NATIONAL BUREAU OF STANDARDS REPORT

8367

PERFORMANCE TEST OF TWO "HI-FLOW AEROSOLVE"
EXTENDED-AREA, DRY MEDIA, AIR FILTERS
MODELS 43P-45 AND 43P-95

manufactured by
Cambridge Filter Corporation
Syracuse, New York

by

Joseph C. Davis and Paul R. Achenbach

Report to

Veterans Administration
Washington, D.C.

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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Mechanical Systems Section
Building Research Division

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IMPORTANT NOTICE

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1. Introduction

At the request of the Veterans Administration, the performance characteristics of Cambridge "Hi-Flow Aerosolve Filters", Models 43P-45 and 43P-95, were determined. These filters were of the deep-bed panel type employing a replaceable dry media. The filters were manufactured by the Cambridge Filter Corporation of Syracuse, New York. The scope of the investigation included the determination of the arrestance of the particulate matter of the laboratory air and of Cottrell precipitate by the filters, and the pressure drop of the filters at the rated air flow rate of 1500 cfm as the dust load was gradually increased from zero to a final value corresponding to a pressure drop of 0.5 W.G. for Model 43P-45 and a pressure drop of 1.0 W.G. for Model 43P-95.

2. Description of Test Specimen

The filters, manufactured and supplied for test purposes by the Cambridge Filter Corporation of Syracuse, New York, were identified as "Hi-Flow Aerosolve Filters" Models 43P-45 (a medium glass fiber media) and 43P-95 (a fine glass fiber media). In each specimen the filter media was secured to a stiff No. 20 glass fiber screen mesh on the downstream side. The filter mat with its backing was formed into ten pleats, 20 inches deep and 24 1/2 inches wide presenting an effective filtering surface of approximately 68 sq. ft. The sides of the filter cartridge were secured to a rigid metal frame made of one-inch galvanized angles. The weight of each of the clean filters was approximately 2824 grams (6 1/4 lbs).

The gross face area of each of the filter units was 3.84 ft^2, but the enclosing edges of the metal frame reduced the net face area to 21 7/8" by 21 7/8" or 3.32 ft^2.

At a rated air flow of 1500 cfm, the net face velocity was 452 ft/min and the average velocity through the filter media was about 22 ft/min.

The manufacturer furnished the welded steel frames into which the filter units were placed during operation. The frames had overall dimensions of 24" x 24" x 3".

3. Test Method and Procedure

The filters were tested at the rated air flow rate of 1500 cfm. The arrestance determinations of each specimen were made with the NBS Dust Spot Method described in a paper by R. S. Dill entitled "A Test Method For Air Filters" (ASHVE Transactions, Vol. 44, page 379, 1938). The filter under test was installed in the test apparatus and carefully sealed to prevent any by-pass of air, or inward flow of air into the test apparatus, except through a measuring orifice. After establishing the correct air flow rate through the filter, samples of air were drawn from the center points of the test duct 2 feet upstream and 8 feet downstream of the test specimen. Each sample of air was passed through Whatman No. 41 filter paper. Arrestance determinations were made with the particulate matter in the laboratory air as the aerosol and also with Cottrell precipitate injected into the air stream at a ratio of one gram per 1,000 cu. ft. of air on the Model 43P-45 filter. On the 43P-95 filter specimen, arrestance determinations were made only with the particulate matter in the laboratory air.

The light transmission of the sampling papers was measured on the same area of each paper before and after test, and the two sampling papers used for any one arrestance determination were selected to have the same light transmission when clean.

For determining the arrestance of the particulate matter in the laboratory air, equal areas of filter paper were exposed in the upstream and downstream samplers. A similar increase of the opacity of both sampling papers was obtained by passing the sampling air through the

upstream filter paper only part of the time while operating the downstream sampler continuously. This time-proportioning was accomplished by the use of one solenoid valve in the upstream sampling line and another in a line by-passing the sampler. The solenoid valves were operated by an electric timer and a relay so that one was open while the other one was closed during any desired percentage of a 5-minute timer cycle, reversing the position of the two valves during the remainder of the cycle. The arrest-A, (in percent), was then determined with the formula:

$$A = 100 - T \frac{\Delta D}{\Delta U}$$

Where T is the percentage of time during which air was drawn through the upstream sampler, ΔU and ΔD are the observed changes in the opacity of the upstream and downstream sampling papers, respectively.

For determining the arrestance of the filter with Cottrell precipitate as the test dust, different size areas of sampling paper were exposed upstream and downstream of the filter in order to obtain a similar increase of opacity on both sampling papers. The arrestance was then calculated by this formula:

$$A = (1 - \frac{S_D}{S_U} \times \frac{\Delta D}{\Delta U}) \times 100$$

Where the symbols A, ΔU, and ΔD represent the same quantities as indicated above and S_U and S_D are the upstream and downstream sampling areas, respectively.

Both types of arrestance determinations were made at the beginning and at the end of the test and at several intermediate loading conditions for each specimen as indicated in Table 1 for the 43P-45 filter and in Table 2 for the 43P-95 filter. The loading was done incrementally, each increment weighing 80 to 400 grams and consisting of a mixture of 96 parts Cottrell precipitate and 4 parts cotton linters by weight. The Cottrell precipitate had previously been sifted through a 100-mesh screen and the lint was prepared by grinding No. 7 cotton linters through a Wiley mill with a 4-millimeter screen.

The pressure drop across the filter under test was recorded at the beginning of the test, after each arrestance determination, and after each increment of Cottrell precipitate and lint that was introduced into the test duct. The test was terminated when the pressure drops reached 0.5 in. W.G. and 1.0 in. W.G. across the Filter Model 43P-45 and Filter Model 43P-95, respectively.

The construction of both filters was such that the method of mounting was important. To obtain maximum performance of each filter, it was necessary that the pleats did not sag materially, that their extension during the testing was not impeded by faulty fastening of the media to their frames, and that none of the pleats remained collapsed after subjection to the air flow. It is suggested that these precautions be taken during use of these filters in Government installations.

For each increment of filter loading, two determinations of arrestance were made. The value of arrestance reported was the averaged obtained from two determinations.

Upon completion of the test on both initial filter specimens, a test without load on the filter media was performed on another specimen of each model, supplied by the manufacturer. For this test, an arrestance determination was made using only the laboratory air as the aerosol. The pressure drop across the filter was also observed under these conditions.

4. Test Results

The test results obtained on the air filter 43P-45 are summarized in Table 1.

Table 1

Performance of the Cambridge "Hi Flow Aerosolve" Filter Model 43P-45 at an Air Flow Rate of 1500 cfm.

Cumulative Load: Cottrell Precipitate Grams	Cumulative Load: Lint Grams	Cumulative Load: Load Grams	Arrestance of Aerosol Percent: Atmospheric[A]	Arrestance of Aerosol Percent: Cottrell[B]	Pressure Drop In. W.G.
0	0	0	-	-	.152
4	0	4.0	25.7	85.6	.168
80	3.3	83.3	30.1	86.0	.172
180	7.5	187.5	33.2	86.1	.176
380	15.8	395.8	36.3	87.6	.180
780	32.4	812.4	35.1	88.2	.206
1180	49.0	1229.0	37.5	92.5	.252 C .246 D
1580	65.6	1645.6	41.2	91.3	.320 C .316 D
2300	95.5	2395.5	48.7	93.7	.470 C .432 D
2660	110.0	2770.0	51.1	92.4	.544 C .504 D
Second Filter					
0	0	0	23.7		.168

A - Atmospheric-Aerosol is the particulate matter in the laboratory air

B - Cottrell-Aerosol is Cottrell precipitate in laboratory air

C - Pressure drop at close of day's testing

D - Pressure drop at beginning of next day of testing

When the load on Filter Model 43P-45 was about 1000 grams or greater, the pressure drop decreased over night when the test apparatus was shut down. For example, at a loading of 1229 grams and at the completion of the day's testing, the pressure drop was 0.252 in. W.G. The following morning when the filter was subjected to an air flow at the same specified rate of flow, the pressure drop was .246 in. W.G. This effect became more marked as the testing progressed and the load increased. At a loading of 2770 grams, the pressure drop was 0.544 in. W.G. at the close of the day's testing and the following morning at the beginning of testing it was 0.504 in. W.G. This effect was not appreciable during the testing of Filter Model 43P-95.

It will be noted that the pressure drop for the first specimen of Model 43P-45 increased from 0.168 in. W.G. with a clean filter to 0.544 in. W.G. or (0.504 in. W.G.) after a dust load of 2770 grams had been reached for the filter. The arrestance of the dust in the atmospheric air increased from 25.7 percent to 51.1 percent during the loading period and averaged approximately 42 percent. On the basis of the lower pressure drops observed each morning during the latter part of the test, the dust load of Cottrell precipitate and lint corresponding to a pressure drop of 0.5 in. W.G. was 835 grams/ft^2 of net face area and about 40.8 grams/ft^2 of filter media. The arrestance values determined with Cottrell precipitate increased from an initial value of 85.6 percent to a value of about 93 percent. Average arrestance for Cottrell precipitate was 91.4 percent.

The test results obtained on the air filter Model 43P-95 are summarized in Table 2.

Table 2

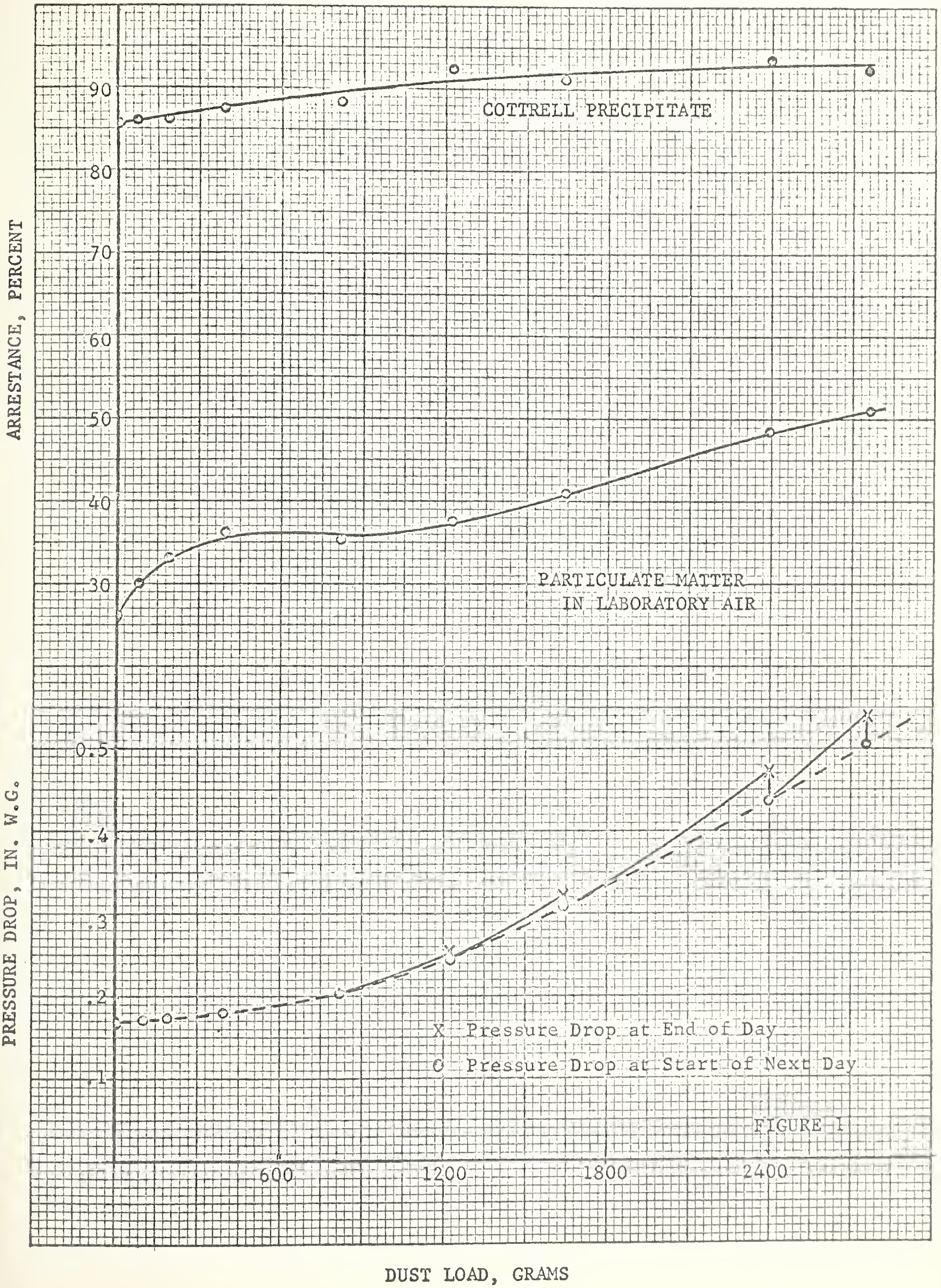
Performance of the Cambridge "Hi Flow Aerosolve" Filter Model 43P-95 at an Air Flow Rate of 1500 cfm.

Cumulative Load				
Cottrell Precipitate Grams	Lint Grams	Load Grams	Arrestance of Atmospheric Aerosol Percent	Pressure Drop In. W.G.
0	0	0	86.6	.434
200	8.3	208.3	89.5	.500
500	20.8	520.8	92.2	.630
880	36.6	916.6	95.0	1.020
Second Filter				
0	0	0	85.6	.434

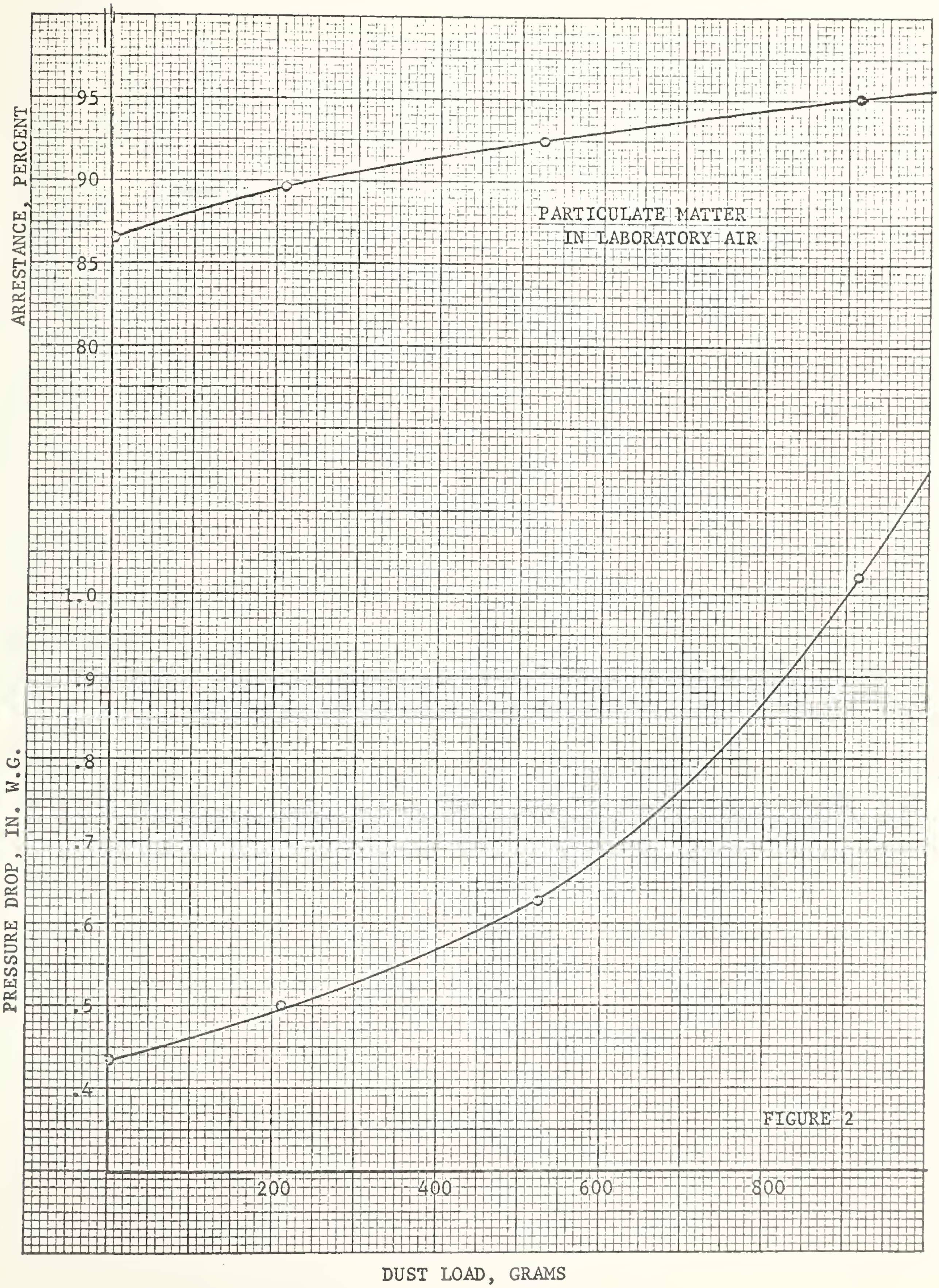
It will be noted that the pressure drop on the first specimen of the Model 43P-95 filter increased from .434 in. W.G. with a clean filter to 1.020 in. W.G. after a dust load of 916.6 grams had reached the filter. The arrestance of the dust in the atmospheric air increased from 86.6 percent to 95 percent during the loading period and averaged about 91.4 percent. The dust load of Cottrell precipitate and lint corresponding to a pressure drop of 1.0 in. W.G. was 270 grams/ft^2 of net face area and about 13.5 grams/ft^2 of filter media.

The values shown in Tables 1 and 2 are graphically presented in Figures 1 and 2. In these figures the arrestance of particulate matter in the laboratory air, the arrestance for the Cottrell precipitate and the pressure differences are all plotted against the dust load.

PERFORMANCE CURVES FOR CAMBRIDGE FILTER
MODEL 43 P-45



PERFORMANCE CURVES FOR CAMBRIDGE FILTER
MODEL 43 P-95



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