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# NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT

NBS REPORT

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July 21, 1954

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PROGRESS REPORT ON ENGINE AIR CLEANERS

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by  
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Heating and Air Conditioning Section  
Building Technology Division

to

Office of the Chief of Transportation  
Department of the Army

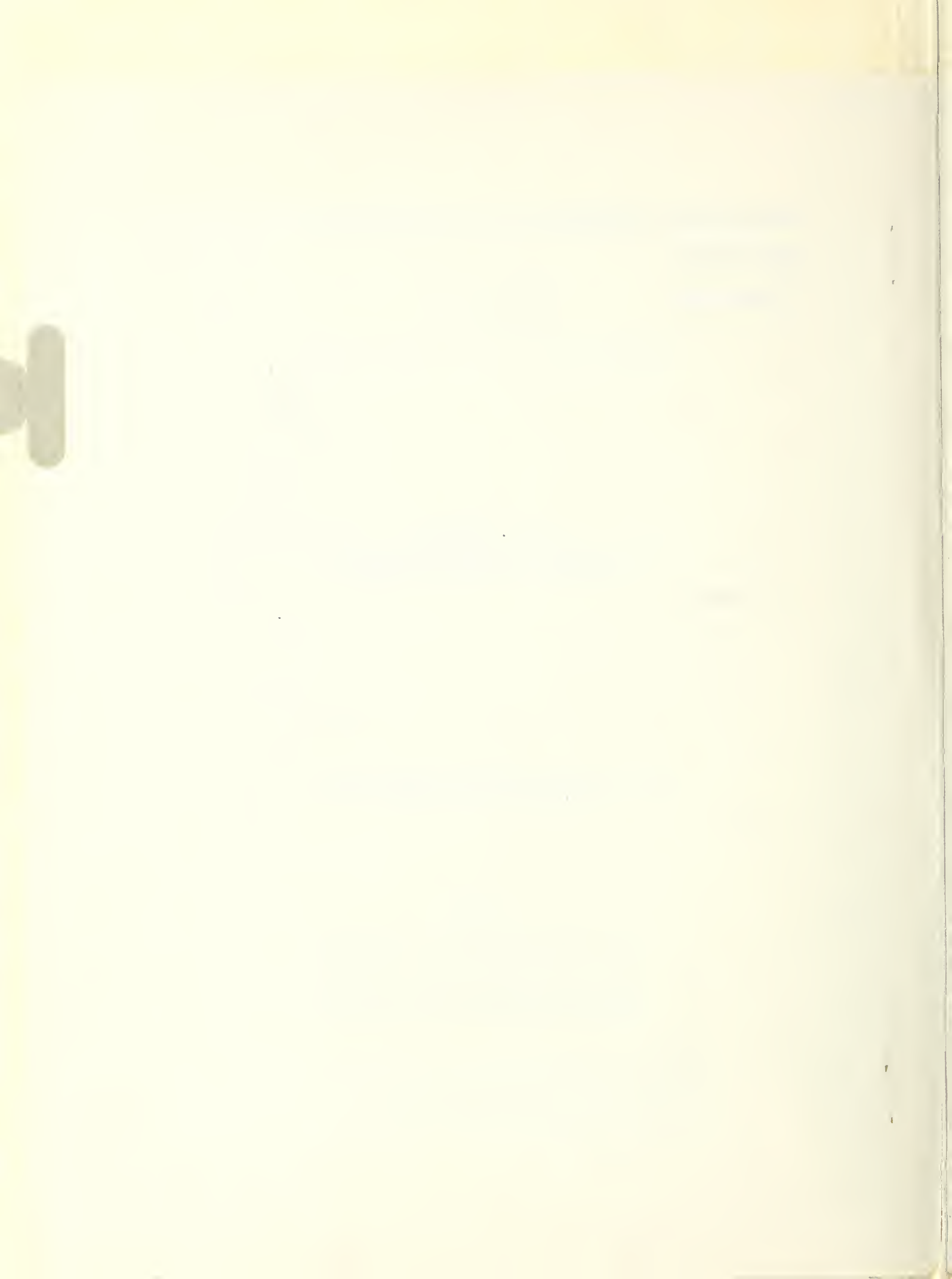


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NATIONAL BUREAU OF STANDARDS

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## PROGRESS REPORT ON ENGINE AIR CLEANERS

A thorough investigation of the publications pertaining to the wear of combustion engines due to dust in the intake air showed that dust particles of 10 to 25 microns size caused the most damage per unit weight.

It appears probable that a large percentage of the smaller dust particles, comprising only a small portion of the total weight of the dust, may pass the conventional air cleaners and cause excessive wear of helicopter engines. This consideration indicated the necessity to investigate not only the overall efficiency of the air cleaners but the several separate efficiencies in various dust size ranges.

Table 1 is a summary of the reports of 19 engine air cleaner tests made at the Detroit Arsenal and received through ASTIA. Of these 19 cleaners only 4 passed the acceptance specifications, and all but 4 did pass the required efficiency test. All other filters failed to meet either the capacity or the restriction requirements. One air cleaner, Code A.8, was found to have such a high restriction to air flow that no further tests were made of this specimen. The efficiencies varied from 95.4% to 99.21%, 97% was the minimum efficiency required for these tests, and it is felt that a better differentiation is desirable than the  $\pm 2\%$  total variation reported on all the various models.

THE HISTORY OF THE UNITED STATES

A history of the United States from the first settlement of the continent to the present time. The first part of the work describes the discovery of the continent, the early settlements, and the progress of the colonies. The second part describes the American Revolution, the formation of the Constitution, and the early years of the Republic. The third part describes the expansion of the United States, the Civil War, and the Reconstruction period. The fourth part describes the growth of the United States in the nineteenth century, the Spanish-American War, and the beginning of the twentieth century.

The history of the United States is a story of a young nation that grew from a few scattered settlements on the eastern coast to a vast empire that spans the continent. The story begins with the discovery of the continent by Christopher Columbus in 1492, and continues through the early years of settlement, the struggle for independence, and the formation of the Constitution. The story is one of a nation that has grown in strength and power, and that has played a leading role in the world.

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Table 1

Summary of 19 U. S. Army Tests on  
Engine Air Cleaners

Filter	Dust Efficiency, %	Test Results			Remarks
		Capacity	Restriction	Acceptance	
UM - 185	98.2	ok	ok	accepted	
Code A-1	99.0	no	no	no	
"	99.21	no	no	no	
1416 A-3	97.9	ok	ok	accepted	
Code A-5	95.4*	no	no	no	
" A-6	97.9	ok	ok	accepted	
" A-8	-	-	no	no	Due to very high re- striction, no further tests were made Experimental model
" A-10	97.45	ok	ok	-	
Experimental model	95.7*	-	-	-	
Code A-24	98.49	no	ok	no	
" A-29	96.91*	ok	no	no	
" A-31	97.82	no	ok	no	
" A-32	97.37	ok	ok	accepted	
" A-33	98.90	no	ok	no	
" A-34	96.84*	no	ok	no	
" A-35	97.0	no	no	no	
" A-42	98.2	no	no	no	
" A-54	98.3	no	yes	no	

\* did not meet requirements

Statement of Financial Position

as at year end 2013

	2013	2012
Assets		
Current assets		
Cash and bank balances	100	100
Accounts receivable	200	200
Inventory	300	300
Prepaid expenses	400	400
Other current assets	500	500
Non-current assets		
Property, plant and equipment	1,000	1,000
Intangible assets	200	200
Other non-current assets	300	300
Liabilities		
Current liabilities		
Accounts payable	100	100
Short-term debt	200	200
Other current liabilities	300	300
Non-current liabilities		
Long-term debt	400	400
Other non-current liabilities	500	500
Equity		
Share capital	1,000	1,000
Reserves	2,000	2,000
Other equity	300	300

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The determination of the efficiency in these tests was based on the assumption that all dust passing the filter was retained in a flannel cloth installed downstream and that the weight increase of this cloth, dried before and after the test, would represent the weight of the escaped dust. Though the evaluation of this method is very simple it has two setbacks:

1. It appears questionable that the flannel cloth will retain a high percentage of small dust particles. The high efficiency of oil-impingement type cleaners for large size particles appears correct. Therefore, if the so-called absolute filter passes a good portion of the small particles, then the weight retained there is no longer indicative for the amount of dust that passed through the cleaner.

2. The handling and weighing of the flannel cloth of up to 30 inches diameter may cause the loss of a certain amount of dust which also tends to distort the test results.

#### Proposed Efficiency Test Method

Based on these reservations it is proposed that three different and independent methods shall be used to determine the air cleaner efficiency. These methods may be modified, later, as experience is gained, and one or the other may be completely deleted.

1. The overall efficiency will be determined by drawing under isokinetic conditions a small flow of air from downstream the cleaner through 0.3 micron glass fibre paper, which retains all particles above the size of the fibre.

The Commission on the Organization of the Executive Branch of the Government, established by Executive Order on July 1, 1947, has the honor to acknowledge the receipt of your letter of July 10, 1947, in which you request information regarding the work of the Commission.

The Commission was established to study the organization and functioning of the Executive Branch of the Government, with a view to recommending such changes as may be necessary to improve its efficiency.

The Commission has held numerous public hearings and has received many suggestions from interested citizens. It has also conducted extensive research into the various problems of the Executive Branch. The Commission's report, which will be published in the near future, will contain a detailed analysis of the current situation and a series of recommendations for improvement.

The Commission is pleased to have your interest in its work. It is particularly gratified that you should be so concerned with the organization of the Executive Branch of the Government.

Very truly yours,

James O. Eastland, Chairman  
Commission on the Organization of the Executive Branch of the Government  
The Commission is currently reviewing the suggestions you have made and will take them into account in its final report.

The Commission's report will be published in the near future. It will contain a detailed analysis of the current situation and a series of recommendations for improvement. The Commission is pleased to have your interest in its work.

2. The dust will be classified in four size ranges by use of a Cascade Impacter. By sampling the air upstream and downstream the filter the number of dust particles of each of four size ranges can be determined for a known volume of air, by counting.

3. The Dill-Trion dust spot tester shall be used to determine the difference of the dust concentration upstream and downstream the filter by means of the discoloration method.

When using dust of the same density the gravimetrically determined efficiency will be related to the cubes of the diameters of the dust particles whereas the discoloration method refers to the square of the dust particles. It is planned to obtain coordination of these two methods by means of dust count from the Cascade Impacter.

The test apparatus being set up is designed to test air cleaners for engines as small as 50 H. P. up to the R-1520 with 1200 H. P. and to handle a pressure drop across the air cleaner of up to 24 in. W. G.

The dust feed was designed to supply dust at a constant rate from 10 mg to 35 mg per cu. ft. of air at any desired air flow rate. The use of three different dusts for the first series of tests is contemplated, namely A. C. Sparkplug Co. dusts "coarse" and "fine" and Cottrell precipitate.

All required test equipment has been ordered and the calibration of the apparatus is about to be commenced. Provided all testing equipment will be on hand as scheduled preliminary tests may be started early in August.

The first part of the report is devoted to a general  
 description of the country and its resources. The  
 second part contains a detailed account of the  
 various industries and the progress of their  
 development. The third part is a statistical  
 summary of the principal facts of the country's  
 history and its present condition. The fourth  
 part is a list of the principal cities and  
 towns and a description of their commerce.  
 The fifth part is a list of the principal  
 rivers and streams and a description of their  
 navigation. The sixth part is a list of the  
 principal mountains and hills and a  
 description of their scenery. The seventh  
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 ponds and a description of their fisheries.  
 The eighth part is a list of the principal  
 minerals and a description of their  
 distribution. The ninth part is a list of  
 the principal animals and a description of  
 their habits. The tenth part is a list of  
 the principal plants and a description of  
 their uses. The eleventh part is a list of  
 the principal diseases and a description of  
 their treatment. The twelfth part is a list  
 of the principal laws and a description of  
 their enforcement. The thirteenth part is a  
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 a description of their duties.

At present, tests are being conducted on a newly designed rotating filter. A pilot model of this filter showed efficiencies in excess of 90% when using the very fine -01000 dust. This filter is designed as a pre-filter for oil-bath cleaners and is expected to be superior to common type filters in both efficiency and flow resistance.

An early conference with representatives of the Office of the Chief of Transportation, U. S. Army, will be welcome to determine the values desirable for flow resistance, dust holding capacity, physical size of the air cleaner, etc.

The first part of the report deals with the general situation of the country and the progress of the war. It is followed by a detailed account of the military operations in the various theatres of war. The author then discusses the political and economic conditions of the country and the effect of the war on the population. The report concludes with a summary of the main points and a list of references.

The second part of the report deals with the military operations in the various theatres of war. It is followed by a detailed account of the political and economic conditions of the country and the effect of the war on the population. The report concludes with a summary of the main points and a list of references.

The third part of the report deals with the political and economic conditions of the country and the effect of the war on the population. The report concludes with a summary of the main points and a list of references.

The fourth part of the report deals with the effect of the war on the population. The report concludes with a summary of the main points and a list of references.

The fifth part of the report deals with the summary of the main points and a list of references.



