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RDT&E PROJECT NO. ______________

USATECOM PROJECT NO. 7-3-0239-09

INTEGRATED ENGINEERING AND SERVICE TEST OF EFFLUENT FUEL TESTER

FINAL REPORT

BY

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MARCH 1969

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U S ARMY
GENERAL EQUIPMENT TEST ACTIVITY
FORT LEE, VIRGINIA

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DEPARTMENT OF THE ARMY
HEADQUARTERS, U. S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005

AMSTE-GE

29 APR 1969

SUBJECT: Final Reports of Engineering and Service Tests of Effluent Fuel Tester, USATECOM Project Nos. 7-3-0239-07/09

Commanding General
U. S. Army Materiel Command
ATTN: AMCRD-JG
Washington, D. C. 20315

1. References.

a. Final Report of Integrated Engineering and Service Test of Fuel Tester, Effluent, RDT&E Project No. 1D643324D58810, USATECOM Project No. 7-3-0239-06 with USATECOM letter to AMC, 6 May 1968.

b. Final Report of Engineering Test (Desert) of Effluent Fuel Tester, Totamiter, 50 GPM and 400 GPM, USATECOM Project No. 7-3-0239-07, January 1969, YPG. (Inclosure 1)

c. Final Report of Integrated Engineering and Service Test of Effluent Fuel Tester, USATECOM Project No. 7-3-0239-09, March 1969, USAGETA. (Inclosure 2)

2. Approval Statement. Subject reports are approved.

3. Background of Test. The effluent fuel tester consists of a group of components which provide a means of monitoring the effluent fuel stream from a filter/separator to assure that fuel is not contaminated with water or solids. Testing was conducted on a 50 GPM size unit and a 400 GPM size unit at each test site.

a. An integrated engineering and service test (arctic winter) was conducted by the U. S. Army Arctic Test Center from 12 December 1967 to 24 March 1968. The results of this test were forwarded by reference 1a. In view of the results of the more extensive tests which are discussed herein, the USATECOM position concerning suitability for use in the arctic is hereby withdrawn.

b. An engineering test (desert) was conducted by Yuma Proving Ground from 27 May 1968 through 6 December 1968 (reference 1b).

c. An integrated engineering and service test (intermediate climate) was conducted by the U. S. Army General Equipment Test Activity from February 1968 through February 1969 (reference 1c).

4. Test Results.

a. The equipment, as tested, failed to meet essential requirements of the approved military characteristics as follows:

(1) The effluent tester was not sufficiently accurate in registering the presence of injurious amounts of contaminants as evidenced by a wide variance between meter readings and actual contamination (Tables 1 and 3 and graph 1, Appendix I, reference 1b).

(2) The tester failed to detect contaminants automatically and continuously as evidenced by two failures of the amplifier at high ambient temperatures (paragraph 2.4.4, reference 1b).

(3) The tester was not adequately resistant to rusting. The steel conduit between the photocell and the conduit box on both testers rusted (paragraph 2.4.4c, reference 1b).

(4) The tester failed to meet the criteria regarding operation in the desert environment as defined in AR 705-15, Change 1, as evidenced by two failures of the amplifier (paragraph 2.4.4a, reference 1b).

(5) The tester was not of one size. Two sizes (50 and 400 GPM capacities) were furnished; two sizes were necessary for detecting the wide range of flow rates.

(6) The tester was not sufficiently rugged as evidenced by chart recorder failures (paragraph 2.5.4d, reference 1c).

b. An analysis of the final reports reveals that seven deficiencies and six shortcomings remain.

(1) Deficiencies:

(a) The amplifier at an ambient temperature of 113°F would activate the contaminant warning bell and caused the fuel flow to be shut off even though there was no contaminant present in the test system (Appendix III, reference 1b).

(b) When the ambient temperature was higher than 105°F, the amplifier when activated by the contaminant simulator button being depressed would close the control but would not allow the control valve to reopen when the simulator button was released (Appendix III, reference 1b).

(c) Fuel leakage from the contaminant simulator button when it is depressed creates a safety hazard (paragraph 5a(1) below)).

(d) The amplifier contaminant meter readings were inaccurate (paragraph 5a(2) below)).

(e) The recorder door was not adequately sealed to prevent damage to the recorder when exposed to rain (paragraph 5a(3) below)).

(f) The draft technical manual was not clear or accurate (paragraph 5a(4) below)).

(g) The test item lacked the sensitivity required for detecting solid contaminants (paragraphs 2.4.2 and 2.4.5, reference 1c).

(2) Shortcomings:

(a) Repair parts and required special tools were not furnished with the test items (paragraph 2.2.4, reference 1c).

(b) A second power supply battery was required to permit uninterrupted operation during frequent required recharging (paragraphs 2.4.11 and 2.5.4, reference 1c).

(c) The dial indicator/chart recorder scale divisions are too large for accurate reading (paragraphs 1.4c(3) and 2.4.2.4, reference 1c)).

(d) Internal corrosion of the flow shut-off valve solenoid caused failure of the flow shut-off sytem (paragraph 2.6.3, reference 1c).

(e) The socket head cap screws on the lamp holder were inaccessible with available tools (cap screws should be compatible with the available hex-head wrench) (paragraph 2.6.3d, reference 1c).

(f) The chart recorder failed once on each of the testers. They were replaced by the developer and the cause of failure was not determined (paragraph 2.6.3e, reference 1c).

5. Comments.

a. The following problems reported in final reports, references 1b and 1c, have been reclassified as follows:

(1) Leakage of fuel from the contaminant simulator button was reported as a shortcoming (paragraph 2, Appendix III, reference 1b). Since leakage of fuel presents a potential safety hazard, it is reclassified as a deficiency.

(2) There was a wide variance between amplifier contaminant meter readings and actual contamination introduced for test purposes (paragraph 2.4.5, charts 1 and 3, Appendix I, reference 1b). This condition is reclassified as a deficiency because the meter indicated much higher contamination than the actual amount.

(3) The recorder door was not adequately sealed. Thus, rain could enter the recorder and cause it to become nonoperational. This is reclassified as a deficiency (paragraph 2.4.4b, reference 1b).

(4) The draft technical manual was not clear or accurate (paragraph 2.5.4, reference 1b and paragraphs 2.7, 2.9, 2.10 and 2.11, Appendix III, reference 1c). This is reclassified as a deficiency. Satisfactory maintenance could not be performed with the furnished manual.

(5) The test item was not of one size capacity as specified in the military characteristics and reported in paragraph 1.1, Appendix III, reference 1c. This is classified as neither a deficiency nor shortcoming since the concept of the two sizes did not adversely affect usage.

(6) Two shortcomings reported in paragraphs 2.1 and 2.2, Appendix III, reference 1c, relate to desired characteristics and are therefore not considered to be shortcomings because they do not adversely affect the performance of the item.

b. The demonstrated reliability of the test item under intermediate climatic conditions was at least 90 per cent at 90 per cent confidence level based on 532 test hours, a mission time of 15 hours and one failure. The reliability of the items tested to detect contamination accurately and stop flow is considered to be inadequate (paragraphs 2.4.2 and 2.4.5, reference 1c). Although reliability was not determined for desert conditions because of limited test time, reliability is considered to be unsatisfactory because of the amplifier failures encountered (Appendix III, reference 1b).

AMSTE-GE 29 APR 1969

SUBJECT: Final Reports of Engineering and Service Tests of Effluent Fuel Tester, USATECOM Project Nos. 7-3-0239-07/09

6. Conclusions.

a. The items, as tested, and the draft technical manual are unsuitable for Army use.

b. The maintainability of the effluent testers was unsatisfactory because of the inadequacies in the draft technical manuals as reported in paragraph 2.5.4, reference 1b and Appendix III, reference 1c. Maintainability should be adequate when the draft technical manuals have been corrected and improved as recommended herein.

7. Recommendations.

a. All deficiencies and as many as possible of the shortcomings identified in paragraphs 4b(1) and (2) above be corrected.

b. Two effluent testers (of each size) corrected as recommended herein be furnished to USATECOM for check test.

c. Corrected and improved maintenance packages be furnished for test concurrent with the check test.

FOR THE COMMANDER:

WILLIAM H. HUBBARD
Colonel, GS
Deputy Chief of Staff

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RDT&E PROJECT NO. ______________

USATECOM PROJECT NO. 7-3-0239-09

INTEGRATED ENGINEERING AND SERVICE TEST OF EFFLUENT FUEL TESTER

TEST REPORT

BY

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MARCH 1969

U. S. ARMY
GENERAL EQUIPMENT TEST ACTIVITY
FORT LEE, VIRGINIA

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U. S. ARMY GENERAL EQUIPMENT TEST ACTIVITY
FORT LEE, VIRGINIA

USATECOM 7-3-0239-09

Final Report of Integrated Engineering and Service Test of Effluent Fuel Tester

Conducted at Fort Lee, Virginia

March 1969

Abstract

An Integrated Engineering and Service Test of the Effluent Fuel Tester was conducted during the period February 1968 - February 1969 to determine the technical performance and safety characteristics of the test item as described in the Military Characteristics, and as indicated by the particular design; and to determine the suitability of the fuel tester and its maintenance package for use by the Army.

It was concluded that: the test item meets the requirements of the Military Characteristics with the exception of the deficiencies and shortcomings (Par. 1.4a and b); technical performance was satisfactory and sufficiently accurate to register the presence of all contaminants to which it was exposed with the exception of the siliceous test dust; the test item is adequately reliable; safety provisions and capability to perform safely are confirmed--(see additional precautions, Par. 2.9.3); and human factors considerations are satisfactory with minor exceptions (Pars. 1.4e and 2.7.3).

It is recommended that: the Effluent Fuel Tester be considered not suitable for use by the Army under limited intermediate climatic conditions ($+10^{\circ}$ to 100°F.) until the two deficiencies and as many as practicable of the shortcomings (App. III) have been corrected; draft technical manual be revised (Par. 1.6d and App. IV-D); a photocell and adapter with attached wires be issued; and repair parts listed in paragraph 1.6d be added to the prescribed load allowance.

FOREWORD

The U. S. Army General Equipment Test Activity was responsible for preparing the test plan, executing the test, and preparing the final test report.

The test was authorized by letter, AMSTE-GE, Headquarters, dated 30 [illegible]e 1965, subject, "Test Directive -- USATECOM Project No. 7-3-0239-06/07/08/09--Fuel Tester, Effluent."

TABLE OF CONTENTS

SECTION 1. INTRODUCTION

1.1 BACKGROUND

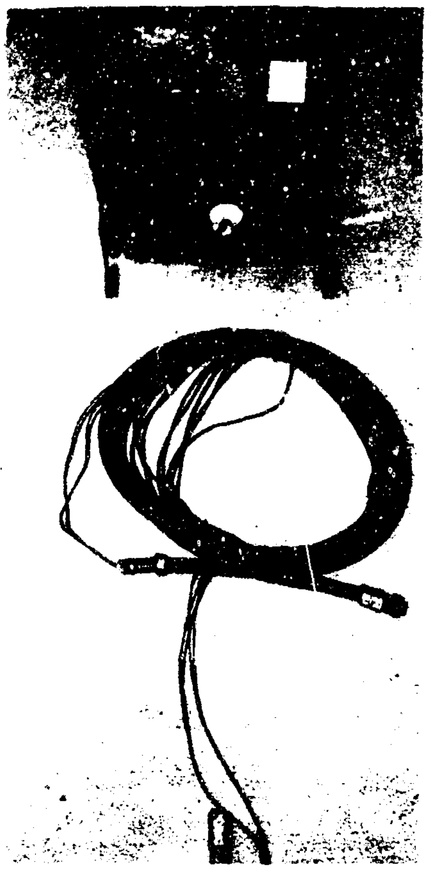
A need exists for monitoring the purity of fuel delivered into fuel tanks of aircraft, combat vehicles, and other equipment. The purity tolerance for aviation fuel is more stringent than for other fuels, and experience of the military services indicates that JP-4 and JP-5 fuels are more difficult to filter than other fuels. Therefore, equipment which will satisfactorily meet aviation requirements for these fuels will in all likelihood, meet the requirements for other fuels. No satisfactory equipment is available to detect harmful contaminants, liquid or solid, in a rapidly-moving fuel stream. The present tests described in Technical Bulletin QM-11-1, 27 December 1957, for determining water and sediment in the effluent fuel stream of filter/separators are too involved for use as a quick check in the field. Technical Bulletins prescribe the apparatus and equipment for testing, the characteristics and design features of which do not meet user requirements for an item of equipment suitable for monitoring the purity of fuel as it is dispensed under field conditions.

1.2 DESCRIPTION OF MATERIEL

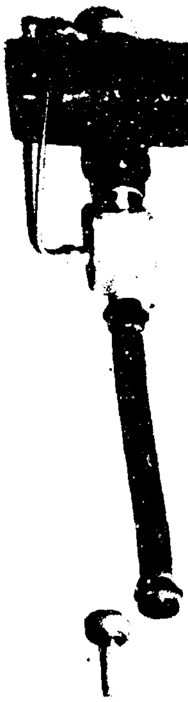
The effluent fuel tester is a group of components which will enable an operator in the field to instantaneously monitor the effluent fuel stream from a filter/separator for water or solid contaminants to insure that contaminated fuel is not issued to using units. The unit utilizes the scattered light principle, scanning the liquid at full flow rate. A light source and photocell arranged in a pickup head assembly detect the scattered light reflected from solid or immersible liquid particles of contamination. The signal produced is amplified for operation of a direct-reading chart recorder, for actuation of an alarm bell, and operation of solenoid valve to terminate the flow in the event contamination exceeds a certain pre-set level. The test item components located within the hazardous area (as defined by the National Fire Code) are fabricated in an explosion proof configuration (pickup head assembly and electrically actuated solenoid valve). The additional components (amplifier, chart recorder, alarm bell, and power supply battery) are located outside the hazardous area and are not explosion proof. Major components are shown in Figure 1.

1.3 TEST OBJECTIVES

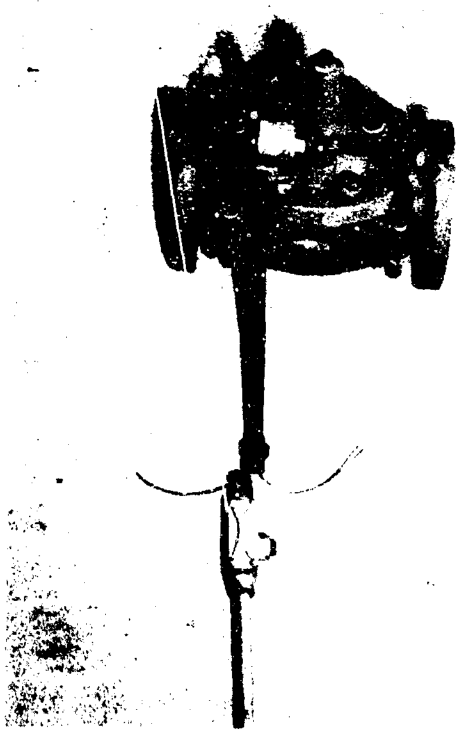
To determine the technical performance and safety characteristics of the Effluent Fuel Tester as described in the Military Characteristics, and as indicated by the particular design; and to determine the suitability of the item and its maintenance package for use by the Army.



Amplifier component with chart recorder and alarm bell.



Pickup head assembly.



Automatic shutoff valve.

Figure 1. Major components of effluent fuel tester.

1.4 SUMMARY OF RESULTS

a. The effluent fuel tester was found to meet all requirements of the Military Characteristics except for the following which were designated as deficiencies:

(1) The fuel tester was not of one size since a 2-inch pickup head assembly with 2-inch automatic shutoff valve and a 4-inch pickup head assembly with 4-inch automatic shutoff valve were furnished for test; however, due to the wide flow rate range of up to 400 gpm, two different sizes were found to be necessary with the 2-inch size being used from 0 to 100 gpm and the 4-inch for 100 to 400 gpm.

(2) The fuel tester did not meet the requirement for automatically and continuously detecting contamination particles as specified by the current military specifications for filter/separators since the sensitivity of the item was not sufficient to detect unacceptable amounts of siliceous test dust; however, detection of red iron oxide and water contaminants was satisfactory.

b. Other requirements of the Military Characteristics not met by the fuel tester, designated as shortcomings, were as follows:

(1) The fuel tester was not found to be capable of being used with a separate device to assist in the detection of unacceptable gum content as specified by applicable military specification; however, this requirement was judged to be unrealistic and not within the state of the art at the present.

(2) The test item did not include a visual warning device to permit operating personnel to determine whether filter coalescing elements of the filter/separator require replacement; however, an audible warning device was furnished and proved adequate during test operations.

c. Shortcomings detected during test operations included the following:

(1) The chart recorder furnished with the test item was found to be inadequate as it did not possess the required durability.

(2) A second power supply battery is required to allow uninterrupted operation during frequent recharging.

(3) A dial indicator with smaller scale divisions and with a total range of 0 to 20 ppm is needed to increase accuracy in reading. The dial

indicator presently furnished with a range of 0 to 100 ppm is not needed as critical contamination values are at the lower extremes, primarily below 10 ppm.

d. An AC-DC converter would greatly simplify fuel tester operations in a static installation where AC current is available.

e. A protective carrying case is needed to protect the amplifier, alarm bell, and chart recorder components from damage and to allow for much easier hand carrying.

f. Explosion-proof flexible conduit instead of the rigid conduit should be provided to reduce installation effort and simplify handling.

g. The test item experienced three unscheduled maintenance actions, one of which was classified as a failure. Maintenance instructions were considered inadequate and caused excessive time to troubleshoot the problems. Replacement of the solenoid, the recorder, and the adapter-photocell (as a "component") was easily accomplished. Daily maintenance is the only scheduled maintenance for the test item. Although the test item met reliability requirements, it did not meet maintainability requirements because of the inadequacy of the maintenance instructions, troubleshooting instructions, repair parts data, and special tool requirement.

h. Transportability tests were not conducted as the test items were not received individually packaged; however, due to the lightweight and small size of the test item it was judged to be capable of being transported by rail, ship, and aircraft with a minimum of disassembly or preparation and to be capable of being delivered in Phase II of airborne operations with a minimum of packaging and protective materials provided it is packaged as is normal to similar sensitive electronic equipment.

1.5 CONCLUSIONS

a. The effluent fuel tester meets the requirements of the Military Characteristics with the exception of the deficiencies and shortcomings shown in paragraph 1.4a and b and performs suitably under the intermediate climatic conditions ($+10^{\circ}$F. to 100°F.) to which it was exposed.

b. The technical performance of the fuel tester was satisfactory and found to be sufficiently accurate to register the presence of all contaminants to which it was exposed with the exception of the siliceous test dust.

c. The fuel tester is adequately reliable, and its maintainability, although presently inadequate, will be adequate when the troubleshooting instructions and repair parts data are improved and the lamp assembly fastener problem is corrected.

d. Safety provisions and capability of the test equipment to perform safely are confirmed, however, additional precautions are furnished in paragraph 2.9.3.

e. Human factors considerations of the test item are satisfactory with minor exceptions listed in paragraphs 1.4e and 2.7.3.

f. The item was designed with due consideration to value engineering aspects.

1.6 RECOMMENDATIONS

It is recommended that:

a. The Effluent Fuel Tester be considered not suitable for use by the Army under limited intermediate climatic conditions (+10°F. to 100°F.) until the two deficiencies and as many as practicable of the shortcomings (App. III) have been corrected.

b. The draft technical manual be revised to incorporate the changes in Appendix IV-D and to illustrate the test item as it will be issued, including troubleshooting instructions that will enable the organizational mechanic to locate malfunctions and their causes without excessive delay.

c. A photocell and adapter (EPR L7-6) with attached wires be issued as a component.

d. The following additional repair parts be added to the prescribed load allowance:

(1) 1 each Chart Recorder (14869) Model 88

(2) 8 each Rolls, Chart, Recording

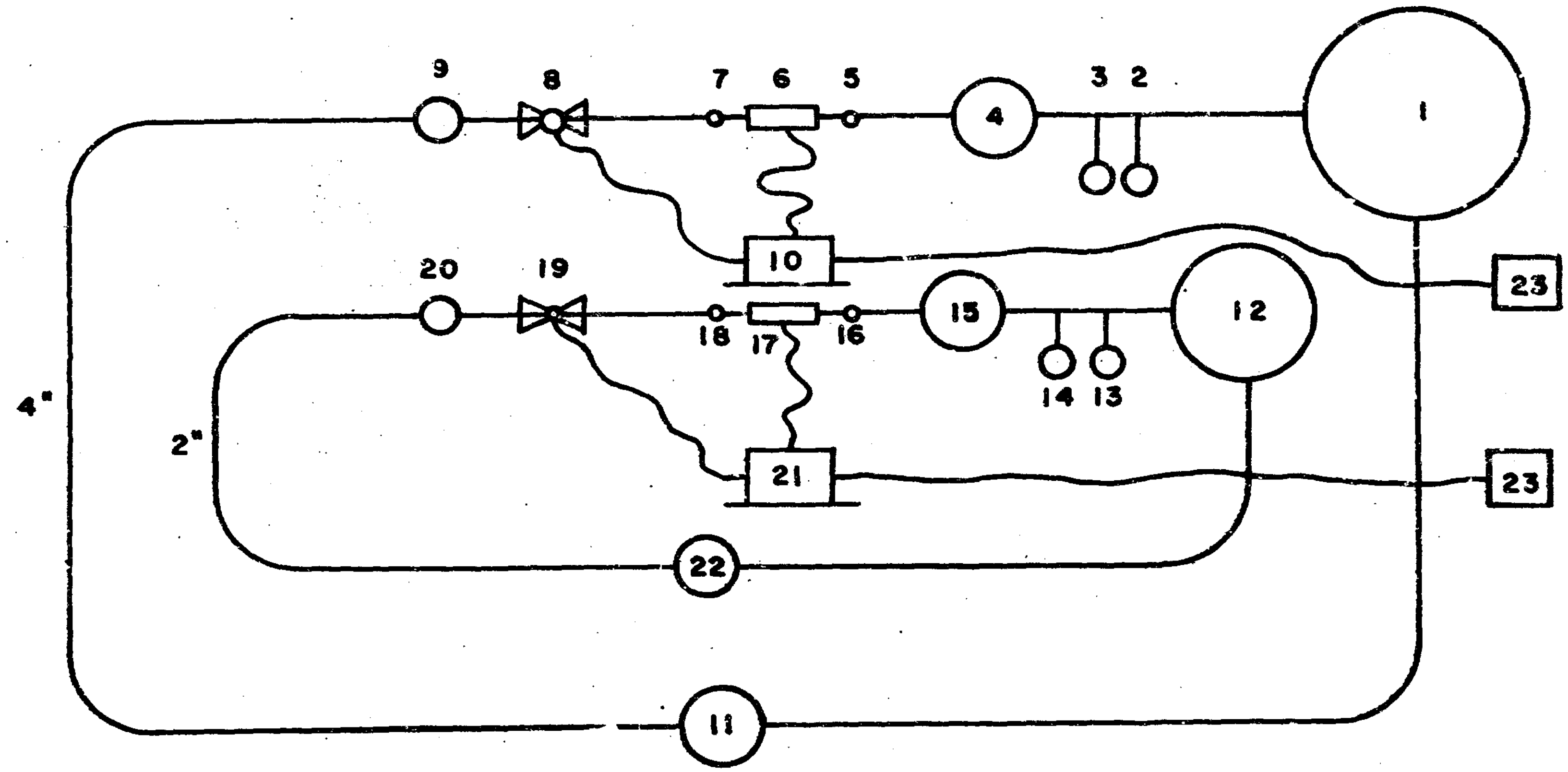
(3) 2 each Diaphrams for each control valve

SECTION 2. DETAILS OF TEST

2.1 INTRODUCTION

a. The engineering test was originally initiated by the U. S. Army General Equipment Test Activity (USAGETA), Fort Lee, Virginia, in September 1964 in accordance with the Plan of Test dated August 1964 under the Project No. 7-3-0239-02 of which the fuel tester was one of three such items tested. An engineering design test by USAGETA had been terminated prior to the initiation of the engineering test and was reported by letter report submitted in January 1965 (Ref. 1, App. V). Subsequently, an interim report (July 1965) on the engineering portion of the integrated engineering and service test (Ref. 2, App. V) recommended that the fuel tester be deleted from the test because it failed to meet the specifications of the National Fire Code for equipment operating in a Class I - Division I hazardous area. USATECOM suspended testing of this device and the items were returned to the developer for modifications. A separate test directive for the fuel tester was issued under USATECOM Project No. 7-3-0239-09 and testing on the fuel tester was suspended pending modification. Testing was continued on the other two fuel testers and a final report was submitted on Project No. 7-3-0239-02 in November 1965. Modified test items were again submitted to this activity in February 1968 and engineering tests subsequently resumed.

b. The engineering test was conducted by installing both capacity test items into closed-loop fuel systems of similar capacity as shown in Figure 2. This system conformed to MIL-F-8901B (Ref. 7, App. V) and utilized equipment which for the most part is standard to the military supply system. The test items were placed in series with a test fuel storage tank, water and solids injection equipment, pumping unit, influent and effluent sampling valves, and a cleanup filter separator. Maximum use was made of glass piping in the test system to allow an actual visual control on the test fuel during operations. Test system piping was arranged so that the fuel could be circulated until the required cleanliness levels of MIL-F-8901B were met, then contaminated at a controlled injection rate with water or solid contaminants, pumped through the test item, and then recleaned by the cleanup filter/separator prior to re-entering the fuel storage tank. The test item performance was evaluated by comparing the item's indicated and recorded fuel contamination levels with laboratory analysis of influent samples, and calculated fuel contamination levels determined from a measured total contaminant injection, length of injection period, and test system flow rate. Maximum use was made of laboratory controls and instrumentation, such as thermocouples and pressure gages.



4-Inch - 400 GPM System

1 - 1500-Gal. Fuel Storage Tank
2 - Water Injection Facility
3 - Solids Injection Facility
4 - 400-GPM Electric Pump
5 - Influent Sampling Device
6 - Fuel Tester Pickup Head
7 - Effluent Fuel Tester
8 - Fuel Tester Automatic Shutoff Valve
9 - 400-GPM Flow Meter
10 - Fuel Tester Amplifier, Alarm and Chart Recorder
11 - 350 GPM Cleanup Filter/Separator

2-Inch - 50 GPM System

12 - 600-Gal. Fuel Storage Tank
13 - Water Injection Facility
14 - Solids Injection Facility
15 - 100-GPM Pump
16 - Influent Sampling Device
17 - Fuel Tester Pickup Head
18 - Effluent Sampling Device
19 - Fuel Tester Automatic Shutoff Valve
20 - 100-GPM Flow Meter
21 - Fuel Tester Amplifier, Alarm and Chart Recorder
22 - Cleanup Filter/Separator
23 - Power Source Battery

Figure 2. Engineering test system layout for 2- and 4-inch effluent fuel testers.

c. Test fuels utilized in the tests consisted mainly of automotive combat gasoline (MOGAS) and JP-4; however, checks were also made with aviation gasoline (AVGAS-115/145), diesel fuel (DF-1), and combustion ignition turbine engine fuel (CITE). Laboratory analyses for total water were conducted by the Karl Fischer Method according to paragraph 4.6.7.4.2.1 of MIL-F-8901A and total solids analyses on fuel samples were conducted by the Millipore Method in accordance with paragraph 4.6.7.4k, MIL-F-8901A. Water fuel saturation curves were constructed for each batch of test fuel utilized during the test. Each Karl Fischer determination was compared with the saturation curve for the test fuel so as to determine the actual amount of free water in the sample above the allowed total saturation value for that specific temperature at which the sample was taken. Due to inconsistencies in values obtained from the Karl Fischer analysis, greater emphasis was placed on fuel contamination values obtained from direct calculations utilizing actual measurements.

d. In addition to formal engineering tests conducted, the item was used extensively to monitor the effluent fuel flow during engineering tests of various filter/separators.

e. The service test was conducted during the period 23 December 1968 through 28 February 1969. The test items were installed in a closed-loop fuel recirculating system at the U. S. Army General Equipment Test Activity Petroleum Equipment Test Facility. The items were operated and maintained by petroleum storage specialists (MOS 76 W). MOGAS was utilized as test fuel. Reliability of the items was ascertained based on 301 hours of operation on the 4-inch fuel tester and 231 hours on the 2-inch fuel tester.

f. Transportability characteristics were determined by results of a paper evaluation as well as actual transport over primary and secondary roads at Fort Lee, Virginia.

g. Human factors were observed throughout the test, and user personnel were questioned regarding ease of operating, handling, installation, and maintenance of the item.

h. Adequacy of the Draft Technical Manual (DTM 10-4930-207-12) was determined during operation and maintenance of the test item in accordance with prescribed instructions and performance of simulated maintenance actions which did not occur normally during tests.

i. Safety characteristics were determined and a list of recommended safety precautions developed.

2.2 INSPECTION (ES)

2.2.1 Objective

To determine the physical characteristics of the test items and to insure that they were in satisfactory operational condition prior to initiation of tests.

2.2.2 Method

A thorough inspection and inventory were made of the test items and components received. Any damages and mechanical deficiencies were recorded as well as serial number on each item. Items were weighed, photographed, and examined to insure that they were of the most practical, simple, and rugged construction.

2.2.3 Results

a. Two 50-gpm and two 400-gpm test items were received for tests. Each item was found to be in a complete and undamaged condition.

b. Each item was disassembled into its major components and the following weights and physical dimensions recorded:

TABLE I

COMPONENT WEIGHTS

Quantity	Item	Weight (lbs) per Item
2	2-inch Pickup Head (including couplings)	19
2	4-inch Pickup Head (including couplings)	23
2	2-inch control valve	15
2	4-inch control valve	55
2	Control and instrument panel (including amplifier, alarm bell, and recorder)	23
4	Cable	4
4	Conduit (50-feet)	22

c. The test items were received by 1/2-ton truck shipment in a crated condition. The shipping crate was fabricated from 1/4-inch plywood material and possessed the following dimensions:

Length - 32 inches
Width - 34 inches
Height - 60 inches

No repair parts or batteries were received with the test items; however, an adequate supply of repair components was on hand at this activity as a result of previous tests conducted on the item (Proj. No. 7-3-0239-02). A list of recommended repair parts and components to be furnished with the test item was determined later in the test and is indicated in paragraph 2.6.

d. The construction, materiel, and design characteristics of the items were examined by engineering and service test supervisory personnel and were judged to be simple, lightweight, compact, self contained, inexpensive, and portable when compared to conventional means of determining water and solids contamination.

e. The fuel tester was found to incorporate materials and provisions to provide maximum resistance to the detrimental effects of fungi, humidity, rain, snow, and extremes of dust and dirt, and to provide a warning device (audio) to alert operating personnel when fuel contamination reaches an unacceptable level; no visual warning device was included.

f. The test item was not found to be of one size though it was of the same type, it did not provide a visual warning device, and it did not have the capability of being used with a separate device to assist in the detection of unacceptable gum content.

g. Inspection of the items revealed no factors which could increase the vulnerability of the systems in which the fuel testers may be installed.

2.2.4 Analysis

a. The physical characteristics of the fuel tester were found to meet the requirements of the military characteristics with exception of the following:

(1) The item was not of one size, requiring a 2-inch pickup head and 2-inch solenoid valve for 50 gpm flow rates and a 4-inch pickup head and 4-inch solenoid valve for 400 gpm flow rates (essential).

(2) The item did not include a visual warning device to indicate excess levels of contamination (desired).

(3) The item did not have the capability of being used with a separate device to assist in the detection of unacceptable gum content (desired).

b. The pickup head assembly and solenoid valve designed into two separate sizes for 50 and 400 gpm flow rates were judged to be the most practical design due to the wide flow rate range. Test operations conducted showed that the audible alarm was adequate and that a visual alarm was not needed. The requirement to be capable of being used with a separate device to assist in the detection of unacceptable gum content was judged to be impracticable and not within the state of the art at this time.

2.3 PRELIMINARY OPERATIONS (ES)

2.3.1 Objectives

To insure that test personnel and users of the fuel tester were thoroughly and properly oriented in the use of the test item and that they were properly instructed in the method of installation, zeroing, calibration, operation, and maintenance.

2.3.2 Method

a. Each capacity fuel tester was installed and assembled as directed in the draft technical manual into the engineering test system of comparable capacity shown in Figure 2 utilizing MOGAS test fuel. On-the-job training of engineering test personnel was conducted. The test items were zeroed and calibrated as directed in the draft technical manual. Test fuel was circulated through each test item for an 8-hour period. Water contaminants at a rate of 0.01 percent of rated flow and solid contaminants at a rate of 0.016 pound per gallon of fuel flow were injected for a 2-minute period at the start of each 15-minute flow rate interval. The fuel tester's performance in indicating injected water and solid contaminants and terminating fuel flow when contaminant exceeded the alarm setting was observed during pumping operations.

b. User personnel were instructed as to the purpose of the effluent fuel testers, the method of installation of the items in the simulated test dispensing systems, and how to operate and maintain the items. Instruction consisted of 1 hour of lecture, demonstrations, and on-the-job training.

2.3.3 Results

a. With 1 hour of instruction and on-the-job training during fuel cycling operations, test personnel could adequately install and operate the fuel tester in a flow system.

b. In each instance when contaminants (water or solids) were injected, the fuel tester immediately detected their presence by indications of the dial indicator, chart recorder, and alarm bell. The automatic fuel shutoff valve terminated the fuel flow in each instance approximately 26 seconds after detection of the contaminant by the dial indicator. Due to the large volume of contaminants injected, the limits of the dial indicator were exceeded during each injection causing the indicator and chart recorder to "peg."

2.3.4 Analysis

Personnel can be trained within 1 hour to operate and maintain the effluent fuel tester. Personnel with MOS 76W20 require no additional training and can adequately operate and maintain the test item with only brief on-the-job training.

2.4 TECHNICAL PERFORMANCE (ET)

The following tests were conducted to determine the technical performance of the effluent fuel tester.

2.4.1 Red Iron Oxide Injection Test With MOGAS Test Fuel.

2.4.1.1 Objective. To determine the ability and accuracy of the fuel tester to indicate the presence of various concentrations of red iron oxide contaminants in MOGAS test fuel.

2.4.1.2 Method. Red iron oxide contaminants ranging from 0.5 mg/l to 11.0 mg/l were injected in various predetermined concentrations into the influent flow stream of MOGAS test fuel. The indications of the fuel tester as recorded on the chart recorder were compared with calculated values based on known actual injections to determine the accuracy of the test item. Twenty injections of red iron oxide were conducted.

2.4.1.3 Results. The fuel tester was found to consistently indicate the presence of iron oxide contaminants with concentrations as low as 0.5 mg/l. Precise accuracy could not be determined due to difference in units between the contaminants injected (mg/l) and the readout of the fuel tester (ppm). Relationships between the different units were established allowing a general indication of accuracy which was judged to be adequate for field determinations.

2.4.1.4 Analysis. Concentrations (mg/l) of iron oxide injected were plotted and superimposed on a chart of contaminant indications (ppm) by the fuel tester. Due to the difference in units, the charts did not coincide, however, an obvious linear relationship existed as shown in Appendix I-A. An injection of 0.5 mg/l was found to yield a fuel tester indication of approximately 10 ppm. Since 0.5 mg/l is the maximum allowable solid content for fuel allowed by Specification MIL-F-8901B, the item was judged to be capable of indicating unacceptable levels of contamination with iron oxide dust.

2.4.2 Siliceous Test Dust Injection Test with MOGAS Test Fuel.

2.4.2.1 Objective. To determine the ability and accuracy of the fuel tester to indicate the presence of various concentrations of siliceous test dust contaminants in MOGAS test fuel.

2.4.2.2 Method. Siliceous test dust contaminants (meeting the specification of MIL-F-8901B) ranging from 2.0 mg/l to 30.0 mg/l were injected in various predetermined concentrations into a MOGAS flow stream on the influent side of the test item. The indications of the fuel tester as recorded on the chart recorder were compared with known actual injections to determine the accuracy of the test item. Twenty injections with siliceous test dust were conducted.

2.4.2.3 Results. The fuel tester was found to consistently indicate the presence of siliceous test dust contaminants in the flowstream during each instance of injection except for concentrations below 20 mg/l. As with iron oxide contaminants, the precise accuracy was not determined due to the difference in units; however, a definite relationship between the different units was established. The item lacked sufficient sensitivity to detect siliceous test dust contaminants to the level required by specification MIL-F-8901B (0.5 mg/l).

2.4.2.4 Analysis. Concentrations (mg/l) of siliceous test dust injected were plotted and superimposed on a chart of contaminant indications (ppm) by the fuel tester. The charts did not coincide due to the difference in units, however, definite linear relationship existed (App. I-B) as with iron oxide dust. The minimum concentration of siliceous test dust detectable was 2.0 mg/l which yielded a readout of approximately 1 ppm on the fuel tester. Fuel tester values below 1 ppm can not be read from the dial indicator or chart recorder as graduations are in 2 ppm.

2.4.3 Water Injection Test with MOGAS Test Fuel.

2.4.3.1 Objective. To determine the ability and accuracy of the fuel tester to indicate the presence of various concentrations of water contaminants.

2.4.3.2 Method. Predetermined volumes of water contaminants were injected into the influent fuel stream. Injection concentrations ranged from 16 to 84 ppm. The indicated contamination values recorded by the chart recorder were plotted on a curve for comparison with the actual concentration as calculated in ppm from the actual volume injected. Twenty injections were performed.

2.4.3.3 Results. The fuel tester was found to consistently indicate the presence of minute concentrations of water contaminants in the flow stream with a sensitivity sufficient to detect unacceptable fuel exceeding Specification allowables.

2.4.3.4 Analysis

a. Contamination values indicated by the fuel tester were consistently lower than the calculated values determined from the actual volume injected. Indicated values when plotted on a curve and compared with calculated values almost directly paralleled calculated values however, they were lower by a factor of one-half as shown in Appendix I-C.

b. Due to limitations of the test injection system, the lowest concentration of water contaminants obtainable by injection were 16 ppm which yielded a fuel tester indication of 8 ppm. It therefore appears that any indication by the dial indicator or chart recorder above 2 to 3 ppm readings when properly zeroed would indicate contaminants in excess of the 5 ppm free water allowed by Specification MIL-F-8901B.

c. Since all critical contamination values are on the lower end of the scale, a dial indicator and chart recorder are needed with much smaller dimensions and a much shorter range, approximately 0 to 20 ppm. This would allow the test item indications to be read with much better precision.

2.4.4 <u>Red Iron Oxide Injection Test with JP-4 Test Fuel.</u>

2.4.4.1 Objective. To determine the ability and accuracy of the fuel tester to detect iron oxide contaminants in JP-4 test fuel.

2.4.4.2 Method. The test item was zeroed with JP-4 test fuel as directed in the draft technical manual and subjected to predetermined concentration of red iron oxide ranging from 0.10 mg/l to 5.0 mg/l contaminant injections in the same manner as indicated in paragraph 2.4.1.2. Twenty injections of red iron oxide were conducted.

2.4.4.3 Results. The fuel tester was found to be capable of consistently indicating the injected contaminants of red iron oxide in a JP-4 flow stream with concentrations as low as 0.5 mg/l. Precise accuracy could not be determined due to the difference in units between the contaminants injected (mg/l) and the readout of the fuel tester (ppm). Relationships between the different units were established allowing a general indication of accuracy which was judged to be adequate for field determinations.

2.4.4.4 Analysis. Concentrations of red iron oxide injected were plotted and superimposed on a chart of contaminant indications (ppm) by the fuel tester. Due to the difference in units, the charts did not exactly coincide, however, an obvious linear relationship existed as shown in Appendix I-D in which the two curves almost directly paralleled each other. An injection of 0.1 mg/l yielded a fuel tester readout increase of 1 ppm. Analysis of the curve in Appendix I-D showed an overall equivalency of 1 mg/l red iron oxide contaminant in JP-4 test fuel equaling a readout of 10 ppm -- throughout the entire subtest.

2.4.5 <u>Siliceous Test Dust Injection Test with JP-4 Test Fuel.</u>

2.4.5.1 Objective. To determine the ability and accuracy of the fuel tester to indicate the presence of various concentrations of siliceous test dust contaminants in JP-4 test fuel.

2.4.5.2 Method. Siliceous test dust contaminants (meeting the specification of MIL-F-8901B) were injected in various predetermined concentrations ranging from 5 mg/l to 250 mg/l into the JP-4 flow stream on the influent side of the test item. The indications of the fuel tester as recorded on the chart recorder were compared with known actual injections to determine the accuracy of the test item. Twenty injections with siliceous test dust were conducted.

2.4.5.3 Results. The fuel tester was found to consistently indicate the presence of siliceous test dust contaminants in the flow steam during each instance of injection except below 5.0 mg/l. As with iron oxide the precise accuracy was not determined due to the difference in units, however, a definite relationship between the different units was established. The item lacked sufficient sensitivity to detect siliceous test dust contaminants to the level required by the specification MIL-F-8901B (0.5 mg/l).

2.4.5.4 Analysis. Concentrations (mg/l) of siliceous test dust injected were plotted and superimposed on a chart of contaminant indications (ppm) by the fuel tester. The charts did not coincide due to a difference in units, however, a definite linear relationship existed (App. I-E), as with iron oxide though not as regularly as with MOGAS test fuel. Differing from siliceous test dust injections with MOGAS test fuel which showed an almost direct equivalency of 1 mg/l injection equaling 1 ppm fuel tester indication, siliceous test dust injections with JP-4 test fuel showed test item sensitivity to siliceous test dust in a JP-4 environment to have greatly decreased. An injection of 5.0 mg/l resulted in a fuel tester indication of slightly less than 1 ppm. Appendix I-E shows that large quantities of siliceous test dust contaminants were required to yield fuel tester indications with the tester indicating a value which was approximately one-third in ppm of the actual injected concentration in mg/l.

2.4.6 <u>Water Injection Test with JP-4 Test Fuel.</u>

2.4.6.1 Objective. To determine the ability and accuracy of the fuel tester to indicate the presence of various concentrations of water contaminants.

2.4.6.2 Method. Predetermined volumes of water contaminants were injected into the influent flow stream. Injection concentrations ranged from 14 to 160 ppm. The indicated contamination values were plotted on a curve for comparison with the actual concentration as calculated in ppm from the actual volume injected. Twenty injections were performed.

2.4.6.3 Results. The fuel tester was found to consistently indicate the presence of minute concentrations of water contaminants in the flow stream with a sensitivity sufficient to detect unacceptable fuel exceeding specification allowables.

2.4.6.4 Analysis

a. Contamination values indicated by the fuel tester were consistently lower than the calculated values determined from the actual volume injected. Indicated values when plotted on a curve and compared with calculated values almost directly paralleled calculated values, however, they were consistently lower by a factor of one-half to one-third as shown in Appendix I-F.

b. Due to limitations of the test injection system the lowest concentration of water contaminants obtainable by injection during the test was 14 ppm which yielded a fuel tester indication of 7 ppm. Judging by this relationship which was essentially constant for injections conducted, a fuel tester indication of 2 to 3 ppm would indicate contaminants exceeding the specification allowed by MIL-F-8901B (5.0 ppm).

2.4.7 Automatic Shutoff Valve Reaction Time Test.

2.4.7.1 Objective. To determine the capability and time required for the fuel tester to terminate fuel flow upon detection of an unacceptable amount of contamination.

2.4.7.2 Method. Utilizing the 4-inch 400-gpm fuel tester, the alarm set was positioned at 20 ppm so that the alarm would activate when the simulator button was depressed. Upon depression of the simulator button, the lapsed time was measured between activation of the alarm until the fuel flow was terminated as determined by observing a flow meter.

2.4.7.3 Results. The fuel tester was found to be capable of completely terminating fuel flow upon detection of a contamination level in excess of the alarm set adjustment, however, a time lapse averaging 26 seconds occurred.

2.4.7.4 Analysis. Lapsed time determinations required for the shutoff valve to terminate fuel flow upon detection of unacceptable contaminants ranged from 26 to 27 seconds at an operating pressure of 32 psi at the rated flow of 400 gpm. Due to the time lapse of 26 seconds required before the fuel flow is completely terminated, it would be necessary to locate the shutoff valve at a distance downstream from the detector head, calculated from the flow velocity, to prevent contaminated fuel from passing the shutoff valve.

2.4.8 Power Supply Evaluation.

2.4.8.1 Objective. To determine if a decrease in strength of the power supply battery results in a subsequent decrease in accuracy.

2.4.8.2 Method. Utilizing a fully charged battery, the fuel tester was subjected to continuous operation. At periodic 30-minute intervals, the simulator button was depressed to simulate contamination and a check made of the battery strength with a DC voltmeter.

2.4.8.3 Results. A decrease in battery strength to the point where a need for recharge was signaled caused no resultant decrease in test item accuracy.

2.4.8.4 Analysis. After 15 hours of operation, battery strength decreased to 11 volts causing the alarm bell to sound and signaling the need for a recharge. The readout indication gave the same reading in ppm upon depression of the simulator button as it did at the start of the test.

2.4.9 Automatic Shutoff Valve Operational Evaluation.

2.4.9.1 Objective. To determine the capability and reliability of the shutoff valve to effectively terminate fuel flow in the presence of repeated injections of unacceptable contaminants.

2.4.9.2 Method. The 400-gpm test item was subjected to fifty water injections and fifty solids injections of 30 ppm and 30 mg/l respectively with the alarm adjustment control set at 10 ppm. A rated flow of 400 gpm at 30 psi was maintained during the test.

2.4.9.3 Results. The shutoff valve successfully and reliably terminated fuel flow for 100 repetitions without failure when the fuel tester was exposed to unacceptable contaminant injection.

2.4.9.4 Analysis. In each instance, fuel flow termination was complete though an average of 26 seconds was required for the valve to activate after the contaminated fuel was detected by the fuel tester.

2.4.10 Performance with Various Fuels.

2.4.10.1 Objective. To determine the relative difference in performance of the fuel tester when exposed to various petroleum fuels.

2.4.10.2 Method. The fuel tester was zeroed with jet fuel (JP-4) in a static condition. When depressed, the simulator button yielded a value of 50 ppm. The item was then exposed under static conditions to diesel fuel (DF-1), combustion ignition turbine engine fuel (CITE), motor gasoline (MOGAS), and aviation gasoline (AVGAS), and the zero reading and reading with the simulator button depressed were recorded.

2.4.10.3 Results. Values obtained with the different fuels showed that fuel coloration definitely affects readout, making it imperative that the item be rezeroed whenever fuel types are changed.

2.4.10.4 Analysis. After being zeroed with JP-4, the fuel tester yielded the following values when exposed to the indicated fuels:

Fuel	Zero Reading ppm	Simulator Button Depressed ppm
JP-4	0	50
DF-1	4	60
CITE	8	61
MOGAS	10	55
AVGAS	10	40

2.4.11 Performance Monitoring of Effluent Fuel Stream from Test Filter Separator

2.4.11.1 Objective. To determine the performance of the test item when installed on the effluent flow stream from a test filter/separator during Specification MIL-F-8901B injection tests.

2.4.11.2 Method

a. The 4-inch and the 2-inch effluent fuel testers were installed on the effluent side of a 350-and 100-gpm test filter separator respectively and used to monitor flow during the series of contaminant injection tests described in Specification MIL-F-8901B.

b. Each item was utilized for a total of 250 hours with flow rates, pressures, fuel temperatures, fuel tester indications, and laboratory analyses for solids and water being periodically recorded.

2.4.11.3 Results

a. The fuel tester was found to be very useful in monitoring the performance of the filter/separator being tested as it provided an instantaneous indication when contaminants were passed even though it did not differentiate between water or solid contamination. The item also furnished a permanent chart recording of contamination and shut off the flow stream automatically at the desired alarm set position.

b. It became evident that an additional power source battery was needed to maintain operation on an 8-hour per day basis.

c. It was also found that a AC-DC converter would greatly simplify fuel tester operations in the field where AC current is available.

d. Repeated problems experienced with the chart recorder evidenced the need for a more durable chart recorder to withstand field handling.

e. It was found that a protective carrying case is needed to protest the amplifier, alarm bell, and chart recorder components from damage and to allow for easy hand carrying.

2.4.11.4 Analysis

a. During the tests of the filter/separator, frequent problems were encountered with faulty filter/coalescer elements. The effluent fuel tester proved extremely useful in detecting these failures long before a failure was made evident by visual means or laboratory analysis. Subject failures characteristically occurred with an initial very slight increase of approximately 2 ppm which was immediately detected by the fuel tester. As the failure worsened the effluent contamination increased, being verified by laboratory analysis which required several hours, and finally by visual means. In each instance the filter/coalescer elements were removed, examined, and found to have ruptured end caps which had allowed contamination to pass. Without the fuel tester, this failure would probably have gone undetected until it increased to a point where it could be detected by visual means.

b. When operated on a continuous 8-hour per day basis it was found that the power supply battery required a recharge after 1 to 2 days operation. This need for recharge was signaled by a continuous ringing of the alarm bell. Since several hours are required for a battery recharge, the fuel tester cannot be operated. A second battery is therefore needed to allow continuous operation.

c. It also became evident that if an AC-DC converter had been provided with the fuel tester, the AC current available in the area could have been utilized eliminating the need for batteries and greatly simplifying the operation. In most non-mobile type installations in the field, AC current is available, and for mobile type installation batteries will be required.

d. Frequent problems with the chart recorder furnished with the test items were experienced requiring frequent replacement. The chart recorder was very delicate and sensitive to handling. A more durable component to withstand field handling is required.

e. Test operations showed the amplifier component, with alarm bell and chart recorder to be very bulky, difficult to handle, and subject to damage as presently mounted on the plywood frame. These three components should be mounted in a lightweight protective carrying case.

2.5 OPERATIONAL PERFORMANCE (ST)

2.5.1 Objective

To determine through normal operations by users in standard POL distribution and dispensing systems, the capability of the test items to reliably and accurately detect and register the presence of harmful contaminants; and to determine the capability of the test items to be easily and readily installed on or attached to standard or proposed POL distribution and dispensing systems.

2.5.2 Method

a. The fuel testers (2- and 4-inch) were initially installed and operated in a closed-loop fuel recirculating system at the USAGETA Petroleum Equipment Test Facility, Fort Lee, Virginia. Operations consisted of circulating MOGAS through the fuel testers which were utilized on the effluent side of a 600-gpm filter/separator. Contaminated conditions were simulated hourly by depressing the simulator button on the 2-inch and 4-inch pickup heads.

b. The test items were subsequently taken to the Petroleum Training Area, U. S. Army Quartermaster Petroleum School, Fort Lee, where students installed them in a fuel system supply point after being instructed in installation and operation procedures.

c. The 2- and 4-inch items were then attached to 1,200- and 5,000-gallon tankers respectively. Operations consisted of driving the tankers over a specified distance and then cycling fuel through the fuel testers.

d. Observations were made regarding the durability, maintainability, and reliability of the test items as well as the capability of the test items to be easily and readily installed and committed to use, including time and men involved. The compatibility of the test items with associated equipment was observed and evaluated. The ability of user personnel to operate the items efficiently was recorded and assessed.

2.5.3 Results

a. Operations on the test items (2- and 4-inch) were similiar. The 4-inch fuel tester was operated for 301 hours in the closed loop recirculating system. During this time, contaminants were simulated 396 times and fuel flow was terminated each time without failure. The battery utilized as the energy source for the item was replaced and recharged 17 times or roughly after every 17 hours of operation. The 2-inch item was operated for 231 hours during which time contaminants were simulated 324 times. The item failed to terminate fuel flow 2 times out of the 324 times contaminants were simulated. The battery utilized with the 2-inch item was replaced and recharged 12 times or roughly after every 19 hours of operation.

b. The fuel testers were installed, operated, and maintained by petroleum storage specialists (MOS 76W). One hour of instruction, including demonstrations and on-the-job training, was required for the operator personnel to effectively utilize the test items.

c. Time required to install the 2-inch item on a 1, 200-gallon tanker was approximately 15 minutes (Figure 3). The time required to install the 4-inch fuel tester in a 5, 000-gallon tanker was one-half hour. The tanker trucks with the installed fuel testers were driven a specified distance of 1.4 miles over rough roads and terrain a total of 20 times. At the end of each run, contaminated conditions were simulated three times while fuel was being cycled. Both items functioned properly each time contaminants were simulated.

d. The following failures occurred during service test operations at Fort Lee:

(1) The recorder utilized with the 2-inch fuel tester malfunctioned after 231 hours (Ref. EPR L7 [illegible]). A similiar malfunction of the recorder utilized with the 4-inch item also occurred.

(2) After 301 hours of testing, the 4-inch fuel tester could not be correctly zeroed due to a short in the system and the deteriorated accuracy of the photocell (Ref. EPR L7-5).

(3) After 136 hours of operation, the 2-inch item failed to shut down fuel flow when contaminated conditions were simulated due to a failure of the solenoid which activates the shutoff valve.

2.5.4 Analysis

a. The continuous operation of the test items and the resulting necessity that the batteries utilized as the energy source must be recharged dictates the need for two batteries to be supplied with each fuel tester rather than the one which is now supplied. Availability of a battery charger is also necessary so that continuous operation of the fuel testers can be assured. The test items should also be equipped with an AC-DC converter so that other available sources of electricity could be utilized in lieu of the batteries.

b. Installation and maintenance of the fuel testers were easily accomplished although extensive manual changes are necessary to facilitate these operations. The test items were easy to handle, move, assemble, and disassemble. Handling and movement of the fuel testers could be enhanced by replacing the rigid cable conduit with an explosion-proof flexible cable which could be rolled up into a more compact configuration. Operator personnel were able to understand the operation of the items and no additional skills or specialized training requirements for MOS qualified personnel were generated.

Figure 3. 2-inch fuel tester installed on a 1,200-gallon tanker truck.

c. The installation of the test items on the tank trucks was relatively easy to accomplish. The shutoff valve was not utilized in these operations due to the distance between the pickup head and the valve that is required to compensate for the rate of flow and the time lag that exists between the detection of contaminants and the activation and complete closing of the shutoff valve. Modifications to the tankers and/or the fuel testers would be necessary to make the use of the fuel testers on the trucks entirely adequate.

d. The chart recorders furnished with the test items were exceptionally sensitive and not sufficiently rugged to withstand field service conditions. The other components were adequate and displayed a high degree of compatibility with each other and with associated equipment, although some modifications are necessary when used with tanker trucks as stated.

2.6 MAINTAINABILITY AND RELIABILITY EVALUATION (ST)

2.6.1 Objective

To determine whether the test item meets maintainability and reliability requirements for the service intended.

2.6.2 Method

a. One 2-inch 50-gpm and one 4-inch 400-gpm fuel tester was used and maintained under service type test conditions in a TOE environment at Fort Lee. The test items operated 24 hours per day until 532 hours were accumulated.

b. The test items were technically inspected before and after the service test.

c. Accumulated records of unscheduled and simulated maintenance and repair parts usage and service life data were summarized and evaluated. (Scheduled maintenance, direct support, and general support maintenance were not prescribed or required because of the nature of the test item) Computations were made to determine maintainability and reliability indicators as required by USATECOM Regulation 750-15. Tables II and III show the definitions and equations used to compute those indicators.

d. The unscheduled and simulated maintenance actions were performed by 63K40 and 76W20 MOS personnel from USAGETA, utilizing the basic issue items and common tools of the general mechanics tool set and organizational No. 2 common tool set, FSN 4910-754-0650.

TABLE II

MAINTAINABILITY, RELIABILITY, AND AVAILABILITY SYMBOLS

The symbols listed below will be used as variables in the computations in Table III.

$R_L(x; 1-\alpha)$	= The lower confidence limit on reliability
$\chi^2_{1-\alpha,\, 2r+2}$	= Chi-square value for a confidence level of 100 $(1-\alpha)$ % and $2r+2$ degrees of freedom
x	= Mission time
$1-\alpha$	= Confidence coefficient
MTBF	= Mean time between failures
MDT	= Mean downtime
MTTR	= Mean time to repair (failures)
$\bar{M}$	= Mean active maintenance downtime
MTBM	= Mean time between maintenance
MR	= Maintenance ratio
A_i	= Inherent Availability
A_a	= Achieved Availability
A_o	= Operational Availability
b	= Operating time (hours, miles, etc.)
c	= Active maintenance man-hours (scheduled and unscheduled)
d	= Active maintenance clock hours (scheduled and unscheduled)
f	= Unscheduled active maintenance clock hours
g	= Downtime in hours (include active and inactive maintenance time for both scheduled and unscheduled maintenance actions)
r	= Number of failures
s	= Number of maintenance layovers (include both scheduled and unscheduled maintenance actions)
p	= Active maintenance man-hours to correct failures
q	= Active maintenance clock hours to correct failures

TABLE III

MAINTAINABILITY, RELIABILITY, AND AVAILABILITY COMPUTATIONS

	2-inch	4-inch	SAMPLE
Mission Time (x) =	15	15	15
Confidence Level ($1-\alpha$) =	0.90	0.90	0.90
No. of Failures (r) =	0	1	1
Operating Time (b) =	231.0	301.0	532.0
Maintenance Man-hours (c) =	0.6	8.1	8.7
Maintenance Clock hours (d) =	0.6	10.1	10.7
Unscheduled Maintenance Clock hours (f) =	0.6	10.1	10.7
Downtime (g) =	0.6	10.1	10.7
No. of Maintenance Layovers (s) =	2	2	4
Maintenance Man-hours (p) =	0	8.0	8.0
Maintenance Clock hours (q) =	0	10.0	10.0
COMPUTATIONS:			
MDT = (g/s) =	0.3	5.05	2.67
MTBF = (b/r) =	*	301	532
$\overline{M}$ = (d/s) =	0.3	5.05	2.67
MTTR (man-hours) = (p/r) =	*	8.0	8.0
MTTR (clock hours) = (q/r) =	*	10.0	10.0
MTBM = (b/s) =	115.5	150.5	133.0
MR = (c/b) =	0.0025	0.0269	0.0163
A_i = (MTBF/(MTBF+MTTR (clock hours))) =	1.000	0.9678	0.9815
A_a = (MTBM/(MTBM+$\overline{M}$)) =	0.9974	0.9675	0.9803
A_o = (MTBM/(MTBM+MDT)) =	0.9974	0.9675	0.9803

RELIABILITY; $R_L(x,\ 1-\alpha) = \exp\left(-\frac{x\chi^2_{1-\alpha,\ 2r+2}}{2b}\right)$ = 90 percent

*Indeterminable due to division by zero.

e. Draft Technical Manual 10-4930-207-12 furnished with the test item was used by operators and organizational maintenance personnel for all maintenance actions and was evaluated for completeness, accuracy, simplicity, and clarity.

2.6.3 Results

a. Prior to beginning the service test, the maintenance test package (App. IV-C) was verified and the test items were technically inspected and repaired as necessary to return them to a satisfactory condition.

b. Daily maintenance, consisting of cleaning and visual inspections for leaks and loose wiring connections, required approximately 0.1 hour each operating shift. Slight leakage occurred at the inlet and outlet threads of the pickup heads, and temporary repair was made with a sealing compound. Daily maintenance time is not included in maintenance and reliability computations.

c. The solenoid-operated "three-way valve" malfunctioned (EPR L7-1) at 136 test hours and was replaced (App. IV-B).

d. The zero test and adjustment of the indicating meter could not be accomplished as indicated in DTM 10-4930-207-12 because the instructions did not apply to the configuration of the item tested (EPR L7-3) and because a special tool, a short angle hexagon wrench for socket head capscrews ("Allen wrench") was not provided (EPR L7-2). Improvised methods were used to remove the screws from the lamp holder assembly, and the adjustments were accomplished (App. IV-B).

e. The chart recorder (Par. No. 14869, Model 88) malfunctioned on each test item (EPR L7-4), and they were replaced (App. IV-B).

f. Simulated maintenance performed at 301 hours on the 4-inch fuel tester revealed it could not be calibrated. All major components were replaced in an effort to isolate the cause. Short circuits and a defective photocell were finally diagnosed as the causes of the malfunction. The photocell and the window assembly were replaced, the bare wires in the adapter and tube assembly were repaired, and the item was calibrated satisfactorily (EPR L7-5).

g. Removal of the photocell during simulated maintenance revealed changes in the configuration when compared with Figure D-1, Page D-21 of the Technical Manual; and the instructions in Figure 3-1, Page 3-4a were inadequate (EPR L7-6). The component could not be replaced without possible damage.

h. Maintainability of the fuel tester is considered inadequate (Par. 2.5 through 2.11 of App. III) based on a comparison of the test results with the criteria stated in paragraph 2.2b of the test plan.

i. The test item met the reliability requirements (Tables II and III; and App. IV-A).

j. One special tool was required to remove the lamp holder assembly as stated in paragraph d. A hexagon wrench did not fit in the space allowed for the removal and installation of the socket head capscrews, and improvised tools were used to remove the capscrews.

k. Repair parts used in the conduct of the test are shown in Appendix IV-B. These parts were obtained by substitution from like-type items available to the test team. Many parts were not assigned part numbers (EPR L7-7) in the technical manual.

l. DTM 10-4930-207-12 was inadequate for troubleshooting the test item and for replacing the photocell (EPR L7-7).

2.6.4 Analysis

a. The maintenance test package is considered inadequate because DTM 10-4930-207-12 does not contain up-to-date illustrations, parts data, and satisfactory instructions (EPR L7-7). The inspection and service upon receipt were satisfactory.

b. Daily maintenance is not excessive and is simple and adequate. The leakage at the inlet and outlets of the pickup head is attributed to quality control of the threads on the pickup head. The 3/4-inch taper per foot normally associated with pipethreads may not be precise due to manufacturing methods (lathe cut versus die cut).

c. Malfunction of the solenoid-operated 3-way valve (EPR L7-1) is classified as a shortcoming because the mission could be completed with the operator manually closing the proper valve upon signal from the alarm which indicates contaminated fuel. Troubleshooting instructions to identify the above malfunction are inadequate, and instructions developed during the test were submitted on DA Form 1598. Cause of the malfunction is attributed to internal corrosion of the solenoid piston. The corrosion was observed during disassembly and inspection of the solenoid, and it was probably due to storage for 4 years after initial use.

d. Instructions pertaining to the present test item configuration were requested from the developing agency; and recommendations were submitted concerning the use of hexagon head capscrews (Item 26, Figure D-1 of the technical manual) instead of the socket head capscrews, or the inclusion of a special short angle hexagon wrench. Improvised methods used to remove the lamp holder assembly are not satisfactory.

e. The fuel tester recorder is a very sensitive component and appears to be a high mortality item. Repair of the item is programmed at organizational level. Mechanics with MOS 63K40 were unable to repair the item, and it is recommended that it be repaired at general support or depot level.

f. The malfunction of the photocell is classified a failure because the fuel tester could not be accurately calibrated and would operate below an acceptable level for reliable monitoring of contamination. Cause of malfunction is attributed to a defective photocell and a short circuit.

g. Photocell removal problems resulted from a design change and inadequate maintenance instructions. The present photocell configuration unites the photocell and the adapter into a single component which should be replaced as a component (EPR L7-6).

h. Maintainability of the fuel tester is considered inadequate because the technical manual instructions, illustrations, and parts data are not satisfactory for field use until updated to correspond to the item to be issued.

i. The test item indicated 90-percent reliability at a 90-percent lower confidence level. This was based on 532 test hours, a 15-hour mission duration, and one failure.

j. A special tool will not be required to remove the lamp holder assembly if hexagon head capscrews are used in the component as illustrated (Item 26, Figure D-1, Page D-21, DTM 10-4930-207-12).

k. The repair parts used indicate a high degree of interchangeability with older items. The following additional repair parts are recommended for the prescribed load allowance:

1 each	Chart Recorder (14869) Model 88
8 each	Rolls, Chart, Recording
2 each	Diaphrams for individual size control valves

1. DTM 10-4930-207-12 requires major revision and updating to permit satisfactory performance of all authorized maintenance.

2.7 HUMAN FACTORS EVALUATION (ES)

2.7.1 Objective

To observe the effectiveness of the man-item relationship during operational use and to assess the degree of ease, simplicity, and effort in operating, installing, and servicing the items in normal use.

2.7.2 Method

Throughout all testing, observations were made and recorded concerning the degree of design simplicity inherent in the test items relative to users' ability to easily and readily handle, install, operate, and maintain the items.

2.7.3 Results

a. Observations of test teams revealed no factors that caused any difficulty in the ability of operators to install and maintain the test items although extensive changes in and additions to the Draft Technical Manual are required to facilitate these operations.

b. Transportation and handling of the test items were easily accomplished due to their relative light weight and compactness, with exception of the amplifier component, alarm bell, and chart recorder which should be mounted in a protective carrying case as indicated in paragraph 2.4.11.3e due to its bulkiness and sensitivity to damage as presently mounted.

c. The test items are easy to operate, assemble, and disassemble, requiring not more than 1 hour of orientation and training for the operators to be able to utilize them in a safe and sufficient manner.

2.7.4 Analysis

The man-item relationship is effective with regard to user personnel, however, a protective carrying case is needed for the amplifier, alarm bell, and chart recorder components for easier hand carrying.

2.8 VALUE ANALYSIS (ES)

2.8.1 Objective

To determine if the test items have any unnecessary, costly, or nice-to-have features which might be eliminated or redesigned to reduce cost.

2.8.2 Method

Throughout the conduct of the test, observations were made and users were questioned concerning features which could be eliminated or modified without compromising the performance, reliability, durability, or safety of the test items.

2.8.3 Results

Based on observations by engineering and service test teams and questions of users, the test items have no unnecessary, costly, or nice-to-have features.

2.8.4 Analysis

The test items are adequate with regard to cost awareness in design and manufacture.

2.9 SAFETY EVALUATION (ES)

2.9.1 Objective

To determine and confirm the safety characteristics of the test item.

2.9.2 Method

During the engineering test period, observations were made for detecting any condition which might present a safety hazard, to determine the cause, and to note steps taken to alleviate the hazard encountered. A safety release was issued as a result of engineering tests in accordance with USATECOM Regulation 386-6 prior to initiation of service tests. Service tests adhered to safety procedures developed during the engineering test phase and embodied in the safety release. Confirmation of the safety characteristics was in accordance with USATECOM Regulation 385-7.

2.9.3 Results

During testing, it was determined that the following precautions should be taken to enhance the safety of the test item.

a. Pressure test the pickup heads of the fuel testers to 125 psi before installation to insure that they are leakproof and glass lenses are completely sealed.

b. Position the amplifier alarm assembly outside the hazardous area at least 25 feet from the pickup head and in an area having good vapor drainage away from the amplifier and battery since these components are not explosion proof.

c. Position the power supply battery an additional 25 feet from the amplifier component, or a minimum of 50 feet from the pickup head, also well away from vapor drainage.

d. Utilize sparkproof tools when working with the items.

e. Insure all explosion-proof conduit connections are completely sealed.

f. Insure that power supply is off whenever connecting or disconnecting any of the components in the hazardous areas.

g. Insure that the pickup head assembly has metal-to-metal contact for bonding with the pipeline in which it is installed.

2.9.4 Analysis

The fuel testers are capable of being operated without hazard to operator personnel provided that the recommended precautions listed in paragraph 2.9.3 as well as other normal safety procedures for operating similar POL equipment are observed. The draft technical manual should emphasize safety procedures.

SECTION 3. APPENDICES

APPENDIX I - TEST DATA

A MOGAS Red Iron Oxide Injections
B MOGAS Siliceous Test Dust
C MOGAS Water Injections
D JP-4 Red Iron Oxide Injections
E JP-4 Siliceous Test Dust Injections
F JP-4 Water Injections

APPENDIX II - FINDINGS

APPENDIX III - DEFICIENCIES AND SHORTCOMINGS

APPENDIX IV - MAINTENANCE EVALUATIONS

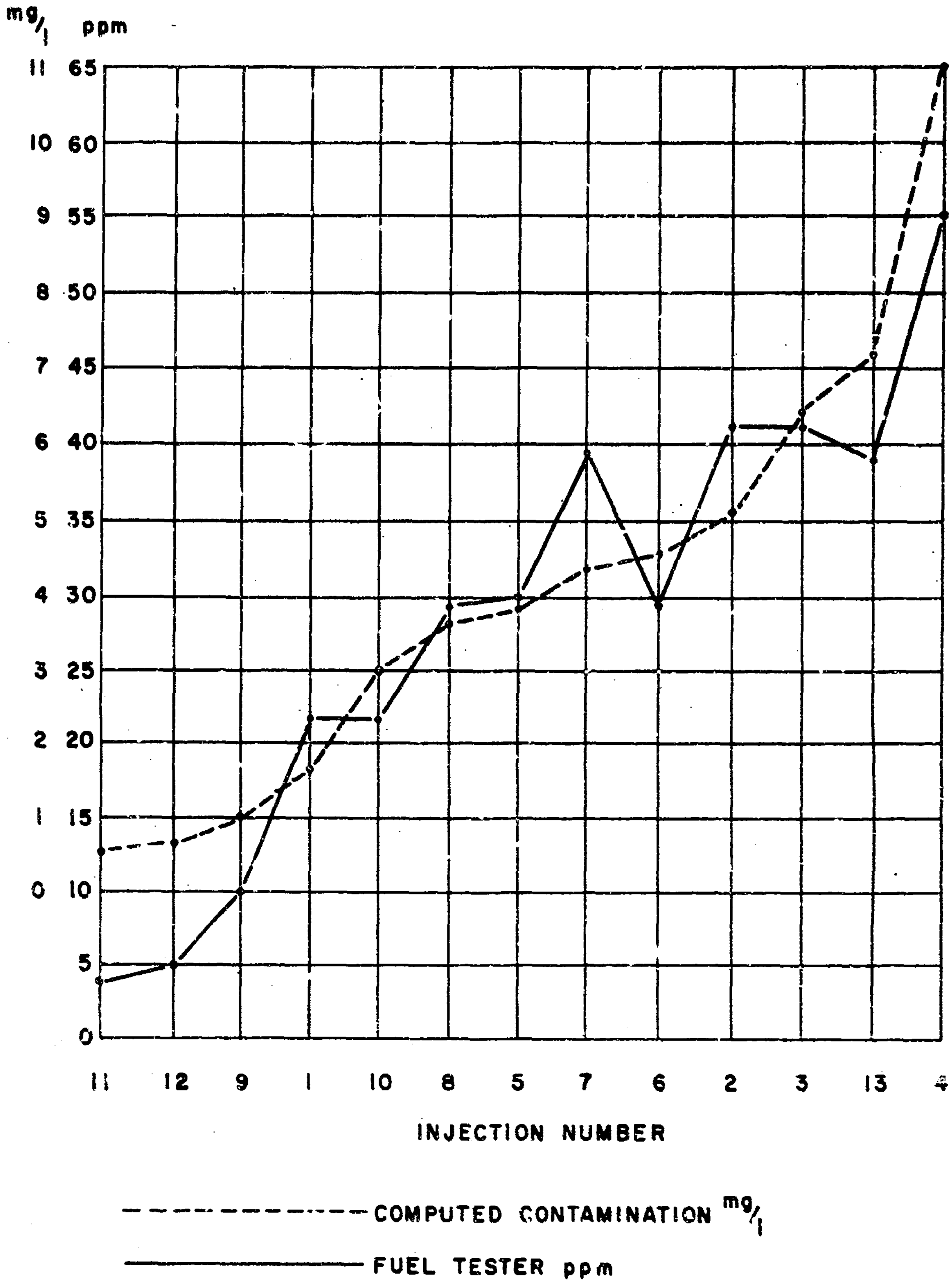
A Maintenance and Reliability Analysis Chart
B Parts Analysis Chart
C Maintenance Package Literature Chart
D Recommended Changes to Draft Technical Manual

APPENDIX V - REFERENCES

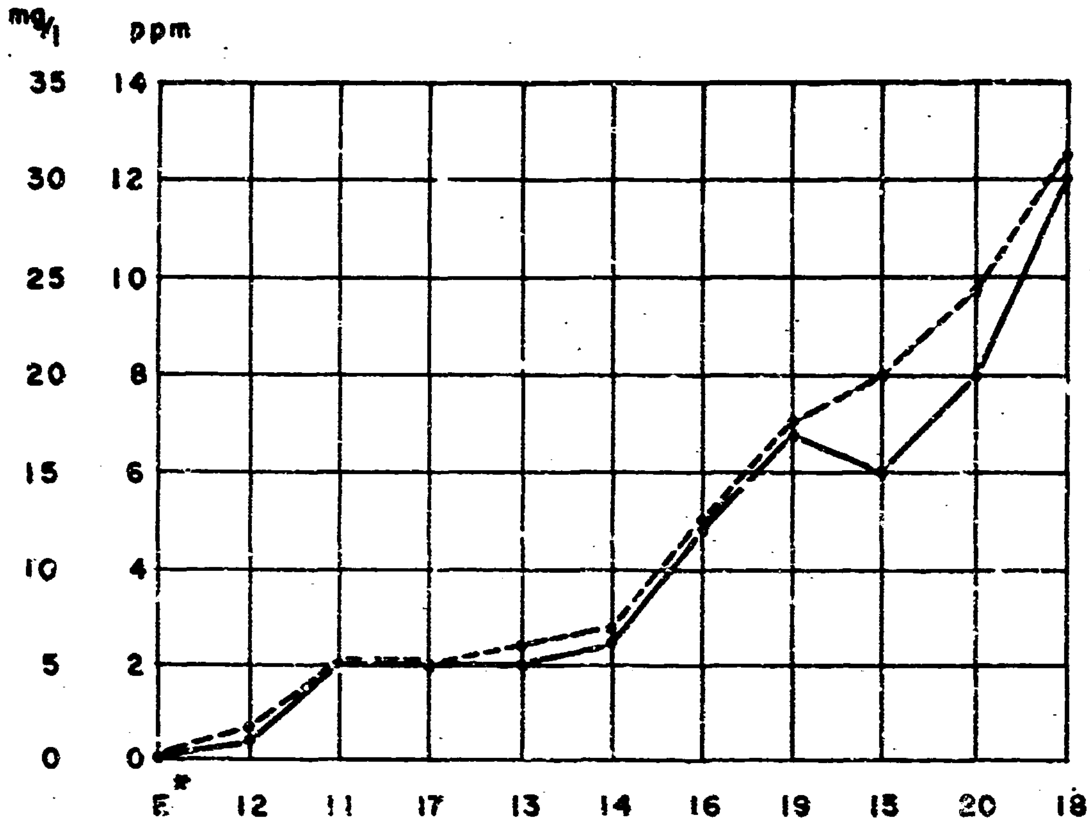
APPENDIX VI - DISTRIBUTION LIST

APPENDIX I-A

MOGAS-RED IRON OXIDE INJECTIONS



MOGAS—SILICEOUS TEST DUST INJECTIONS

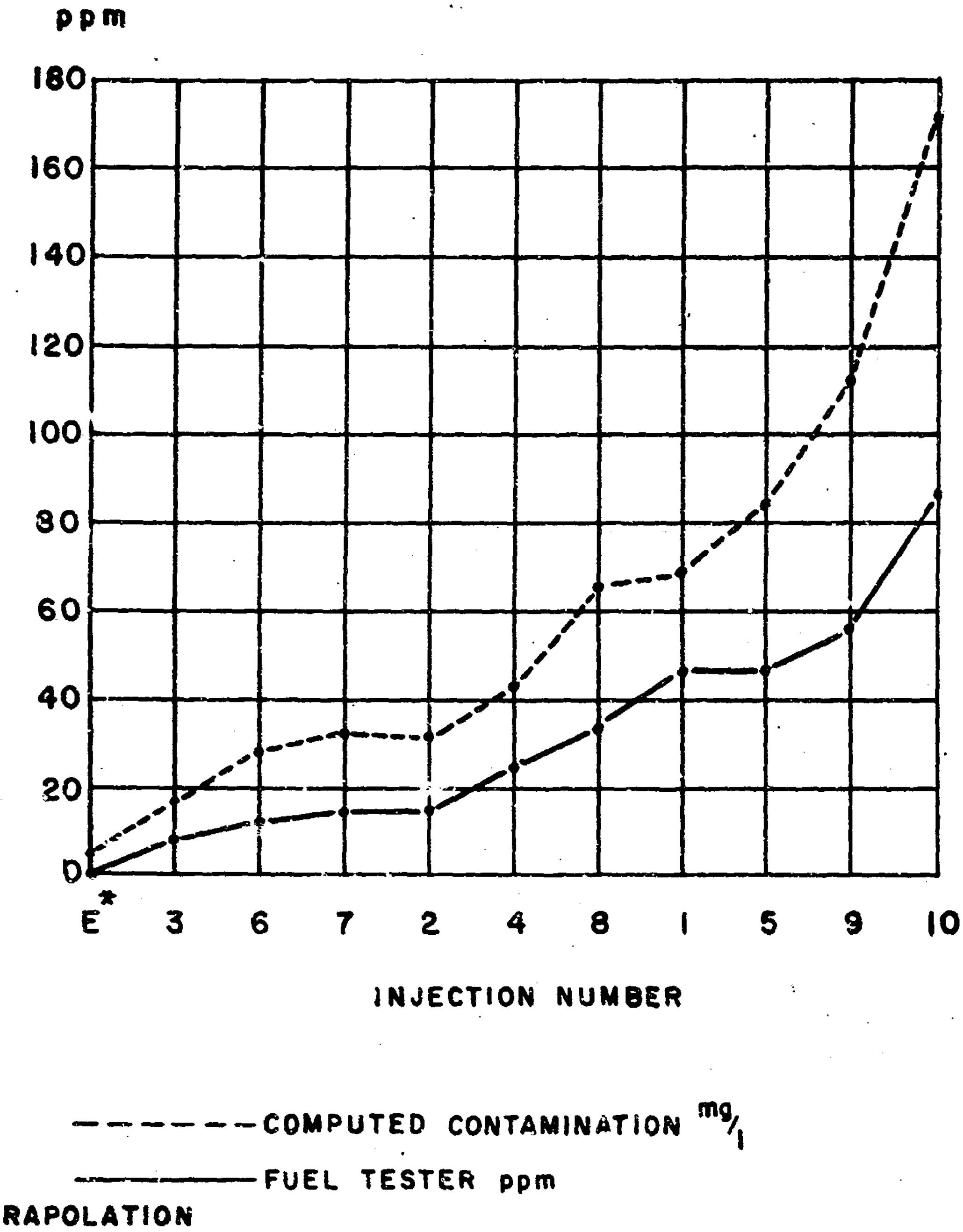


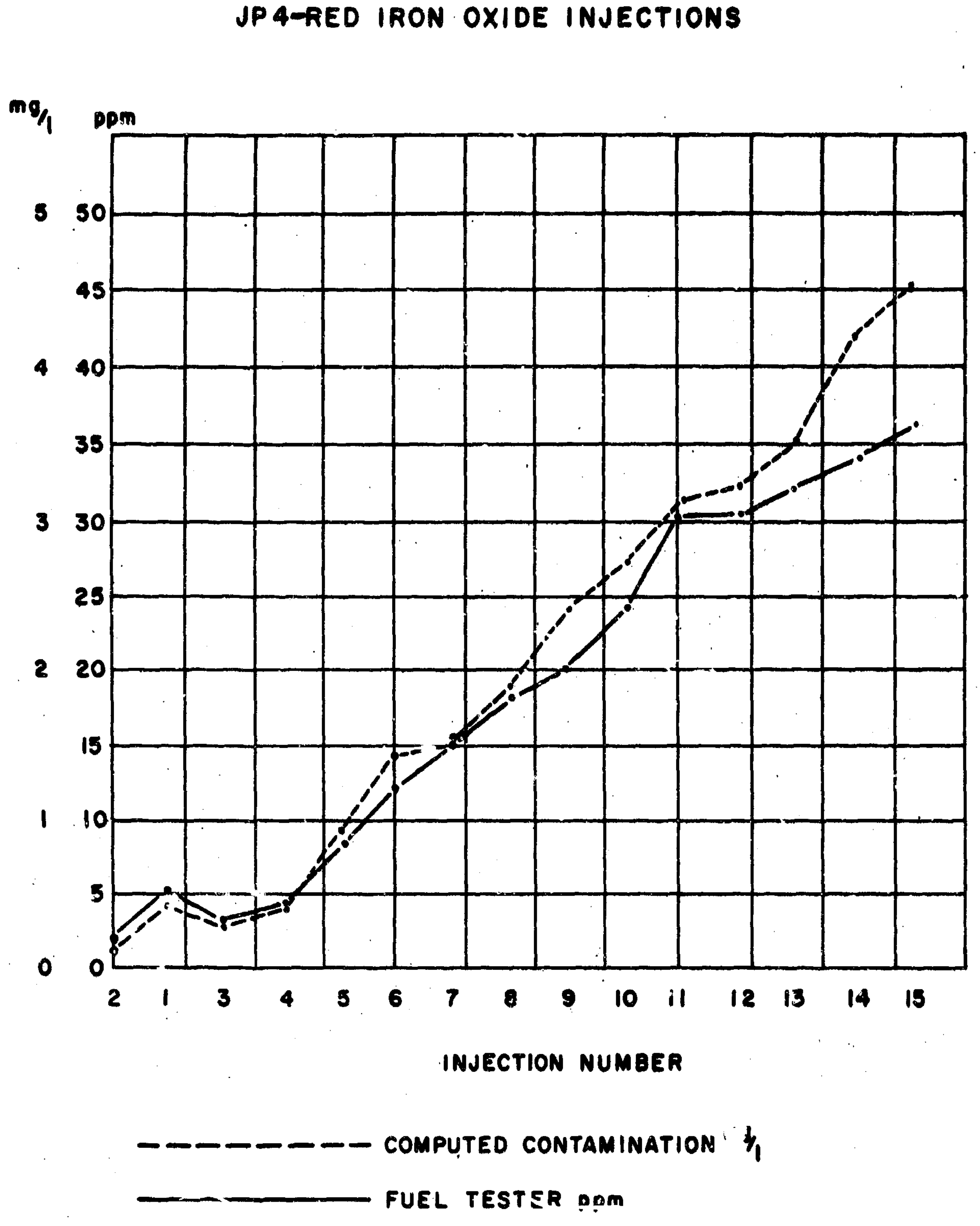
- - - - - - COMPUTED CONTAMINATION mg/l

———— FUEL TESTER ppm

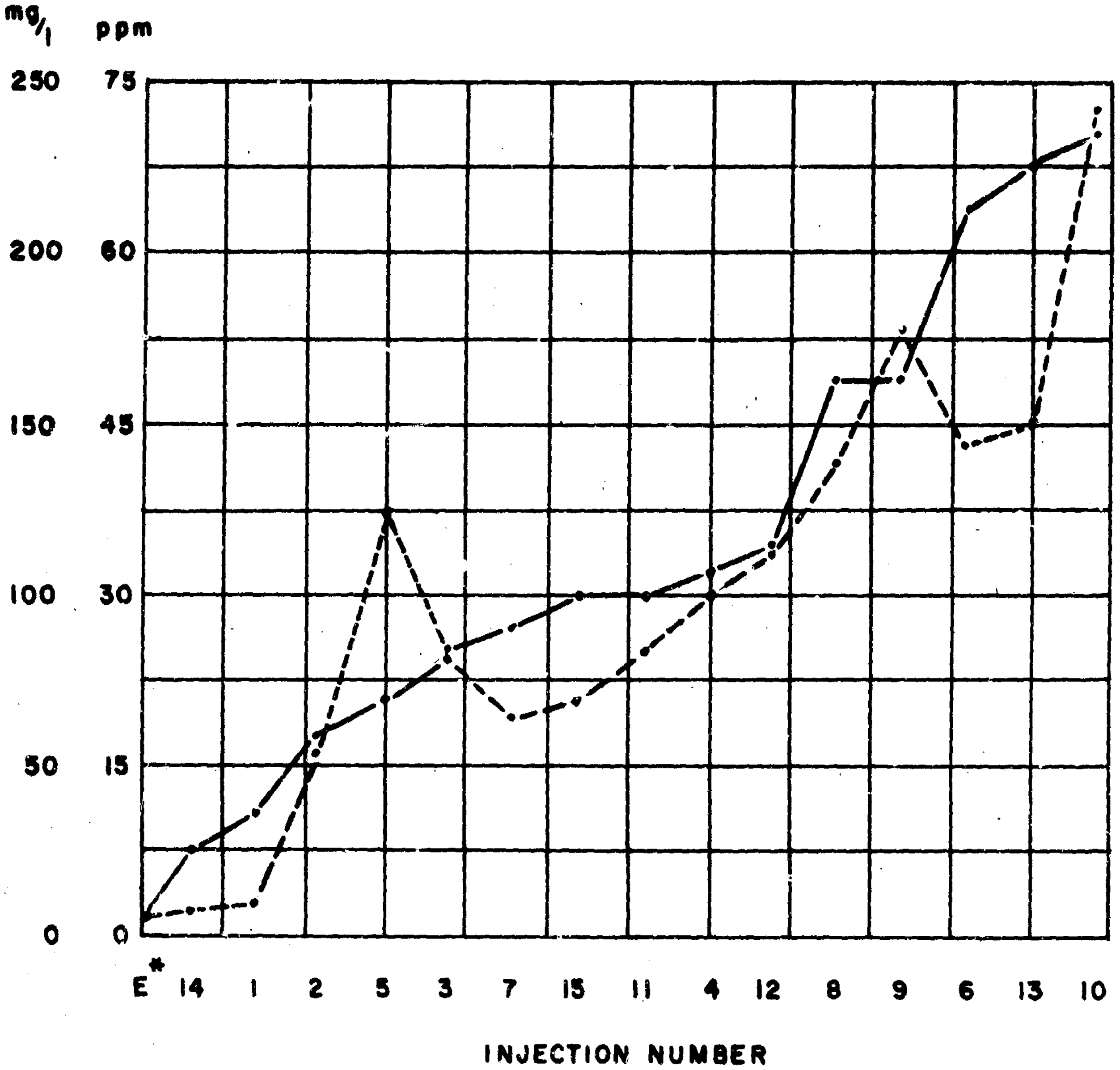
* *EXTRAPOLATION*

MOGAS-WATER INJECTIONS




JP4-RED IRON OXIDE INJECTIONS
mg/l
ppm
5
50
45
4
40
35
3
30
25
2
20
15
1
10
5
0
0
2
1
3
4
5
6
7
8
9
10
11
12
13
14
15
INJECTION NUMBER
COMPUTED CONTAMINATION ⅟l
FUEL TESTER ppm

JP 4-SILICEOUS TEST DUST INJECTIONS



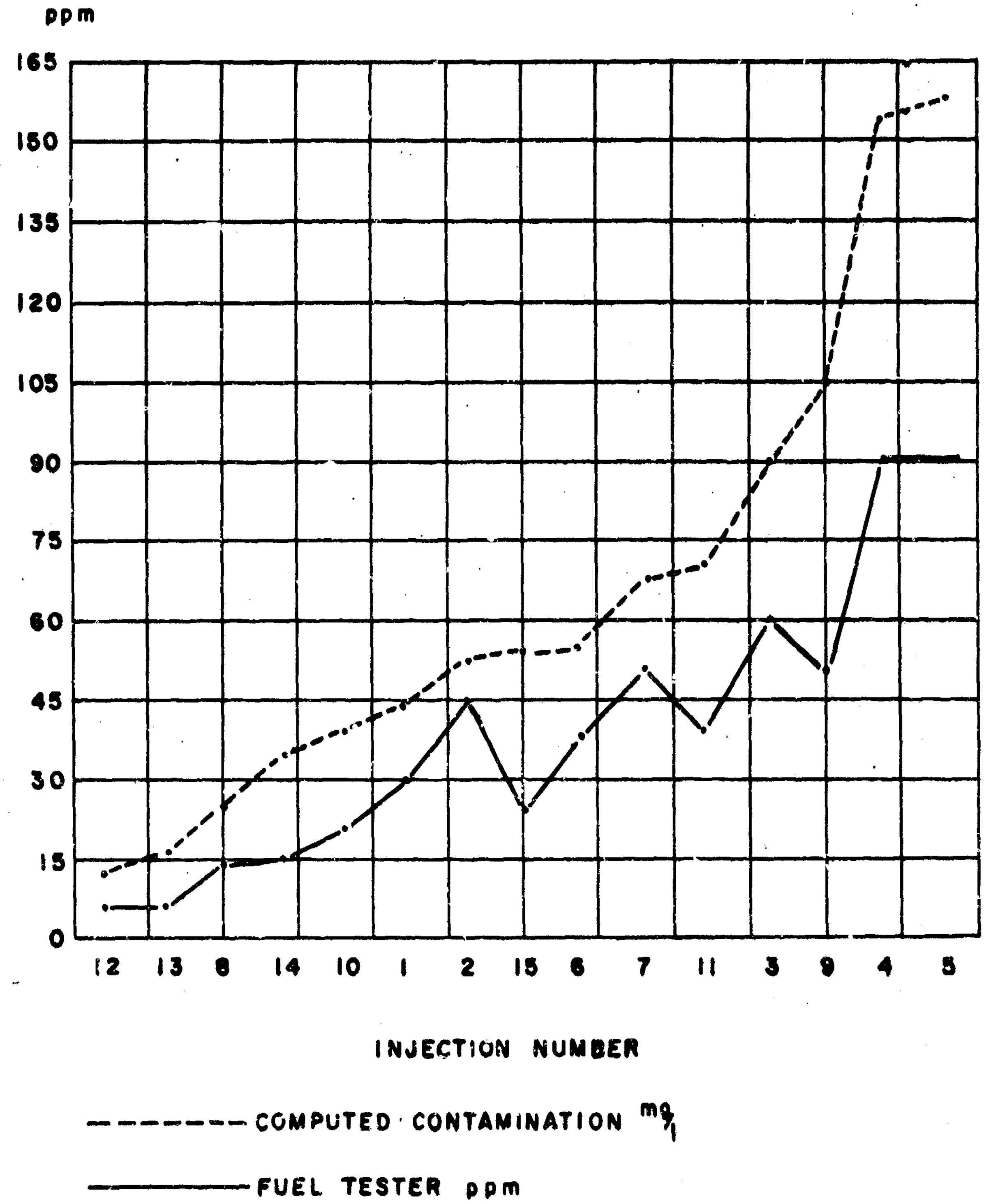
* EXTRAPOLATION

-------- COMPUTED CONTAMINATION mg/l

———— FUEL TESTER ppm

I-E

JP 4-WATER INJECTIONS



APPENDIX II. FINDINGS

MC Reference	Military Characteristics Requirement	Met	Not Met	Remarks and Paragraph References
Par. 8.a(1)	The fuel tester shall be reliable, simple to operate, and sufficiently accurate to register presence of injurious amounts of contamination.		X	Not sufficiently accurate to register presence of injurious amount of siliceous test dust contamination Par. 2.4.2, 2.4.5.
Par. 8.a(2)	The fuel tester shall automatically and continuously detect contamination particles and indicate that the water content does not exceed unacceptable amounts specified by the current military specification for filter/separators.		X	Par. 2.4.2, 4.4.5.
Par. 8.a(3)	The fuel tester shall provide a warning device to alert operating personnel when fuel contamination reaches an unacceptable level and/or when any free water is present.	X		Par. 2.2
Par. 8.b(1)	A visual warning device shall be incorporated to permit operating personnel to determine whether filtering and coalescing elements of the filter/separators require replacement.		X	Visual warning device not included, however audible signal provided which proved adequate during test operations Par. 2.2.
Par. 8.b(2)	The fuel tester shall automatically terminate the flow of fuel when the presence of an intolerable amount of contamination is registered.	X		Par. 2.3, 2.4.7, 2.5
Par. 8.b(3)	The fuel tester shall be capable of being used with a separate device to assist in the detection of unacceptable gum content, as specified by applicable military specifications.		X	Requirement considered unrealistic and not within present state-of-the-art.

APPENDIX II. FINDINGS

MC Reference	Military Characteristics Requirement	Met	Not Met	Remarks and Paragraph References
Par. 9.a(1)	The fuel tester shall be self-contained, capable of being emplaced in, or attached to, all standard and proposed military fuel-dispensing equipment.	X		Par. 2.1, 2.4.11, 2.5.
Par. 9.a(2)	The fuel tester shall be compatible with various rates of flow of all standard and proposed military fuel-dispensing equipment.	X		Par. 2.1, 2.4.11, 2.5.
Par. 9.a(3)	The fuel tester shall be compact, inexpensive, and of one type and size.		X	Not of one size -- two sizes furnished however found to be necessary during tests Par. 2.2.
Par. 9.b.	Weight and size of the fuel tester shall be kept to the minimum commensurate with the state-of-the-art at the time of development.	X		Par. 2.2.
Par. 9.c(1)	The fuel tester shall be capable of transportation by rail, ship, motor vehicle, and aircraft (including external helicopter loading) with a minimum of disassembly or preparation.	X		Transportability tests not conducted however judged suitable to meet requirement provided item is adequately packaged Par. 1.4h.
Par. 9.c(2)	The fuel tester shall be capable of being delivered in Phase II of airborne operations with a minimum of packaging and protective materials.	X		Transportability tests not conducted however judged suitable to meet requirement provided item is adequately packaged Par. 1.4h.
Par. 9.d(1)	The fuel tester shall be sufficiently rugged to withstand the vibrations and shock encountered in handling and transportation in the field without developing leaks and other malfunctions.	X		Exception-chart recorder which requires replacement with a more durable type. Par. 2.5.4, 2.6.4.
Par. 9.d(2)	The fuel tester shall provide a high degree of functional reliability.	X		App. IV-A, Par. 2.4.9, 2.6.

APPENDIX II. FINDINGS

MC Reference	Military Characteristics Requirement	Met	Not Met	Remarks and Paragraph References
Par. 9.e.	The vulnerability of the fuel tester shall not exceed that of any component of the associated fuel-dispensing equipment.	X		Par. 2.2.
Par. 9.f(1)	The fuel tester shall be designed for use under field conditions and shall have all-weather capability to include extreme hot and cold climates. It shall conform insofar as practicable to the requirements of paragraph 7, AR 705-15, 14 August 1957.	X		Tested under intermediate climatic conditions ranging from +10°F to 100°F. Environmental tests conducted under separate tasks. Par. 2.2, 2.4, 2.5.
Par. 9.f(2)	The fuel tester shall incorporate materials and provisions that provide maximum resistance to the detrimental effects of fungi, humidity, rain, snow, and extremes of dust and dirt.	X		Par. 2.2.

APPENDIX III. DEFICIENCIES AND SHORTCOMINGS

1. DEFICIENCIES

Deficiency	Suggested Corrective Action	Remarks
1.1 The test item was not of one size as required - two sizes furnished.	The requirement for one size item should be deleted and allow two sizes due to the wide flow rate range.	See Para. 2.2.4.
1.2 The test item would not detect unacceptable amounts of AC Test Dust contaminant.	The sensitivity of the test item should be improved and a narrower range dial indicator and chart recorder provided with smaller divisions to increase accuracy in reading.	See Para. 2.4.2, 2.4.5.

2. SHORTCOMINGS

Shortcoming	Suggested Corrective Action	Remarks
2.1 The fuel tester was not capable of being used with a separate device to assist in detection of unacceptable gum content.	This requirement should be deleted from the MC's as it is not considered realistic and not within the state-of-the-art at the present.	See Para. 2.2.4.
2.2 The test item did not include a visual warning device to permit operating personnel to determine whether filter coalescing elements of the filter/separator require replacement.	This requirement should be deleted from the MC's. The audible alarm furnished with the test items proved adequate during test operations.	See Para. 2.2.4.
2.3 A second power supply battery was required to allow uninterrupted operations during frequent required recharging.	Furnish two power supply batteries with each fuel tester.	See Para. 2.4.11, 2.5.4.

APPENDIX III

Shortcoming	Suggested Corrective Action	Remarks
2.4 The dial indicator and chart recorder furnished could not be read with the required accuracy as the scale divisions were too large (2 ppm) and the total range (0-100 ppm) unnecessarily wide.	A dial indicator and chart recorder with smaller scale divisions and a total range of 0-20 ppm is needed to increase accuracy in reading at the critical lower extremes.	See Para. 1.4.c (3), 2.4.2.4.
2.5 The 3-way valve (solenoid operated) malfunctioned during simulation of contaminated conditions.	Provide internal protection against corrosion.	EPR L7-1. Malfunction is attributed to internal corrosion of the solenoid piston resulting from 4 years storage following previous use and from lack of corrective protection (Par. 2.6.3c).
2.6 The socket head capscrews item #25 on the lamp holder were inaccessable with standard hexagon (Allen) wrenches in the mechanic's tool set and the organizational #2 common tool set FSN 5910-754-0650.	Provide hexagon head capscrews with the component as illustrated in the D.T.M. 10-4930-207-12.	EPR L7-2. Improvised tools used to remove the hollow head screws were considered unsatisfactory (Par. 2.6.3j).
2.7 Instructions in the D.T.M. 10-4930-20-7-12 for zero adjustment of the indicating meter were not applicable to the present configuration of the test item and will cause damage to the lamp holder assembly wiring.	Provide instructions applicable to the present configuration.	EPR L7-3 and paragraph 2.6.3e).
2.8 Two chart recorders malfunctioned.	Provide a more durable chart recorder.	EPR L7-4. Malfunction occurred at 231 and 301 hours respectively. Repair of the recorder is recommended to depot level (Par. 2.6.3e).

APPENDIX III

Shortcoming	Suggested Corrective Action	Remarks
2.9 During simulated maintenance the 4-inch fuel tester could not be calibrated.	Provide adequate instruction for troubleshooting the test item.	Failure: EPR L7-5. Replacement of the photocell and window assembly and repairing bare wires in the photocell outlet tubing returned the fuel tester to operation. (Par. 2.6.3f).
2.10 During simulated maintenance the photocell could not be replaced because of design change and inadequate instructions in the maintenance manual D.T.M. 10-4930-207-12.	Update instructions to conform to design of the test item as it will be issued.	EPR L7-6 and paragraph 2.6.3g.
2.11 The instructions are inadequate in D.T.M. 10-4930-207-12 and certain maintenance actions could not be performed without potential damage to the test item and excessive troubleshooting was required to correct noncalibration (EPR L7-5).	Institute revision of the operator and organizational maintenance manual.	EPR L7-7 and paragraph 2.6.3.1.

CORRECTED DEFICIENCIES AND SHORTCOMINGS

Deficiency/Shortcoming	Corrective Action	Remarks
None.	None.	None.

APPENDIX IV. MAINTENANCE EVALUATION

APPENDIX IV-A

MAINTENANCE AND RELIABILITY ANALYSIS CHART

INSTRUCTION SHEET - DESCRIPTION

COLUMN

1. Functional group number as indicated in the Maintenance Allocation Chart (ref AR 310-3) of the assembly or subassembly. The sequence number of the maintenance operation is in parenthesis below the group number.

2. Component and related operations as indicated in the Maintenance Allocation Chart. Operations assigned to depot level maintenance are not shown.

3. Maintenance Level, Prescribed. The maintenance level prescribed by the Maintenance Allocation Chart or the parts manual, whichever is appropriate, is indicated using the following code: C - Operator/Crew; O - Organizational; F - Direct Support; and H - General Support.

4. Maintenance Level, Recommended. Use the code letters, C, O, F or H to indicate the level of maintenance recommended by the test agency.

5. TM Instructions, Adequate. An X in this column indicates the TM instructions covering this maintenance action are adequate.

6. TM Instructions, Inadequate. When the TM instructions are considered inadequate, insert the test agency reference number used on the DA Form 1598.

7. Active Maintenance Time. Man-hours and clock hours required for the maintenance operation to the nearest tenth of an hour. If the operation was not actually performed but was reviewed, the estimated active maintenance time is indicated by using the prefix E. (Unusual differences in maintenance times for the same operation should be explained in the body of the test report.)

8. Life. The number of operational hours (essential) and miles, events, etc., as required in the test plan, accumulated during the test prior to the occurrence of the malfunction or scheduled service. (Under the life figure enter in parenthesis the sequence number for which that particular operation was last performed followed by the appropriate life unit; i.e. M, H, etc.) "S" will be placed in this column if the operation was performed on a sampling basis and not because of an actual failure.

MAINTENANCE AND RELIABILITY ANALYSIS CHART

INSTRUCTION SHEET (Cont'd)

COLUMN

9. Reason Performed. The symbol "Unscd" will be shown in this column if this operation was performed as a result of unscheduled maintenance. If the operation was performed and recorded as a required portion of a scheduled maintenance service, the symbol "Scd" will be used. If the operation was performed only to verify procedure and tool requirements, not to correct a malfunction, the symbol "Sim" will be used.

10. Remarks. If the operation was not performed as a result of using the sampling technique authorized by AR 750-6, one of the following remarks will be entered:

   a. Reviewed - not performed.

   b. Neither reviewed nor performed due to (No. TM's) or (insufficient service test time).

   c. Other as appropriate.

If an EPR is related to the operation, the EPR reference number will be shown. When the operation was performed to correct a failure as defined in this regulation, it will be indicated by the word "Failure" in this column.

MAINTENANCE AND RELIABILITY ANALYSIS CHART

GROUP NO.	COMPONENT AND RELATED OPERATIONS	MAINT LEVEL C--OPER/CREW O--ORGZN F--DIRECT H--GENERAL		TM INSTRUCTIONS		ACTIVE MAINTENANCE TIME		LIFE H-HOURS M-MILES	REASON PERFORMED	REMARKS
		PRE-SCRIBED	RECOM-MENDED	ADE-QUATE	INADE-QUATE	CLOCK HOURS	MAN-HOURS			
1	2	3	4	5	6	7		8	9	10
4200	Simulator Repaired	0	0	x		0.3**	0.3**	0	unsch	During initial T.I. after Eng. Test and before service test.
4205	Solenoid Replaced	0	o		x	0.5	0.5	136	unsch	2-inch 50 GPM test item. EPR L7-1.
4210	Recorder Replaced	0	0	x		0.1	0.1	231	unsch	2-inch 50 GPM item. EPR L-7-4
4200	Pick up head Repaired	0	0		x	10.0	8.0	301*	unsch	EPR L-7-5 Failure
4210	Recorder Replaced	0	0	x		0.1	0.1	301	unsch	4-inch totamitor EPR not submitted
4200	Window Assembly Replaced	0	0		x	*	*	301*	unsch	EPR L7-5.
4200	Photo cell Replaced	0	0		x	*	*	301*	unsch	EPR L7-5.
4200	Adapter Replaced	0	0		x	*	*	301*	unsch	EPR L7-5.
N/A	Final T.I.	0	0	x		0.5**	0.5**	**	Sch.	2 inch item.
N/A	Final T.I.	0	0	x		0.5**	0.5**	**	Sch.	4 inch item.

*Replacement was the result of pickup head calibration

**Maintenance time not included in reliability computations.

MAINTENANCE AND RELIABILITY ANALYSIS CHART

SIMULATED

GROUP NO.	COMPONENT AND RELATED OPERATIONS	MAINT LEVEL C-OPER/CREW O-ORGZN F-DIRECT H-GENERAL		TM INSTRUCTIONS		ACTIVE MAINTENANCE TIME		LIFE H-HOURS M-MILES	REASON PERFORMED	REMARKS
		PRE-SCRIBED	RECOM-MENDED	ADE-QUATE	INADE-QUATE	CLOCK HOURS	MAN-HOURS			
1	2	3	4	5	6	7		8	9	10
06	Battery									
0612	Battery Service	C	C	X		0.1	0.1	N/A	Sim	
	Inspect	C	C	X		0.1	0.1	N/A	Sim	
	Test	0	0	X		0.1	0.1	N/A	Sim	
	Replace	0	0	X		0.1	0.1		Sim	
42	Electrical Equipment									
4206	Automatic Control Device Valve, 3-way, Solenoid Operated Test	0	0		X	0.4	0.4		Sim	Instructions inadequate (EPR L7-3)
	Replace	0	0	X		0.1	0.1		Sim	

APPENDIX IV-A

MAINTENANCE AND RELIABILITY ANALYSIS CHART

SIMULATED

GROUP NO.	COMPONENT AND RELATED OPERATIONS	MAINT LEVEL C-OPER/CREW O-ORGZN F-DIRECT H-GENERAL		TM INSTRUCTIONS		ACTIVE MAINTENANCE TIME		LIFE H-HOURS M-MILES	REASON PERFORMED	REMARKS
		PRE-SCRIBED	RECOM-MENDED	ADE-QUATE	INADE-QUATE	CLOCK HOURS	MAN-HOURS			
1	2	3	4	5	6	7		8	9	10
4209	Signaling Devices Bell, Alarm									
	Inspect	0	C	X		0.1	0.1		Sim	
	Replace	0	0	X		0.5	0.5		Sim	
4209	Pickup Head Service	C	C	X		0.1	0.1		Sim	
	Inspect	0	C	X		0.1	0.1		Sim	
	Test	0	0	X		0.3	0.3		Sim	
	Replace	0	0	X		0.8	0.8		Sim	
	Repair	0	0	X		E1.0	E1.0			Reviewed only.
	Light Holder Assembly									
	Inspect	0	C	X		0.1	0.1		Sim	
	Replace	0	0	X		0.3	0.3		Sim	
	Light Bulb Window Assembly									
	Service	0	N/A	N/A		N/A	N/A		N/A	Not applicable to the component.

APPENDIX IV-A

MAINTENANCE AND RELIABILITY ANALYSIS CHART

SIMULATED

GROUP NO.	COMPONENT AND RELATED OPERATIONS	MAINT LEVEL C-OPER/CREW O-ORGZN F-DIRECT H-GENERAL		TM INSTRUCTIONS		ACTIVE MAINTENANCE TIME		LIFE H-HOURS M-MILES	REASON PERFORMED	REMARKS
		PRE-SCRIBED	RECOM-MENDED	ADE-QUATE	INADE-QUATE	CLOCK HOURS	MAN-HOURS			
1	2	3	4	5	6	7		8	9	10
	Inspect	0	0	X		0.1	0.1		Sim	Can only be inspected during disassembly.
	Replace	0	0	X		0.7	0.7		Sim	
	Light Bulb Inspect	0	0	X		0.5	0.5		Sim	Can only be inspected during disassembly.
	Replace	0	0	X		0.5	0.5		Sim	
4209	Simulator Service	0	0	X		0.1	0.1		Sim	
	Inspect	0	0	X		0.1	0.1		Sim	
	Replace	0	0	X		0.5	0.5		Sim	
	Photo Cell Assembly Inspect	0	0	X		0.1	0.1		Sim	Inspect externally.
	Replace	0	0		X	0.3	0.3		Sim	Instructions are inadequate EPR L7-6.
	Photo Cell Window Assembly				X					

APPENDIX IV-A

MAINTENANCE AND RELIABILITY ANALYSIS CHART

SIMULATED

GROUP NO.	COMPONENT AND RELATED OPERATIONS	MAINT LEVEL C-OPER/CREW O-ORGZN F-DIRECT H-GENERAL		TM INSTRUCTIONS		ACTIVE MAINTENANCE TIME		LIFE H-HOURS M-MILES	REASON PERFORMED	REMARKS
		PRE-SCRIBED	RECOM-MENDED	ADE-QUATE	INADE-QUATE	CLOCK HOURS	MAN-HOURS			
1	2	3	4	5	6	7		8	9	10
	Service	C	N/A	N/A		N/A	N/A		N/A	Not applicable except on disassembly.
	Inspect	0	0	X		0.1	0.1		Sim	Can only be inspected during disassembly.
	Replace	0	0	X		0.3	0.3		Sim	
4210	Instruments Amplifier									
	Adjust	0	0	X		0.1	0.1		Sim	See EPR L7-2 and L7-3.
	Calibrate	0	0	X		0.1	0.1		Sim	See EPR L7-2 and L7-3.
	Inspect	0	0	X		0.1	0.1		Sim	See EPR L7-2 and L7-3.
	Test	0	0	X		0.1	0.1		Sim	See EPR L7-2 and L7-3.
	Replace	C	0	X		0.2	0.2		Sim	See EPR L7-2 and L7-3.
	Repair	0	D		X					Repair is not recommended at organizational level.
4210	Recorder Service	C	C	X		0.1	0.1		Sim	

APPENDIX IV-A

MAINTENANCE AND RELIABILITY ANALYSIS CHART

SIMULATED

GROUP NO.	COMPONENT AND RELATED OPERATIONS	MAINT LEVEL C-OPER/CREW O-ORGZN F-DIRECT H-GENERAL		TM INSTRUCTIONS		ACTIVE MAINTENANCE TIME		LIFE H-HOURS M-MILES	REASON PERFORMED	REMARKS
		PRE-SCRIBED	RECOM-MENDED	ADE-QUATE	INADE-QUATE	CLOCK HOURS	MAN-HOURS			
1	2	3	4	5	6	7		8	9	10
	Adjust	0	0	X		0.2	0.2		Sim	
	Calibrate	0	N/A		X	N/A	N/A		N/A	Not considered applicable.
	Inspect	0	0	X		0.1	0.1		Sim	
	Test	0	0	X		0.1	0.1		Sim	
	Replace	0	0	X		0.1	0.1		Sim	
	Repair	0	D		X	N/A	N/A		N/A	Repairs not recommended below depot level.
43 4305	Fluid Sys Control Valve Assembly Service	0	0	X		0.1	0.1		Sim	
	Inspect	0	0	X		0.1	0.1		Sim	
	Replace	0	0	X		0.5	0.5		Sim	
	Repair	0	0	X		E1.0	E1.0		Sim	Reviewed.

MAINTENANCE AND RELIABILITY ANALYSIS CHART

SIMULATED

GROUP NO.	COMPONENT AND RELATED OPERATIONS	MAINT LEVEL C-OPER/CREW O-ORGZN F-DIRECT H-GENERAL		TM INSTRUCTIONS		ACTIVE MAINTENANCE TIME		LIFE H-HOURS M-MILES	REASON PERFORMED	REMARKS
		PRE-SCRIBED	RECOM-MENDED	ADE-QUATE	INADE-QUATE	CLOCK HOURS	MAN-HOURS			
1	2	3	4	5	6	7		8	9	10
	Diaphram Assembly Inspect	0	0	X		0.3	0.3		Sim	
	Replace	0	0	X		0.5	0.5		Sim	
	Repair	0	N/A	N/A		N/A	N/A			N/A
	Seat Inspect	0	0	X		0.3	0.3		Sim	
	Replace	0	0	X		0.5	0.5		Sim	
	Valve, 3-way, Solenoid Operated	(See Group 4206)								

APPENDIX IV-B

PARTS ANALYSIS CHART

INSTRUCTION

GENERAL: This chart is a list of the parts which were used in maintaining the test item. Parts will be grouped in this chart by functional groups and in Federal Stock Number (FSN) numerical order within each group.

COLUMN	DESCRIPTION
1.	Group Number (Sequence Number). Parts usage by maintenance operation is indicated by cross referencing the group number and sequence number in Column 1 of the Maintenance and Reliability Analysis Chart.
2.	Federal Stock Number. Record the Federal Stock Number, Technical Services Part Number, Manufacturer's Part Number, or Drawing Number in this order of preference.
3.	Noun Nomenclature. Self-explanatory.
4.	Maintenance Level, Prescribed. The maintenance level prescribed by the parts list under review. Use the code: C - Operator/Crew; O - Organizational; F - Direct Support; H - General Support.
5.	Maintenance Level, Recommended. The code symbols C, O, F or H indicate the maintenance level recommended by the test agency.
6.	Part Life. The number of operating hours (essential) and miles, rounds, effects, etc., as required by the test plan, accumulated by this part. This is True Part Life and should agree with the part life reported on the EPR. Each entry in this column is followed by the appropriate life unit symbol; i.e., H, M, or R, etc.
7.	Reason Used. The symbol "Unscd" will be shown in this column if this part was replaced as a result of unscheduled maintenance. If the part was replaced as a required action of a scheduled maintenance service, the symbol "Scd" will be used. If the part was consumed to verify procedures or tools, not to correct a malfunction, the symbol "Sim" will be used.
8.	Remarks. If an EPR is related to the part used, the EPR reference number will be inserted in this column. When the part was replaced to correct a failure, as defined in this regulation, it will be indicated by inserting the word "Failure" in this column.

APPENDIX IV-B

PARTS ANALYSIS CHART

GP NO. CROSS REF	FEDERAL STOCK NUMBER	NOUN NOMENCLATURE	MAINTENANCE LEVEL C - Operator/Crew O - Organizational F - Direct H - General: Prescribed	Recommended	PART LIFE M - Miles H - Hours	REASON USED	REMARKS
1	2	3	4	5	6	7	8
4209	204592 204696	Simulator O-Rings (packing)	O O	O O	N/A N/A	Unsch. Unsch.	During initial T.I. after Eng. test prior to service test- 4 inch test item.
4206	L-M-8314 A25 serial # 32331N	Solenoid	O	O	136	Unsch.	50 GPM 2-Inch Totamitor EPR L-7-1
4210	14869	Recorder	O	O	231	Unsch.	50 GPM 2-Inch Totamitor EPR L-7-4
4210	14869 Model 88	Recorder	O	O	301	Unsch.	400 GPM 4-Inch Totamitor EPR was not submitted.
4209	(08189) 116558	Window assembly	O	O	301	Unsch.	400 GPM 4-Inch Totamitor
4209	(81483) A7PL	Photo cell	O	O	301	Unsch.	400 GPM 4-Inch Totamitor
4205	AMXRE-MPL-471-B	Adapter "B"	O	O	301	Unsch	400 GPM 4-Inch Totamitor

APPENDIX IV-C

MAINTENANCE PACKAGE LITERATURE CHART

INSTRUCTION SHEET - DESCRIPTION

COLUMN

1. Give Army or manufacturer's publication or draft manual number.

2. Number of copies received. Insert "O" if none were supplied. Use Para III 1, Chapter 9, of AR 310-3 as a guide to determine those manuscripts and publications that should accompany the test item. Manuscripts and publications contained in the maintenance package should cover operations and functions through general support maintenance and should specify the categories involved.

3. Complete title.

4. Fill in date manuscript (MSS) or publication was received.

5. Fill in date test item or materiel was received.

6. Insert "X" in appropriate block. Minor errors on 1598 forms are not in themselves sufficient reason to term a manuscript inadequate. Evaluation may be omitted if fewer than 25% of the specified maintenance operations were performed.

7. Insert date 1598 form was forwarded and 1598 form reference No.

8. In addition to appropriate remarks, explain if manuscript was not evaluated.

APPENDIX IV-C

MAINTENANCE PACKAGE LITERATURE CHART

Manuscript			Date Received		Evaluation		Form 1598	
Number	Qty	Title	Lit	Materiel	Adqt	Inadqt	Reference No. and date fwd	Remarks
1	2	3	4	5	6	7	8	9
DTM 10-4930-207-12	2	Operator and Organizational Maintenance Manual Fuel Tester, 50-GPM Model 861-F-LS-2 FE, and Fuel Tester 400-GPM, Model 861-F-LS-4 SF	Dec 68	Dec 68		X	EPR L7-7	Major revision is recommended, updating design, parts data, and additional instructions at the organizational level.

APPENDIX IV-D

RECOMMENDED CHANGES TO DRAFT TECHNICAL MANUAL

RECORD OF COMMENTS ON PUBLICATIONS — *For use of this form, see AR 310-3; the proponent agency is Office of the Assistant Chief of Staff for Force Development.* — DATE: 26 February 1969

SUBJECT: Fuel Tester, Int. Engineer-Service Test, USATECOM Project No. 7-3-0239-09

REVISION NOTES FROM: DTM 10-4930-207-12, Operator & Organizational Maintenance Manual, Fuel Tester, 50 GPM, Model 861-F-LS-2-FE, December 1966

ITEM NO.	PAGE	PARAGRAPH	LINE *	COMMENT (Exact wording of recommended change must be given.)
1	vi	Section V		Change: "Preoperational test and adjustment 3-15" to "Preoperational test and adjustment 3-12". Explanation: Preoperational test must be performed before "Indicating meter zero test and adjustment 3-12" can be performed.
2	vi	Section V		Change: "Amplifier sensitivity calibration 3-13" and "Alarm setting adjustment 3-14" to "3-14" and "3-15", respectively. Explanation: Change necessary in order to correspond with change in item 1 above.
3	1-4a	Figure 1-3		Delete: "Alarm Adjustment"; add: "Plug Calibration Screw." Explanation: "Plug Calibration Screw" is used as nomenclature on Page 3-7a, Fig 3-4, and it appears logical.
4	1-4b	Figure 1-4		Add a section of conduit to the illustration. Explanation: For identification purposes.
5	1-7a	Figure 1-5		Letters A and B on the line leading to the control valve are not lettered on the test item. Additional identification is desired. Explanation: Self expanatory.
6	2-2	Section II, 2-5		Correct spelling: Dismantling. Explanation: Spelling error.
7	2-2b	Figure 2-2		Delete: "Alarm Adjustment". Add: "Plug Calibration Screw". Explanation: Same as item 3.
8	2-2b	Figure 2-2	Step 3	Delete: "Figure 1." Add: "Figure 1-5." Explanation: Figure 1-5 is the wiring diagram.
9	2-2c	Figure 2-3	Step 3	Delete: "Figure 1." Add: "Figure 1-5." Explanation: Same as item 8 above.
10	2-2d	Figure 2-4	Step 1	Delete: "Figure 1." Add: "Figure 1-5." Explanation: Same as item 8 above.
11	2-3a	Figure 2-6		Delete: "Alarm Adjustment"; add: "Plug Calibration Screw." Explanation: Same as item 3 above.
12	3-1	3-1		See EPR L7-2. The hollow head screws furnished with test item require a wrench shorter than the one furnished in standard mechanics tool set.

* Reference to line number within the paragraph or subparagraph.

DA FORM 1 DEC 55 1598

RECORD OF COMMENTS ON PUBLICATIONS

For use of this form, see AR 310-3; the proponent agency is Office of the Assistant Chief of Staff for Force Development.

DATE: 26 February 1969

SUBJECT: Fuel Tester, Int. Engineer-Service Test, USATECOM Project No. 7-3-0239-09

REVISION NOTES FROM: DTM 10-4930-207-12, Operator & Organizational Maintenance Manual, Fuel Tester, 50 GPM, Model 861-F-LS-2-FE, December 1966

ITEM NO.	PAGE	PARAGRAPH	LINE *	COMMENT (Exact wording of recommended change must be given.)
12	3-1 (Continued)	3-1		Explanation: Either the screws must be changed to standard hexagon head type, as indicated on Page D-21, Fig D-1, item 26, or a special wrench furnished with the test item.
13	3-2	Following Par 3-5 of Sec III		Add: Paragraph 3-5a Valve, Solenoid, Three way (04845) LMB314A25, Fails to close when solenoid is energized. **Probable Cause** / **Possible Remedy** Low battery voltage — Charge battery Loose electrical connections — Check and tighten all electrical connections Short circuit in electrical system. Use multimeter to check for continuity and short circuits — Repair short circuits and replace defective units Inoperative solenoid Check as follows: a. Disconnect tube assembly at Port C, Fig 3-8 b. Energize valve assembly by pushing simulator button. Fuel should stop flowing through Port C. c. If fuel continues to flow through Port C, the solenoid is defective. — Replace solenoid operated three way valve, LMB314A25 Explanation: Service testing developed the above instructions when the valve solenoid, three way, malfunctioned, EPR L7-1.
14	3-4	Section IV, 3-10	4	Delete period after "light." Explanation: Sentence continues on next page (3-5), ending after "photo cell."
15	3-4a	Figure 3-1		Delete: "Photo Cell". Add: "Adapter." Explanation: Photo cell is inside of adapter. Adapter is the nomenclature used for parts data, Page D-10, line 1, Fig D-1, item 15.

* Reference to line number within the paragraph or subparagraph.

DA FORM 1 DEC 55 1598

RECORD OF COMMENTS ON PUBLICATIONS	For use of this form, see AR 310-3; the proponent agency is Office of the Assistant Chief of Staff for Force Development.	DATE 26 February 1969
SUBJECT Fuel Tester, Int. Engineer-Service Test, USATECOM Project No. 7-3-0239-09		
REVISION NOTES FROM DTM 10-4930-207-12, Operator & Organizational Maintenance Manual, Fuel Tester, 50 GPM, Model 861-F-LS-2-FE, December 1966		

ITEM NO.	PAGE	PARAGRAPH	LINE *	COMMENT (Exact wording of recommended change must be given.)
16	3-4a	Figure 3-1		Add additional instructions to remove photo cell following "Step 4." Explanation: Instructions are incomplete (EPR L7-5).
17	3-6	3-12		Revise instructions (EPR L7-3) and re-number paragraph from "3-12" to "3-13." Explanation: Paragraph 3-15 should be paragraph 3-12 because paragraph 3-15a and 3-15b must be performed before indicating meter can be adjusted to zero.
18	3-6	3-13		Change paragraph 3-13 to 3-14. Explanation: To accommodate item 17.
19	3-7	3-14		Change paragraph 3-14 to 3-15. Explanation: To accommodate item 18.
20	3-6a	Figure 3-3		Correct illustration. Explanation: The pickup head being tested does not have an electrical connector (EPR L7-3), and a special short angle hollow head wrench is required to follow the instructions.
21	3-8	3-15		Change to paragraph 3-12. Explanation: Paragraph 3-15a, 1 and 2, preoperational tests and adjustments must be performed prior to present paragraphs 3-12, 3-13, and 3-14.
22	C-7	4210 Amplifier	Col H	Delete "O"; add "D". Explanation: Depot maintenance allocation is recommended to repair because tools, skills and spare parts are not adequate at "O" level.
23	C-8	4210 Recorder	Col H	Delete "O"; add "H". Explanation: Same as item 22.
24	D-10	Section II Rpr Parts	2	Assign part number to body pickup head, 50 GPM. Explanation: Parts cannot be ordered without a part number.
25	D-10		3	Assign part number to body pickup head, 400 GPM. Explanation: Same as item 24.
26	D-10		6	Assign part number to cover, junction box. Explanation: Same as item 24.
27	D-10		7	Assign part number to gasket rubber. Explanation: Same as item 24.

* Reference to line number within the paragraph or subparagraph.

DD FORM 1598 (DEC 64)

RECORD OF COMMENTS ON PUBLICATIONS	For use of this form, see AR 310-3; the proponent agency is Office of the Assistant Chief of Staff for Force Development.	DATE 26 February 1969

SUBJECT Fuel Tester, Int. Engineer-Service Test, USATECOM Project No. 7-3-0239-09

REVISION NOTES FROM DTM 10-4930-207-12, Operator & Organizational Maintenance Manual, Fuel Tester, 50 GPM, Model 861-F-LS-2-FE, December 1965

ITEM NO.	PAGE	PARAGRAPH	LINE *	COMMENT (Exact wording of recommended change must be given.)
28	D-11	Section II, Repair Parts	2	Assign part number to screw machine, lightshield mtg. Explanation: Same as item 24.
29	D-12		2	Assign part number to screw machine, photo cell mtg. Explanation: Same as item 24.
30	D-12		3	Assign part number to screw cap socket head window mtg. Explanation: Same as item 24.
31	D-12		4	Assign part number to screw machine window mtg. Explanation: Same as item 24.
32	D-12		5	Assign part number to screw, cap hexagon head cover mtg. Explanation: Same as item 24.
33	D-12		6	Assign part number to screw machine adapter mtg. Explanation: Same as item 24.
34	D-13		2	Assign part number to nut. Explanation: Same as item 24.
35	D-13		3	Assign part number to connector. Explanation: Same as item 24.
36	D-13		4	Assign part number to ferrule. Explanation: Same as item 24.
37	D-14		2	Assign part number to fuse. Explanation: Same as item 24.
38	D-14		5	Assign part number to adapter, male. Explanation: Same as item 24.
39	D-14		6	Assign part number to adapter pipe. Explanation: Same as item 24.
40	D-15		1	Assign part number to connectors. Explanation: Same as item 24.
41	D-15		4	Assign part number to elbow, pipe to tube. Explanation: Same as item 24.
42	D-16		7	Assign part number to tube assembly VALVE. Explanation: Same as item 24.
43	D-16		8	Assign part number to washer diaphram: Valve. Explanation: Same as item 24.

* Reference to line number within the paragraph or subparagraph.

DA FORM 1 DEC 55 1598

APPENDIX IV-D

RECORD OF COMMENTS ON PUBLICATIONS	For use of this form, see AR 310-3; the proponent agency is Office of the Assistant Chief of Staff for Force Development.	DATE 26 February 1969

SUBJECT Fuel Tester, Int. Engineer-Service Test, USATECOM Project No. 7-3-0239-09

REVISION NOTES FROM DTM 10-4930-207-12, Operator & Organizational Maintenance Manual Fuel Tester, 50 GPM, Model 861-F-LS-2-FE, December 1966

ITEM NO.	PAGE	PARAGRAPH	LINE *	COMMENT (Exact wording of recommended change must be given.)
44	D-17	Section II Repair Parts	2 and 3	Assign part number to tube assembly. Explanation: Same as item 24.
45	D-17		4	Assign part number to valve control, solenoid operated. Explanation: Same as item 24.
46	D-18		6	Assign part number to bolt machine. Explanation: Same as item 24.
47	D-18		7	Assign part number to washer lock. Explanation: Same as item 24.
48	D-18		8	Assign part number to washer flat. Explanation: Same as item 24.
49	D-18		9	Assign part number to nut, plain hexagon. Explanation: Same as item 24.
50	D-20		5	Assign size and material to tubing. Explanation: Parts cannot be ordered without size and material being given.
51	D-23	Figure D-3	15	Delete: "Elbow"; add: "Valve" solenoid, three way. Explanation: Error in nomenclature.

* Reference to line number within the paragraph or subparagraph.

DD FORM 1598

APPENDIX V. REFERENCES

1. Final Letter Report of Engineer Design Test of Effluent Fuel Tester, USATECOM Project No. 7-3-0239-01, dated 19 January 1965.

2. Interim Letter Report, Engineering Test Portion of Integrated EST of Fuel Tester, Effluent, USATECOM Project No. 7-3-0239-02, dated 2 July 1965.

3. DA Approved Military Characteristics for Effluent Fuel Tester.

4. Test Directive, - USATECOM Project No. 7-3-0239-06/07/08/09 - Fuel Tester Effluent, dated 30 June 1965.

5. Plan of Test for Integrated Engineering/Service Test of Fuel Tester, Effluent, dated August 1964.

6. Safety Release - USATECOM Project No. 7-3-0239-06/07/09, Engineering Service and Environmental Tests of Fuel Tester, Effluent, 50/400 GPM Fuel Tester.

7. Military Specification MIL-F-8901B, 15 August 1966, Filter/Separtors, Aviation and Motor Fuel, Ground and Shipboard Use, Performance Requirements and Test Procedures For.

AD — Accession No.

U. S. Army General Equipment Test Activity, Fort Lee, Virginia

INTEGRATED ENGINEERING AND SERVICE TEST OF EFFLUENT FUEL TESTER, by Daniel S. Gafford, 2LT Frederick G. Wedell, and Joseph T. Harvey, March 1969, 73 p.; -tables, -illus., -graphs. 6 Appendices p37-73. (TECOM Proj. No. 7-3-0239-09) Unclassified Report

An Integrated Engineering and Service Test of the Effluent Fuel Tester was conducted during the period February 1968 - February 1969 to determine the technical performance and safety characteristics of the test item as described in the Military Characteristics, and as indicated by the particular design; and to determine the suitability of the fuel tester and its maintenance package for use by the Army.

It was concluded that: the test item meets the requirements of the Military Characteristics with the exception of the deficiencies and shortcomings (Par. 1.4a and b); technical performance was satisfactory and sufficiently accurate to

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2. FUEL CONTAMINATION
3. PERFORMANCE TESTS

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register the presence of all contaminants to which it was exposed with the exception of the siliceous test dust; the test item is adequately reliable; safety provisions and capability to perform safely are confirmed--(see additional precautions, Par. 2.9.3); and human factors considerations are satisfactory with minor exceptions (Par. 1.4e and 2.7.3).

It is recommended that: the Effluent Fuel Tester be considered not suitable for use by the Army under limited intermediate climatic conditions (+10° to 100°F.) until the two deficiencies and as many as practicable of the shortcomings (App. III) have been corrected; draft technical manual be revised (Par. 1.6d and App. IV-D); a photocell and adapter with attached wires be issued; and repair parts listed in paragraph 1.6d be added to the prescribed load allowance.

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UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)
Department of the Army
U. S. Army General Equipment Test Activity
Fort Lee, Virginia 23801

2a. REPORT SECURITY CLASSIFICATION
UNCLASSIFIED

2b. GROUP

3. REPORT TITLE
Integrated Engineering and Service Test of Effluent Fuel Tester

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Final Report

5. AUTHOR(S) (Last name, first name, initial)
GAFFORD, Daniel S.; WEDELL, Frederick G., 2LT; HARVEY, Joseph T.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
March 1969	73	7

8a. CONTRACT OR GRANT NO.

b. PROJECT NO.
USATECOM 7-3-0239-09

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. AVAILABILITY/LIMITATION NOTICES This document may be further distributed by any holder only with specific prior approval of Commanding General, U. S. Army Mobility Equipment Command, St. Louis, Missouri.

11. SUPPLEMENTARY NOTES
None

12. SPONSORING MILITARY ACTIVITY
U. S. Army Mobility Equipment Command
St. Louis, Missouri

13. ABSTRACT

An Integrated Engineering and Service Test of the Effluent Fuel Tester was conducted during the period February 1968 - February 1969 to determine the technical performance and safety characteristics of the test item as described in the Military Characteristics, and as indicated by the particular design; and to determine the suitability of the fuel tester and its maintenance package for use by the Army.

It was concluded that: the test item meets the requirements of the Military Characteristics with the exception of the deficiencies and shortcomings (Par. 1.4a and b); technical performance was satisfactory and sufficiently accurate to register the presence of all contaminants to which it was exposed with the exception of the siliceous test dust; the test item is adequately reliable; safety provisions and capability to perform safely are confirmed--(see additional precautions, Par. 2.9.3); and human factors considerations are satisfactory with minor exceptions (Pars. 1.4e and 2.7.3).

It is recommended that: the Effluent Fuel Tester be considered not suitable for use by the Army under limited intermediate climatic conditions (+10° to 100°F) until the two deficiencies and as many as practicable of the shortcomings (App. III) have been corrected; draft technical manual be revised (Par. 1.6d and App. IV-D); a photocell and adapter with attached wires be issued; and repair parts listed in paragraph 1.6d be added to the prescribed load allowance.

DD FORM 1 JAN 64 1473

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Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Effluent fuel testers						
Fuel testers						
Fuel contamination						
Filter/separator						
Fuel filters						
Separators						
Performance tests						
Service tests						

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