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NATIONAL BUREAU OF STANDARDS REPORT

2197

PERFORMANCE TESTS OF CLEANABLE
IMPINGEMENT TYPE AIR FILTERS
AIR MAZE TYPE P-5W

manufactured by
Air Maze Corporation
Cleveland, Ohio.

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

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

U. S. DEPARTMENT OF COMMERCE
Charles Sawyer, *Secretary*

NATIONAL BUREAU OF STANDARDS
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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.

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

Radio Propagation. Upper Atmosphere Research. Ionospheric Research. Regular Propagation Services. Frequency Utilization Research. Tropospheric Propagation Research. High Frequency Standards. Microwave Standards.

Ordnance Development.
Electromechanical Ordnance.
Electronic Ordnance.
These three divisions are engaged in a broad program of research and development in advanced ordnance. Activities include basic and applied research, engineering, pilot production, field testing, and evaluation of a wide variety of ordnance matériel. Special skills and facilities of other NBS divisions also contribute to this program. The activity is sponsored by the Department of Defense.

Missile Development. Missile research and development: engineering, dynamics, intelligence, instrumentation, evaluation. Combustion in jet engines. These activities are sponsored by the Department of Defense.

● Office of Basic Instrumentation ● Office of Weights and Measures.

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT		NBS REPORT
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Performance Tests of Cleanable
Impingement Type Air Filters
Air Maze Type P-5W

manufactured by
Air Maze Corporation
Cleveland, Ohio.

by

Henry E. Robinson
Thomas W. Watson
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 an Air Maze Type P-5W Air Filter

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 a specimen filter submitted by its 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 specimen at three face air velocities, namely 300, 600 and 900 feet per minute.

II. DESCRIPTION OF THE FILTER SPECIMEN

The filter was manufactured by the Air Maze Corporation of Cleveland, Ohio, and was of the cleanable viscid type, 20x20x2 inches in nominal size. It was identified by nameplate as an Air-Maze Type P-5W. The filtering media was composed of 16-mesh screen wire cut in strips about 20 inches long and 2 inches wide, crimped diagonally, and placed one on the other in the aluminum metal edge-frame with the crimps reversed, the angle between reversed crimps being about 45°. There were approximately 6 layers of strip per inch of pile. The media faces were covered by expanded metal sheet having diamond-shaped openings approximately 1-1/8x2-7/8 inches in size. The filter had actual outside dimensions of 19-5/8x19-1/2x2 inches, leaving a free opening 18-1/8x18 inches (2.26 ft^2 net face area) and weighed 11.5 lb. when clean, without oil.

The manufacturer submitted an adhesive designated as "Filterkote M" for oiling the filter. This was done in preparation for test by immersing the filter in the liquid and letting the excess oil drain off with the filter standing on edge for a minimum of 18 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 filter, 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
At start of 300 fpm test	0.042	.148	.306
At start of 600 fpm test	.045	.160	.338
At start of 900 fpm test	.046	.162	.339
After 900 fpm test	.045	.158	.334
In crease in P.D. after 3 cleanings, %	7	7	9

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.

Table 2

Face Air Velocity fpm	Dirt Load* grams/sqft	Pressure Drop inch WG	Efficiency percent
300	0	.042	-
	4	.043	47
	107	.074	-
	192	.103	54
	260	.149	62
	309	.204	60
	342	.258	63
	375	.345	63
	419	.518	64

* Average mixture: 4.0% lint, 96.0% Cottrell precipitate by weight.
Average rate of dirt loading: 16.7 grams per square foot per hour.

Face Air Velocity fpm	Dirt Load* grams/sqft	Pressure Drop inch WG	Efficiency percent
600	0	.160	-
	6	.166	56
	18	.172	59
	25	.198	59
	88	.250	63
	115	.271	64(P)
	121	.270	62(A)
	212	.327	-
	236	.350	64
	272	.381	64(P)
	278	.378	66(A)
	348	.490	65
	423	.636	66(P)
	429	.654	69(A)
	484	.864	73

* Average mixture: 4.1% lint, 95.9% Cottrell precipitate by weight.
Average rate of dirt loading: 20.8 grams per square foot per hour.

Table 2 - continued

Face Air Velocity fpm	Dirt Load* grams/sqft	Pressure Drop inch WG	Efficiency percent
900	0	.339	-
	27	.364	61
	83	.506	67
	110	.538	68(P)
	120	.543	66(A)
	129	.578	70
	175	.652	74(P)
	184	.658	74(A)
	230	.717	-
	285	.788	73
	332	.865	75(P)
	341	.876	74(A)
	387	.978	-
	452	1.105	71

* Average mixture: 3.9% lint, 96.1% Cottrell precipitate by weight.
Average rate of dirt loading: 22.6 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, which shows the variation of the pressure drop and of the efficiency of the filter as it was 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, at various specific dirt loading.

Table 3

Spec.Dirt L'd'g grams per sq ft	0 (Initial)		100		200		300		400	
Face Velocity,fpm	P.D.	Eff.	P.D.	Eff.	P.D.	Eff.	P.D.	Eff.	P.D.	Eff.
300	0.04	47	.07	51	.11	55	.19	60	.44	63
600	.16	56	.26	63	.32	63	.41	65	.59	66
900	.34	60	.53	68	.68	74	.81	74	1.00	72

B. Cleanability

The pressure drops of the clean oiled filter 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, its average percentage increase in pressure drop was about 8 percent, or about 2.7 percent per loading and cleaning operation. It is assumed that the factor of the care and thoroughness of the cleaning operation, which is necessarily involved in the process of ascertaining cleanability, was approximately constant. It is believed the filter can be considered as satisfactorily cleanable.

C. General

The fact that efficiencies determined at the end of a day of loading of the filter (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 rate to which the filter was subjected did not overtax the wetting-rate of the filter adhesive and cause the filter surfaces to become "dry".

AIR-MAZE P-5 W

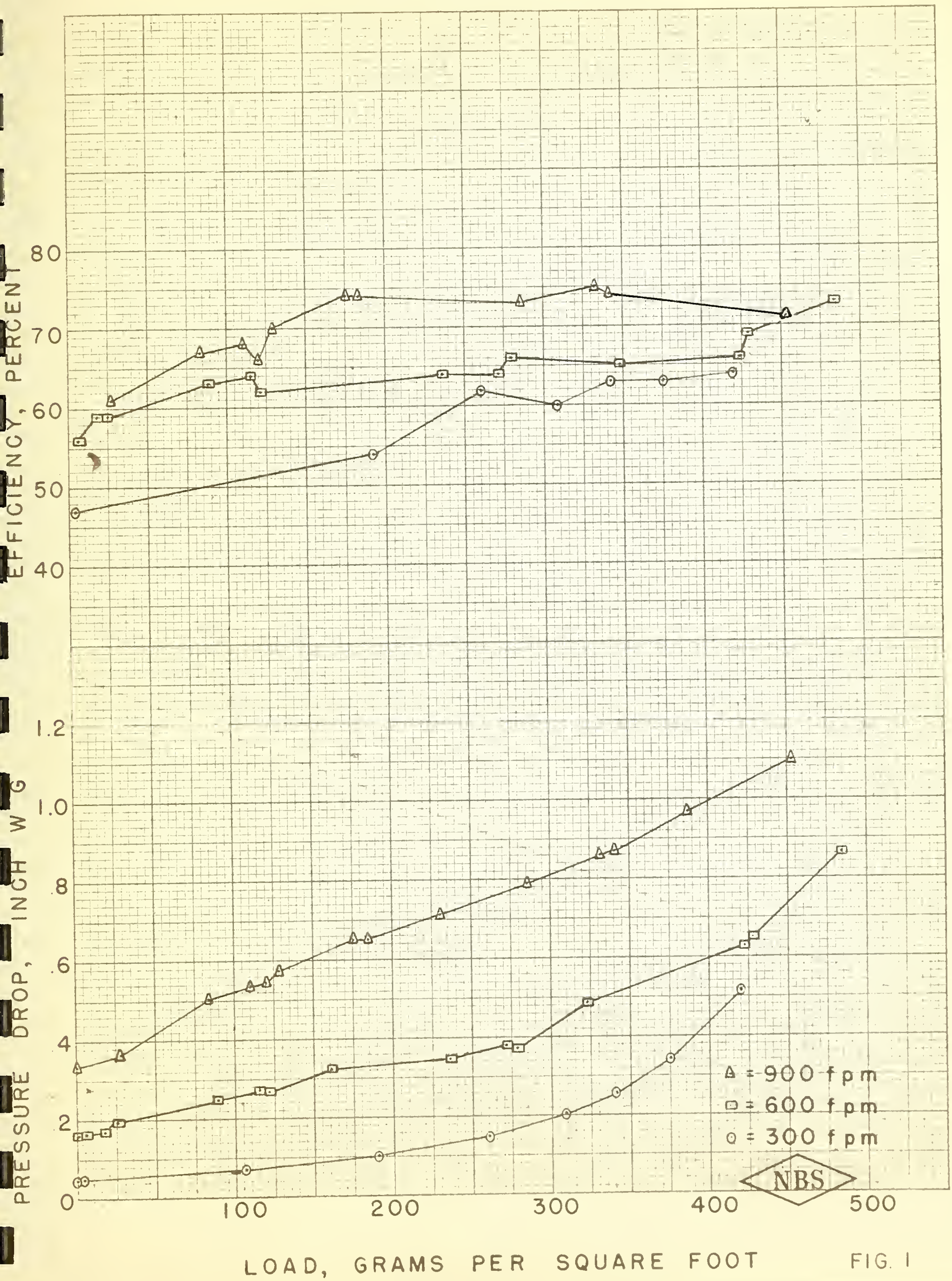

FIG. 1

THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

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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