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UNITED STATES MARINE CORPS
Marine Corps Schools
Quantico, Virginia

46/4B/LLD:nfk
46-62-04

MAY 16 1963

From: Coordinator, Marine Corps Landing Force Development Activities,
Marine Corps Schools, Quantico, Virginia
To: Commandant of the Marine Corps

Subj: Test of A042 Engine in M274 Mechanical Mule, final report

Ref: (a) CMC Project Directive 46-62-04, A04H of 2 Oct 62 to CMCLFDA

Encl: (1) Test results of A042 engine, Project No. 46-62-04
(2) Distribution List

INTRODUCTION

a. Purpose

(1) To determine the suitability and functioning of a prototype model of the A042 engine installed in a CARRIER, LIGHT WEAPONS, INFANTRY, 1/2 TON, 4x4, M274, under the primary environmental and operating conditions that can be expected during amphibious operations. Further, to develop data which will enable designers to correct any deficiencies encountered.

(2) The test was for the purpose of evaluating the engine in the vehicle and not the vehicle itself.

(3) This report was initially required on 1 January 1963 by reference (a), however, the test item was not received until 13 March 1963; as a result, the report due date was extended to 7 May 1963.

2. BACKGROUND

The Truck, Platform, 1/2 Ton, 4x4, M274, was developed to meet requirements for the lightweight utility vehicle for front line use by combat troops. Numerous deficiencies in the present A053 engine have resulted in a program to modify the Corps of Engineer A042 military standard 10 HP stationary engine for automotive use in this vehicle. Certain external modifications have been made to meet the mounting, spatial, fording and slope operational requirements of the vehicle. The induction and ignition systems have been modified to match the engine performance characteristics to vehicle operational requirements. This modified engine package has been designated Model A042.

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3. PRELIMINARY DESCRIPTION

a. General. The A042 engine hereafter referred to as the test item is a 42 cubic inch displacement, 2-cylinder, 4 cycle, opposed, air cooled, spark ignited engine. The present M274 was modified to accept this engine by the installation of four blocks between the frame and bed, redesign of rear outriggers, installation of a dry type air cleaner, and a lower gear ratio which enables the obtainment of 25 MPH at an engine speed of 3600 RPM.

4. DISCUSSION

a. The test item was received on 13 March 1963. The vehicle was inspected, serviced, and loaded with a 1000 pound cargo consisting of boxes filled with crushed rock.

b. Initial operation of the vehicle presented no unusual problems. Oil analysis as requested by reference (a) were negative except after deep water fording tests which are discussed in subsequent paragraphs.

c. During the 2,500 miles of testing the following items required replacement:

- (1) Pulley, starter, sheave.
- (2) Coupling, impulse, magneto
- (3) Sparkplugs (one set of two plugs)

d. Operators of the test vehicle were impressed with its operation and power. The horsepower of the A042 engine is less than that of the A053 engine, however, the lower gear ratio in the power train and the torque characteristics of the test item compensates for the difference in horsepower.

e. Deficiencies noted during testing were:

(1) Oil filler tube and oil level indicator are not accessible when cargo is loaded over the engine access cover.

(2) Throttle linkage connectors are the "sleeve" type with set screws used to hold the cables. These set screws become loose and require frequent tightening.

(3) The starter assembly pulley sheave separated during a starting attempt and was removed. The external pulley was used throughout the remainder of the test.

(4) A bolt in the magneto impulse coupling vibrated loose,

damaging the magneto housing. A modified magneto from the A053 engine was used throughout the remainder of the test.

(5) Spark plugs required replacement at 300 hours operation. This was not considered unrealistic due to the type operation the engine was subjected to, e.g., twenty minutes idle, ten minutes stop, in each hour of operation. The vehicle was operated on a 24 hour, 7 day week schedule to meet the completion deadline date.

(6) Initially the crankcase filled with water while fording, although all normal precaution was taken, and meticulous maintenance performed prior to fording. Special waterproofing agents, which included Tempseal and Silastastic RTV-732 adhesive sealant were used around all areas where water might enter into the engine. The test item was again submerged in water for three 15 minute periods, with heavy oil dilution resulting from each test. Ignition and fuel systems performed satisfactorily in all water tests, as did the deep water fording kit.

(7) Due to the oil dilution after fording, extended operation after fording was not performed.

(8) Ease of maintenance and tool requirements are discussed in enclosure (1).

(9) Fuel consumption, operating in high range, third speed, on hard surface roads averaged 17 miles per gallon.

5. CONCLUSIONS

a. That the A042 test item engine, when suitably modified for deep water fording, will be satisfactory for use in the M274 Mechanical Mule.

b. That waterproofing by using units is not feasible due to the extensive preparation necessary to waterproof the engine prior to fording.

c. That an external recoil starter assembly would be preferable and easier to service.

d. Although reference (a) did not invite comments regarding cost evaluation, the following are considered worthy of consideration:

(1) Cost of special gears necessary in the power train when the A042 engine is used.

(2) Cost of factory waterproofing the A042 engine, since waterproofing by using units is not considered feasible.

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(3) Cost of modifying any components which failed during current tests, e. g. magneto coupling, recoil starter mechanism, etc.

6. RECOMMENDATION

That the A042 test item engine, when suitably modified for deep water fording, be considered satisfactory for use in the M274 Mechanical Mule, in temperate climate pending outcome of environmental testing.

L. W. WALT
DEPUTY COORDINATOR

DETAILS OF TEST

1. TEST NO. 1 -- PHYSICAL CHARACTERISTICS AND INITIAL INSPECTION

a. PURPOSE

(1) To determine and record the differences between the test and control vehicles.

(2) To assure that the engine and vehicle is in good mechanical condition.

b. METHOD

(1) Comparisons were made of size, weight, and engine accessibility.

(2) A technical inspection was performed, ignition output and engine vacuum measured. Idle RPM was adjusted to 800 RPM $\pm$ 15 RPM.

c. RESULTS

(1) Comparison of physical characteristics is listed below:

	<u>M274</u>	<u>w/A042</u>	<u>w/A053</u>
Horsepower		10	17
Weight		897 lbs.	900 lbs.
Width (overall)		49 in.	49 in.
Height (over platform)		28.5 in.	27.5 in.
Length (w/foot rest)		118 in.	118 in.
Road Speed (Max)		27 MPH	35 MPH
Payload (cross-country and Highway)		1000 lbs.	1000 lbs.
Cruising Range (Loaded)		136 miles	151 miles
Angle of Approach		40 degrees	40 degrees
Angle of Departure		35 degrees	34 degrees

(2) The test item was inspected and found in an "almost new" condition. Ignition (magneto) and engine vacuum were satisfactory.

(3) Engine accessibility with the cover removed is good, however, with the cover in place the bayonet oil gauge is difficult to remove and replace.

(4) Engine idle speed was set at 800 RPM $\pm$ 15 RPM.

2. TEST NO. 2 -- LUBRICATION AND SERVICING

a. PURPOSE

Establish fuel and lubricant capacities and requirements.

b. METHOD

. All power train components were drained and refilled using POL's obtained through the Marine Corps supply system.

c. RESULTS

- | | |
|--|---------|
| (1) Fuel tank capacity | 8 gal. |
| (2) Crankcase capacity | 4 pints |
| (3) Transmission and Transfer capacities | 2 pints |

3. TEST NO. 3 -- PRELIMINARY OPERATION AND BREAK-IN

a. PURPOSE

(1) Assure that the engine can be made available for immediate service without special preparation.

(2) To insure proper functioning of the engine and other components prior to service test.

b. METHOD

- (1) All components were cleaned of preservatives.
- (2) All components were inspected prior to starting the test item.

c. RESULTS

(1) The gasoline tank contained a preservative which was removed, all other components were cleaned.

(2) All components were in good order and functioning properly at the start of test.

4. TEST NO. 4 -- SERVICE AND LIMITED ENDURANCE TEST

a. PURPOSE

To determine serviceability, durability, maintenance requirements, and fuel consumption.

b. METHOD

(1) The test vehicle was operated for 2,500 miles composed of cycles of:

- (a) 30 minutes test course operation

(b) 20 minutes idling time

(c) 10 minutes of inoperative time

(2) After each 50 hours of engine operation an oil analysis was made.

(3) Periodically throughout the test the following specific checks were conducted:

(a) Negotiate a 5 per cent grade at 25 MPH while fully loaded.

(b) Negotiate a 60 per cent grade at 1 mile per hour while fully loaded.

(c) Start and operate on a 60 per cent grade.

c. RESULTS

(1) The test item was operated for 2,500 miles as specified by paragraph 4.b.(1) above.

(2) Oil analysis after each 50 hours of operation were negative.

(3) During the accumulation of 2,500 miles, the engine started easily (1-4 pulls).

(4) Specific performance checks revealed that:

(a) The test item will negotiate a 5 per cent grade at 25 MPH (3,600 RPM engine speed) with a 1000 pound payload.

(b) Negotiate a 60 per cent grade at 1 MPH with a 1000 pound payload.

(c) Start and operate on a 60 per cent fore and aft slope without difficulty; and side slopes of 40 per cent without stalling or misfiring. This was repeated satisfactorily with one pint of engine oil removed.

(d) The angle of approach is 40 degrees; angle of departure is 35 degrees. The front footrest must be removed for angles of approach in excess of 40 degrees.

(e) In low range, first gear, the vehicle will move at approximately 1 MPH. Oil pressure and engine temperature remain satisfactory.

(f) The test vehicle, without fording kit, will ford 18 inches of water. During testing the vehicle was successfully forded to a depth of 22 inches.

5. TEST NO. 5 -- MAINTAINABILITY OF ENGINE

a. PURPOSE

To evaluate ease of maintenance and cost of parts and supplies during tests.

b. METHOD

Necessary repairs were evaluated for time requirements, accessibility, special tool and MOS requirements.

c. RESULTS

(1) Repair and maintenance of the test item is very similar to the A053 engine. Engine removal required only one hour on the initial removal. All maintenance operations are relatively simple and can be performed in short periods of time.

(2) Using organizations will require 3/8 inch drive socket sets and torque wrenches will be required for proper maintenance to be performed (specified in paragraph 8. below).

(3) Training currently provided for maintaining the A053 engine is adequate for the test item. Special training will not be required.

6. TEST NO. 6 -- FORDABILITY

a. PURPOSE

To determine the effect of fording in salt water under service conditions on the test vehicle.

b. METHOD

The test item was prepared for fording and completely submersed in three 15 minute periods. Oil samples were taken after each submersion.

c. RESULTS

(1) First fording was conducted for 15 minutes. The engine ran and performed well. Immediately upon leaving the water the engine oil was checked and found to contain water; approximately 85 per cent dilution.

(2) Second fording was terminated after 13 minutes due to erratic engine operation. Again water was present in the engine oil; approximately 50 per cent dilution.

(3) The final (third) fording was 15 minutes in duration. The engine ran well and the induction, carburetion and ignition systems were obviously functioning properly. Oil analysis after fording revealed water; approximately 20 per cent.

7. TEST NO. 7 -- EXTENDED OPERATION AFTER FORDING

a. PURPOSE

To determine what failures, if any, might occur in the test item when operated after fording without benefit of decontamination or maintenance.

b. This test was not performed due to presence of water in the engine oil; and the certainty of damaging the engine if operation continued.

8. TEST NO. 8 -- OPERATIONAL MAINTENANCE IN RELATION TO AMPHIBIOUS OPERATIONS

a. PURPOSE

To determine the time and tool requirements to properly service the test item after submergence; and to install and remove the fording kit.

b. RESULTS

(1) Preparation for and after fording maintenance consists of an annual or 12,000 mile P.M. service.

(2) Installation time for the deep water fording kit requires 15-20 minutes per vehicle.

(3) Minimum additional special tools required for A042 engine.

(a) First and second echelon maintenance (organizational)

Wrench Set, socket, 3/8 in. sq. DV FSN 5120-449-8200

(b) 3d Echelone Maintenance

None, if equipped with Shop Set Automotive; if not,
Wrench Set, socket, 3/8 in. sq. DV FSN 5120-449-8200.

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(c) 4th Echelon Maintenance

Same as paragraph 2. above.

(d) 5th Echelon (depot) Maintenance

None

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