TARDEC

---TECHNICAL REPORT---

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LAB TEST OF MIGNOT FREE-FLOW

AIR FILTER/AIR COOLER DENSIFIER (FFCD)

TERMED WATER AIR FILTER

MAY 1999

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13. ABSTRACT *(Maximum 200 words)*

A Mignot free flow air filter/air cooler air densifier (Termed FFCD) was lab tested to determine restriction and efficiency performance. The device is called a water air filter since water is used in place of a barrier filter media to trap dirt/dust. The restriction of the water air filter remains constant; however requires the water holding reservoir be cleaned of dust/dirt at prescribed intervals.

Lab test results showed at advertised max airflow rating of 6000 liters of air per minute (210 cubic feet per minute) the water air filter was very restrictive (43 inches of water). This could affect engine operation/performance based on factory set air fuel controls and engine management settings.

At airflow of 130 to 140 cfm the water air filter FFCD-1 units experienced a term call water pull over. This is where water moisture/droplets or streams of water are observed in the clean air outlet duct of water air filter. This could do harm to an engine's internal parts by exposure to water.

It was demonstrated the FFCD-1 units tested could be safely operated at airflows not to exceed 140 cfm. At this airflow three FFCD-1 units would have to be packaged to meet airflow demands for a future planned HMMWV demonstration. The assembly of three FFCD-1 units for HMMWV application would not be considered practical and/or feasible due to space limits.

Efficiencies of 88.18 and 82.35% were the two highest recorded during lab dust tests. These efficiencies fall way short of present military vehicle air cleaner designs which have a minimum initial efficiency requirement of 99.5%. Based on TARDEC's lab test efficiency results the Mignot wate air filter would not be considered acceptable for use on military vheicles.

14. SUBJECT TERMS			15. NUMBER OF PAGES
Water Air Filter	Air Intake	Airflow	
Restriction	Pressure Drop	Initial Efficiency	16. PRICE CODE
Free-flow Air Fitler	Air Cooler/Air Densifier		

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The limited lab tests were performed for AMSTA-CS-SF, Foreign Materials Evaluation Office under the Directorate for Intelligence and Counterintelligence AMSTA-CS-S. Headquarters AMC has annually provided funds (D650) for the acquisition of available foreign material systems or subsystems for the purpose of assisting RDE activities through testing or reverse engineering of foreign hardware. FY 98 is the last year for D650 funding.

Key personnel contributing to this project effort included the following:

-Mr. Larry Sierpien, Mobility Test Operations, instrumental in test set-up, testing and correspondence with inventor in South Africa and U.S. representative in Florida.

-Mr. Harry Bellany, Foreign Materials Evaluation Office, provided coordination and approval for project funding.

-Ms. Mary Resop, Mobility Propulsion, TARDEC prepared majority of typing additions to final report.

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ABBREVIATIONS/ACRONYMS

ABBREV/ACRONYM	DEFINITION
FFCD	Free-flow Air Filter, Air Cooler Air Densifier
HMMWV	High Mobility Multi-Purpose Wheeled Vehicle
SAE J726	Society of Automotive Engineer Air cleaner Test Code
PTI	Powered Technology Incorporated
SCFM	Standard Cubic Feet Per Minute
MM	Millimeters
CFM	Cubic Feet Per Minute
%	Percent
ft^3	Cubic Feet
IN^2	Square Inches
ft/min	Feet Per Minute
LBS/ft^3	Pounds Per Cubic Feet
H_2O	Inches of Water

1.0 SUMMARY:

Two Mignot free-flow air filter/air cooler air densifier (termed FFCD) were purchased for a cost of $2000.00. The FFCD can be called a water air filter since water is used in place of a barrier filter media for trapping dust. The lab tests would compare restriction/pressure drop and efficiency of a water air filter to a typical barrier filter design used in military vehicles.

The two Mignot air filters were models FFCD-1 advertised for engines with an airflow of up to 6,000 litres of air per minute. (210 cubic feet per minute). Two Mignot water air filters were ordered so that if lab tests were successful there would be a possibility that two water air filters could be fitted together and packaged into a HMMWV (As shown on bottom of Appendix A, Page A-3) for field test evaluations.

The water air filter was advertised as showing improvements in fuel economy of from 10 to over 20 % which could be verified in HMMWV field test evaluations. Also, an independent testing facility named, Cornaglia Research Center in Europe published a test report based on lab tests they had conducted in 1995 on a FFCD-4 water air filter. Their conclusion was that the Mignot FFCD-4 water air filter at max operative airflow of 800 cubic meter per hour or (471 cubic feet per minute) produced a pressure drop of 3000 pascals (12.0 inches of water) and had filtration efficiency of 97 to 97.5 %.

One of the two model FFCD-1 Mignot water air filters (designated sample 1) was lab tested. The first tests conducted were restriction/pressure drop tests and were conducted both dry and wet. "Dry" was the termed used when there was no water in the bottom half of water air filter assembly and "wet" was the term used when the bottom half of water air filter contained water. Restriction in the dry mode measured just over 15 inches of water at 120 cfm and 43.3 inches of water at 200 cfm. The 43.3 inches of water is considered higher than normal and would not be an acceptable restriction level for most commercial/military engines.

During wet restriction tests streams of water or moisture droplets were observed in the clean air outlet duct at air flows of 135 cfm and above. This condition would permit water entry into the engine intake manifold and/or combustion chamber and would not be considered an acceptable engine practice. The lab test results were made available to the water air filter manufacture.

A sample 2 model FFCD-1 water air filter was shipped to TACOM for lab test. The manufacturer made a design change as to the entry method of water into the bottom cup assembly of water air filter. Restriction tests were repeated on sample 2. Sample 2 dry restriction tests showed results nearly identical to sample 1. Sample 2 wet restriction tests showed streams of water or moisture droplets at air flows of 145 cfm and above. Indications of a little water stream or small amounts of moisture droplets were observed at air flows of 141 to 142 cfm. Thus, it was concluded that the air flow should not exceed 140 cfm to assure no water stream or moisture droplets would enter the clean air outlet duct and possibility contaminate the internal parts of an engine. There were no further design changes made to the water air filter by the manufacturer.

Prior to terminating all test activities, it was decided to conduct some 30 minute efficiency tests on sample 2 water air filter. Four efficiency tests were conducted and the highest efficiencies obtained for two of the tests were 82.52 % and 88.18%. Efficiencies tests were ran at a constant air flow of 140 cfm.

2.0 INTRODUCTION:

2.1 OVERALL DESCRIPTION OF WATER AIR FILTER:

The water air filter system is defined as a free-flow air filter, air cooler and densifier (FFCD) and is termed a water air filter. In addition to the FFCD housing there is a water reservoir. The dirty air enters around the periphery of the FFCD housing and is transported through cylindrical tubes to the base of the FFCD housing which contains the water. Figure 1 shows an inside view of the top half of FFCD housing positioned up-side down. In a normal installation the cylindrical tubes would be pointing into the paper and the top cover would be the only item that would be seen.

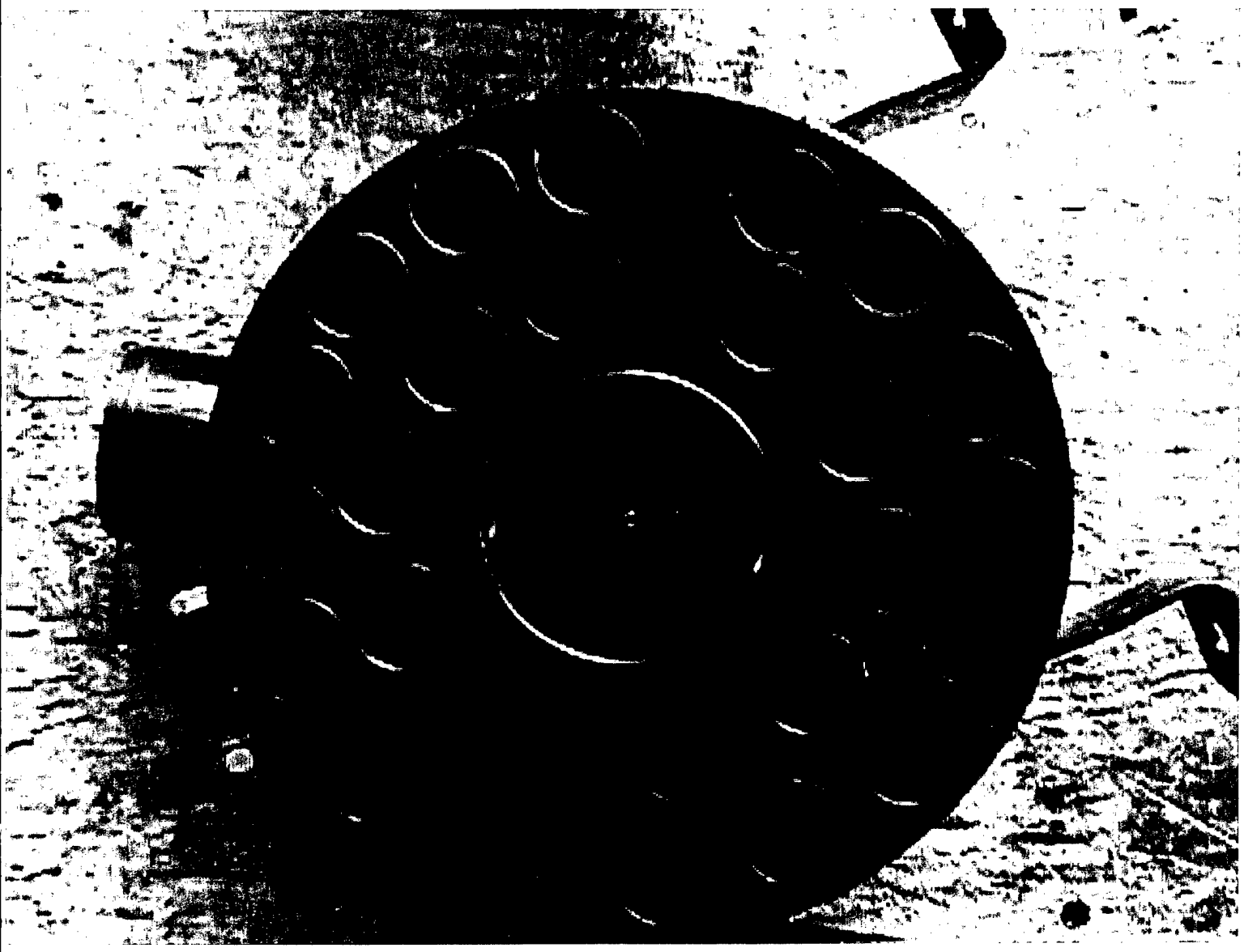


Figure 1: Inside View of Top Half FFCD-1 Housing

Figure 2 shows an inside view of the base of the FFCD housing in it's normal position. The base is attached to the top half of FFCD housing by three spring loaded clamps. Figure 2 also shows the individual compartments which hold the water and the float (white in color) which maintains the correct water level. The water is supplied from the water reservoir and enters through a nozzle opening which sets in the top half of FFCD housing. The dirty air exits the cylindrical tubes which are positioned approximately .538 inches above the water level. The dust particles in the air because of their weight are swirled and propelled into the water. The remaining relative clean air turns 180 degrees and enters upward through the center of the FFCD housing. The relative clean air then must make several right angle turns in the upper half of FFCD housing including a shallow pan which acts as a diverter to prevent water droplets from entering the tubular clean air outlet.

The water reservoir is mounted where suitable and at a level as near the FFCD housing as possible but not higher than 50 centimeters. The FFCD housing bowl must be cleaned every 15,000 kilometers (9,000 miles) or sooner if in severe dust. The bowl is cleaned and replaced dry.

The water air filter system has no filter media to clog and therefore the restriction remains constant. In addition to having shown fuel savings of up to 20 %, it is also an air cooler creating engine volumetric expansion and an air densifier which compensates for altitude and creating optimum combustion in an engine. Figure 3 is a sketch of the FFCD-1 water air filter showing some overall dimensions.

2.2 DETAILED DESCRIPTION OF TWO SAMPLES TESTED:

This technical report describes some limited lab tests conducted on two slightly different production type water air filter systems with schedule of events and dates shown in Table 1. The first water air filter system (designated FFCD-1, sample 1) had a spring operated movable plunger installed in a nozzle assembly. The nozzle/plunger assembly was the entry point for water coming from the water reservoir. A cylindrical plastic float was positioned just below the nozzle/plunger and would rise as the water entered through the nozzle. Once the cylindrical plastic float reaches a preset height, contact with the spring operated plunger occurs and seals any water from exiting the nozzle into the bottom half FFCD housing. However, during air cleaner operation water is continually drawn out at a slow rate which means the float raises and lowers constantly. The sample 1 nozzle with plunger is detailed in Figure 4. A close-up view of the plastic float for FFCD-1, sample 1 is shown in Figure 5.

Water air filter system (designated FFCD-1, sample 2) eliminated the movable valve or plunger and installed a soft foam disk on top of the cylindrical plastic float. Figure 6 shows the nozzle without movable valve or plunger. Figures 7 and 8 shows the soft foam disk attached to the plastic float. With the plunger removed, the plastic float with soft foam disk directly contacted the nozzle opening when it reached a preset height.

2.3 PURPOSE OF PROJECT:

The purpose of the water air filter test was to determine if it had any application to military vehicles. At Appendix A is a packet of correspondence detailing the apparent success of the water air filter in overseas applications. Highlights of Appendix A information include: (1) lab tests demonstrating an efficiency in the 97 + percent range and (2) an increase in vehicle fuel economy through the water air filter's application as an air cooler and densifier.

U.S. military vehicle air cleaners have a requirement that they must meet an initial efficiency of 99.5 %. Based on the overseas lab efficiency test results of around 97 % it was felt this efficiency was close enough to the 99.5 % requirement to warrant a lab test evaluation at TACOM. The water air filter is also a barrierless design which means there is no filter element which requires periodic cleaning. The water air filter does require cleaning of the dust which gets trapped in the water but the servicing should occur less frequent than an air cleaner system with a barrier filter design.

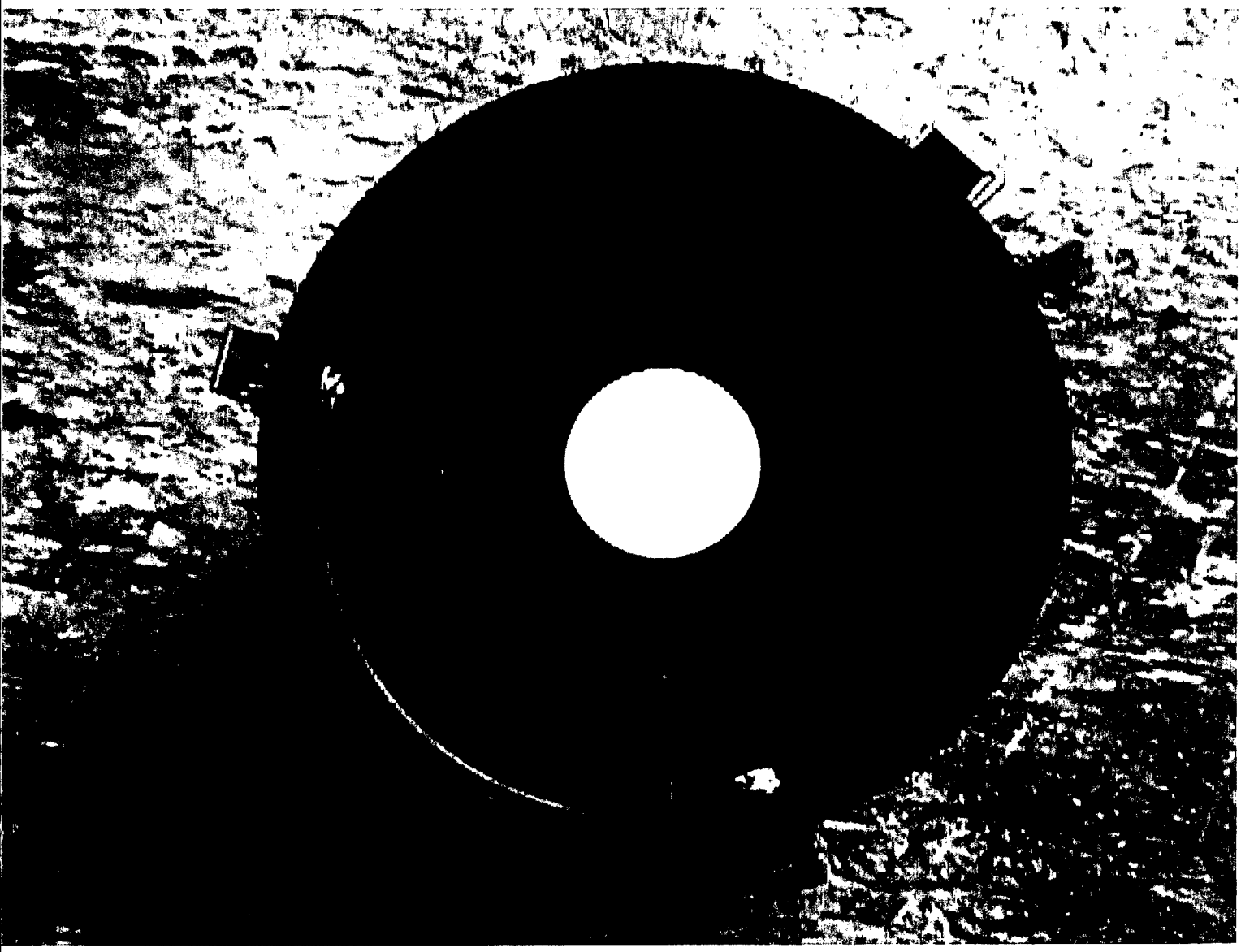


Figure 2: Inside View of Bottom Half (Base) FFCD Housing

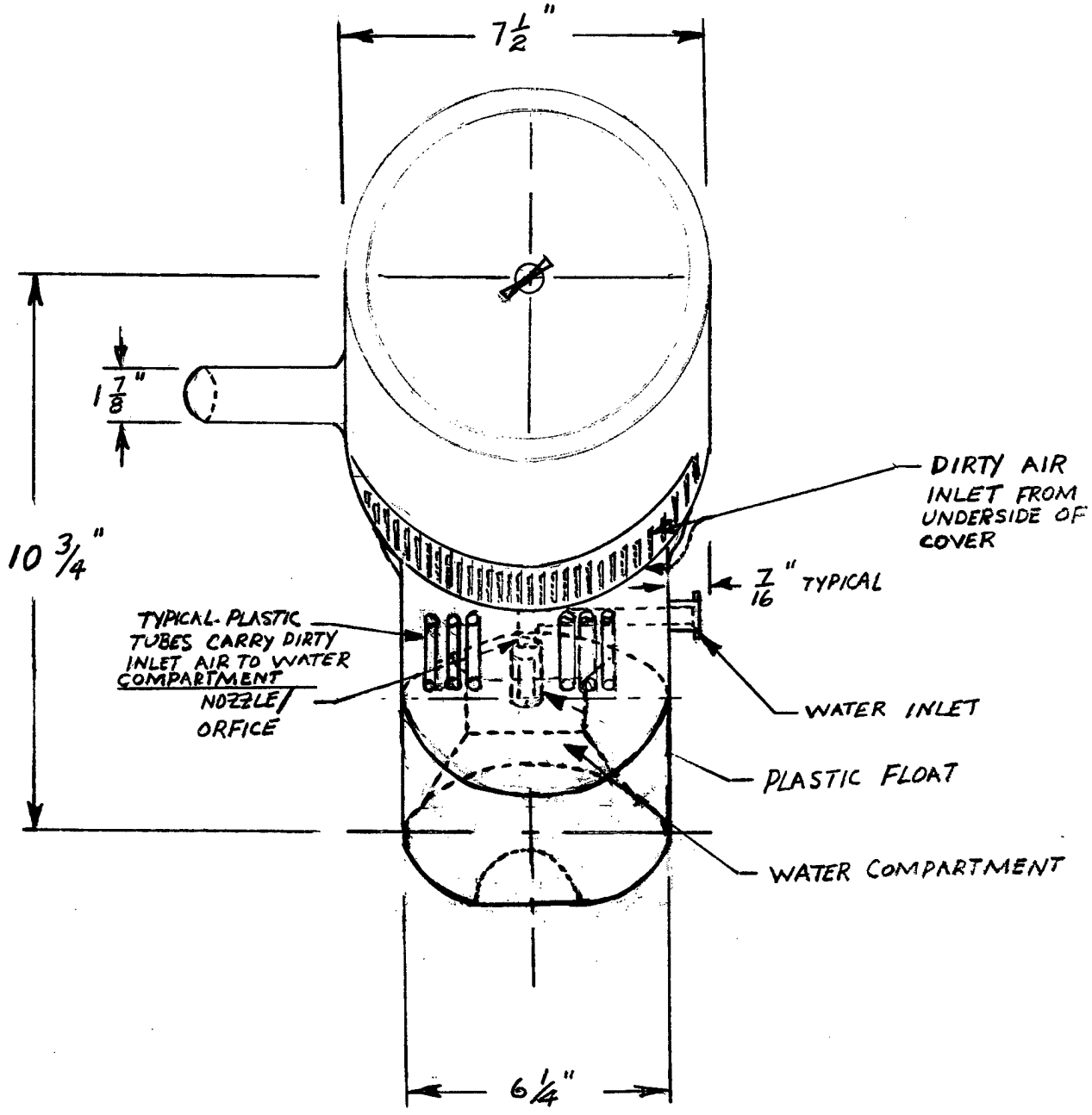


Figure 3: Sketch of FFCD-1 Water Air Filter Sh6wing Overall Dimensions

Table 1: SCHEDULE OF EVENTS

DATE	EVENT
21 Jul 97	Contact with EGFI, POC Patrick Dunaway on cost of two Mignot FFCD-1 Water air Fitler
26 Nov 97	Water Air Filter Project approved 29K total includes 2K for hardware
26 Mar 98	Water Air Filter project established JON NO: 8RA469 through procurement work directive, AMC Form 1095
21 Apr 98	Invoice to purchase 2 FFCD-1 units with water reservoir
17 Jul 98	First lab tests started 17 Jul 98
10 Aug 98	Discussions with inventor Alan Macdonald from South Africa on water pull over condition at 135 cfm.
12 Aug 98	Alan Macdonald to send new water air filter with updated valve thrrough Ido Fischler, U.S. Representative, Clearwater, Florida
10 Sep 98	New water air filter sent from south Africa
2 Dec 98	Received new water air filters with updated valve
2 Feb 99	Tested new water air filter with updated valve and sent results to Alan Macdonald

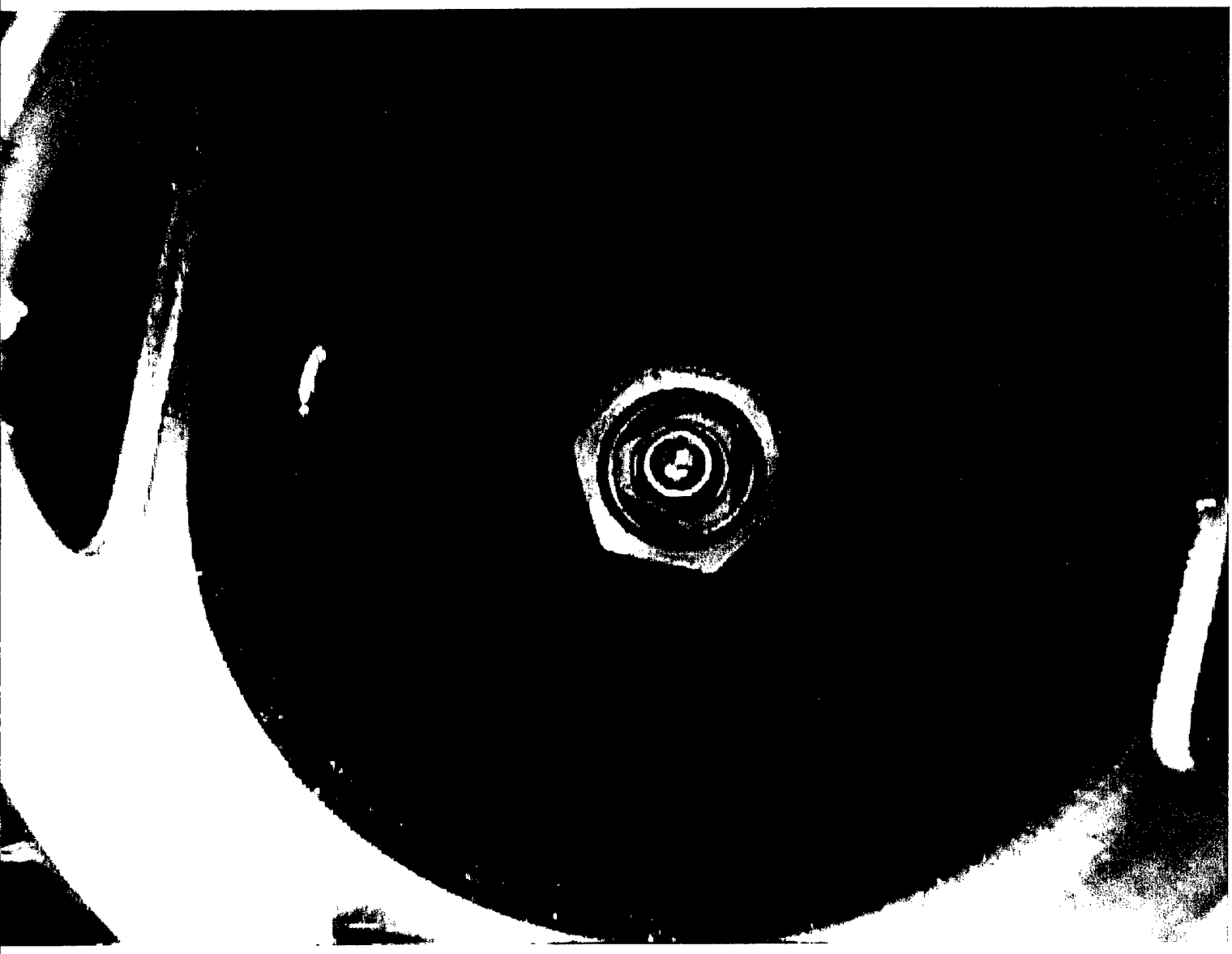


Figure 4: Sample 1 Nozzle/Plunger Assembly Located Top Half FFCD Housing

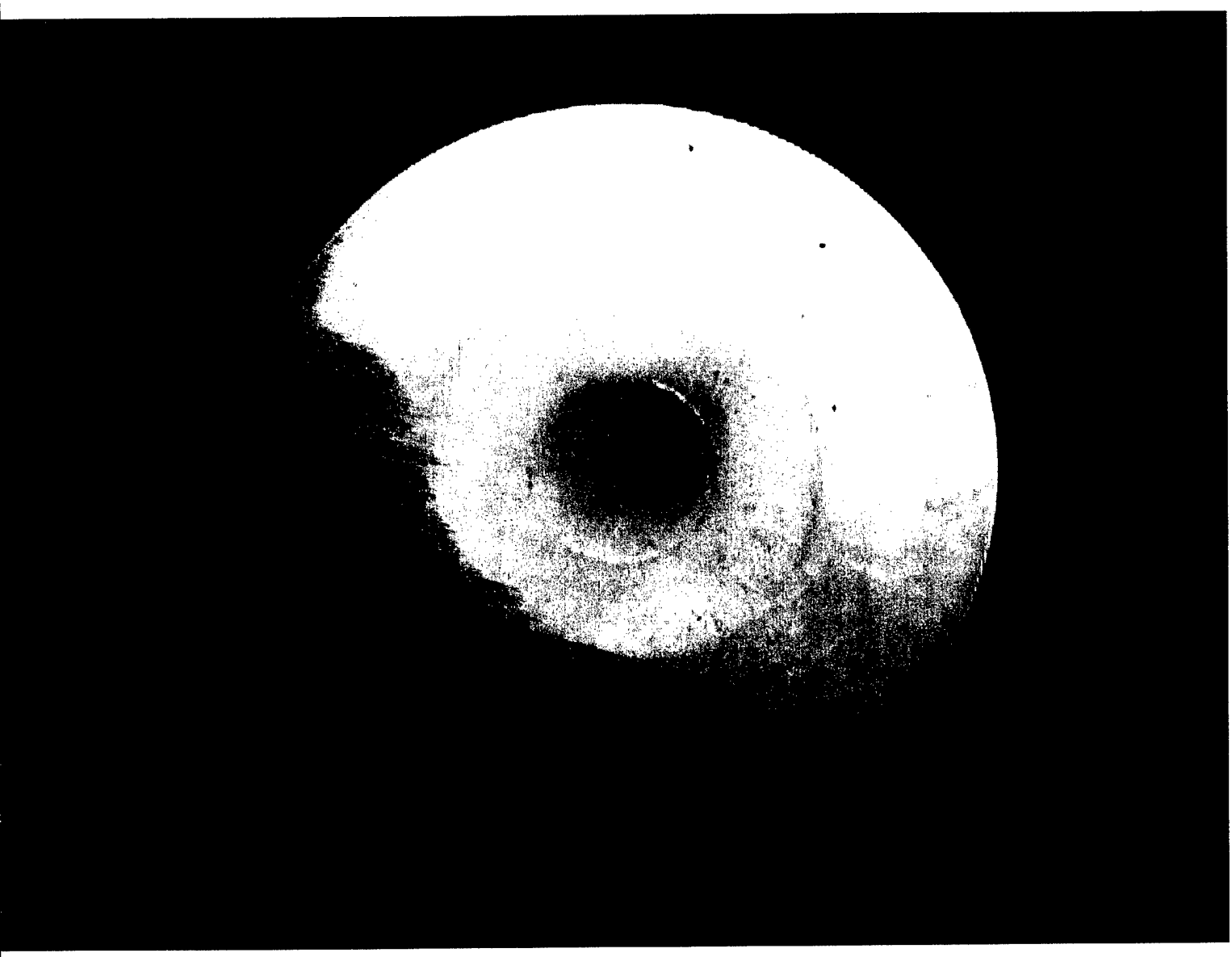


Figure 5: Sample 1, Plastic Float Located Bottom Half FFCD Housing

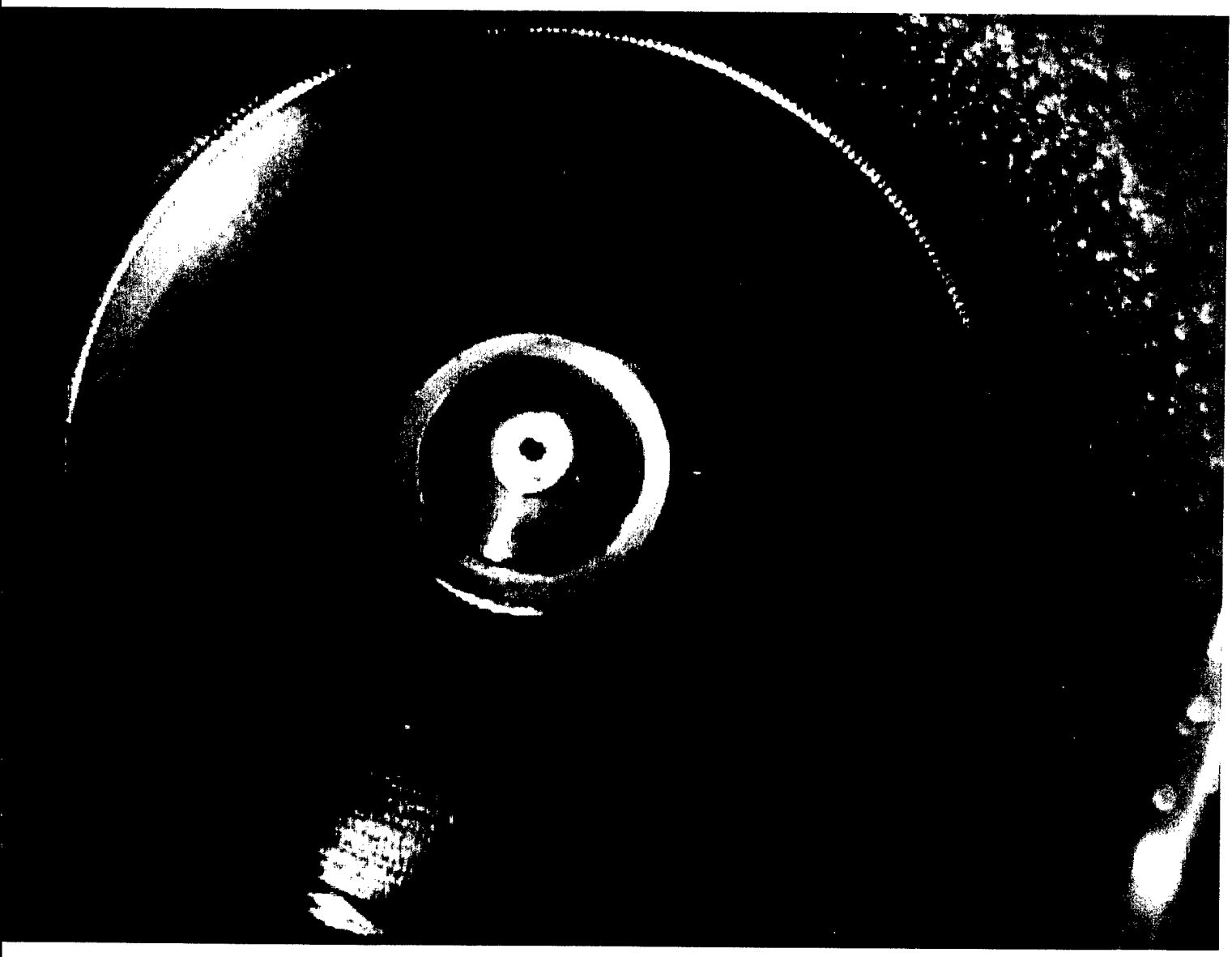


Figure 6: Sample 2, Nozzle Located Top Half FFCD Housing

Figure 7: Sample 2, Soft Foam Disk Installed on Plastic Float

Figure 8: Sample 2, Close-up View of Soft Foam Disk

The Mignot FFCD-1 Free-Flow Air Filter Air Cooler Air Densifier was obtained by the air flow test team in the April 1998 time frame (see Appendix B). Appendix A (see Page A-2) specified a capacity for fitting engines up to 6000 litres of air flow per minute. This converts to about 212 cubic feet per minute.

The capacity information also stated that for engines using 5500 to 9000 litres of air per minute, two FFCD-1 units must be used. It was envisioned that if lab tests were successful two FFCD-1 units could possibly be fitted to the HMMWV. The HMMWV requires a maximum of 420 cubic feet per minute of induction air flow capacity. Following lab tests, Aberdeen field and engineering tests could be conducted to demonstrate the water air filter military application. Another purpose of field tests would be to demonstrate the nearly 20 % improvement in fuel economy that was claimed in the water air filter packet of information (Appendix A).

At Appendix C is another testimonial on the water air filter given by a company that performs tests on vehicles for the Israeli Army. The company stated that, "lab test data showed filtration was to our expectations and dust filtration was better than other known filters in the market today". Therefore, the company working for the Israeli Army installed a water air filter on a vehicle working in extreme dust and sand environments. Preliminary test results showed better filtration than regular air filters that required more servicing. They stated, "the water air filter is meeting the needs of the customer and testing is continuing for both civilian and army vehicles in highway and off road applications". This letter dated May 1997 was another reason to test the water air filter since it was already being tested in army vehicles.

In 1998 the National Automotive Center here at TACOM invited Mr. Smoky Yunick to TACOM to discuss engine design philosophy with TARDEC's Technical Staff. Mr. Yunick is considered an engine expert from years ago and use to publish an article, "Ask Smoky" in the Popular Science Magazine. During Mr. Yunick's discussion at TACOM he stated that a water injection system is not good for an engine. He did not distinguish between gasoline or diesel engines. The water air filter is not a water injection system but could under special situations provide increased moisture content to an engine.

3.0 TEST EQUIPMENT/TEST SET-UP/TEST PLAN AND RATIONALE:

3.1 TEST EQUIPMENT:

The following equipment was used to conduct the water air filter test.

- 600 CFM Air Flow Bench
- Accurate Dust Feeder
- PTI Fine Test Dust
- Manometer to restriction, 0 –30 inches of water
- Oven, for weighing master filter
- Scales for weighing
- Dust Injector Nozzle

3.2 TEST SET-UP:

An overall view of test set-up is shown in Figures 9 and 10. Figure 9 shows the water air filter and water reservoir located nearby. Figure 10 shows the ducting connections from the water air filter clean air outlet to 600 CFM airflow bench. The pipe going into the table top connects into the master filter which is inside the bench. The 600 CFM blower motor is equipped with orifice and pressure/temperature to measure flow.

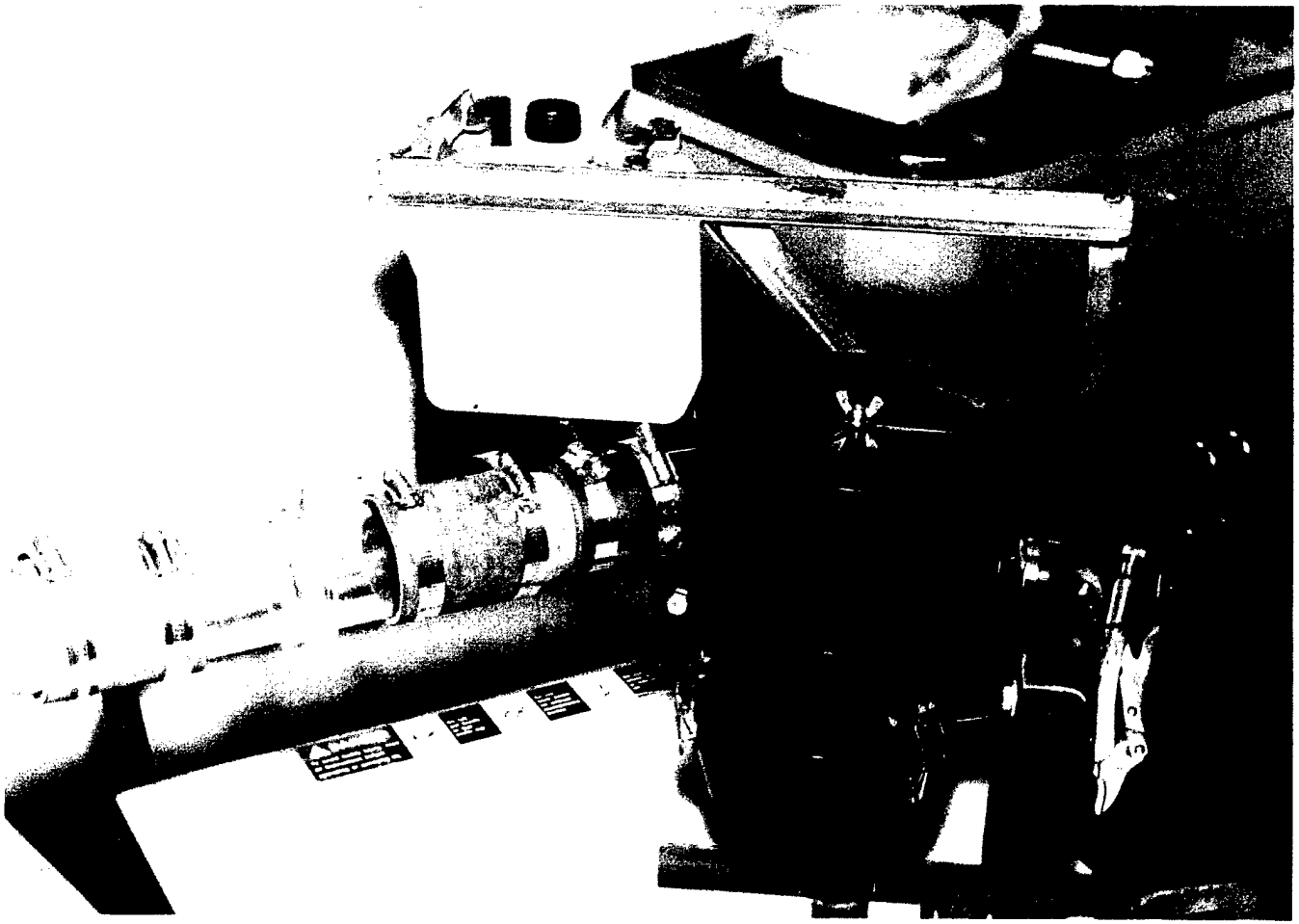


Figure 9: View of Water Air Filter/Water Reservoir Test Set-up

Figure 10: Water Air Filter Test Set-up To 600 CFM Air Flow Bench

Figures 9 and 10 do not show the Accurate Dust Feeder which was use to feed a specified quantity of dust to the water air filter. Dust was augered unto a turn table and picked-up through a hose assembly. A dust injector nozzle was incorporated near the end of dust feeding tube. Test dust was then directed to a cone shaped housing positioned around the periphery of the water air filter. The air supply to the dust injector nozzle was regulated at 35 to 40 pounds per square inch gauge pressure.

3.3 TEST PLAN:

At Appendix D is a test plan that was prepared for testing the water air filter. The test plan consisted of four basic tests: (1) Restriction and Pressure Drop Test, (2) Efficiency Tests, (3) Full Life Efficiency and Capacity Test and (4) Water carry over Test. These tests were based on oil bath air cleaner test procedures specified in SAE J 726. It was realized that pressure drop/restriction of the water air filter would not increase over time which is a positive feature. However, it was also realized that too much dust accumulation in the water compartment just below the cylindrical tubes would displace the water causing the water air filter to malfunction. Thus, efficiency tests were limited to 30 minutes until it could be established the quantity of dust that the water compartment could retain over a period of time.

The test plan was followed per se, however only 2 of the 4 scheduled tests were conducted. Only the restriction and pressure drop test and efficiency test were conducted. The restriction and pressure drop test was conducted on both sample 1 and sample 2 and the efficiency test was conducted only on sample 2. Four efficiency tests were conducted on sample 2. The efficiency tests were limited to a 30 minute time period for two reasons: (1) the bottom housing of the water air filter contained a quantity of water which also served as the holding tank for the dust. In a 30 minute time period the airflow test team could measure the quantity of dust captured and based on results could predict a maximum time period to fill the dust holding tank. (2) the master filter should not exceed a 10 inch of water pressure drop rise during the efficiency tests. Therefore 30 minutes was considered as the maximum time period to establish the restriction range across the master filter.

4.0 RESULTS AND DISCUSSIONS:

4.1 RESTRICTION AND PRESSURE DROP TEST, SAMPLE 1:

4.1.1 RESTRICTION TESTS,DRY:

The first restriction and pressure drop test was conducted on 17 July 98. A copy of the raw data sheets for these tests are shown in Table 2 sheets 1, 2 and 3. Table 2, sheet 1 of 3 shows two sets of test data. Test data signified with letter A is with shroud in place and test data signified with letter B is with shroud removed. The shroud is shaped like a cone and was installed to distribute the test dust evenly into the water air filter. Restriction tests were conducted with and without the shroud in place to determine if the shroud added any increased restriction. Six sets of restriction and pressure drop tests were conducted and the average restriction was recorded for each airflow. Test data showed that for the four airflow test points the restriction was slightly higher with the shroud in place than with shroud removed. The smallest difference occurred at an airflow of 50 cfm. At this cfm, restriction averaged 3.23 with shroud in place and 2.96 inches of water with shroud removed. The largest difference was at 200 cfm where restriction in inches of water was 46.6 with shroud in place and 43.3 inches of water with shroud removed. These tests were conducted with no water inside water air filter (dry condition) and without the water reservoir in place.

4.1.2 RESTRICTION TESTS, WET:

Table 2 sheet 2 of 3 shows restriction tests with water contained inside the water air filter (wet) and water reservoir attached. Test results showed nearly identical restriction readings with and without shroud in place up to 120 cfm. Restriction readings with and without shroud in place seem to vary less in wet mode than in dry mode. However in the wet mode operation a condition occurred at 135 cfm which will be termed water pull over. At cfm readings above 135 water/moisture droplets or streams of water was seen in the water air filter clean air outlet duct.

GENERAL DATA - A	CRN	DATE 7-17-98	TESTER
	TITLE RESTRICTION TESTS (DRY)		CHECKER
SPECIMEN WATER AIR CLEANER	MANUFACTURER	CODE	APPROVED
TEST (A) = SHROUD IN PLACE (B) = SHROUD REMOVED		SPEC	PARA
CONDITIONING NO WATER,			
APPARATUS			

		(A) TEST #1			(B) TEST #2		
	CFM	RESTR.		CFM	RESTR.		DIFF.
H^2O	50	3.2	H^2O	50	3.0		0.20
H^2O	80	7.35	H^2O	80	6.9		0.45
H^2O	120	16.20	H^2O	120	15.15		1.05
H^2O	200	46.7	H^2O	200	43.4		3.30
		(A) TEST #5 7/21/98		(B) TEST #3 7/21/98			
H^2O	50	3.20	H^2O	50	2.90		0.30
H^2O	80	7.30	H^2O	80	6.80		0.50
H^2O	120	16.20	H^2O	120	15.10		1.10
H^2O	200	46.50	H^2O	200	43.20		3.30
		(A) TEST #6 7/21/98		(B) TEST #4 7/21/98			
H^2O	50	3.30	H^2O	50	3.0		0.30
H^2O	80	7.20	H^2O	80	6.80		0.40
H^2O	120	16.20	H^2O	120	15.20		1.0
H^2O	200	46.60	H^2O	200	43.30		3.30
	(A)	AVERAGE		RESTRICTION	(B)		
H^2O	50	3.23	H^2O	50	2.96		0.27
H^2O	80	7.28	H^2O	80	6.83		0.45
H^2O	120	16.20	H^2O	120	15.15		1.05
H^2O	200	46.60	H^2O	200	43.30		3.30

Table 2: Sample 1, Water Air Filter Restriction Test Results, Dry Sheet 1 of 3

GENERAL DATA - A	CRN	DATE 7-22-98	TESTER
	TITLE RESTRICTION TESTS (WET)		CHECKER
SPECIMEN WATER AIR CLEANER	MANUFACTURER	CODE	APPROVED
TEST (A) = SHROUD IN PLACE (B) SHROUD REMOVED		SPEC	PARA
CONDITIONING WATER RESERVIOR FILLED			
APPARATUS			

		(A)	#7				(B)	#8
	CFM		RESTR			CFM		RESTR.
H^2O	50		3.20		H^2O	50		3.10
H^2O	80		7.30		H^2O	80		7.10
H^2O	120		16.30		H^2O	120		16.30
H^2O	200				H^2O	200		

SYSTEM PRESSURE DRAWS
WATER ABOVE 135 CFMS

Table 2: Sample 1, Water Air Filter Restriction Test Results, Dry Sheet 2 of 3

The airflow test team had expected to take restriction readings up to 200 cfm as in the dry mode and possibly slightly beyond. However at about 135 cfm the test operator began to notice moisture and/or water droplets on the plastic tube positioned in the water air filter outlet duct. This caused alarm because on a real engine application these moisture or water droplets would enter the engine. This was also a concern of Mr. Smokey Yunick as previously discussed. These moisture droplets or streams of water at air flows above 135 cfm are shown in Figure 11. Figure 12 is another figure which shows these conditions along with the inclined manometer which recorded the cfm at which water streams or moisture droplets occurred.

Figure 12 shows a cfm reading of slightly less than 135 at which water/moisture droplets were observed in the water air filter outlet duct. Table 2, sheet 3 of 3 shows the longer test periods run to verify the cfm at which water pull over or blow by occurred. The test data showed no water pull over or blow by occurred at both 120 and 130 cfm when tested for a one hour period. The critical cfm occurred between 133 and 135 cfm. A trace of moving water occurred at 133 cfm and a steady stream of water occurred at 135 cfm.

4.2 CORRESPONDENCE WITH WATER AIR FILTER INVENTOR AND U.S REPRESENTATIVE:

Following water air filter Sample 1 restriction tests messages were sent to the inventor, Mr. Allan MacDonald of South Africa and his U.S. representative Mr. Ido Fischler located in Tampa Bay, Florida. The messages were sent to alert the inventor of the problems the air flow test team experienced during the wet restriction tests. The air flow test team waited for a response from the inventor as to a course of action they thought would be appropriate to solve the water pull over/blow by problem. Nearly six months later a revised water air filter arrived which was designated as Sample 2. A slight change to the float was made by adding a soft rubber disk to the top of the float and the movable plunger inside the nozzle was removed. This was the fix the inventor envisioned as an answer to the water moisture/droplets or streams of water occurring in the clean air outlet duct at around 135 cfm. The various correspondence between TACOM'S air flow engineering technician and the water air filter inventor/representative is shown at Appendix E.

4.3 RESTRICTION AND PRESSURE DROP TEST, SAMPLE 2:

4.3.1 RESTRICTION TESTS, DRY:

Sample 2 restriction test data is shown in Table 3 sheets 1 through 3. The same identifiers used in previous restriction tests, letters A and B represents shroud in place and shroud removed respectively. The number 3 represents the new configuration and is designated FFCD-1, Sample 2. FFCD-1, Sample 2 is fully described in paragraph 2.2, titled " Detailed description of two samples tested ". Sample 2 eliminated the movable valve or plunger and installed a soft foam disk on top of the cylindrical plastic float.

Sample 2 restriction test data was conducted on 5/6 January 1999 in dry configuration (no water contained in bottom of water air filter housing). Three different sets of restriction test data was taken at air flows of 50, 80, 120 and 200 cfm. The lowest restriction was obtained at 50 cfm and averaged 3.0 inches of water for the three runs. The highest restriction was obtained at 200 cfm and averaged 43.03 inches of water for the three runs. An average restriction reading of 6.77 inches of water was obtained for the three test runs at the 80 cfm test point and an average restriction 15.10 inches of water was obtained for the three test runs at the 120 cfm test point. Test data recorded is shown in Table 3, sheet 1 of 3.

When these restrictions are compared with Sample 1 test data (Table 2, sheet 1 of 3) the results are nearly identical as shown below.

CFM	SAMPLE 1 RESTRICTION B SHROUD REMOVED	SAMPLE 2 RESTRICTION B SHROUD REMOVED
50	2.96	3.00
80	6.83	6.77
120	15.15	15.10
200	43.30	43.03

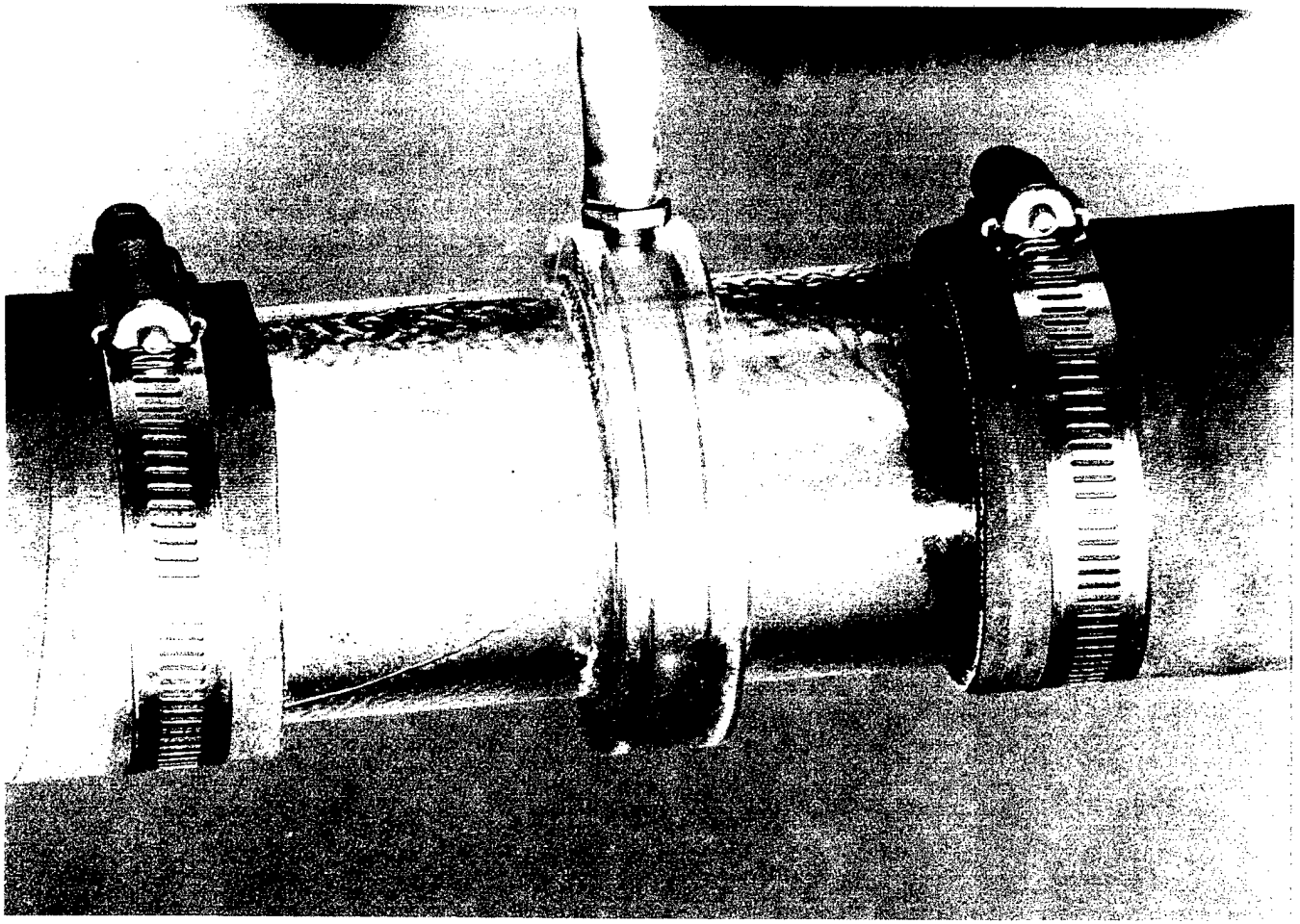


Figure 11: Streams of Water in Sample 1 Outlet Duct Above 135 CFM

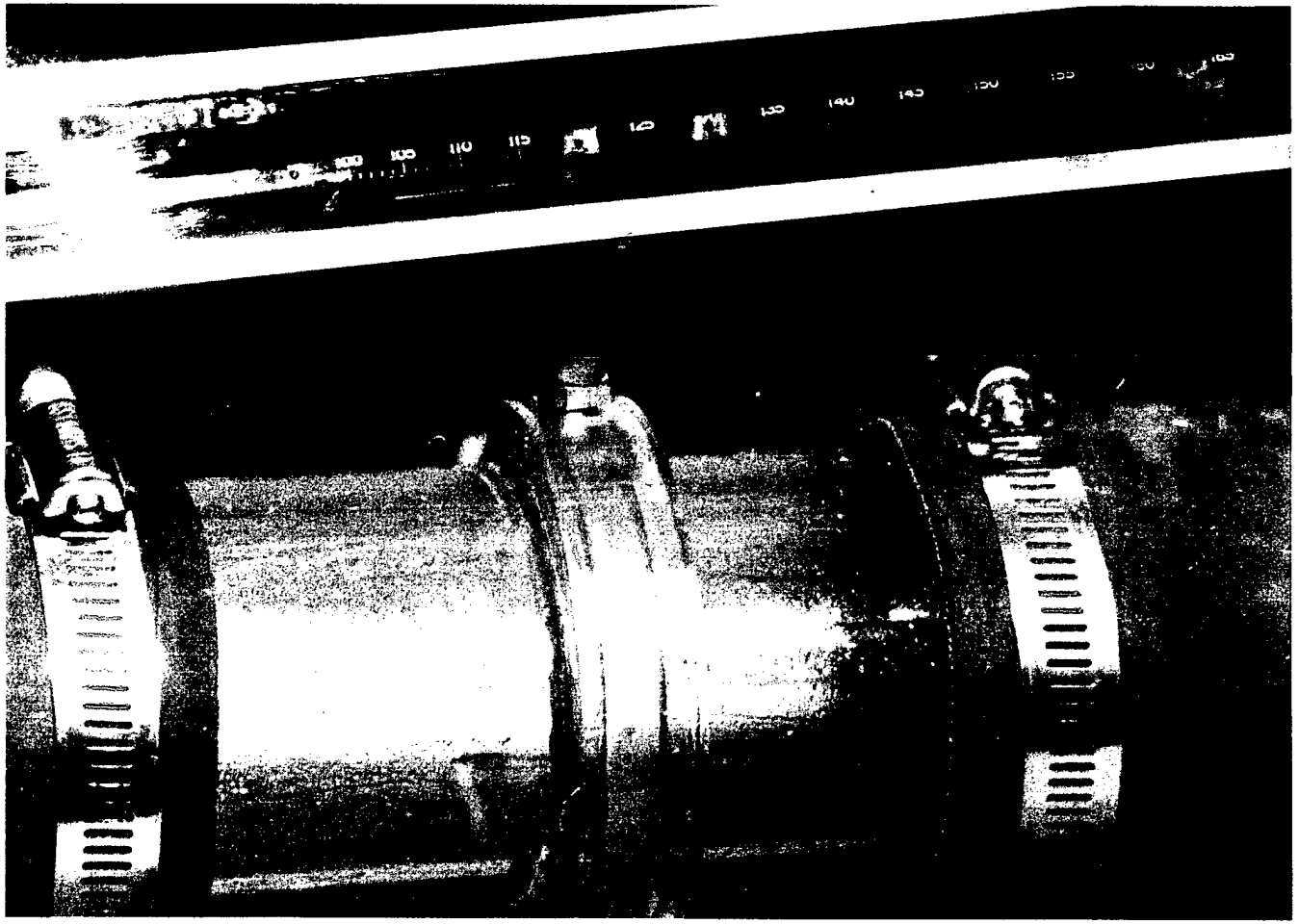


Figure 12: Correlation Between Streams of Water and CFM in Sample 1

GENERAL DATA - A	CRN	DATE 7-24-98	TESTER
	TITLE WATER BLOW BY TEST (WET)		CHECKER
SPECIMEN MIS NOT FFED-1 WATER AIR FILTER	MANUFACTURER	CODE	APPROVED
TEST WATER RESERVIOR FILLED		SPEC	PARA
CONDITIONING SHROUD REMOVED (A)			
APPARATUS			

CFM		LEAKAGE		test #9					
100		NONE							
105		NONE							
110		NONE							
115		NONE							
120		NONE							
125		NONE							
130		NONE ✱							
135		MOVING STREAM OF H^2O							
133		TRACE OF H^2O							
120		SIX HOUR TIME FRAME = NO BLOW BY /							
130		ONE HOUR TIME FRAME = NO BLOW BY ✱							
		✱ = MAX. AIR FLOW							

Table 2: Sample 1, Water Air Filter Restriction Test Results, Dry Sheet 3 of 3

GENERAL DATA - A	CRN	DATE 1-5+6-99	TESTER
	TITLE RESTRICTION TESTS (DRY)		CHECKER
SPECIMEN MINGOT WATER AIR FILTER	MANUFACTURER MINGOT	CODE	APPROVED
TEST Restriction in inches of Water		SPEC	PARA

CONDITIONING
(A) = SCHROUD IN PLACE (B) = SCHROUD REMOVED (3) = NEW CONFIGURATION

APPARATUS

TEST # 10 (B)(3)

MANOMETER	CFM	RESTRICTION	BAR.	ORIFICE TEMP.
H^2O	50	3.10	29.5	66°F
H^2O	80	6.70	29.3	66°F
H^2O	120	15.20	28.6	67°F
H^2O	200	43.0	26.5"	67°F

TEST # 11 (B)(3)

MANOMETER	CFM	RESTRICTION	BAR.	ORIFICE TEMP
H^2O	50	2.90	29.5	68°F
H^2O	80	6.80	29.2	68°F
H^2O	120	15.10	28.6	69°F
H^2O	200	42.80	26.4	69°F

TEST # 12 (B)(3)

H^2O	50	3.00	29.0	68°F
H^2O	80	6.80	28.8	68°F
H^2O	120	15.00	28.2	68°F
H^2O	200	43.30	25.9	67.5°F

TEST # AVERAGE

H^2O	50	3.00
H^2O	80	6.77
H^2O	120	15.10
H^2O	200	43.03

TEST #

H^2O	50
H^2O	80
H^2O	120
H^2O	200

TEST # AVERAGE OF 10-11-12

H^2O	50	3.00
H^2O	80	6.77
H^2O	120	15.10
H^2O	200	43.03

Table 3: Sample 2, Water Air Filter Restriction Test Results, Dry Sheet 1 of 3

4.3.2 RESTRICTION TESTS, WET:

Table 3, sheet 2 of 3 test data shows the restriction test results when the water air filter reservoir is filled with water. As previously discussed in Paragraph 4.1.2 a term water pull or blow by was phrased and was defined as a water stream or water droplets/moisture seen in the clean air outlet duct. This is an undesirable condition and could cause damaging harm to an engine. Previous wet restriction tests presented in paragraph 4.1.2 for Sample 1 water air filter showed water pull over occurred around 135 cfm. Sample 2 water air filter restriction test results showed that water pull over occurred above 145 cfm. Table 3, sheet 3 of 3 provides a more detail analysis of the exact cfm at which water pull over occurred. Sheet 3 shows that a trace of water pull over occurred at 142 cfm and no water pull over occurs at 140 cfm.

The FFCD-1, Sample 2 provided only a slight improvement over Sample 1. Water pull over occurred at 141 cfm for Sample 2 and 135 cfm for Sample 1. This is not considered a significant improvement and would not reduce the number of FFCD-1 units required on a HMMWV. As previously discussed more than 2 FFCD-1 units would be required on a HMMWV to produce the required air flow. In addition it would also be necessary to make an assessment of possible risk to the HMMWV engine if water droplets or water were allowed to enter the engine.

4.3.3 MIGOT FFCD-4 VS. FFCD-1 PRESSURE DROP TEST COMPARISONS:

At Figure 13 is pressure drop/restriction comparison curves between Mignot FFCD-1 and FFCD-4. The curves show the large differences in pressure drop readings between the two systems. Pressure drop readings for the Mignot FFCD-1 water air filter was taken at TACOM'S air flow lab. The pressure drop readings for the Mignot FFCD-4 water air filter was taken during lab testing at Cornaglia Research Center. Test report findings conducted by the Cornaglia Research Center (a European Company) are found in Appendix A. There is no explanation for the vast differences in pressure drop readings between the two systems.

4.4 EFFICIENCY TESTS, SAMPLE 2:

Four efficiency tests were conducted on Mignot FFCD-1, Sample 2. The test set-up except for the Accurate Dust Feeder was previously shown in Figures 9 and 10. Based on previous efficiency tests done on a FFCD-4 water air filter unit an efficiency of around 97% had been obtained. Thus, the air flow test team expected an efficiency some where in the 97 % range. TACOM'S tests were based on a zero dust visibility condition (.025 grams of dust per cubic foot of air) and a maximum air flow of 140 cubic feet per minute. This required that 3.5 grams of dust be feed into the inlet of the water air filter every minute. The first efficiency test was conducted on 1 March 1999 and was considered a trial with no test results being recorded. Efficiency test data recorded is shown in Table 4, sheets 1 through 3.

4.4.1 EFFICIENCY TEST NO 1:

The first efficiency test was conducted on 2 March 1999 with PTI fine test dust. Table 4, sheet 1of 3 shows some of the test data taken. The test was ran for 30 minutes with 101.5 grams of dust being fed. The target goal was 105.0 grams of dust. There was 13.5 grams of dust trapped in the dust injector and tubing ahead of the water air filter inlet. Actual dust fed to the water air filter was 88.0 grams of dust with 10.40 grams of dust being trapped by the master filter. Efficiency was calculated at 88.18 %. The 88.18 % efficiency is considerably less than the 97 % efficiency measured by the European lab shown in Appendix A and falls way short of the 99.5 % efficiency required by all military vehicle air cleaner systems.

4.4.2 EFFICIENCY TEST NO. 2:

The second efficiency test was ran on 3 March 1999 with PTI fine test dust. Table 4, sheet 2 of 3 shows some of the test data taken. This test could not be ran for the targeted 30 minutes due to the plugging of the master filter. SAE J 726 specifies that efficiency tests are not to be continued when there is more than 10 inches of pressure drop across the master filter. At between 22 and 23 minutes into the test the master filter

GENERAL DATA - A	CRN	DATE 1-8-99	TESTER
	TITLE RESTRICTION TEST (WET)		CHECKER
SPECIMEN MINGOT WATER AIR FILTER	MANUFACTURER MINGOT	CODE	APPROVED
TEST		SPEC	PARA

CONDITIONING
(A) = SCHROUD IN PLACE (B) = SCHROUD REMOVED (3) = NEW CONFIGURATION

APPARATUS
WATER RESERVIOR FILLED

TEST # 13

MANOMETER	CFM	RESTRICTION	BAR.	ORIFICE TEMP
H^2O	50	3.00	29.20	68.5°F
H^2O	80	6.90	28.95	68.0°F
H^2O	120	15.10	29.30	68.5°F
H^2O	200		27.70	67.5°F

SYSTEM PRESSURE DRAWS WATER ABOVE 145 CFM

TEST #

MANOMETER	CFM	RESTRICTION	BAR.	ORIFICE TEMP
H^2O	50			
H^2O	80			
H^2O	120			
H^2O	200			

TEST #

H^2O	50
H^2O	80
H^2O	120
H^2O	200

TEST #

H^2O	50
H^2O	80
H^2O	120
H^2O	200

STA FORM

Table 3: Sample 2, Water Air Filter Restriction Test Results, Wet Sheet 2 of 3

GENERAL DATA - A	CRN	DATE 1-12-99	TESTER
	TITLE WATER BLOW BY TEST (WET)		CHECKER
SPECIMEN FILTER MINGOT WATER-AIR	MANUFACTURER MINGOT	CODE	APPROVED
TEST WATER RESERVIOR FILLED		SPEC	PARA
CONDITIONING SHROUD REMOVED (B) NEW CONFIGURATION (3)			
APPARATUS			

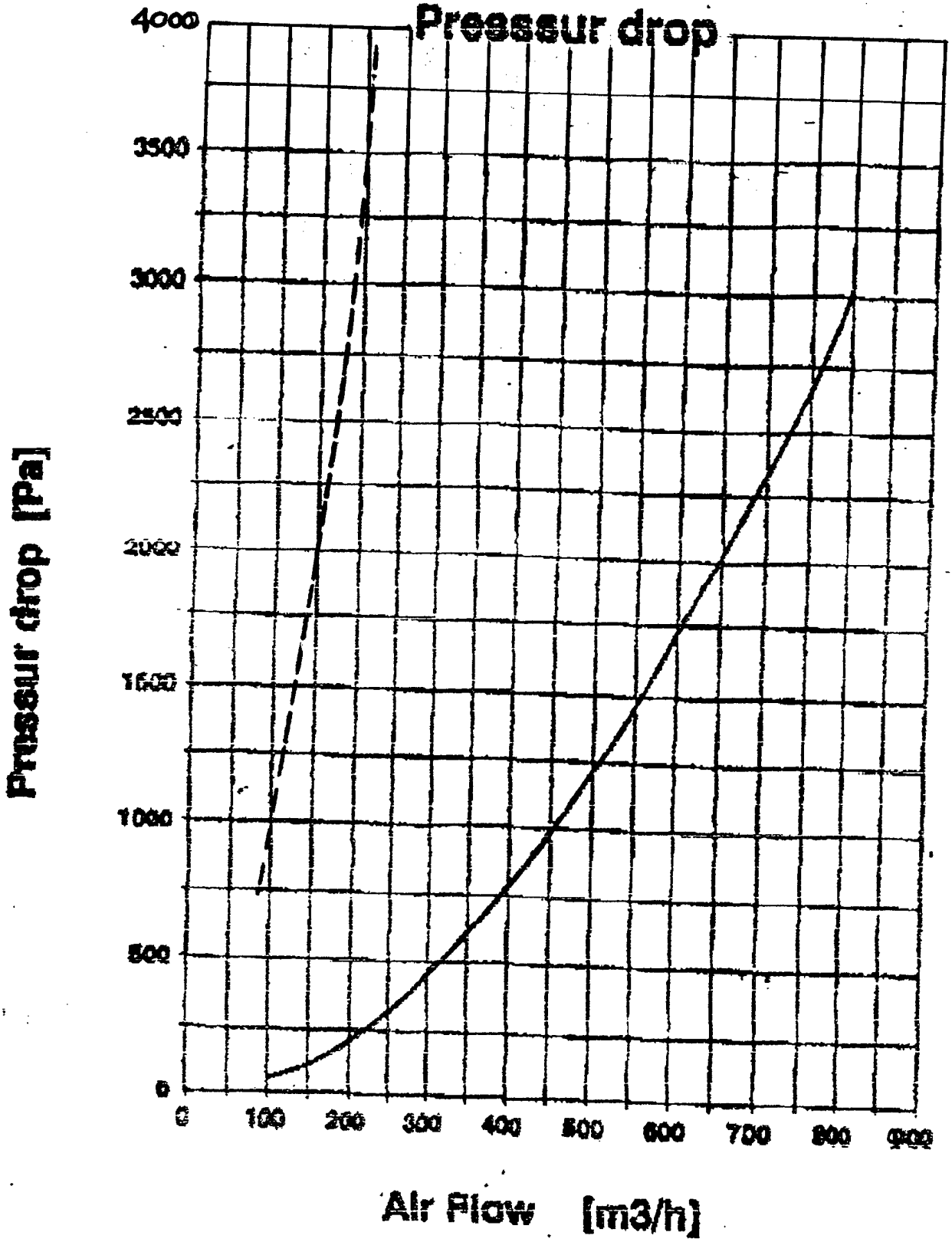
TEST # 14

MANOMETER	CFM	BAR.	ORIFICE TEMP	START	STOP	RESULT
H^2O	130	28.00	69°f	0909	1009	NO LEAKAGE
H^2O	135	27.90	70°f	1013	1230	"
H^2O	140	27.80	75°f	1235	1350	" ★
H^2O	145	27.70	72°f	1351	1358	TRACE OF H^2O
H^2O	140	27.80	71°f	1400	1520	NO LEAKAGE
	1-19-99					
H^2O	141	27.80	72°f	1325	1425	NO LEAKAGE
H^2O	142	27.80	71°f	1425	1428	TRACE OF H^2O
H^2O	141	27.75	69°f	1435	1445	" "
H^2O	140	29.80	72°f	1415	1530	NO LEAKAGE ★

★ = MAX AIRFLOW BEFORE H^2O IS VISIBLE AT PIZZOMETER TUBE

Table 3: Sample 2, Water Air Filter Restriction Test Results, Wet Sheet 3 of 3

FIGURE : 13 **AIR FILTER MIGNOT FFCD-4 — VS. FFCD-1 ---**



GENERAL DATA - A	CRN	DATE 2/MAR/92	TESTER
	TITLE EFFICIENCY TEST		CHECKER
SPECIMEN WATER AIR CLEANER	MANUFACTURER MINGOT	CODE	APPROVED
TEST 210 GRAMS OF DUST/HR		SPEC	PARA
CONDITIONING PTI FINE TEST DUST			
APPARATUS TEST #2			

TIME	C.F.M	REST.	ORIFICE TEMP	WET BULB	DRY BULB	RH	Master FILTER M.F	BAR			
0 MIN	140	20.80	79°	50	65	34°	3.80				
10	141	20.50	65°				4.40				
20	140	20.20	64°				6.00				
30	140	20.20	64	50	64	36°	11.60	27.10			
40											
50											
60											
MASTER FILTER WEIGHT —					AFTER -		117.0				
					BEFORE		101.60				
					TOTAL -		10.40	GR	GRAMS		
NOZZLE, PIPING, HOSE					AFTER			3,434.0			
& INJECTOR					BEFORE		~~3,420.5~~	3,420.5			
					TOTAL -				13.5	GR	GRAMS

EFFICIENCY = TOTAL DUST FED - DUST IN MASTER FILTER = TOTAL DUST FED X 100

= 88 Grams - 10.4 Grams ÷ 88 Grams X 100 = 88.18 % EFFICIENCY

Table 4: Sample 2 Efficiency Test Results

Sheet 1 of 3

GENERAL DATA - A	CRN	DATE 2 MAR 99	TESTER
	TITLE EFFICIENCY TEST		CHECKER
SPECIMEN WATER AIR CLEANER	MANUFACTURER MINGOT	CODE	APPROVED
TEST 210 GRAMS OF DUST/HR		SPEC	PARA
CONDITIONING PTI FINE TEST DUST			
APPARATUS TEST # 3			

TIME	CFM	REST.	ORIFICE TEMP	WET BULB	DRY BULB	RH	MF	BAR			DUST FED (Grams)
0 MIN	140	19.10	71°				3.80	27.40			
10	140	18.70	70°				6.00	27.30			
20	MASTER FILTER READING 23". STOP TEST										80
30											
40											
50											
60											
MASTER FILTER WEIGHT —					AFTER-		126.0				
					BEFORE-		101.30				
					TOTAL-		24.70 Grams				
NOZZLE, PIPING, HOSE + INJECTOR —					AFTER-		3429.5				
					BEFORE		3420.5				
					TOTAL-		9.0 Grams				
EFFICIENCY = TOTAL DUST FED - DUST IN MASTER FILTER ÷ TOTAL DUST FED X 100											
			(71 Grams)		-(24.7 Grams)		÷	(71 Grams)		X100 =	65.21%

Table 4: Sample 2 Efficiency Test Results

Sheet 2 of 3

had a restriction/pressure drop reading of 23 inches of water. This caused the air flow to become erratic resulting in a termination of the efficiency test.

The amount of dust trapped by the master filter measured 24.7 grams which is over double the amount which was trapped during the first efficiency test. There were 9.0 grams of dust found in the nozzle and tube assembly pick-up from the Accurate dust feeder to the water air filter inlet. This resulted in 71 grams of dust being fed and 24.7 grams of dust getting through to the water air filter clean side. Efficiency was calculated at 65.2 % which is considerably less than the first efficiency test.

The only explanation the air flow test team could come up with for this lower efficiency is that the water level inside the water air filter lower housing was about ¼ inch lower than during the first efficiency test. It may be that the height of the water level (below the cylindrical tubes) effects the water air filter's ability to achieve maximum efficiency.

4.4.3 EFFICIENCY TEST NO. 3:

The last efficiency test was ran on 3 March 1999 with data shown on Table 4 sheet 3 of 3. Prior to starting the efficiency test, water was added to the lower cup assembly to bring it up to the maximum fill line. The efficiency test was ran for 31 minutes and 5 seconds at 140 cubic feet per minute (cfm) air flow. After 31 minutes the air flow became hard to stabilize indicating a high master filter pressure drop reading. A total of 102.0 grams of dust was fed into the water air filter and 18 grams of dust were trapped by the master filter. The efficiency was measured at 82.35 % which is nearly 6 % lower than the first efficiency test.

At completion of the test it took about 250 millimeters of water to replenish the plastic water reservoir to the level it was at start of test. Also, the water level in the lower compartment appeared to be at least 1/8 inch lower than at start of test. This may indicate that the water reservoir and the delivery of the water to the lower housing through the nozzle and float may be unable to keep the water level in the lower assembly to the maximum full line. This condition could cause a lower efficiency.

5.0 CONCLUSIONS/RECOMMENDATIONS:

1. The FFCD-1 water air filter was intended to supply around 200 cfm of air flow. Two FFCD-1 water air filters were envisioned as a possible application for the HMMWV. However at an air flow of 130 to 140 cfm, water droplets and/or channels of water were seen exiting the water air filter clean air duct. Water moisture/droplets entering the air intake of a diesel is not desirable unless approved by engine manufacturer. Also, the air flow rating of the FFCD-1 does not appear to meet the advertised 200 cfm air flow rating. Therefore it would take more than two FFCD-1 water air flow units to meet the HMMWV air flow demands which would make installation and packaging difficult if not impossible.

2. There were two FFCD-1 prototype samples provided for test. The condition of water pull over (water moisture/droplets entering clean air duct) was only slightly changed between Sample 1 and Sample 2. The slight improvement shown in Sample 2 was not considered significant.

3. The restriction of the water air filter exceeded 43 inches of water at 200 cfm and 15 inches of water at 120 cfm. The 43 inches of water restriction at 200 cfm is considered prohibitive and would effect engine, air fuel management and emission controls. Although the restriction is fixed and shouldn't increase, the 43 inches of restriction is not recommended or considered desirable.

3. The efficiency of the water air filter ranged from 82 to 88 % in two tests. This efficiency falls way short of the 99.5 % minimum air cleaner efficiency required by all military vehicles. Engine manufacturers would not approved an air cleaner design with such a low efficiency.

5. The water air filter bottom cup assembly houses a specified amount of water. This water level is regulated to a specified height by a float. It is not certain if a water air filter could maintain a level water condition during military vehicle operation in severe slope applications. It is possible that efficiency would decrease caused by lower water levels as demonstrated during efficiency tests.

APPENDIX A

MIGNOT FFCD 1-2 INFORMATION

MIGNOT FFCD 1 - 2

Free-Flow Air Filter, Air Cooler Air Densifier

FITTING INSTRUCTIONS

The Mignot FFCD is mounted in the engine compartment.

It must be mounted upright while the vehicle is on level ground.

The Mignot FFCD is connected to the engine inlet - manifold as per air filters.

Small trucks - The Mignot FFCD - 2 is chassis mounted.

Water Reservoir
The water reservoir is mounted where suitable with a level as near as that of FFCD, but not exceeding 50 cm. above.

Summer/Winter
In icy conditions, 10% of AF402 by volume should be added to the water reservoir.

CLEANING INSTRUCTIONS

The Mignot FFCD must be cleaned every 15 000 kms, or more frequently under severe conditions.

Cleaning
Simply remove the bowl, clean and replace (dry). Remove wing-nut, and secondary filter on top, clean and re-grease, +- 2mm thick, by hand or brush on inside surfaces.

Capacity
Mignot FFCD - 1 fits engines using up to 6 000 litres of air per minute. For engines using 5 500 to 9 000 litres of air per minute, 2 x FFCD - 1 's must be fitted.

Mignot FFCD's fit all private, agricultural and industrial applications.

THE REVOLUTIONARY

Mignot f.f.c.d.

FREE-FLOW AIR FILTER, AIR COOLER AIR DENSIFIER

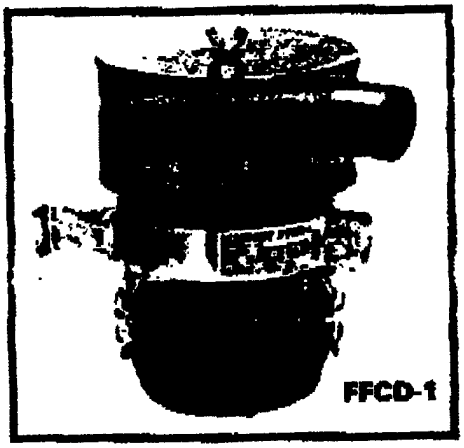
FOR Cars - Commercials - Agricultural Tractors Forklift Trucks - Industrial Engines etc.

FREE FLOW AIR FILTER
No paper, foam or filtration material - no restriction at all times.

AIR COOLER
Creates volumetric expansion.

AIR DENSIFIER
Compensates for altitude and creates optimum combustion.

ENVIRONMENT FRIENDLY

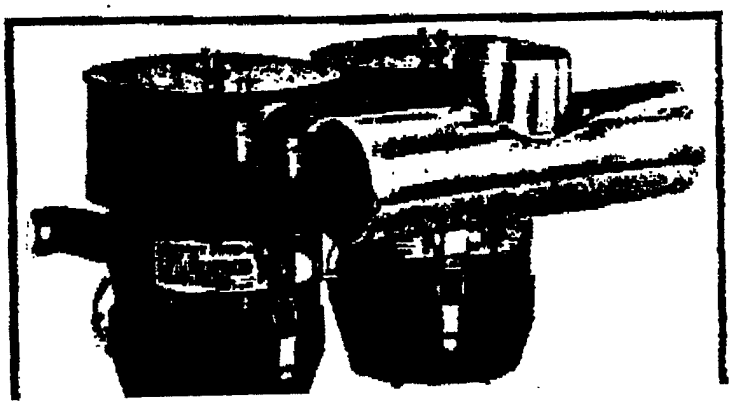


RESULTS

- **Fuel savings up to 22,8% and more.**
- **No more engine-damaging high exhaust temperatures due to blocked air filter elements.**
- **More power**
- **More performance**
- **No replacement costs**

"The concept for the next 20 years"
(European Auto Maker)

"Performance Too Good"



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Tel: 032 22 05 44
077 31 32894
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Bienne, 28 Octobe 1993

FFCD

In my capacity as an Engineer specializing in Anti-pollution, I have effected trials with the FFCD Filter.

Its principle of filtration is exceptional because it does not use re-newable filters such as paper or others. It permits to diminish the fuel consumption and as such it diminishes the charge of pollutants emitted by the engine.

The principle in itself allows the air to penetrate in the engine without any restriction, hence its determination of FREE FLOW FILTER. It is clear that, thanks to this system, there is no restriction to the air flow which would not be negatively influenced whatsoever.

The filtration system itself is new and of high tech design. Effectively the filter accelerates the mass of dirt saturated air in the direction of the "water bath". This provokes a blockage of particles and liberates the air in a proportion neighbouring 99% in efficiency.

The simple fact that the filter works with water and in this case charges the air being aspised, provokes a diminution of the combustion temperature and so diminishes the NOx.

It is then clear that the beneficial effect of this filter is not only rentability (reduced consumption, no filters to pay for and renew), but even more, a diminution of the atmospheric pollutant charges. In other words, it helps to protect our environment.

TEST DATA SUMMARY
Mignot f.f.c.d. Free-Flow Air Filter

Fuel Efficiency

A) MRK Publications Report of January 5, 1996

CONCLUSION: 22.8% increased fuel efficiency over paper air filter

B) MRK Publications Report of January 20, 1997

CONCLUSION: 10.66% increased fuel efficiency over paper air filter

C) Xtreme Marketing International Report of January 24, 1997

CONCLUSION: 19% improved fuel consumption on Nissan 1400 Sentra 17% improved fuel consumption on Toyota 2200 Venture

D) Berea West Cartage & Storage Report of January 27, 1997

CONCLUSION: 19.5% Fuel savings and increased vehicle performance on Mercedes 1417 Truck

E) Globus Carriers Report of February 17, 1988

CONCLUSION: 16% Fuel savings, Reduced emissions, Improved performance

Air Filtration

A) Cornaglia - an independent testing facility and automotive systems supplier to FIAT - Report of March 5, 1995

CONCLUSION: Mignot f.f.c.d. Filter had filtration of 97% to 97.5% - better overall behavior than paper air filters

Cornaglia

CENTRO RICERCHE BRASSICARDA
Regione Brassicarda, 18 - 14019 VILLANOVA D' ASTI
Tel. 0141-947444 - Fax 0141-937181

Data : 05-05-1995
Prot. n. : 168\cr\95
Numero Pagine Inviate: 12

DA : Massimo MARCARINI

A : MIGNOT International

C.A: [redacted] MIGNOT [redacted]
Dr. PALMARIN

COPIA : Dr. U. CORNAGLIA, Mr. NALIN, Eng. RAMPONI, Mr. VITAGLIANI

__OGGETTO :__ FFCD 4 Test Report

Dear Sirs,
please find here enclosed copy of the Test Report you are waiting for.

Don't hexitate to contact us for any further information or clarification

Best Regards

Massimo MARCARINI

Cornaglia

TEST REPORT | Date: 03/05/95

Document:	**CR-RP-032**	**Rev.:**	**1.0**
Title:	**MIGNOT Filter FFCD 4 Test Bench Verification**		
Object:	**MIGNOT Filter FFCD 4**	**Drawing:**	
Vehicle:		**Type:**	

P. VITAGLIANI

CORNAGLIA Research Center
Laboratory Department Resp.

C. RAMPONI

CORNAGLIA Research Center
Intake System Division Dir.

INDEX

1.0 SCOPE

Scope of the tests herein reported was to verify the behaviour of the Filter in para 2.0.

The test were performed at the CORNAGLIA RESEARCH CENTER.

2.0 OBJECT

Object of tests was the Air Filter FFCD 4 in its final definitions after the set up carried out by Eng. MIGNOT at the CORNAGLIA RESEARCH CENTER manufactured in ITALY by CORNAGLIA - Intake System Division.

3.0 TEST PERFORMED

The tests performed were:

TEST N. 1 - Pressure Drop

TEST N. 2 - Dust Capacity and Accumulation Efficiency (10 g\min)

TEST N. 3 - Dust Capacity and Accumulation Efficiency (3 g\min)

4.0 TEST N. 1 - Pressure Drop

4.1 TEST CONDITION

Temperature	21 C
Humidity	65 %
Atmospheric Pressure	1002 mb

4.2 TEST SET UP

In fig. 1 is shown the Test Set Up

4.3 TEST PROCEDURE

The FFCD 4, installed on the Test Bench as per para 4.2, has been fluxed to the max operative air flow (600 m^3/h).

Decreasing the air flow it has been measured the pressure drop utilizing a measuring point downstream the Filter.

4.4 TEST RESULT

In fig. 2 is reported the Pressure Drop Curve.

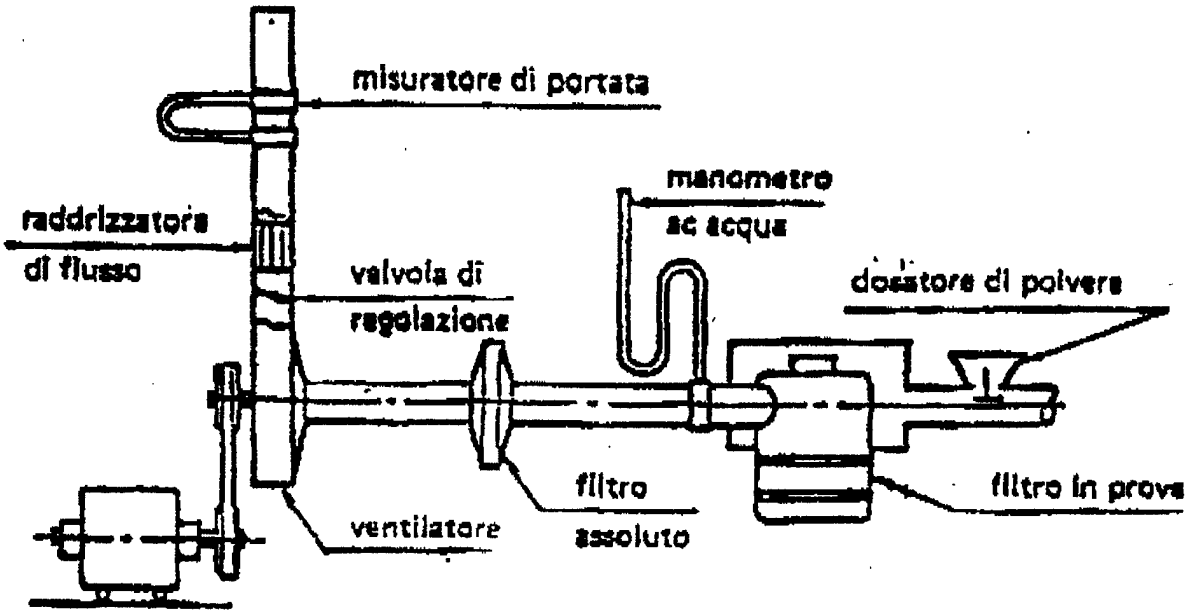
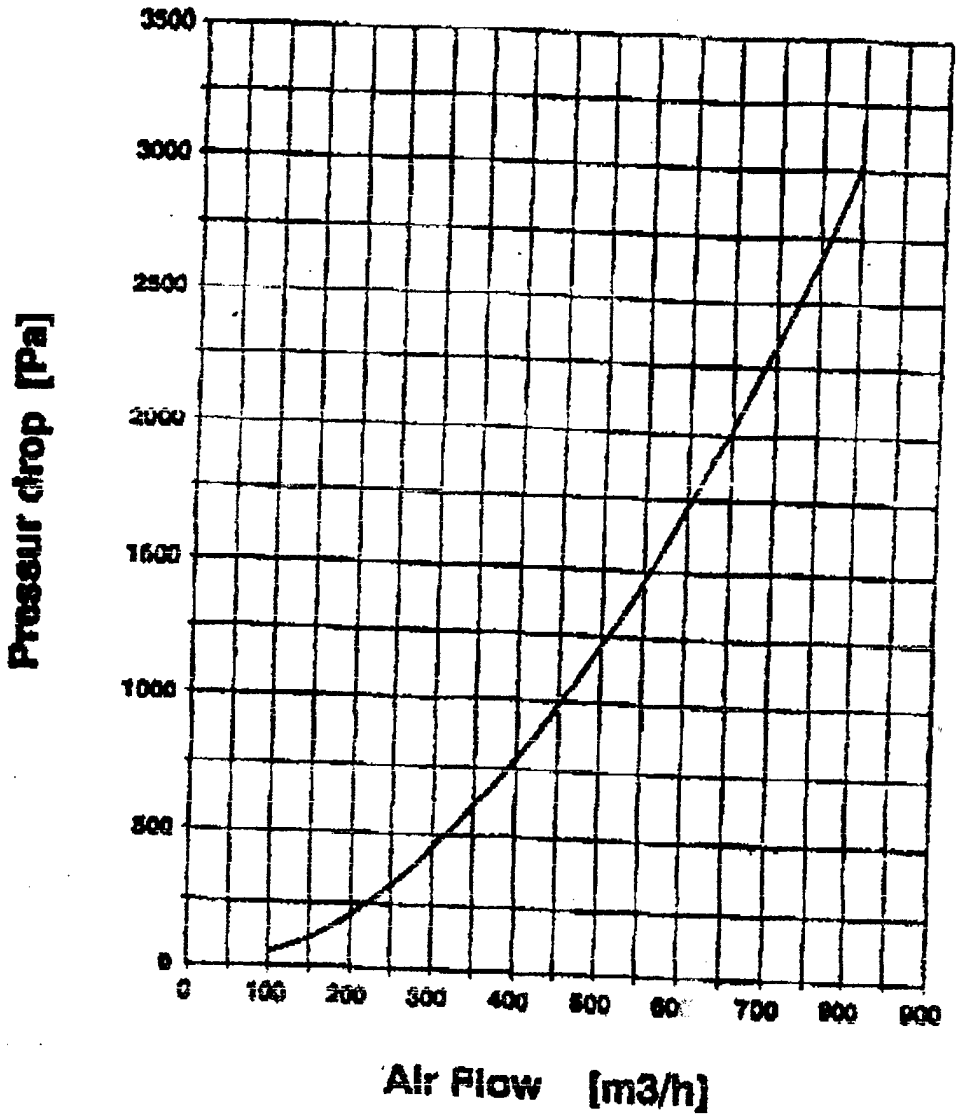


Fig. 3 - Dust Capacity and Accumulation Efficency Test Set Up

AIR FILTER MIGNOT FFCD-4

Preessur drop



EUROPEAN TESTS

TEST WITH DUST AC-COURSE 10 g/min F.F.C.D. - 3

Engine revolutions 2 000 r.p.m.

No.	Time	t	t	[illegible]	Δp	Weight of dust	Fuel consumption
	min	°	°	[illegible]	mm H_2O	g	l/h
1	0	308	46	0.8	175	0	2.46
2	5	312	57	0.8	174	50	2.48
3	10	316	63	0.7	176	100	2.48
4	15	317	66	0.8	175	150	2.48
5	20	318	64	0.8	175	200	2.48
6	25	[illegible]	[illegible]	0.8	175	250	2.49
7	30	320	72	0.8	175	300	2.50
8	35	322	75	0.8	173	350	2.51
9	40	322	75	0.7	173	400	2.50
10	45	325	76	0.8	172	450	2.51
11	50	325	72	0.8	172	500	2.50
12	55	[illegible]	76	0.7	171	550	2.50
13	60	326	77	0.7	172	600	2.51
14	65	326	79	0.7	171	650	2.50
15	70	328	75	0.7	171	700	2.51
16	75	329	76	0.7	171	750	2.51
17	80	330	75	0.7	171	800	2.50
18	85	[illegible]	76	0.7	171	850	2.51
19	90	327	75	0.7	171	900	2.51
20	95	[illegible]	75	0.7	172	950	2.50
21	100	332	76	0.7	171	1000	2.51
22	105	330	77	0.8	173	1050	2.51
23	110	331	76	0.7	172	1100	2.51
24	115	330	79	0.7	171	1150	2.51
25	120	331	79	0.7	171	1200	2.51

TEST WITH DUST AC-COURSE 3 g/min F.F.C.D. - 3

Engine revolutions 2 000 r.p.m.

Time 180 minutes

No.	Time	Weight of dust	Inlet manifold [illegible] pressure
	min.	g	mm H_2O
1	0	0	178
2	5	15	177
3	10	30	176
4	15	45	176
5	20	60	176
6	25	75	175
7	30	90	174
8	35	105	176
9	40	120	174
10	45	135	174
11	50	150	174
12	55	165	173
13	60	180	173
14	65	195	172
15	70	210	171
16	75	225	171
17	80	240	172
18	85	255	171
19	90	270	171
20	95	285	172
21	100	300	171
22	105	315	171
23	110	330	171
24	115	345	171
25	120	360	171
26	125	375	172
27	130	390	172
28	135	405	172
29	140	420	172
30	145	435	172
31	150	450	172
32	155	465	171
33	160	480	172
34	165	495	171
35	170	510	171
36	175	525	171
37	180	540	171

GRAPH ILLUSTRATING BENEFITS OF MIGNOT F.F.C.D. FREE FLOW DESIGN AGAINST STANDARD PAPER FILTER AIR CLEANER

TECHNICAL SPECIFICATIONS F.F.C.D. - 1

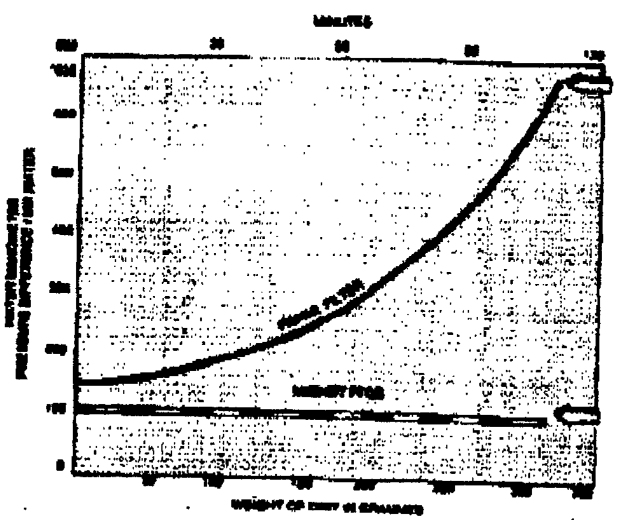
Height 28 cm.

Diameter 16,5 cm.

Dry weight 2,8 kg.

Filtration 98% +

Maximum capacity 600 ltr/min.



400 mm OF WATER = STALL RATE OF DIESEL ENGINE

AS MORE DUST IS SUCKED IN, THE PAPER FILTER GRADUALLY CLOGS UP, REDUCING THE FLOW OF AIR TO THE ENGINE. THIS CAUSES:

- ENGINE-DAMAGING HIGH EXHAUST TEMPERATURES
- SHARPLY INCREASING FUEL CONSUMPTION
- LOSS OF POWER
- ILLEGALLY HIGH EXHAUST POLLUTION
- EVENTUAL ENGINE STALLING

THE MIGNOT FFCD FREE FLOW CONCEPT ELIMINATES ANY RISK OF THE ABOVE SERIOUS DISADVANTAGES.

Mignot f.f.c.d.

5.0 TEST N. 2 - Dust Capacity and Accumulation Efficency (10 g\min)

5.1 TEST CONDITION

Temperature	21 C
Humidity	66 %
Atmospheric Pressure	1002 mb

5.2 TEST SET UP

In fig. 3 is shown the Test Set Up

5.3 TEST PROCEDURE

The FFCD 4, installed on the Test Bench as per para 5.2, has been fluxed to the max operative air flow (800 m^3/h).

The dust used has been of the "Coarse" type, classified in reference of the Arizona Natural one, supplied by the G. M. Laboratory - Phoenix, prepared by AC Spark Plug Div. (General Motor Corp. - Flint - Michigan), with the following characteristics:

Particle Diameter [micron]	0 - 5	5 - 10	10 - 20	20 - 40	40 - 80	80 - 200
Quantity [%]	12 +- 2	12 +- 3	14 +- 3	23 +- 3	30 +- 3	9 +- 3

The Total Dust Weight introduced has been 800 g at a rate of 3 g/min for a test duration of 265 min.

5.4 TEST RESULT

The Pressure Drop, measured during the test, doesn't evidenced any appreciable variation.

The Filtration Efficency calculated is 97,3 %

6.0 TEST N. 3 - Dust Capacity and Accumulation Efficency (3 g\min)

6.1 TEST CONDITION

Temperature	21 C
Humidity	65 %
Atmospheric Pressure	1002 mb

6.2 TEST SET UP

In fig. 3 ie shown the Test Set Up

6.3 TEST PROCEDURE

The procedure used has been the same of the para 5.3.

The Total Dust Weight introduced has been 600 g at a rate of 10 g/min for a test duration of
60 min.

6.4 TEST RESULT

As per the Test N. 2 the Pressure Drop doesn't evidenced any appreciable variation.

The Filtration Efficency calculated is 97,1 %

7.0 CONCLUSION

The test results shows that the Mignot Filter FFCD 4 has, in the maintenace intervall, a behaviour, on the Accumulation Efficiency point of view, better than the normally used Paper Air Filters.

Contrary to the Paper one, it doesn't evidence any Pressure Drop decay with the increasing of the dust introduced starting from a Pressure Drop level that, for what is our experience, is in same cases lower and at least comparable with Paper Filters.

The Dust Capacity calculated is between 97% and 97.5%

Cornaglia

ANNEX 1 - CORNAGLIA Group

In order to provide some information on the company, a brief outline is given here. This is not comprehensive but covers the main points of the company development.

Cornaglia provides complete air intake systems. We work with clients from conception through design, development to manufacture. We use simultaneous engineering or co-design techniques and philosophies.

Founded in 1916, Cornaglia supplied sheet metal components to the automotive industry. The company has evolved to provide a wide range of products in sheet metal and plastic. Supply partnerships with clients are based on co-design and the use of integrated systems. The company is now 30 % owned by MAGNETI MARELLI (ex GILARDINI).

The range of products now includes:

- air intake systems - from air inlet to engine manifold
- fuel supply systems - from fuel tanks to system components
- exhaust systems - from manifold to tailpipe
- Oil sumps - pressed

Research and development activities to support the companies within the Group are carried out at the Cornaglia Research Center, where a team of 40 engineers and support staff is responsible for design, devlopment, experimentation and evaluation.

The majority of the Group business has historically been with the Fiat Group (FIAT AUTO, LANCIA, ALFA, IVECO, etc.) of which, for the Air Intake System we are leader supplier, withthe total design responsibility. In the recent there have been developments to supply other manufacturers.

Teams of engineers provide liaison and support to clients from the start of a project. Continuous exchange of CAD drawings is maintained with the client, either directly or through a linkage system.

Certification of Conformance is accomplished internally, according to standards and procedures agreed with the client. ISO certification to 9001 and 9002 is planned for 1995, based on systems which are in use at present (and which are approved by other major clients.)

The Cornaglia Group aims to provide clients with the highest level of excellence in terms of innovation, design, quality and service and to achieve these at economically competitive rates.

A modern production line is used for components and this assures high quality levels, in conjunction with the manufacturing and assessment systems in use.

ON GOING SOUTH AFRICAN ROAD TESTS

1988

MRK Publications (PTY) LTD.

Mr. G. Mignot
Mignot International Ltd
16.05.88

Dear Mr. Mignot,

The following are results carried out on a 2 litre 3 ton truck. Test distance was 875 km, in fine weather at a temperature range of 26-16 degrees.

Fuel Consumption Test

Route 1: 26,6 kilometres, temperature 20 degrees

Route 2: 288,0 kilometres, temperature 18 degrees

Standard Filter

	Average Speed	litres/100 km.	intake temp.
Route 1:	71,2	30,17	22
Route 2:	62,1	29,12	20

FFCD Filter

	Average Speed	litres/100 km.	intake temp.
Route 1:	70,1	23,57	19/22
Route 2:	61,65	24,48	18/20

Improvement of 21,87% on the 26 km. route

Improvement of 15,93% on the 288 km. route

Water consumption for the 288 km. route was 1 litre - giving a range of just over 578 km. for the 2 litre water bottle.

I hope these results are satisfactory.

Yours sincerely.

Malcolm R. Kinsey

MALCOLM R. KINSEY
MRK PUBLICATIONS (PTY) LTD.
TEL. 445770 DURBAN, NATAL, RSA.

1996

MRK Publications (PTY) LTD.

MRK

Mr G F Mignot
Mignot International Ltd
5.01.96

Dear Mr Mignot,

Enclosed are the results of tests conducted on your FFCD filter to a Toyota 2,8 Diesel Double cab 2 x 4..

The first test consisted of a trip from Durban to Port Alfred via Kokstad, Umtata with the Mignot filter in operation. The return drive was with the original Toyota-supplied filter fitted - a paper element filter which had been in use for 2 330 kilometres and was therefore still quite clean and in good condition. An older, dirtier filter would have restricted airflow and consequently increased fuel consumption on this leg of the journey.

Taking the best run with the Mignot filter, the OE Toyota filter was **22,28%** higher on consumption and this would become still higher as the filter grows older. Paper filters have continuously deteriorating performance with useage, which is not the case with the Mignot filter. On this test the water consumption in the Mignot filter was 300 ml. for the 95,5 km. of the test route.

I hope these figures will be of use to you.

Sincerely.

Malcolm R. Kinsey

MALCOLM R KINSEY

REGISTERED PATENT NUMBERS

USA4746336 AUSTRALIA 597334
EUROPE 0260132 RSA 861365 ROC 38512
BRAZIL 8700842 ARGENTINA 241038
INDIA 137 DEL 87 Others pending

Servicing is simple & easy

- Remove bowl, clean and replace.(No adjustments).
- Remove secondary on top. Clean and grease inside surfaces +−2mm.

Mignot f.f.c.d.

Coca-Cola Sabco (S.A.) (Pty) Ltd
REG. NO. [illegible]
159 Harrower Road, Port Elizabeth 6001.
P O Box 3509, North End, Port Elizabeth 6056.
Telephone (041) 33 4116. Fax (041) 33 1338.

Fax Number: 011-8322575

7 March 1996

Mr I Fischler
Managing Director
R&MP Ltd.
C/o P.O. Box 476
CROUN MINES
2025

Dear Ido

RE : MIGNOT FFCD AIR FILTER SYSTEM

Subsequent to our meeting at Alert Engine Parts' offices in Johannesburg and after carefully studying the documents you supplied regarding the *MIGNOT FFCD* air filter systems, I am highly impressed. There is little doubt in my mind that your product can be of benefit to our company and that it will reduce operating cost of our fleet tremendously if the test results are accurate. Unlike other products in the market this filtration system, in my mind, provides a simple yet extremely effective solution for air filtration which will at the end of the day materialise in real savings.

In the coming two week I would like to commence conducting extensive test of your Model 5 on our haulage fleet, as well as Model 1&2 on our forklift and light fleet and if my tests verify or produce even half of the mentioned benefits, we would like to be the first fleet in our industry and in the country to have these units fitted.

Although the price mentioned is high when compared to existing filtration systems, I believe however that the return on investment will be less than twelve months on average, on vehicles travelling between six hundred and one thousand kilometres per day.

Tests will be performed at our Port Elizabeth, Bloemfontein, Kimmen and Port Shepstone operations on our existing ERF and Mercedes Trucks operating on haulage. Forklift tests will be performed at our Port Elizabeth operation on our TCM and Toyota 2,5 ton units.

Globus Carriers

LONG DISTANCE & LOCAL CARRIERS

OFFICE 48-3779
48-1179
AFTER HOURS 231-229
L DIESEL 286329

213 VOORTREKKER STREET
JACOBS/DURBAN 4052

17 February 1998

MIGNOT INDUSTRIES (PTY) LTD
P.O. BOX 12204
JACOBS 4026

ATTENTION: MR. G. MIGNOT

Dear Mr Mignot,

The Free-Flow Filter Densifier that was fitted to my Foden mechanical horse on the 10th October 1997 has been so successful that I take pleasure in confirming the following:

1. I now get a solid 16% saving on fuel.
2. Smoke emission from the exhaust has visibly decreased.
3. Engine peformance has improved so much that my driver is still talking about its increased power. This is particularly evident on the highveld.
4. It is no longer nnecessary to buy and fit new paper filters.
5. This level of performance has not deteriorated at all since the filter was fitted.
6. Maintenance, which does not require replacement parts, is quick and simple.

As a result of my experience with your filter I have no hesitation in recommending it to all truck operators as a positive money saver and improver of efficiency. I calculate that on this rig alone it is saving me R7 000 per annum.

Finally, may I reiterate that I intend to fit your filters to all my trucks as soon as they are available.

Yours faithfully,

XTREME MARKETING
INTERNATIONAL
P.O. BOX 80540, PLAINMEAD BOKMAKIE 7441
TEL: (021) 857-6018 FAX: (021) 857-6019

ATTENTION: GUY MIGNOT
DATE : 24 JANUARY 1997

As discussed here are the results of the vehicles we have done fitments on.

Nissan 1400 Centre 19% better fuel consumption.

Toyota 2200 Venture 17% better fuel consumption.

These figures were calculated over a distance of approximately 2000km.

Overall performance on both vehicles were improved.

Regards

GARY LABUSCHAGNE

APPENDIX B

INVOICE ON PURCHASE OF TWO FFCD-1 UNITS

Invoice

Invoice Number: 2501
Date: April 21, 1998

EGFI US INC.
500 North Osceola Ave. Suite 208
Clearwater, FL 34615
Tel: 813 449-2209
Fax: 813 443-3651

To:	Ship to (if different address):
US Army TACOM/TARDEL AMSTA - TR - R Warren, MI. 48397-5000 Attn.: Frank Margrif Tel: 810 574-5796	

SALESPERSON	ORDER NO.	DATE SHIPPED	SHIPPED VIA	F.O.B.	TERMS
Patrick Dunaway	Verbal PO	To Be Determine	UPS	California	Prepaid

QTY.	DESCRIPTION	UNIT PRICE	TOTAL
2	FFCD -1 unit including water reservoir and attachment bracket	1,000.00	2,000.00
			0.00
			0.00
			0.00
			0.00
			0.00
			0.00
		SUBTOTAL	2,000.00
		SALES TAX RATE %	
		SALES TAX	0.00
		SHIPPING & HANDLING	Inc.
		TOTAL DUE	$2,000.00

THANK YOU FOR YOUR ORDER!

Submited By: Ido Fischler
Ido Fischler

Paid By Check:___ **Money Order:___** **Credit Card:___**

Credit Card: M/C___ **Visa____** **Amex___** **Discovery___**

Card No. _____ **Expiration Date: _____**

Approved By:_____
Army Representative.

APPENDIX C

ISRAELI ARMY INVOLVEMENT IN WATER AIR FILTER

May 6, 1997

To Mr. Avner Golan

RE: Preliminary test results on the water air filter

To whom it may concern

I would like to report to you on the preliminary test results that we conducted on the new water air filter that I received today.

A. The filter was tested by a company that preforms test on vehicles for the Israeli army. The test was done on an engine in a lab where the filter was connected to a vacuum cleaner that measures the amount of dust that goes through the filter. In that test we found that the filtration was to our expectation, and we received better dust filtration than the known filters in the market today.

B. Based on the above results the filter was given for further tests to the importer of 4x4 vehicles and dirt bikes of Kawasaki Japan, in Israel. This particular importer is working together in different areas with the Israeli army. At a preliminary test the filter was installed on a vehicle that works in a extreme dust and sand environment in a quarry and on unpaved roads. the results are better filtration than regular air filters that were clogged more often. At this time we don't have the final test results nor the fuel economy savings that we are receiving by using the new air filter. We will supply you with those results immediately after the test completion.

At this time the filter is meeting our expectation, therefore we decided to continue the test on open field and off road vehicles for civilian and army use.

Sincerely yours

Hagi Golan.
Office Manager

Translated by Avner Golan

APPENDIX D

TEST PLAN FOR WATER AIR FILTER

TEST PLAN FOR WATER AIR FILTER

I. WATER AIR FILTER DESCRIPTION

A. FITTING INSTRUCTIONS

1. MIGNOT FREE FLOW AIR FILTER, AIR COOLER, AIR DENSIFIER (FFCD)
2. MOUNTED IN ENGINE COMPARTMENT
3. FFCE IS CONNECTED TO THE ENGINE INLET MANIFOLD AS PER AIR FILTERS
4. SMALL TRUCKS- THE FFCD IS CHASSIE MOUNTED
5. WATER RESERVOIR IS MOUNTED WERE SUITABLE WITH A LEVEL AS NEAR FFCD AS POSSIBLE BUT NOT EXCEEDING 50 CM.
6. SUMMER/WINTER- ICY/COLD CONDITIONS REQUIRES ADDING 10 % OF AF402 (TYPE OF ANTI-FREEZE) TO THE WATER RESERVOIR.

B. CAPACITY

1. FFCD-1 FITS ENGINES USING UP TO 6000 LITERS OF AIR PER MINUTE (210 CUBIC FEET PER MINUTE). FOR ENGINES USING UP TO 5500 TO 9000 LITERS OF AIR PER MINUTE, 2 X FFCD SYSTEMS MUST BE USED. 9000 LITERS OF AIR PER MINUTE EQUALS 318 CUBIC FEET PER MINUTE.
2. FFCD FITS ALL PRIVATE, AGRICULTURAL AND INDUSTRIAL APPLICATIONS.

C. CLEANING

1. THE FFCD MUST BE CLEANED EVERY 1500 KILOMETERS OR MORE FREQUENTLY UNDER SEVERVE DUST CONDITIONS.
2. CLEAN BY REMOVING THE BOWL, CLEAN AND REPLACE (DRY). REMOVE WING-NUT AND SECONDARY FILTER ON TOP, CLEAN AND RE-GREASE, + 2 MM THICK, BY HAND OR BRUSH ON INSIDE SURFACE.

D. PREVIOUS TESTS

1. A FFCD-4 WAS TESTED BY CORNAGLIA RESEARCH CENTER (MANUFACTUERER IN COUNTRY OF ITALY)AT MAXIMUM OPERATIVE AIRFLOW OF 800 CUBIC METERS PER HOUR OR 470 CUBIC FEET PER MINUTE.
2. PRESSURE DROP AND TWO DUST CAPACITY TESTS/ACCUMULATIVE EFFICIENCY TESTS CONDUCTED AT 10 GRAMS/MINUTE AND 3 GRAMS PER MINUTE. THREE GRAMS/MINUTE FOR 265 MINUTES EQUALS ABOUT 800 GRAMS AND 10 GRAMS PER MINUTE FOR 60 MINUTES EQUALS 600 GRAMS.
3. PRESSURE DROP DIDN'T SHOW ANY APPRECIABLE VARIATION.
4. FILTRATION EFFICENCY CALCULATED TO 97.3 % AND 97.1 % FOR TWO TESTS.
5. TEST CONDITIONS FOR PRESSURE DROP AND DUST CAPACITY TESTS: TEMPERATURE 21 C , HUMIDITY 65 % AND ATMOSPHERIC PRESSURE 1002 MB.
6. TEST DUST SUPPLIED BY G.M. LABORATORY PREPARED BY AC SPARK PLUG DIVISION WITH FOLLOWING CHARACTERISTICS:

MICRONS	0-5	5-10	10-20	20-40	40-80	80-200
PERCENT	12± 2	12± 3	14± 3	23± 3	30± 3	9± 3

II TACOM TESTING PLAN GUIDE

A. BELIEVE SHOULD FOLLOW OIL BATH AIR CLEANER TEST PROCEDURES IN SAE J 726, WITH A REFERENCE OR GUIDANCE FROM A MILITARY OIL BATH SPEC.(SAY ONE USED FOR JEEP, IF IT CAN STILL BE FOUND).

B. WATER AIR FILTER INSTALLED LEVEL POSITION.

C. SET-UP FOR DUST FEED, PREFERRED METHOD CONE SHAPE DUST FEED (SEE ENCL 1 SHEET ON SPECIAL TEST SET-UPS PROVIDED TO AIRFLOW TEST TEAM FROM AIR MAZE). ALTERNATE METHODS: (1) CORNAGLIA RESEARCH CENTER TEST SET-UP (ENCL 2) AND (2) SY-KLONE PRE-CLEANER TEST SET-UP. NOTE: THE CORNAGLIA TEST SET-UP IS SIMILAR TO OIL BATH TEST PROCEDURE RECOMMENDED (ENCL. 4). ALL TEST SET-UPS REQUIRE EVEN DISTRIBUTION AND DELIVERY OF TEST DUST TO THE INLET OF UNIT. ALL TEST DUST IS FED TO UNIT UNDER TEST. IF DUST SETTLING OCCURS, THEN THE COMPRESSED AIR JET MAY BE USED TO RE-ENTRAIN THE TEST DUST.

D. A DUST INJECTOR TO SAE J 726 TEST METHODS AND PROCEDURES SHOULD BE USED.

E. TESTS INCLUDE: (1) RESTRICTION AND PRESSURE DROP TEST, (2) EFFICIENCY 30 MINUTES AND/OR 60 MINUTES, FINE TEST TEST, (3) FULL LIFE EFFICIENCY AND CAPACITY TEST AND (4) WATER CARRYOVER TEST(OPTIONAL)

III. RESTRICTION AND PRESSURE DROP TEST

A. FOLLOW GUIDELINES OF SAE J726 PARAGRAPH 3.3 AND 4.3 WITH FOLLOWING CHANGES:

1. PERFORM THE RESTRICTION/PRESSURE DROP TEST VERSUS AIRFLOW AT MORE THAN 100% RATED, ONLY AS LONG AS NO WATER CARRYOVER OCCURS. NOTE IF WATER CARRYOVER OCCURS AND IF SO AT WHAT AIRFLOW.
2. THE AIRFLOW SHALL BE MAINTAINED UNTIL THE PRESSURE DROP ACROSS THE AIR CLEANER HAS STABLIZED.
3. TEST RESTRICTION/PRESSURE DROP WITH AND WITHOUT DUST MANIFOLD FEED SYSTEM INSTALLED TO ASSURE IF ANY EXTRA RESTRICTION HAS OCCURED. NOTE ANY INCREASE IN RESTRICTION.
4. FOR COMPARISON PURPOSES CONDUCT ONE RESTRICTION/PRESSURE DROP TEST RUN WITHOUT WATER IN RESERVOIR TO DETERMINE ANDY CHANGE IN RESTRICTION.
5. DETERMINE (IF POSSIBLE) IF THERE IS AN INCREASE IN HUMIDITY IN WATER AIR FILTER IN OUTLET DUCT WITH WATER INSTALLED IN MANIFOLD AND COMPARED HUMIDITY READINDS WITH/WITHOUT WATER IN RESERVOIR.

IV EFFICIENCY TESTS

A. FOLLOW GUIDELINES FOR CONDUCTING EFFICIENCY TESTS WITH FOLLOWING CONCERNS

1. DO NOT FEED DUST BEYOND CAPACITY OF RESERVOIR CAPACITY. THIS WILL REQUIRE SEVERAL TRIAL RUNS TO DETERMINE THE AMONT OF DUST IT TAKES TO FILL THE RESERVOIR.IF WATER IS SEEN ESCAPING INTO TOP OF WATER AIR FILTER (EXAMINE TRAY AT TOP OF WATER AIR FILTER) THE MAXIMUM DUST CAPACITY OF RESERVOIR HAS BEEN REACHED. STOP AND CLEAN
2. RUN SUFFCIENT TRIAL RUNS TO SEE HOW MUCH DUST RESERVOIR CAN HOLD FOR 30 MINUTES (2-3 MINIMUM) AND RECORD AMOUNT OF TEST DUST. IF DUST FEED FOR 30 MINUTES DOES NOT EXCEED RESERVOIR CAPACITY SEE IF 60 MINUTES EFFICIENCY TEST WOULD OVER FILL RESERVOIR.ESTABLISH RESERVOIR CAPACITY.
3. USE PREVIOUS TESTING RESULTS TO PROVIDE A GUIDELINE.
4. USE SAE J 726 TEST METHODS/PROCEDURES WITH DUST INJECTOR, PTI FINE TEST DUST. CONDUCT EFFICIENCY TESTS AT 30 OR 60 MINUTES DEPENDING ON RESERVOIR CAPACITY, PREFER 60 MINUTES IF RESERVOIR CAPACITY IS BIG ENOUGH.
5. TO ASSIST IN DETERMINING CAPACITY OF DUST THAT RESERVOIR CAN HOLD, A RESERVOIR MADE UP OF CLEAR PLASTIC OR WINDOWS TO SEE THE INTERACTION OF

DUST AND WATER COULD BE CONSTRUCTED. THIS WOULD DETERMINE IN KNOWING IF PURE DUST, PURE WATER OR A COMBINATION OF WATER/DUST (MUD) IS FIRST TO EXIT TO EXIT THE RESERVOIR WHEN IT'S BECOMES FULL AND MUST BE CLEANED.

V. FULL LIFE EFFICIENCY AND CAPACITY TEST

A. FOLLOW GUIDELINES OF PREVIOUS FOREIGN MANUFACTURER TESTING WITH FOLLOWING CHANGES/CONCERNS.

1. USE EFFICIENCY TEST RESULTS FOR RESERVOIR CAPACITY.
2. USE PTI COARSE TEST DUST AND SAE J 726 TEST METHODS/PROCEDURES.
3. VEFIFY RESERVOIR CAPACITY IS SAME FOR PTI FINE TEST DUST AS FOR PTI COARSE TEST DSUT.
4. CONDUCT FULL LIFE EFFICIENCY FOR 1, 2 AND 3 RESERVOIR FILL-UP AND CLEANINGS. VERIFY EFFICIENCY IS REPEATABLE FOR A MINIMUM OF TWO SEPARATE RUNS AT 1 RESERVOIR FILL -UP. VEFIFY SAME EFFICIENCY NUMBERS (APPROXIMATE) FOR 2 AND 3 RESERVOIR FILL-UPS.

VI WATER CARRYOVER TEST

A. FOLLOW SAE J726 FOR OIL BATH TESTING

VII OTHER EFFORTS (IF NECESSARY)

A. CONSIDER TESTING TWO WATER AIR FILTERS SUCH AS WOULD HAVE TO BE USED IN AN HMMWV APPLICATION. THIS WILL BE CONSIDERED BASED ON SUCCESS OF TEST RESULTS FROM ONE INDIVIDUAL WATER AIR FILTER TEST DESCRIBED IN PARAGRAPHS I THROUGH VI.

B. IF DONE, CONSTRUCT MANIFOLD TO CONNECT TWO WATER AIR FILTER IN PARALLEL, CONSIDER HOW THIS MIGHT BE DONE BASED ON SPACE AVAILABILTY IN A HMMWV.

APPENDIX E

CORRESPONDENCE BETWEEN TACOM AND MIGNOT

Author: Larry Sierpien at AMSTAR2POST
Date: 9/10/98 8:07 AM
Priority: Normal
TO: Frank Margrif
Subject: Re: Mignot filter
---------- Forwarded ----------
Author: "Alan Macdonald" <alertjhb@icon.co.za> at INTERNET 9/10/98 1:59 PM
TO: Larry Sierpien at AMSTAR2POST
Subject: Re: Mignot filter

Hi Larry, Sorry for the delay on my side as well, I sent to complete new filter to Ido fischler in Clearwater this week with some other goods and he is going to forward to you. Let me know when you have received so we can move further, Regards Alan.
-----Original Message-----
From: Larry Sierpien <sierpiel@cc.tacom.army.mil>
To: Alan Macdonald <alertjhb@icon.co.za>
Cc: Ido Rabbi Fischler <sfischl1@tampabay.rr.com>; Frank Margrif <margriff@cc.tacom.army.mil>
Date: Wednesday, September 09, 1998 3:09 PM
Subject: Re: Mignot filter

> Greetings Alan...Sorry for the long response delay but I was waiting for
> the new Mignot filter to arrive and hopefully, have some news for you. As
> of today (9-9-98) we have not received delivery. Are we getting a complete
> assembly or new valve or both? I will keep you informed of any progress in
> this matter.
>_____ Reply Separator _____
>Subject: Mignot filter
>Author: "Alan Macdonald" <alertjhb@icon.co.za> at INTERNET
>Date: 8/12/98 7:00 PM
>
>
>Hi Larry, Nice chatting to you the other day, I am sending a new filter with an
>uprated valve to you via Ido Fischler this week and will get back to you with
>more info shortly, Regards Alan.
>

Author: Larry Sierpien at AMSTAR2POST
Date: 9/29/98 12:33 PM
Priority: Normal
TO: Frank Margrif
CC: Julian Kozowyk
Subject: Re:

---------- Forwarded ----------

Author: egfi us inc [SMTP:sfischl1@tampabay.rr.com] at TACOMWARREN 9/25/98 7:55 AM
TO: Larry Sierpien at AMSTAR2POST
Subject: Re:

dear larry
one filter should be here monday morning .
i will send it as soon as i get it and e mail you all the data needed
for you to trace it
best regards
ido fischler
-----Original Message-----
From: Sierpien, Larry <sierpiel@tacom.army.mil>
To: sfischl1@tampabay.rr.com <sfischl1@tampabay.rr.com>
Date: Friday, September 25, 1998 12:14 PM

> Hello Ido:
>
> I received mail from Allan Macdonald regarding shipment of the Mignot Air
> Filter. This was about two weeks ago and he tells me that two new model
> filters were on there way to you with a final destination of our test lab.
> here in Warren Michigan. If they were already or are about to be shipped,
> kindly let us know and we will be watching out for them.
>
> Thanks for your cooperation
>
> Larry Sierpien

Author: Larry Sierpien at AMSTAR2POST
Date: 11/10/98 7:37 AM
Priority: Normal
TO: Frank Margrif
CC: Mike Richard, Julian Kozowyk
Subject: Re: Mignot Water Air Filter
---------- Forwarded ----------
Author: "egfi us inc" [SMTP:sfischl1@tampabay.rr.com] at TACOMWARREN 11/10/98 12:06 AM
TO: Larry Sierpien at AMSTAR2POST
Subject: Re: Mignot Water Air Filter

dear Larry
please accept my apology for the delay on the filter we had some problems
on clearing customs here I hope to get it fast and send it to you
sincerely yours
ido fischler
-----Original Message-----
From: Sierpien, Larry <sierpiel@tacom.army.mil>
To: sfischl1@tampabay.rr.com <sfischl1@tampabay.rr.com>; Allen Macdonald
<alert.jhb@icon.co.za>; Margrif, Frank <margriff@tacom.army.mil>
Cc: Richard, Mike <richardm@tacom.army.mil>; Kozowyk, Julian
<kozowykj@tacom.army.mil>
Date: Monday, November 09, 1998 11:18 AM
Subject: Mignot Water Air Filter

>
> Gentlemen:
>
> We are all aware that the Mignot Freeflow Air Cooler, Air Densifier (FFCD)
> that was tested in our laboratory in Warren Michigan about three Months
ago
>
> was found to release a stream of water into our system when the air flow
> rose above 135 cfm's. Based on our communication, we are awaiting
delivery
>
> of a revised version of the Filter with a different check valve enabling
> mostely filtered air to be vacuumed through for dust efficiency testing.
>
>
> At this time, we have not received shippment of the test specimen and the
> head engineer (Mr. Frank Margrif) is considering termonating this test and
> prepairing a short test report.
>
>
> If, by any chance, the revised Filter is in the process of shipment within
> say Thirty (30) days or so kindly let us know and we will proceed
> accordingly.
>
>
> Sincerely,
>
> Larry Sierpien, Eng. Tech.

Author: Larry Sierpien at AMSTAR2POST
Date: 12/6/98 11:20 AM
Priority: Normal
TO: Frank Margrif, Julian Kozowyk
Subject: Re: Mignot Water Air Filter
---------- Forwarded ----------
Author: "egfi us inc" [SMTP:sfischl1@tampabay.rr.com] at TACOMWARREN 12/4/98 10:29 PM
TO: Larry Sierpien at AMSTAR2POST
Subject: Re: Mignot Water Air Filter

Dear Larry
thanks for your fast respond, please let me know if you need anything in
terms of technical support or any design or modification issues .
best regard and happy holidays
ido
-----Original Message-----
From: Sierpien, Larry <sierpiel@tacom.army.mil>
To: "egfi us inc" <sfischl1@tampabay.rr.com>
Date: Friday, December 04, 1998 11:01 AM
Subject: RE: Mignot Water Air Filter

> Hello again Ido:
>
> We received the new water air cleaner in fine condition and I just
finished
>
> taking pictures of the differences of the two configurations. In a short
> time I will connect it to our flow bench and put it through the test
> procedure. I will keep the project engineer and yourself informed of the
> results when the test is completed.
>
> Happy Holidays
>
> Larry

Margrif, Frank

From: Sierpien, Larry
Sent: Tuesday, February 02, 1999 10:42 AM
To: 'Allen Macdonald'; 'Ido Fischler'; Margrif, Frank
Cc: Kozowyk, Julian; Richard, Mike
Subject: TEST RESULTS

Gentlemen:

We have now completed leakage and restriction testing of the Mignot Freeflow Air Cooler, Air Densifier (FFCD) new configuration. No dust filtration tests have been ran.

1- Restriction comparison tests show about the same Delta "P" reading on both original design and new configuration.

ORGINAL DESIGN CFM. - RESTRICTION / H2O		NEW CONFIGURATION CFM. - RESTRICTION / CFM	
50	2.96"	50	3.00"
80	6.83"	80	6.77"
120	15.15"	120	15.1O"
200	43.30"	200	43.03"

2.- Water Blow-BY Tests showed a slight improvement on the new configuration compared to the original design model.

a - Original Design = System draws a steady stream of H2O above 135CFMs.

b - New Configuration = Steady stream above 145 CFMs.

Trickle above 142CFMs.

Safe Area below 141CFMs.

Sincerely,

Larry Sierpien, Eng. Tech.

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APPENDIX F