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# NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT

NBS REPORT

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## PROGRESS REPORT ON ENGINE AIR CLEANERS

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by  
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to

Office of the Chief of Transportation  
Department of the Army

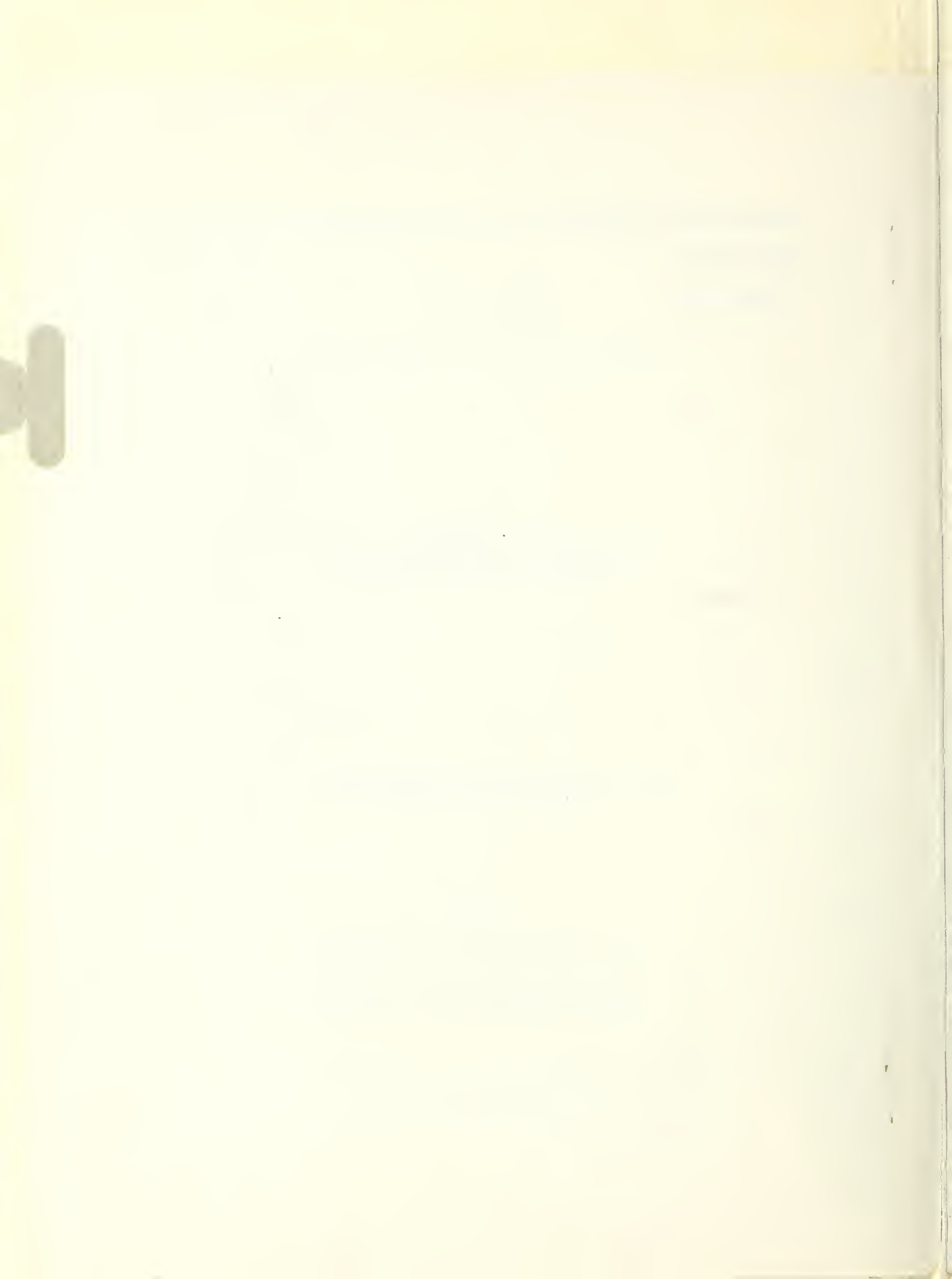


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## PROGRESS REPORT ON ENGINE AIR CLEANERS

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 rise of the Progressive Movement. The fifth part describes the United States in the twentieth century, the two World Wars, and the Cold War.

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 two continents. The story begins with the first European settlers, who came to the Americas in search of new lands and new opportunities. They found a continent that was rich in natural resources and that offered a new way of life. The early years of the colonies were marked by struggle and hardship, but the settlers persevered and built a new society that was based on the principles of liberty and self-government. The American Revolution was a turning point in the history of the United States. It was a struggle for independence from British rule, and it resulted in the formation of a new nation. The Constitution was a landmark document that established the framework of the government and guaranteed the rights of the people. The early years of the Republic were marked by growth and expansion. The United States acquired new territories and states, and its economy flourished. The Civil War was a period of great suffering and sacrifice, but it resulted in the preservation of the Union and the abolition of slavery. The Reconstruction period was a time of great change and progress. The United States emerged from the war as a more unified and powerful nation. The nineteenth century was a time of great achievement and progress. The United States became a world power, and its influence was felt around the globe. The Spanish-American War and the rise of the Progressive Movement were two of the most important events of the century. The twentieth century was a time of great change and progress. The United States emerged from the two World Wars as a superpower, and its influence was felt around the globe. The Cold War was a period of great tension and conflict, but it resulted in the end of the Soviet Union and the beginning of a new era of peace and cooperation.

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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 2010

	2010	2009	2008
Assets			
Current assets			
Cash and bank balances	100	100	100
Accounts receivable	200	200	200
Inventory	300	300	300
Prepaid expenses	400	400	400
Other current assets	500	500	500
Non-current assets			
Property, plant and equipment	1000	1000	1000
Intangible assets	200	200	200
Other non-current assets	300	300	300
Liabilities			
Current liabilities			
Accounts payable	100	100	100
Short-term debt	200	200	200
Other current liabilities	300	300	300
Non-current liabilities			
Long-term debt	1000	1000	1000
Other non-current liabilities	200	200	200
Equity			
Share capital	1000	1000	1000
Reserves	200	200	200
Other equity	300	300	300



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, created by Executive Order on July 18, 1947, and reauthorized by Public Law 80-107, 80 Stat. 1017, July 2, 1966, and Public Law 90-104, 80 Stat. 1017, July 2, 1966, has the honor to acknowledge the receipt of your letter of July 10, 1966, regarding the proposed reorganization of the Executive Branch of the Government.

The Commission is currently engaged in a study of the organization of the Executive Branch of the Government, and your letter is being reviewed in connection with this study. The Commission is particularly interested in the views of interested parties on the proposed reorganization of the Executive Branch of the Government, and your views are being given careful consideration.

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Very truly yours,

James M. Cannon, Chairman  
Commission on the Organization of the Executive Branch of the Government

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.

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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 -oilwell dust. This filter is designed as a pre-filter for oil-bath cleaners and is expected to be superior to ordinary 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 belligerent nations, and finally offers his own views on the probable outcome of the conflict.

The report is written in a clear and concise style, and is well illustrated with maps and diagrams. It is a valuable contribution to the study of the war, and is highly recommended to all those who are interested in the subject.

The author's analysis of the military situation is particularly interesting, and his predictions regarding the future course of the war are well founded. He has done his best to provide a comprehensive and accurate account of the events of the war, and his work is a model of historical writing.

The report is a masterpiece of military and political analysis, and it is a pleasure to read it. It is a book that should be read by all those who are interested in the war, and it is a book that will stand the test of time.

The author's treatment of the various aspects of the war is thorough and detailed, and his conclusions are well supported by the facts. His writing is clear and readable, and his analysis is sound and logical. This is a book that is well worth reading, and it is a book that will be read for many years to come.

The report is a valuable and interesting work, and it is a pleasure to read it. It is a book that should be read by all those who are interested in the war, and it is a book that will stand the test of time.



