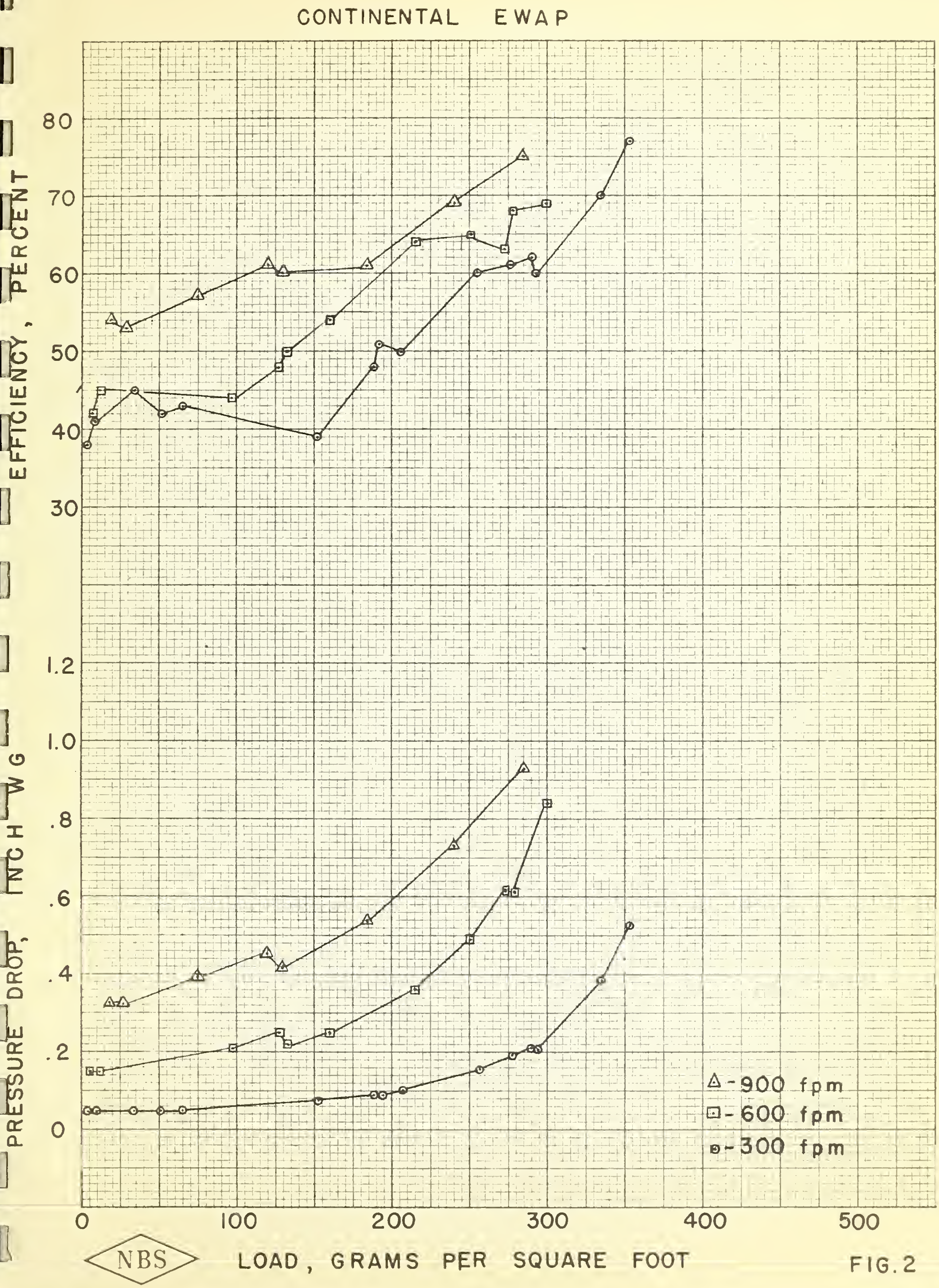

CONTINENTAL EWAP
EFFICIENCY, PERCENT
80
70
60
50
40
30
PRESSURE DROP, INCH W G
1.2
1.0
.8
.6
.4
.2
0
0
100
200
300
400
500
LOAD, GRAMS PER SQUARE FOOT
△-900 fpm
□-600 fpm
⊙-300 fpm
NBS

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.

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