SUBCOURSE **EDITION**

QM 5181 **A**

DIRECT OPERATION AND MAINTENANCE OF LABORATORY FACILITIES

THE ARMY INSTITUTE FOR PROFESSIONAL DEVELOPMENT

ARMY CORRESPONDENCE COURSE PROGRAM

DIRECT OPERATION AND MAINTENANCE OF LABORATORY FACILITIES

Subcourse Number QM 5181

EDITION A

United States Army Combined Arms Support Command
Training Directorate
Fort Lee, VA 23801-6000

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SUBCOURSE OVERVIEW

This subcourse was designed to provide the soldier with information on performing American Society for Testing and Materials (ASTM) tests, evaluating the preparation of chemical solutions, and directing mobile laboratory operations. SIMPLEX procedures, petroleum laboratory preventive maintenance programs, standardization and calibration of laboratory equipment, and petroleum laboratory supply will be covered as well.

There are no prerequisites for this subcourse.

This subject reflects the doctrine which was current at the time it was prepared. In your own work situation, always refer to the latest official publications.

Unless otherwise stated, the masculine gender of singular pronouns is used to refer to both men and women.

TERMINAL LEARNING OBJECTIVE:

ACTION: The soldier will acquire knowledge on performing ASTM tests, evaluating the preparation of chemical solutions, directing mobile laboratory operations, SIMPLEX procedures, petroleum laboratory preventive maintenance programs, standardization and calibration of laboratory equipment, and petroleum laboratory supply.

CONDITION: Given all applicable information.

STANDARDS: To demonstrate proficiency of this task you must achieve a minimum of 70 percent on the subcourse examination.

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ADMINISTRATIVE INSTRUCTIONS

1. Number of lessons in this subcourse: Seven

2. Materials you need in addition to this booklet are a No. 2 lead pencil, the ACCP examination response sheet, and the preaddressed envelope you received with this subcourse.

3. Supervisory requirement: None

GRADING AND CERTIFICATION INSTRUCTIONS

Examination. This subcourse contains a multiple-choice examination covering the material in the seven lessons. After studying the lessons and working through the practical exercises, complete the examination. Mark your answers in the subcourse booklet, then transfer them to the ACCP examination response sheet. Completely black-out the lettered oval which corresponds to your selection (A, B, C, or D). Use a No. 2 lead pencil to mark your responses. When you have completed the ACCP examination response sheet, mail it in the preaddressed envelope you received with this subcourse. You will receive your examination score by return mail. You will receive two credit hours for successful completion of this examination.

LESSON 1

PERFORMING ASTM TESTS

Critical Task:
101-523-3400

OVERVIEW

In order for a petroleum laboratory non-commissioned officer (NCO) to successfully perform ASTM tests, he or she needs to have knowledge of assembling the apparatus, calculating and reporting the results, and performing PMCS on the laboratory equipment.

Lesson Description:

This lesson covers the procedures for assembling the laboratory apparatus, performing the tests, calculating and reporting the results, and performing PMCS on the laboratory equipment.

Terminal Learning Objective:

Action: Acquire knowledge on performing PMCS, preparing and assembling laboratory apparatus for each test, calculating and reporting the results, completing DA Form 2077, and identifying the applicable safety procedures and environmental considerations.

Condition: Given all required materials.

Standards: These tasks will be accomplished according to MIL-STD-3004, MIL-HDBK-200 and ASTM Standards.

INTRODUCTION

As a Petroleum Laboratory Supervisor, you must perform various tests on petroleum products to determine if they can be utilized for their intended purposes. You must also be able to observe laboratory technicians in order to determine if they are performing the laboratory tests in accordance with the current Annual Book of ASTM Standards. Performing the laboratory tests allows you to handle and assemble the test apparatus, report the results of the tests, and determine if the product can be used for its intended purpose.

PART A - SIGNIFICANCE AND USE OF EACH TEST PROCEDURE (D-95, D-473, D-1319, D-1322, D-3338)

ASTM D-95 Standard Test Procedure for Water in Petroleum Products and Bituminous Materials by Distillation. This test method covers the determination of water in petroleum products, tars, and other bituminous materials by the distillation method.

- Significance - A knowledge of the water content of petroleum products is important in the refining, purchase, sale, and transfer of products.
- Use - The amount of water determined by this method is used to correct the volume involved in the custody transfer of oils.

ASTM D-473 Standard Test Method for Sediment in Crude Oils and Fuel Oils by the Extraction Method. This test method covers the determination of sediment in crude oils and fuel oils by extraction with toluene.

- Significance - A knowledge of the sediment content of crude oil and fuel oils is important both to the operation of refining and the buying or selling of the oil.
- Use - The amount of sediment determined by this method is used in the operation of refining and marketing fuel.

ASTM D-1319 Standard Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption. This test method is for determining hydrocarbon types over the concentration ranges from 5 to 99 volume % aromatics, 0.3 to 55 volume % olefins, and 1 to 95 volume % saturates in petroleum fractions that distill below 315°C.

- Significance - A knowledge of the total volume percent of saturates, olefins, and aromatics in petroleum fractions is important in describing the quality of petroleum fractions as gasoline blending components and as feeds to catalytic reforming processes.
- Use -This information is also important in describing petroleum fractions and products from catalytic reforming and from thermal and catalytic cracking as blending components for motor and aviation fuels.

ASTM D-1322 Standard Test Method for Smoke Point of Kerosene and Aviation Turbine Fuel. This test method covers a procedure for determination of the smoke point of kerosene and aviation turbine fuel.

- Significance - This test method provides an indication of the relative smoke producing properties of kerosene and aviation turbine fuels in a diffusion flame.
- Use - This information is quantitatively related to the potential radiant heat transfer from the combustion products of the fuel.

ASTM D-3338 Standard Test Method for Estimation of Net Heat of Combustion of Aviation Fuels. This test method covers the estimation of the net heat of combustion of aviation gasolines and aircraft turbine and jet engine fuels.

- Significance - A knowledge of this test method is a guide in cases where experimental determination of heat of combustion is not available and cannot be made easily and where an estimate is more satisfactory.
- Use - This method is not intended as a substitute for experimental measurements of heat of combustion. Instead, by establishing a correlation of application to other hydrocarbon distillates and hydrocarbons, the methodology can be used in determining heat combustion.

PART B - D-95 STANDARD TEST PROCEDURE FOR WATER IN PETROLEUM PRODUCTS AND BITUMINOUS MATERIALS BY DISTILLATION

Requirements and Warnings.

- Xylene/Toluene Warning. Flammable. Vapor harmful. Keep away from heat, sparks, and open flame. Keep container closed. Use with adequate ventilation. Avoid breathing of vapor or spray mist. Avoid prolonged or repeated contact with skin.
- Naphtha Warning. Extremely flammable. Harmful if inhaled. Vapors may cause flash fire. Keep away from heat, sparks, and open flame. Keep container closed. Use with adequate ventilation. Avoid a build-up of vapors and eliminate all sources of ignition, especially non explosion-proof electrical apparatus and heaters. Avoid prolonged breathing of vapors or spray mist. Avoid prolonged or repeated skin contact.
- Environmental precautions for this test method are to clean up all spills immediately. Dispose of hazardous materials and hazardous waste in accordance with (IAW) laboratory standard operating procedure (SOP). Report all hazardous material and hazardous waste spills immediately. Be familiar with and know the location of material safety data sheets (MSDS) for all hazardous materials present in the workplace.
- Apparatus for this test method includes a glass or metal still, a heater, a reflux condenser, and a graduated glass trap.
- Sampling requirement for this test: the size of the test portion should be based on the expected water content of the sample, such that the water yield does not exceed the capacity of the trap.

Testing procedure.

- Measure a suitable amount of sample to an accuracy of ± 1% and transfer it to the still.
- Measure ordinary liquid samples in a graduated cylinder of an appropriate size. Rinse the material adhering to the cylinder with one 50-ml and two 25-ml portions of the solvent-carrier liquid. Drain the cylinder thoroughly after the sample transfer and each rinsing.
- Weigh solid of viscous materials directly into the still and add 100 ml of the selected solvent-carrier liquid. In cases of material with a low-water content when large samples must be used, a solvent-carrier liquid volume in excess of 100 ml may be necessary.
- Glass beads or other boiling aids may be added if necessary to reduce bumping.
- Assemble the components of the apparatus, choosing the trap in accordance with the expected water content of the sample and making all connections vapor- and liquid-tight. If a metal still with a removable cover is used, insert a gasket of heavy paper, moistened with solvent, between the still body and the cover. The condenser tube and trap must be chemically clean to assure free drainage of water into the bottom of the trap. Insert a loose cotton plug in the top of the condenser to prevent condensation of atmospheric moisture inside it. Circulate cold water through the jacket of the condenser.
- Apply heat to the still, adjusting the rate of boiling so that condensed distillate discharges from the condenser at the rate of 2 to 3 drops per second. If the metal still is used, start heating with the ring burner about 76 ml (3 in.) above the bottom of the still and gradually lower the burner as the distillation proceeds. Continue distillation until no water is visible in any part of the apparatus except in the trap and the volume of water in the trap remains constant for 5 minutes. If there is a persistent ring of water in the condenser tube, carefully increase the rate of distillation or cut off the condenser water for a few minutes.
- When the evolution of water is complete, allow the trap and contents to cool to room temperature. Dislodge any drops of water adhering to the sides of the trap with a glass rod or other suitable means and transfer them to the water layer. Read the volume of the water in the trap to the nearest scale division.

Calculation and reporting procedures. Calculate the water in the sample, as weight or volume present, in accordance with the basis on which the sample was taken, as follows:

Water, %= V/W x 100
where:
V = volume of water in trap and
W = weight (or volume sample).
Volatile water-soluble material, if present, may be measured as water.

Report the results as the water content to the nearest 0.05% if the 2-ml receiver has been used and to the nearest 0.1% if the 10-ml or 25-ml receiver has been used with a 100-ml or 100-gram sample.

PART C - D-473 STANDARD TEST METHOD FOR SEDIMENT IN CRUDE OILS AND FUEL OILS BY THE EXTRACTION METHOD

Requirements and Warnings.

- Toluene Precaution - Keep away from heat, sparks, and open flame. Vapor harmful. Toluene is toxic.
- Additional Precaution - Care must be taken to avoid breathing the Toluene vapor and to protect the eyes. Keep container closed. Use with adequate ventilation. Avoid prolonged or repeated contact with the skin.
- Environmental precautions for this test method are to clean up all spills immediately. Dispose of hazardous materials and hazardous waste IAW laboratory SOP. Report all hazardous material and hazardous waste spills immediately. Be familiar with and know the location of MSDS for all hazardous materials present in the workplace.
- Apparatus for this test method consists of extraction apparatus, extraction flask, condenser, extraction thimble, thimble basket, water cup, and source of heat.
- Sampling for this test is obtained from the Practices of D 4057 and D 4177.

Testing procedure.

- For referee tests, use a new extraction thimble. For routine tests, thimbles may be reused. Before reusing a thimble, it must be heated to a dull red heat to remove the combustible portion of the accumulated sediment.
- Before using a new thimble, rub the outside surface with fine sandpaper and remove all loosened material with a stiff brush. Give the thimble a preliminary extraction with the toluene, allowing the solvent to drip from the thimble for at least 1 hour. Then dry the thimble for 1 hour at a temperature of 115 to 120°C; cool in a desiccator, without desiccant, for 1 hour, and weigh to the nearest 0.1 mg. Repeat this extraction until the masses of the thimble after two successive extractions do not differ by more than 0.2 mg.
- Place an estimated 10-gram test portion of the sample in the thimble immediately after the sample is mixed. Do not attempt to adjust this estimated 10-gram portion to any exact predetermined amount. Weigh to the nearest 0.01 gram. Place the thimble in the extraction apparatus, and extract with the hot toluene for 30 minutes after the solvent dropping from the thimble is colorless. Ensure that the rate of extraction is such that the surface of the mixture of oil and toluene in the thimble does not rise higher than to within 20 mm of the top.
- When testing samples have a high water content, any water in the test portion is removed as its toluene azeotrope and is collected in the water cup, where it separates as a bottom layer. The toluene layer overflows into the thimble. If the cup becomes full of water, allow the apparatus to cool and empty the cup.
- After the extraction is completed, dry the thimble for 1 hour at 115 to 120°C; cool in a desiccator, without desiccant, for 1 hour, and weigh to the nearest 0.2 mg.
- Repeat the extraction, allowing the solvent to drip from the thimble for at least 1 hour but not longer than 1.25 hour; dry, cool, and weigh the thimble. Repeat this extraction for further 1 hour periods, if necessary, until masses of the dried thimble plus sediment, after two successive extractions, do not differ by more than 0.2 mg.

Calculation and reporting procedures. Calculate the mass of the sediment as a percent of the original sample as follows:

$$\text{Mass \%} = \frac{\text{mass sediment}}{\text{original sample mass}} \times 100$$

Report the results to the nearest 0.01% as the mass percent of sediment by extraction. The test report shall reference this Test Method D 473 as the procedure used.

PART D - D-1319 STANDARD TEST METHOD FOR HYDROCARBON TYPES IN LIQUID PETROLEUM PRODUCTS BY FLUORESCENT INDICATOR ADSORPTION

Requirements and Warnings.

- Isoamyl Alcohol Warning - Flammable. Health hazard.
- Isopropyl Alcohol Warning - Flammable. Heath hazard.
- Pressuring Gas Warning - Compressed gas under high pressure.
- Acetone Warning - Flammable. Heath hazard.
- Environmental precautions for this test method are to clean up all spills immediately. Dispose of hazardous materials and hazardous waste IAW laboratory SOP. Report all hazardous material and hazardous waste spills immediately. Be familiar with, and know the location of MSDS for all hazardous materials present in the workplace.
- Apparatus for this test method consists of absorption columns, zone-measuring device, ultraviolet light source, electric vibrator, hypodermic syringe, and regulator.
- Sampling requirements are to get a sample according to procedures in practice D 4057. Store the sample until ready for analysis at 4°C.

Testing procedure.

- Freely suspend the column from a loose-fitting clamp placed immediately below the spherical joint of the charger section. While vibrating the column along its entire length, add small increments of silica gel through a glass funnel into the charger section until the separator section is half full. Stop the vibrator and add a 3 to 5-mm layer of dyed gel. Start the vibrator and vibrate the column while adding more silica gel. Continue to add silica gel until the tightly packed gel extends 75 mm into the charger section. Wipe the length of the column with a damp cloth while vibrating the column. This aids in packing the column by removing static electricity. After filling is complete, vibrate the column for about 4 minutes.
- Attach the filled column to the apparatus assembly in the darkened room or area, and when a permanently mounted meter rule is used, fasten the lower end of the column to the fixed rule with a rubber band.
- Chill the sample and a hypodermic syringe to 2 to 4°C. Draw 0.75 ±0.03-ml of sample into the syringe and inject the sample 30 mm below the surface of the gel in the charger section.
- Fill the charger section to the spherical joint with isopropyl alcohol. Connect the column to the gas manifold and apply 14 kPa gas pressure for 2.5 minutes to move the liquid front down the column. Increase the pressure to 34 kPa gage for another 2.5 minutes and then adjust the pressure required to give a transit time of about 1 hour. Usually a gas pressure of 28 to 69 kPa gage is needed for gasoline-type samples and 69 to 103 kPa gage for jet fuels. The pressure required will depend on the tightness of packing of the gel and the molecular weight of the sample. A transit time of 1 hour is optimum; however, high-molecular weight samples may require longer transit.
- Avoid touching the column with the hands during this operation. Also, direct exposure to ultraviolet light can be harmful, and operators should avoid this as much as possible, particularly with regard to their eyes.
- After the red, alcohol-aromatic boundary has advanced 350 mm into the analyzer section, make a set of readings by quickly marking the boundary of each hydrocarbon-type zone observed in ultraviolet light in the following sequence. For the nonfluorescent saturate zone, mark the front of the charge and the point where the yellow fluorescence first reaches its maximum intensity; for the upper end of the second, or olefin zone, mark the point where the first intense blue fluorescence occurs; finally, for the upper end of the third, or aromatic zone, mark the upper end of a reddish or brown zone. With colorless distillates, the alcohol-aromatic boundary is clearly defined by a red ring of dye. However, impurities in cracked fuels often obscure this red ring and give a brown coloration, which varies in length, but which shall be counted as a part of the aromatic zone; if no blue fluorescence is present, the brown or reddish ring shall be considered a part of the next distinguishable zone below it in the column. If boundaries have been marked off with index clips, record the measurements.
- When the sample has advanced another 50 mm down the column, make a second set of readings by marking the zones in reverse order as described in the previous step so as to minimize errors due to the advancement of boundary positions during readings. If the marking has been made with a glass-writing pencil, two colors can be used to mark off each set of measurements and the distances measured at the end of the test with the analyzer section lying horizontally on the bench top. If the boundaries have been marked off with index clips, record the measurements.
- Erroneous results can be caused by improper packing of the gel or incomplete elution of hydrocarbons by the alcohol. With precision bore columns, incomplete elution can be detected from the total length of the several zones, which must be at least 500 mm for a satisfactory analysis. With standard wall tubing, this criterion of total sample length is not strictly applicable because the inside diameter of the analyzer section is not the same in all columns.

- For samples containing substantial amounts of material boiling above 240°C, the use of isoamyl alcohol instead of isopropyl alcohol may improve elution.
- Release the gas pressure and disconnect the column. To remove used gel from the precision bore column, invert it above the sink and insert a long piece of No. 19-gage hypodermic tubing with a 45 angle tip through the wide end. By means of 6-mm outside diameter copper tubing at the opposite end for attaching a rubber tube, connect to a water tap and flush with a rapid stream of water. Rinse with residue-free acetone and dry by evacuation.

Calculation and reporting procedures. For each set of observations calculate the hydrocarbon types to the nearest 0.1 volume % as follows:

Aromatics, % volume = (La / L) x 100 (1)
Olefins, % volume = (Lo / L) x 100 (2)
Saturates, % volume = (Ls / L) x 100 (3)
where:
La = length of the aromatic zone, mm
Lo = length of the olefin zone, mm
Ls = length of the saturate zone, mm and
L = sum of La + Lo + Ls

Average the respective calculated values for each type. If necessary, adjust the result for the largest component so that the sum of the components is 100%. The above results can be corrected to a total sample basis as follows:

C = C x 100 - B / 100 (4)
where:
C = concentration of hydrocarbon type (% volume) on a total sample basis.
C = concentration of hydrocarbon type (% volume) on an oxygenate-free basis.
B = concentration of total oxygenate blending components (% volume) in sample.

Report the averaged value for each hydrocarbon type to the nearest 0.1 volume % and the total volume % oxygenates in the sample as calculated.

PART E - D-1322 STANDARD TEST METHOD FOR SMOKE POINT OF KEROSENE AND AVIATION TURBINE FUEL

Requirements and Warnings.

- Toluene Warning - Flammable. Vapor harmful. Keep away from heat, sparks, and open flame. Keep container closed. Use with adequate ventilation. Avoid breathing of vapor or spray mist. Avoid prolonged or repeated skin contact.
- Trimethylpentane Warning - Extremely Flammable. Harmful if inhaled. Vapor may cause flash fire. Keep away from heat, sparks and open flame. Keep container closed. Use with adequate ventilation. Avoid build-up of vapors and eliminate all sources of ignition, especially nonexplosion-proof electrical apparatus and heaters. Avoid breathing of vapor or spray mist. Avoid prolonged or repeated skin contact.
- Methanol Warning - Flammable. Vapor harmful. May be fatal or cause blindness if swallowed or inhaled. Cannot be made nonpoisonous. Keep away from heat, sparks and open flame. Keep container closed. Avoid contact with eyes and skin. Avoid breathing of vapor or spray mist. Use with adequate ventilation. Do not take internally.
- Heptane Warning - Extremely flammable. Harmful if inhaled. Vapor may cause flash fire. Keep away from heat, sparks, and open flame. Keep container closed. Use with adequate ventilation. Avoid build-up of vapors and eliminate all sources of ignition, especially nonexplosion-proof electrical apparatus and heaters. Avoid breathing of vapor or spray mist. Avoid prolonged or repeated skin contact.
- Environmental precautions for this test method are to clean up all spills immediately. Dispose of hazardous materials and hazardous waste IAW laboratory SOP. Report all hazardous material and hazardous waste spills immediately. Be familiar with and know the location of MSDS for all hazardous materials present in the workplace.
- Apparatus for this test method consists of smoke point lamp, wick, and pipettes or burettes.
- Sampling requirements for this test are aviation turbine fuel (a refined petroleum distillate) and kerosene (another refined petroleum distillate), boiling between 140 and 300°C, generally used in lighting and heating applications.

Testing procedure.

- The sample is burned in an enclosed wick-fed lamp that is calibrated daily against pure hydrocarbon blends of known smoke point.
- The maximum height of flame that can be achieved with the test fuel without smoking is determined to the nearest 0.5 mm.

Calculation and reporting procedures.

In the use of a correspondence between smoke point and luminometer number, the relationship is based on regression of data on 315 fuels having luminometer numbers falling within the range from -2 to 100. There were 160 Jet A, A-1, JP-4, and JP-5 fuels in this group. The remaining fuels were diesel fuels, kerosenes, blends of refinery fractions, and other miscellaneous petroleum fractions. The correlation coefficient is 0.95.

Reporting can be demonstrated through the confidence intervals about the correlation line which is explainable almost completely by the inherent error in the smoke point and luminometer measurements. This means that if there is a fuel-type effect different for each of the two methods, it is small and masked by smoke point and luminometer number measurement errors.

PART F - D-3338 STANDARD TEST METHOD FOR ESTIMATION OF NET HEAT OF COMBUSTION OF AVIATION FUELS

Requirements and Warnings.

- Safety precautions are not necessary for this test because it is an empirical (by observation) method. However, this method does not purport to address all of the safety concerns, if any, associated with its use.
- Environmental precautions, if any, are the responsibility of the user of this method to establish appropriate safety and heath practices and determine the applicability of regulatory limitations prior to use.
- Apparatus for this test method is not required because it consists of correlating observations.
- Sampling for this test consists of correlating various equations and formulas and substituting values relating to various fuels into the equations.

Summary of Test Method.

A correlation (6) in inch-pound units has been established between the net heat of combustion and gravity, aromatic content, and average volatility of the fuel. This correlation is converted to SI units; the relationship is given in the following equations:

Type Fuel: All aviation gasolines, aircraft turbine and jet engine fuels

Equation:

$$Qp1 = 16.24(G) - 3.007(A) + 0.01714(GxV) - 0.2983(AxG) + 0.00053(AxGxV) + 17685 \quad (1)$$

Or in SI units

$$Qp2 = [5528.73 - 92.6499A = 10.1601\,T + 0.314169AT] / D + 0.0791707A \quad (2)$$
$$-0.00944893T - 0.000292178AT + 35.9936$$

Where:

Qp1 = net heat of combustion, BTU/lb, sulfur-free basis
Qp2 = net heat of combustion, MJ/kg, sulfur-free basis
A = aromatics, volume %
G = gravity, API (American Petroleum Institute)
V = volatility: boiling point or average of Test Method D 86 10%, 50%, and 90% points, C.

To correct for the effect of the sulfur content of the fuel on the net heat of combustion, apply the following equation:

$$Q = Qp \times [1-0.01(S1)] + C(S1) \quad (3)$$

Where:

Q = net heat of combustion, megajoules/kilogram or British thermal unit (BTU) per pound, of the fuel containing S1 weight percent sulfur,
Qp = Qp1 (inch-pound units) or Qp2 (SI units),
S1 = sulfur content of the fuel, mass %, and

C = 0.10166 (SI units) or 43.7 (inch-pound units) = a constant based on the thermochemical data on sulfur compounds.

The empirical equations for the estimated net heat of combustion, sulfur-free basis, were derived by stepwise linear regression methods using data from 241 fuels, most of which conform to specifications for aviation gasolines and aircraft turbine or jet engine fuels.

Calculation and reporting procedures.

Calculate the net heat of combustion, sulfur-free basis, using equation No. 1. Round the value obtained to the nearest one-thousandth.

Example:
Sample: Kerosene
Determined Values:
Aromatics, A= 12.5% volume
Density, D = 805.0 kg/m^3
Distillation
T10 = 203C
T50 = 233C
T90 = 245C
T= (203 + 233 + 245) / 3 = 227C (4)
Calculated Value: A x T = 2837.5 (5)
Substitute into equation No. 2.
Qp2 = [5528.73 - 92.6499A = 10.1601(227)+ 0.314169 (2837.5)] / D + 0.0791707 (12.5) (2) - 0.00944893(227) - 0.000292178 (2837.5) + 35.9936
Therefore:
Qp2 = 43.4101015 = 43.410 MJ/kg, sulfur-free basis

Report the result to the nearest one-thousandth as net heat of combustion of the fuel in megajoules per kilogram.

LESSON 1

PRACTICE EXERCISE

The following items will test your knowledge of the material covered in this lesson. There is only one correct answer for each item. When you complete the exercise, check your answers with the answer key that follows. If you answer any items incorrectly, go back to the part of the lesson that contains the information involved and study again.

1. When conducting ASTM D-95, standard test procedure for water in petroleum products and bituminous materials by distillation, what formula is used in calculating and reporting the procedure?
   A. Mass % = _____mass sediment x 100.
   B. Olefins, % volume = (Lo/L) x 100.
   C. Water, % = V/W x 100.
   D. Qp1 = G - A + (G x V).

2. What is the significance of ASTM D-473?
   A. A knowledge of the water content of petroleum products is important in the refining, purchase, sale, and transfer of products.
   B. A knowledge of the sediment content of crude oil and fuel oils is important both to the operation of refining and the buying or selling of the oil.
   C. This test method provides an indication of the relative smoke producing properties of kerosene and aviation turbine fuels in a diffusion flame.
   D. A knowledge of this test method is a guide in cases where experimental determination of heat of combustion is not available and cannot be made easily and where an estimate is more satisfactory.

3. When conducting ASTM D-1319, standard test method for hydrocarbon types in liquid petroleum products by fluorescent indicator adsorption, where should you stand when attaching the filled column to the apparatus assembly?
   A. In a sunny area.
   B. Outdoors for proper ventilation.
   C. In a darkened room or area.
   D. Next to a fire extinguisher.

4. What comprises the apparatus for ASTM D-1322?
   A. Glass or metal still, heater, reflux condenser, and graduated glass trap.
   B. Extraction apparatus, extraction flask, condenser, extraction thimble, thimble basket, water cup, and source of heat.
   C. Apparatus for this test method is not required because it consists of correlating observations.
   D. Smoke point lamp, wick, and pipettes or burettes.

5. What makes up the sampling requirements for ASTM D-3338?
   A. Correlating various equations and formulas and substituting values relating to various fuels into the equations.
   B. Aviation turbine fuel and kerosene, boiling between 140 and 300°C, generally used in lighting and heating applications.
   C. The size of the test portion should be based on the expected water content of the sample, such that the water yield does not exceed the capacity of the trap.
   D. Get a sample according to procedures in practice D-4057.

LESSON 2

EVALUATING THE PREPARATION OF CHEMICAL SOLUTIONS, GLASSWARE, AND EQUIPMENT
Critical tasks:
101-523-3400

OVERVIEW

When evaluating the preparation of chemical solutions, the petroleum laboratory NCO should have knowledge of preparing chemical solution formulas, verifying the standardization procedures, and adhering to applicable safety procedures.

Lesson Description:

During this block of instruction we will discuss how to prepare chemical solution formulas, verify the standardization procedures, and adhere to applicable safety procedures.

Terminal Learning Objective:

Action: Acquire knowledge on evaluating chemical solution formulas used to prepare the chemical solutions and verify the standardization procedures.

Condition: Given all required materials.

Standards: These tasks will be accomplished according to FM 10-67-2.

INTRODUCTION

As a Petroleum Laboratory Specialist, you should observe laboratory technicians to insure they are preparing chemical solutions, and handling glassware and equipment correctly.

PART A - VERIFY THE PREPARATION OF CHEMICAL SOLUTIONS

As a petroleum laboratory supervisor, you must ensure that chemical solutions are prepared correctly by considering the following questions:
Has the glassware been cleaned and prepared properly?

- Wash the glassware with soap and water; rinse with tap water and then distilled water.
- Air-dry in the inverted position, if time permits, or in drying oven.
- If chemical cleaning is necessary, soak the glassware in chromic acid for 6 hours; rinse with tap water, and then distilled water.
- Chemicals are inherently dangerous, safety precautions should always be adhered to when chemicals are being handled.

Was the correct formula used?

- Determine the amount of solid solute needed, using the formula W = (V) (N) (MEW) / DEP.
- Determine the volume of liquid needed, using the formula W = (1000) (0.01).

Were the selected chemicals weighed properly ?
Was the correct standard selected to standardize an acid or base?
Was the primary standard paired correctly?

- Weigh a clean, dry Erlenmeyer flask on the analytical balance.
- Add the grams of primary standard calculated weighing a substance using the appropriate balance. Record the weight to the fourth decimal place.
  - Use the analytical balance
  - Use the Harvard Trip balance.
- Dissolve the primary standard in an unmeasured quantity of distilled water.
- Add two or three drops of indicator to the solution.

Indicators are dyes that change the color, depending on the degree of acidity or alkalinity, of a solution. They also show the concentration of hydrogen ion of a solution, and they can be used in volumetric analysis to mark the end of titration, the point of completion of a neutralization reaction.

PART B - EVALUATE CHEMICAL SOLUTION FORMULAS USED BY LABORATORY TECHNICIANS

Determine the amount of solid solute needed, using the following equation:

$$W = \frac{(V)(N)(MEW)}{DFP}$$

Where:
W = Weight of solute needed, in grams.
V = Volume solution to be prepared, in ml.
N = Desired normality of solution to be prepared.
MEW = Milli-equivalent weight of solute, grams/milli-equivalents.
To determine MEW, the EW must first be determined:

$$EW = \frac{\text{Molecular Weight}}{\text{Total Positive Valence}}$$

Then:
The MEW will be determined:

$$MEW = \frac{\text{Equivalent}}{\text{Weight}}$$

1000

Determine the volume of liquid needed, using the following equation:

$$V1 = \frac{(V2)(N)(MEW)}{(DFP)\ (SPGR)}$$

Where:
V1 = Volume of solute needed.
V2 = Volume of solution to be prepared, in ml.
N = Desired normality of solution to be prepared, in ml.
MEW = Milli-equivalent weight of the solution.
DFP = Decimal fractional purity of solute.
SPGR = Specific gravity of solute.

PART C - REVIEW STANDARDIZATION PROCEDURES ENSURING THAT CHEMICAL SOLUTIONS ARE STANDARDIZED AT THE REQUIRED INTERVALS

As a senior petroleum laboratory technician, you must evaluate solutions to ensure that they have been standardized at the required interval. Standardization procedures include:
Set up the titration apparatus.

- Verify that the burettes are clean and serviceable, to include tips and proper fitting stopcocks.
- Rinse burettes several times in solution to be titrated.

Change burettes with solution; zero burettes before titration.
Titrate the primary standard in the Erlenmeyer flask with the solution in the burette.

- Swirl the flask during titration to ensure homogeneous mixing. Wash down the insides of the flask to ensure no titration solution is clinging to the sides of the flask.
- Titrate slowly as the end point approaches.
- Record the volume of solution used to reach the end point.

Repeat the titration procedure at least two additional times.
Calculate normality to four decimal places. Perform calculation for each titration using the following equation:

$$N = \frac{(W)(DFP)}{(MEW)\ (V)}$$

Where
N = Normality of solution.
W = Weight of primary standard use in grams.
DFP = Decimal fractional purity of primary standard.
MEW = Milli-equivalent weight of primary standard.
V = Volume of solution used, ml.

Obtain the average value of normality titrated.
Label the standardization solution for identification. Include the date standardized, the type of solution, the normality, and the rank and name of the person who standardized it.

LESSON 2

PRACTICE EXERCISE

The following items will test your knowledge of the material covered in this lesson. There is only one correct answer for each item. When you complete the exercise, check your answers with the answer key that follows. If you answer any items incorrectly, go back to the part of the lesson that contains the information involved and study again.

1. When verifying the preparation of chemical solutions, what can indicators be used for?
   A. Standardizing an acid or base.
   B. Air-drying glassware.
   C. Determining the amount of solid solute needed.
   D. In volumetric analysis to mark the end of titration.

2. When determining the amount of solid solute needed in the preparation of a chemical solution, what does N represent in the equation?
   A. Desired normality of solution to be prepared.
   B. Volume solution to be prepared.
   C. Weight of solute needed.
   D. Milli-equivalent weight of solute.

3. When determining the volume of liquid needed in the preparation of a chemical solution, what does DFP represent in the equation?
   A. Decimal fractional purity of primary standard.
   B. Decimal fractional purity of solute.
   C. Volume of solute needed.
   D. Volume of solution to be prepared.

4. When reviewing standardization procedures, what should be done before titration?
   A. Swirl the flask.
   B. Zero burettes.
   C. Record the volume of solution used to reach the end point.
   D. Calculate normality to four decimal places.

5. How many times should the titration procedure be repeated?
   A. No more than two additional times.
   B. At least once.
   C. At least two additional times.
   D. No more than once.

LESSON 3

SIMULATED PETROLEUM PROCEDURES
Critical task:
101-523-3400

OVERVIEW

Knowledge of preparing, evaluating, and verifying the accuracy and completeness of the petroleum laboratory analysis reports is important for the petroleum laboratory NCO during SIMPLEX procedures.

Lesson Description:

During this block of instruction we will discuss preparing, evaluating, and verifying the accuracy and completeness of the petroleum laboratory analysis reports.

Terminal Learning Objective:

Action: Acquire knowledge on preparing, evaluating, and verifying the accuracy and completeness of the petroleum laboratory analysis reports.

Condition: Given all required materials.

Standards: This task will be accomplished according to MIL-HDBK-200.

INTRODUCTION

As a petroleum laboratory supervisor, you must observe laboratory technicians to evaluate their testing procedures and follow-up on corrections of their deficiencies.

PART A - VERIFY THAT THE CORRECT TEST METHOD IS SELECTED IAW PRODUCT SPECIFICATIONS

Recommendations. The recommendation for use of a petroleum product is the prime responsibility of the noncommissioned officer in charge (NCOIC) of a laboratory. The use of a petroleum product is based on the results of tests performed by technicians assigned to the laboratory. Therefore, it is important to ensure the correct test method is utilized and all test procedures are strictly followed. Evaluation of a new technician's laboratory techniques and knowledge of appropriate procedures is essential during the first 90 days on the job, as well as periodically thereafter. During the initial 90-day period, correct techniques can be implemented and deficiencies eliminated. In addition, periodic checking thereafter will serve as reinforcement.

Reference Materials. To enable 77L30 soldiers to manage this phase of laboratory administration, they must be thoroughly familiar with the following reference materials:

- Military specifications. Each product has its own specification. A specification is a clear, concise, and accurate description of the technical requirements of a material or product and includes the procedures for determining when requirements have been met. Specific ASTM or Federal Test Method Standard (FTMS) are found in section II and section IV of the specification. Minimum and/or maximum test limits are found in section III of the specification.
- ASTM Standards 05.01, 05.02, 05.03, and 05.04. The ASTM contains the majority of test procedures used by petroleum laboratory technicians. It is published annually in March. The ASTM may be purchased from the American Society for Testing Materials.
- FTMS No. 791. Federal test methods cover those methods adopted for use by federal agencies. Usually, only the federal test methods without adopted ASTM test standards are included in the publication.
- (Military Handbook) MIL-HDBK-200. This handbook provides general instructions and procedures to be used worldwide by the military services in quality surveillance of government-owned fuels, lubricants, and related products. Frequently used special test procedures are found in the appendices.

PART B - IDENTIFY DEFICIENCIES IN TEST METHOD PROCEDURES BY COMPARING THE TECHNICIAN'S PROCEDURE WITH THE TEST METHOD

Testing Errors. It is impossible to list all the errors that may occur when performing various tests since test methods differ greatly. However, the following list contains the general areas you should watch.
Procedures.

- Is the correct ASTM or FTM standard being used as outlined in the specification?
- Are all safety procedures being observed?
- Is the correct sequence being followed?

Glassware.

- Is the glassware correct for the test method?
- Is it clean and serviceable?

Sample preparation.

- Was the sample can shaken?
- Was the correct amount used?
- Was the sample prepared according to the test method?
  - Was the sample cooled to a specific temperature range?
  - Was the sample heated to a specific temperature range?
  - Was the sample filtered?
  - Was the sample dehydrated?

Chemicals.

- Were the correct chemicals and/or indicators used?
- Was the correct amount used?

- Was the chemical outdated/standardized?
- Was it cloudy? If so, was it filtered or was supernatant used?
- If a substitute was used, is it acceptable according to ASTM procedures?

Equipment.

- Bath and oven temperatures must be checked before, during, and upon completion of a test.
- Correctly calibrated thermometers must be used.
- Thermometers must be checked for liquid separation.
- Heating rates and times must be as stated in the text.
- Apparatus must be cooled to room temperature prior to performing another test.

Other.

- Ensure correct size of flame (flash point, Conradson carbon residue [CCR]).
- Ensure correct size of filter (millipore).
- Ensure removal of air bubbles (API gravity, penetration).
- Ensure correct relative centrifugal force (RCF)/revolutions per minute (RPM) (bottom sediment and water [BS&W], precipitation number).
- Ensure correct amount of pressure (gum, foam, oxidation stability).
- Ensure the use of one of the following to determine the correction factor, if needed.
  - Manometer.
  - Barometer.
  - Thermometer.
- Ensure procedure is correctly reported.

Test Evaluation Process (Procedural Example). The following steps are taken to perform the test evaluation:

- Given a petroleum sample, complete with sample tag, DA Form 1804 (Petroleum Sample).
- Determine the military specification number. This number is found on the sample tag and on the sample can.
- Determine the product properties. These are found in the military specification.
- Determine the test procedure. Look up the Carbon residue test in the specification.
- Perform the test in conjunction with ASTM D-524. You must perform all steps in the proper sequence. Observe the test being performed and ensure each step is done "by the book."

PART C - REVIEW DA FORM 2077 FOR COMPLETENESS AND ACCURACY

When a sample is turned into the petroleum laboratory for analysis, the senior petroleum laboratory technician transfers the information from the DA Form 1804 (Fig. 3-1) to the heading of the DA Form 2077 (Fig. 3-2).

- Product Nomenclature.
- Specification No.
- Sample Submitted By.
- Amount Product Sample Represents.
- Manufacturer or Supplier of Product.
- Source of Sample.
- Sample Taken By.
- National stock number (NSN).
- Date Sample Taken.

DA FORM 1804 1 NOV 67 PETROLEUM SAMPLE (FM 10-67-1)		REPLACES EDITION OF 1 DEC 62, WHICH IS OBSOLETE, USE REVERSE SIDE FOR REMARKS
PRODUCT COMBAT GRADE TYPE I MOGAS		
FROM (Installation) CHARLIE COMPANY, 103RD QM BATTALION		
SAMPLE NO. 99-13		LABORATORY NO.
PRODUCT COMBAT GRADE TYPE I MOGAS		
SPECIFICATION NO. MIL- G - 3056		AMT. PRODUCT SAMPLE REPRESENTS 75,000 GALLONS
FROM (Intallation) CHARLIE COMPANY, 103RD QM BATTALION		
MANUFACTURER / SUPPLIER FRANKLIN OIL COMPANY, LAFAYETTE, LA		
SAMPLE SOURCE	TRUCK NO.	TANK NO. 9 / OTHER (Specify)
SAMPLED BY (Name) PVT. W. BANKS		ARMED SERVICES PROCUREMENT NO.
STOCK NO. 9130- 00- 160 - 1818		DATE SAMPLED 15 JAN 1999
QUALIFICATION NO. NA		BATCH NO. NA
FILL DATE NA		SHIPMENT DELIVERY DATE 27 DEC 1998
CONTRACT BULLETIN NO. NA		ITEM NO. NA
_X_FUEL BULK STORAGE	___ROUTINE SURVEILLANCE	___FUEL PACKAGED / ___PROCUREMENT ORIGIN
___ALLIED PRODUCTS	___PROCUREMENT	___FILTER EFFECTIVENESS
___SPECIAL	___QUAL CONTRACT	___DEPOT
TYPE SAMPLE	___TOP	___MIDDLE / _X_BOTTOM
___COMPOSITE	__OTHER (Specify)	

Fig. 3-1. DA Form 1804

Once this information has been transferred to the DA Form 2077, the senior technician then enters the following information:

- Sample No.
- Lab Report No.
- Type of Test(s) to be Performed According to Specification Requirements.
- Date Sample Received.
- Date Test Started.
- Date Test Completed.

Upon completion of the specified test(s), the laboratory technician forwards the results to the senior laboratory technician for review. The senior laboratory technician reviews the results for accuracy and enters the results and a recommendation for disposition on the DA Form 2077 “work copy” and forwards it to the laboratory NCOIC for review approval.

Once the petroleum laboratory NCOIC has approved the results and disposition recommendation, a typed DA Form 2077 is prepared from the approved work copy. The original is kept in a permanent file and enough copies to satisfy all interested parties are forwarded to the requesting agency.

PETROLEUM PRODUCTS LABORATORY ANALYSIS REPORT
For use of this form, see FM 10-67-2; The proponent agency is TRADOC

SAMPLE NO. **XX - 017** | LAB REPORT NO. **XX - 1717**

PRODUCT NOMENCLATURE AND TYPE: **FUEL OIL, DIESEL, MARINE DFM** | SPEC. NO. **MIL-F-16884**

SAMPLE SUBMITTED BY *(Installation)*: **POHANG TERMINAL, KOREA** | AMT PROD SAMPLE REPRESENTS: **10 M BBLS**

MANUFACTURER OR SUPPLIER OF PRODUCT: **PDSK-Trans Korean Pipeline Korea (CONUS)** | SOURCE OF SAMPLE *(Truck, Tank, Aircraft, etc.)*: **Tank 25 (Multi Prod Line Used)**

SAMPLE TAKEN BY *(Name)*	CONTRACT NO.	ITEM NO.	FSN	DATE SAMPLE TAKEN
BP5 JENNINGS			**914-00-273-2377**	**12 Feb 99**

QUAL NO.	BATCH NO.	FILL DATE	DLVR DATE	DATE SAMPLE REC
		5 FEB 99		**12 Feb 99**

NAME AND LOCATION OF LABORATORY: **Pohang Laboratory, Camp Libby, Korea**

x FUEL BULK STORAGE
☐ FUEL PACKAGED
☐ ALLIED PRODUCTS
☐ FILTER EFFECTIVENESS
☐ QUALIFICATION CONTRACT
☐ ROUTINE SURVEILLANCE
☐ PROCUREMENT ORIGIN
☐ PROCUREMENT
☐ SPECIAL
☐ DEPOT

DATE TESTS STARTED: **12 Feb 99**
DATE TESTS COMPL: **12 Feb 99**

TEST	SPEC/QUAL	RESULT	TEST	SPEC/QUAL	RESULT
1. GRAVITY °API/SP GR 60°/60°F TOP			27. WATER AND SEDIMENT % VOL MAX		
a. MID			28. FSII % VOL TOP		
b. BOT			*a.* MID		
c. AVG	**RPT**	**35.0**	*b.* BOT		
2. APPEARANCE/~~WORKMANSHIP~~	**C& B**	**Opaque**	*c.* AVG		
3. COLOR VISUAL			29. PARTICULATE CONTAMINANT MGS/GAL		
a. HELLIGE *(Colorimeter)*			30. THERMAL STABILITY INCHES HG		
b. ASTM MAX/SAYB MIN	**3**	**4**	*a.* PREHEATER RATING		
c. SAYB AFTER HEAT MIN			31. SULFIDES *(Tank Water BTMS)*		
4. ODOR			32. WATER SEPAROMETER INDEX MIN		
5. DISTILLATION 1BP **°C**	**RPT**	**171.0**	33. % ASH PLAIN/SULF MAX		
a. 5 % REC - EVAP AT **°C**	**RPT**	**300.0**	34. % LEAD		
b. 9 % REC - EVAP AT **°C**	**357**	**360.0**	35. % PHOSPHORUS		
c. % REC - EVAP AT **°C**			36. % CHLORINE		
d. % REC - EVAP AT **°C**			37. BURNING TEST *(16 hrs)*		
e. FBP/~~DRY~~ PT **MAX °C**	**385**	**388.0**	38. KIN CS/SSU AT °F		
f. % RECOVERED	**RPT**	**96.0**	*a.* KIN CS/SSU AT °F		
g. % LOSS			*b.* KIN CS/SSU AT °F		
h. % RESIDUE + Loss **MAX**	**3.0**	**4.0**	*c.* KIN CS/SSU AT °F		
i. 10% + 50% EVAP °F MIN			*d.* SSF AT °F		
6. ENGINE RATING O.N. MOTOR METHOD			*e.* VISCOSITY INDEX MIN		
a. ON RESEARCH METHOD			39. EVAP LOSS % MAX		
b. LMR AVIATION METHOD			40. PRECIPITATION NO MAX		
c. RMR SUPER CH METHOD			41. SEPARATION % MAX		
d. CETANE NUMBER/INDEX MIN			42. ACID NO/BASE NO MAX		
7. RVP *(PSI)*			43. CHANNEL PT °F MAX		
8. GUM EXISTENT MG/100 ML MAX			44. SAPONIFICATION NO MAX		
GUM *(Wash)* MG/100 ML MAX			45. DIELECTRIC STRENGTH KV MIN		
GUM POTENTIAL MG/100 ML MAX			46. FOAM SEQ 1. MLS MAX *(TND/STAB)*		
PRECIPITATE MG/100 ML MAX			*a.* SEQ 2. MLS MAX *(TND/STAB)*		
9. TEL/TML *(ML/GM/GAL)* MAX			*b.* SEQ 3. MLS MAX *(TND/STAB)*		
10. OXIDATION STABILITY MINUTES			47. PENETRATION UNWORKED 77°F		
11. DR TEST/MERC S% MAX			*a.* PENETRATION WORKED 77°F		
12. SULFUR BY LAMP BOMB % MAX			48. DROP PT/MELT PT °F MIN		
13. FREEZING PT °F			49. CORR AND OXIDATION STAB		
14. CORROSION COPPER STRIP **3 HR @ 122 degrees F**			50. SWELLING SYN RUBBER %		
15. AROMATICS % VOL MAX			51. LOW TEMP STABILITY		
16. OLEFINS % VOL MAX			52. SALT SPRAY TEST		
17. SMOKE POINT MM MIN			53. WORK STABILITY		
18. SMOKE VOLAT INDEX MIN			54. WATER STABILITY		
19. ANILINE PT °F/ANILINE GRAV PROD MIN			55. THICKENER TYPE		
20. FLASH/~~FIRE~~ POINT °C MIN	**60**	**80**	56. THICKENER CONTENT %		
21. CLOUD POINT °F MAX			57. CORROSION PROTECTION		
22. POUR POINT °F MAX			58. REMOVAL		
23. WATER REACT INTERFACE RATING MAX			59. APPARENT VISC AT °F		
a. VOLUME CHANGE MAX			*a.* SHEAR RATE POISES		
24. CARBON RESIDUE % WT MAX **10% Bottom**	**.20**	**0.258**	60. S ED CONTAM. MILLIPORE, MG/L, MAX		
25. WATER % VOL MAX			61. EFFECTIVENESS OF FILTRATION		
25. SEDIMENT % VOL MAX			62. OTHER *(Specify)*		

REMARKS
SFU. Item # 5.h. within use limits. Recommend using ashore as boiler fuel or in low-speed stationary diesel engines.

DATE FORWARDED	SIGNATURE	TITLE

DA FORM 2077 EDITION OF 1 MAR 62, IS OBSOLETE HU.S. GPO: 1989-0-230-313

Fig. 3-2. DA Form 2077

The proper completion of DA Form 2077 cannot be stressed enough; as you know, there are many factors involved with the recommended disposition of petroleum products. Some of these factors are as follows:

- Large Amounts of Product.
- Mission Essential Requirements.
- Safety.
- Environmental Concerns.

As the senior laboratory technician you must make every effort to ensure that DA Form 2077 is completed as we've discussed and reviewed for accuracy at the required intervals

PART D - INSTRUCT THE TECHNICIAN IN THE CORRECT PROCEDURE WHEN DEFICIENCIES ARE OBSERVED

Correcting deficiencies. Many times corrective action makes rerunning the test necessary. The procedure must be done "by the book" for the result to have meaning. The following actions are taken:

- Look at sample can or tag to find the specification number. If it is not on the tag, call the submitting unit or look in the 9100 Identification List (IL) microfiche for the correct specification number.
- Check the specification to find the test to be run and the correct method.
- Check the appropriate test book (ASTM or FTMS) to find the correct test method to be used.
- Observe the technician to ensure he uses the method correctly.
- Perform corrective action if needed.
- Take the following steps if incorrect test procedures are discovered:
  - Stop the test.
  - Identify all errors.
  - Explain the effect the errors may have on the outcome of the test.
  - Have the technician review the test procedures.
  - Have the test rerun by the technician while you observe the procedures.

LESSON 3

PRACTICE EXERCISE

The following items will test your knowledge of the material covered in this lesson. There is only one correct answer for each item. When you complete the exercise, check your answers with the answer key that follows. If you answer any items incorrectly, go back to the part of the lesson that contains the information involved and study again.

1. At what time(s) during a test should bath and oven temperatures be checked?
   A. Before the test.
   B. During the test.
   C. After the test.
   D. Before, during, and after the test.

2. What information does MIL-STD-3004/MIL-HDBK-200 provide?
   A. Clear, concise, and accurate description of the technical requirements of a material or product and the procedures for determining when requirements have been met.
   B. General instructions and procedures to be used worldwide by the military services in quality surveillance of government owned fuels, lubricants, and related products.
   C. Test methods adopted for use by federal agencies.
   D. Majority of test procedures used by petroleum laboratory technicians.

3. Which of the following is a step in the test evaluation process?
   A. Filter all samples according to the test method.
   B. Use supernatant on all chemicals to prevent cloudiness.
   C. Use the manometer on all samples to determine the correction factor.
   D. Perform all steps in the proper sequence.

4. Which of the following information is transferred from DA Form 1804 to the heading of DA Form 2077?
   A. Specification No.
   B. Date Test Started.
   C. Sample No.
   D. Lab Report No.

5. What should you do if incorrect test procedures are discovered?
   A. Call the submitting unit.
   B. Observe the technician carefully.
   C. Stop the test and identify all errors.
   D. Forward the results to the requesting agency.

LESSON 4

PETROLEUM LABORATORY PREVENTIVE MAINTENANCE PROGRAM
Critical task:
101-523-3403

OVERVIEW

When developing a preventive maintenance SOP, it is necessary for the petroleum laboratory NCO to have knowledge of preventive maintenance, safety and environmental hazard briefing verification, hazardous waste storage/disposal, and safety requirements for a petroleum laboratory.

Lesson Description:

During this block of instruction we will discuss preventive maintenance, safety and environmental hazard briefing verification, hazardous waste storage/disposal, and safety requirements for a petroleum laboratory.

Terminal Learning Objective:

Action: Acquire knowledge on identifying maintenance requirements, establishing a maintenance schedule, developing a preventive maintenance SOP, and identifying safety procedures and environmental considerations.

Condition: Given all required materials.

Standards: This task will be accomplished according to DA PAM 738-750.

INTRODUCTION

To remain mission-ready, petroleum laboratory personnel must constantly and carefully maintain all equipment and systems. All equipment that cannot be maintained in-house must be sent to the appropriate outside maintenance support units. The procedures and considerations that must be followed are contained in a preventive maintenance SOP. All personnel are expected to thoroughly understand and carry out the steps contained within.

PART A - MAINTENANCE STANDARD OPERATING PROCEDURES

Maintenance of equipment is a necessary function of any petroleum laboratory. Normally, 77Ls learn maintenance procedures through practical experience in the laboratory under qualified supervision. Personnel who do not have the chance to learn through actual hands-on experience should be directed to review maintenance manuals, manufacturer's instructions, and similar references for maintenance requirements on specific equipment.

In addition to specific pieces of laboratory test equipment, there are other items associated with the laboratory which require periodic maintenance. Such items include air compressors, vacuum pumps, generators, and in some cases, motor vehicles. In order to keep the laboratory operating at maximum efficiency, it is important that all assigned personnel be knowledgeable in the maintenance of all equipment assigned to the laboratory and maintain a workable system of maintenance records. The procedures to be followed should be organized into a preventive equipment maintenance SOP.

Preventive maintenance of equipment is a necessary function of every petroleum laboratory to ensure that it operates at maximum efficiency. An SOP establishes a standardized and workable system to maintain records, publications, training, and standard procedures for the laboratory. The preventive maintenance SOP contains the following sections:

- Purpose: This section describes the purpose of preparing and maintaining the SOP.
- Scope: This section describes the broad concepts of equipment maintenance, proper record keeping, and training of personnel.
- Responsibilities: This section describes the specific responsibilities of all personnel assigned to the laboratory. Because maintenance personnel are not assigned to petroleum laboratories, all laboratory personnel must perform operator maintenance on the equipment.
- Procedures: This section describes the procedures followed concerning equipment maintenance, record keeping, and personnel training on a daily, weekly, monthly, etc., basis. Instructions for maintaining the laboratories and their special components are in the applicable TMs.
- Record keeping: This section describes the purpose, use, instructions for completion, and disposition of forms and other record-keeping systems that must be followed.
- Equipment maintenance: This section lists equipment and systems that must be maintained on a periodic basis.
- Miscellaneous: This section contains other specifics such as definitions, when to use/not use specific forms, symbols, special instructions, and calibration of equipment.
- References: This section lists the references used to guide personnel in SOP procedures. When establishing maintenance requirements for petroleum laboratory equipment, the operator, organizational, direct support, and general support maintenance manuals should be used.

Listed below are the specific manuals to be consulted:

Petroleum Base Laboratory.

- TM 5-6640-214-14.
- TM 10-1161, C2.
- FM 10-67-2.

Airmobile Aviation Fuel Laboratory.

- TM 5-6640-213-14.
- TM 5-4120-295-15.
- TM 9-2330-271-14.
- FM 10-67-2.

Mobile, Semitrailer Mounted Petroleum Laboratory.

- TM 5-6640-212-14.
- TM 5-4120-274-15.
- TM 11-5410-213-14P.

- FM 10-67-2.

Supplemental maintenance requirements can be obtained from instruction maintenance booklets or owner/operator manuals usually supplied from the manufacturers of the various equipment. If not available, they may be requested from the appropriate manufacturer through command or supply channels.

Maintenance Intervals. Maintenance intervals are established by the appropriate maintenance manual (TMs, FMs, or operator's maintenance manual) covering a particular unit. Depending on where the equipment may be physically located, there could be local factors that would increase maintenance intervals such as dust, temperature, and humidity. Age of equipment and maintenance history of equipment could also require an increase of preventive maintenance.

Laboratory personnel should always be aware of symptoms in equipment that may indicate a change in the interval of preventive maintenance is needed. Such examples might be temperature, vibration, reduced efficiency, noise, and smell. All maintenance intervals that are established should be recorded in the maintenance schedule and maintenance SOP.

Maintenance Schedule Check Sheet. A maintenance schedule check sheet should be prepared detailing the maintenance to be performed on each piece of equipment. Variations may be used to keep track of upcoming PMCS events.

Suspense Folders. Suspense folders containing DD Form 314 (Preventive Maintenance Schedule and Record) should be maintained. These folders are given to technicians in the laboratory to check the listed items and perform the required maintenance. A checklist format is satisfactory. The equipment in the laboratory, whether in use or not, should remain in a high state of readiness.

Use of DD Form 314 (Preventive Maintenance Schedule and Record). The DD Form 314 is used to show when equipment is scheduled for periodic preventive maintenance and when maintenance has been performed. The reverse side of DD Form 314 is used to record the time a piece of equipment was not mission-capable either because of maintenance or because repairers were waiting for parts from supply. Not all preventive maintenance should be recorded on DD Form 314.

Only preventive maintenance that is performed on a time or mileage basis should be scheduled and recorded on DD Form 314. For example, DD Form 314 should be used to schedule and record maintenance that is done every 3 months, after 1,000 hours of operation, or every 5,000 miles.

PART B - COMPLETE DA FORM 2407 WHEN REQUESTING MAINTENANCE SUPPORT

DA Form 2407 (Fig. 4-1) is used by organizational maintenance personnel mainly to request support maintenance. It is used when organizational maintenance personnel cannot repair a piece of equipment because of a lack of ability or proper tools. All copies of DA Form 2407 are sent with the faulty equipment to the support activity. The receipt copy is sent back to the owning organization where it is kept on file until the equipment is returned.

DA Form 2407 is also used to report maintenance on certain sample items and to submit warranty claims. DA Form 2407-1 is used where there are not enough lines on DA Form 2407. DA Form 2405 is used by the owning organization to keep a record of DA Forms 2407 sent to support maintenance.

Purpose. Both DA Form 2407 (Maintenance Request) and DA Form 2407-1 (Maintenance Request Continuation Sheet) serve as a request for maintenance support and give information to all levels of maintenance management.

The DA Forms 2407/2407-1 are the source of information for the Army's work order data base, called the Work Order Logistics File (WOLF) that provides statistical weapon analyses such as mean time to repair and repair parts usage at the Direct Support (DS)/General Support (GS) levels of maintenance for selected major weapon systems.

MAINTENANCE REQUEST
For use of this form, see DA PAM 738-750 and 738-751; the proponent agency is DCSLOG

PAGE NO	NO OF PAGES	REQUIREMENT CONTROL SYMBOL CSGLD-1047(R1)

SECTION I - CUSTOMER DATA

1a. UIC CUSTOMER	1b. CUSTOMER UNIT NAME	1c. PHONE NO
	Seamman Lab	

2a. SAMS-2 UIC/SAMS-I/TDA	2b. UTILIZATION CODE	2c. MCSR

SECTION II - MAINTENANCE ACTIVITY DATA

3a. WORK ORDER NUMBER (WON)	3b. SHOP	3c. PHONE NO

4a. UIC SUPPORT UNIT	4b. SUPPORT UNIT NAME

SECTION III - EQUIPMENT DATA

5. TYPE MNT REQ CODE	6. ID	7. NSN
	A	4540 00401 3905

8. MODEL	
9. NOUN	Petroleum Laboratory Heater

10a. ORG WON/DOC NO	10b. EIC

11. SERIAL NUMBER	12. QTY	13. PD

14. MALFUNCTION DESCRIPTION (for DSU, GSU/AVIM, DEPOT use)

15a. FAILURE DETECTED DURING/WHEN DISCOVERED CODE (Enter code) See DA Pamphlets 738-750 and 738-751	

15b. FIRST INDICATION OF TROUBLE/HOW RECOGNIZED CODE (Enter Code) See DA Pamphlets 738-750 and 738-751	16. MILES/KILOMETERS/HOURS/ROUNDS M	K	H: 427	R

17. PROJECT CODE (if assigned)	18. ACCOUNT PROCESSING CODE	19. IN WARRANTY? (enter Y or N)	20. ADMIN NO

21. REIMBURSABLE CUSTOMER (if intransit customer enter Y or N)	
22. LEVEL OF WORK	23. SIGNATURE

24. DESCRIBE DEFICIENCIES OR SYMPTOMS ON THE BASIS OF COMPLETE CHECKOUT AND DIAGNOSTIC PROCEDURES IN EQUIPMENT TM (Do not prescribe repairs)

Heating elements not functioning

25. REMARKS

26. TECHNICAL REFERENCES

SECTION IV - TASK REQUIREMENTS DATA

27a. FILE INPUT ACT CD	27b. TASK NO	27c. ACT CODE	27d. TASK DESCRIPTION	27e. QTY TO BE RPR	27f. WORK CENTER	27g. FAILURE CODE	27h. MH PROJ	27i. MH EXP

SECTION V - PART REQUIREMENTS

28a. FILE INPUT ACT CD	28b. TASK NO	28c. ID NO	28d. NSN OR PART NUMBER	28e. SFX CD	28f. QTY RQD	28g. QTY ISSUED	28h. NMCS CD	28i. FAILURE CODE	28j. STORAGE LOCATION	28k. INITIALS	28l. COST $

28m. TOTAL MANHOURS	28n. TOTAL MANHOURS COSTS $	28o. TOTAL PARTS COSTS $	

SECTION VI - COMPLETION DATA

29. QTY RPR	30. QTY CONDEMN	31. QTY NRTS	32. EVAC WON	33. EVAC UNIT NAME

SECTION VII - ACTION SIGNATURES

34a. SUBMITTED BY	35a. ACCEPTED BY	35c. DATE	36a. WORK STARTED BY	37a. INSPECTED BY	38a. PICKED UP BY

34b. DATE	35b. STATUS	35d. TIME	36b. STATUS	36c. DATE	36d. TIME	37b. STATUS	37c. DATE	37d. TIME	38b. STATUS	38c. DATE	38d. TIME

DA FORM 2407, JUL 94

Fig. 4-1. DA Form 2407

Submit the maintenance request data to AMC's Logistics Support Activity (LOGSA) through the Standard Army Maintenance System (SAMS) or the Maintenance Information Management System (MIMS).

Use. DA Forms 2407/2407-1 are used as maintenance requests for:

- Requesting support maintenance.
- Repairs beyond the unit's authorized capability or capacity.
- Application of Military Work Orders (MWOs).
- Fabrication or assembly of items.
- Reporting work on DA-directed items under an approved sampling plan.
- Initiating work requests that may become warranty claim actions.
- Showing all support maintenance done on general purpose and passenger-carrying vehicles, and combat and tactical equipment.
- Requesting an estimated cost of damage (ECOD) or technical inspection to determine the serviceability/repairability of an item prior to repair or turn-in for replacement.

General Instructions. A separate DA Form 2407 will be filled out on each item reported under AR 700-138. A separate form will also be filled out on each component of an item reported under AR 700-138, when submitted separate from end item. You may combine items with the same make, model, and NSN on a single DA Form 2407 when they are not reported under AR 700-138. DA Form 2407-1 may be used when more room is needed. Items turned in for classification will be on separate forms. Send a copy of DA Form 2408-5 (Equipment Modification Record) with the equipment to support maintenance. The organization asking for maintenance fills out Section 1 of the DA Form 2407 and sends all copies of the form with the equipment. The support unit fills in Block 24 and puts a local work order number on the form. Copy 1 then goes back to the organization as a receipt for the equipment. The unit returns Copy 1 when the equipment is fixed and ready for pickup. Disposition involves retaining Copy 1 and destroying it when the equipment is returned to the unit.

DA Form 2407 Completion.

Section I Customer Data. Blocks (BLK) 1, 5, 6, 7, 10a, 10b, 11, 12, 13, 15, 16, 20, and 24 are mandatory if equipment is inoperable. Inoperable equipment is equipment that is not-mission-capable (NMC), in accordance with AR 700-138, a subsystem of a reportable weapon system, or command maintenance significant.

- (1a) UIC Customer: Enter the UIC of the customer that owns the equipment.
- (1b) Customer Unit Name: Enter the name of the unit identified by the UIC in Block 1a.
- (1c) Phone Number: Enter the phone number of the unit identified by the UIC in Block 1a.
- (2a) SAMS2UIC/SAMSI/Table of Distribution and Allowances (TDA): If in transit, enter UIC for SAMS2 or SAMS1/TDA unit.
- (2b) Utilization Code: Enter Utilization Code. See Appendix B (Maintenance Management Update 3-14).
- (2c) MCSR Item: Print the word "yes" or the letter "Y" if the item is reported under AR 700-138. This also applies to components and subsystems of an item/system that is reportable. If not, leave this block blank.

Section II Maintenance Activity Data: To be completed by support maintenance Direct Support Unit (DSU)/General Support Unit (GSU)/Aviation Intermediate Maintenance (AVIM)/DEPOT.

Section III Equipment Data.

- (5) Type MNT REQ Code: Enter the Type Maintenance Request Code. Appendix B, Table B-20 (Maintenance Management Update 3-14), lists the codes.
- (6) ID: Enter the Identification (ID) Code as shown below that identifies the type of number you will enter in Block 7.
  - A: National/NATO (North Atlantic Treaty Organization) Stock Number.
  - C: Manufacturer's Code and Reference Number (Part Number).
  - D: Management Control Number (MCN).
  - P: Other Numbers.
- (7) NSN: Enter the National Stock Number or appropriate number identified in Block 6.
- (8) Model: Enter model number.
- (9) Noun: Enter noun nomenclature of item.
- (10a) ORGWON/DOC NO: Enter organization work order number or organization document number.
- (10b) EIC: Enter the end item code (EIC). See Army Master Data File (AMDF).

- (11) Serial Number
  - Enter the serial number of the item in Block 9.
  - For nontactical wheeled vehicles, use the register number.
  - For ammunition, use the lot number.
  - Leave blank if the form is used for more than one item.
  - Leave blank if the equipment has more than one serial number.
  - Mandatory entry if equipment is (inoperable) INOP.
- (12) QTY: Enter the number of items. (Must be only one item listed if equipment is reportable under AR 700-138 and is NMC.)
- (13) PD: Enter the Priority Designator (See DA Pam 710-2-1).
- (14) Malfunction Description (DS, GS, AVIM, Depot Use).
- (15a) Failure Detected During/When Discovered Code.
  - Enter Failure Detected Code from Table B-3 or When Discovered Code from DA Pam 738-751.
  - Leave blank if no failure occurred.
- (15b) First Indication of Trouble/How Recognized Code: Enter First Indication of Trouble Code from Table B4 or How Recognized Code from DA PAM 738-751.
- (16) Miles/Kilometers/Hours/Rounds: Enter hour reading (to nearest hour) beside the "H" from the hour meter mounted on the equipment. If the equipment has no meter, leave blank.
- (17) Project Code: Enter the project code if one has been assigned. If not, leave blank.
- (18) Account Processing Code: Enter the Account Processing Code (APC) if required by your unit. The APC is a code prescribed locally for costing and budget identification of customers and organizations (reference TM 38-711-13). If not required, leave blank.
- (19) In Warranty? - enter Y or N to indicate whether equipment is still under manufacturer's warranty. If Y, submit one work request for each serial numbered item.
- (20) Admin Number: Enter the bumper number/materiel control number or administrative number assigned to the item of equipment.
- (21) Reimbursable Customer: For DSU/GSU/AVIM/Depot use.
- (22) Work Performed By: Enter code for level of work from Table B-24 (Maintenance Management Update 3-14).
- (23) Signature: The commander or the commander's designated representative will sign for all priority 01 through 10 requests. This signature approves the use of the PD.
- (24) Describe Deficiencies or Symptoms.
  - Using the information in column "c" of DA Form 2404, briefly describe the fault or symptoms. For example, print "Engine does not develop full power" or "Equipment uses two quarts of oil daily," etc. Do not ask for general or specific repair of parts to be replaced; for example, do not tell support to "replace the hydraulic system" or "repair as needed."
  - When the form is asking for work on more than one item with the same NSN, list the number of items, their serial numbers (if they have serial numbers), and anything else support will need. INOP equipment (equipment reported on the Materiel Condition Status Report), components/subsystems of reportable equipment, or command maintenance significant equipment) must have its own separate forms.
  - When the form is for components or assemblies with a recoverability code of A, D, F, H, or L, give the end item NSN. Put the NSN on the last line of Block 25. You will find recoverability codes in the RC code column on the AMDF. You will also find the codes listed as part of the item's Source, Maintenance, and Recoverability (SMR) code in the parts manual.
  - If you need more room, use a DA Form 2407-1.
  - When the form is requesting standard repair after a battle-damage expedient has been applied, print "BDAR" in bold letters before describing the fault or symptoms. NOTE: The end item's Battlefield Damage and Assessment Repair (BDAR) TM and AR 750-1 describe when and how BDAR repairs will be made.
- (25) Remarks. When the item in Block 7 needs onsite or deferred maintenance, support will note that action here. Shop office NCO will make one of these entries for onsite or deferred work:
  - Maintenance request received on (date), signature of shop office NCO.
  - Onsite repair scheduled for (date), signature of shop office NCO.
  - Owner to return item on (date) for repair, signature of shop office NCO.

- Block 35a will be completed by support only when onsite repair is started or the deferred item is brought back to support. The receipt copy will be sent to the support unit. The owning unit keeps all other copies until the onsite repair is started or deferred item is taken back to support.

Section VII - Action Signatures.

- (34a) Submitted By: The person sending in the DA Form 2407 enters first initial and last name in this block.
- (34b) The person signing the forms enters the original ordinal date the form was given to support.

PART C - VERIFICATION THAT BEFORE-, DURING-, AND AFTER-OPERATION PMCS ON EQUIPMENT HAS BEEN CORRECTLY DONE AND CORRECTLY ANNOTATED ON DA FORM 2404

DA Form 2404 (Fig. 4-2) is used to report any faults or malfunctions discovered by an equipment operator. It is also used by organizational maintenance personnel to record periodic maintenance services and spot-check inspections. This form is a temporary record of needed and completed repairs. DA Form 2404 should be destroyed after uncorrected faults have been recorded on DA Forms 2402 and 2407 or action has been taken to request repair parts. However, if equipment is not combat-ready because of needed repairs, DA Form 2404 should be kept on file until the equipment has been repaired.

Purpose. DA Form 2404 has three major purposes. Operators and crews, firstline leaders, maintenance supervisors, and commanders are equally responsible for keeping information current and correct on the DA Form 2404. This form is the central record for managing and controlling maintenance as follows:

- It is a record of faults found during an inspection. These faults include PMCS, maintenance activity inspections, diagnostic checks, and spot-checks (unless otherwise noted).
- It shows faults and repairs required for ECOD reports.
- It shows Battlefield Damage and Assessment Repair (BDAR) performed.

Use. DA Form 2404 will be used by personnel performing inspections, maintenance services, diagnostic checks, technical evaluations, marine condition surveys on watercraft, and PMCS (unless otherwise noted):

- To inspect all components or subsystems that make up one equipment system, you may use one DA Form 2404 or separate forms for each subsystem.
- To inspect several like items of equipment; e.g., one DA Form 2404 to inspect 25 M16A1 rifles.
- As a temporary record of required and completed maintenance.
- To list faults that operators or crews cannot fix and list parts replaced.
- By unit maintenance during periodic services to list all faults found and action taken to fix faults. When used to inspect several like items, the DA Form 2404 will list all deficiencies, shortcomings, and corrective action taken.

General instructions. The way to complete some blocks and columns on DA Form 2404 varies with the form use. Make sure to read the instructions that apply to the use of the form. When more than one DA Form 2404 is needed for an inspection or service, print the page number on the right side of the form's title block. (Put 1 of 2 on the first page and 2 of 2 on the second, etc.) Parts on order or actions pending under Anticipated Not-Mission-Capable (ANMC) conditions may go on the DA Form 2408-1-4 with a diagonal status symbol. Administrative motor pools, using ADP cards or other automated forms, do not need the DA Form 2404.

Disposition. The DA Form 2404 will be kept in the equipment record folder or in a protected cover until it is completed if no faults have been found. If faults are found during an operator's or crew's PMCS, it will be given to the maintenance supervisor for action. Maintenance section leaders will review the DA Form 2404 prior to destruction to ensure all corrective actions have been completed. Transfer faults that must be fixed at support maintenance to the DA Form 2407 and attach DA Form 2404. Faults that cannot be fixed until a part comes in or action(s) that must be deferred will be entered on the DA Form 2408-1-4.

EQUIPMENT INSPECTION AND MAINTENANCE WORKSHEET

For use of this form, see DA PAM 738, 780, and 738-751: the proponent agency is DCSLOG

1. ORGANIZATION	2. NOMENCLATURE AND MODEL
Seaman Petroleum Laboratory	Jet Fuel Thermal Oxidation Tester – MM Model

3. REGISTRATION/SERIAL/NSN	4a. MILES	b. HOURS	c. ROUNDS FIRED	d. HOT STARTS	5. DATE	6. TYPE INSPECTION
MM 1072	N/A	N/A	N/A	N/A	4 AUG 98	**BEFORE-OPERATION**

7. APPLICABLE REFERENCE

TM NUMBER	TM DATE	TM NUMBER	TM DATE
N/A	**N/A**	**N/A**	**N/A**

COLUMN A - Enter TM Item Number

COLUMN B - Enter the applicable condition status symbol.

COLUMN C - Enter deficiencies and shortcomings.

COLUMN d - Show corrective action for deficiency or shortcoming listed in Column c.

COLUMN e - Individual ascertaining completed corrective action initial in this column.

STATUS SYMBOLS

"X" - Indicates a deficiency in the equipment that places it in an inoperable status.

CIRCLED "X" - Indicates a deficiency; however, the equipment may be operated under specific limitations as directed by higher authority or as prescribed locally, until corrective action can be accomplished.

HORIZONTAL DASH "(-)" - Indicates that the required inspection, component replacement, maintenance operation check, or test flight is due but has not been accomplished, or an overdue MWO has not been accomplished.

DIAGONAL "(/)" - Indicates a materiel defect other than a deficiency which must be corrected to increase efficiency or to make the item completely serviceable.

LAST NAME, INITIAL IN BLACK, BLUE-BLACK INK, OR PENCIL - indicates that a completely satisfactory condition exists.

FOR AIRCRAFT - Status symbols will be recorded in red.

ALL INSPECTIONS AND EQUIPMENT CONDITIONS RECORDED ON THIS FORM HAVE BEEN DETERMINED IN ACCORDANCE WITH DIAGNOSTIC PROCEDURES AND STANDARDS IN THE TM CITED HEREON.

8a. SIGNATURE (Person performing inspection)	8b. TIME	9a. SIGNATURE (Maintenance Supervisor)	9b. TIME	10. MANHOURS REQUIRED
P. Moynihan PFC	**0830**			

TM ITEM NO. a	STATUS b	DEFICIENCIES AND SHORTCOMINGS c	CORRECTIVE ACTION d	INITIAL WHEN CORRECTED e
	/	**AC CABLE LOOSE AT CONNECTION**		**PM**
	/			
	/			
	/			

DA FORM 2404, APR 79 Edition of 1 Jan 64, which will be used

Fig. 4-2. DA Form 2404

PMCS Verification. It is the responsibility of all personnel to keep the DA Forms 2404 up to date and accurate. In order to support the mission, the operability of each piece of equipment must be known at all times. In order to keep current on the status of identified faults or malfunctions, periodic maintenance services, and needed/completed repairs, personnel should spot-check DA Forms 2404 frequently.

PART D - VERIFY OPERATORS ARE ABLE TO CORRECT AND REPORT MAINTENANCE DEFICIENCIES

Maintenance Deficiencies. Based on a preventive maintenance checklist, operators are required to perform before-, during-, and after-checks to equipment/systems. If maintenance deficiencies are discovered, operators are expected to notify their supervisors immediately. Some maintenance can be performed by operators. Tools and supplies needed for maintenance by laboratory personnel must be requested as needed.

Tools and Supplies. A list of tools and supplies that are required can be found in FMs and supply catalogs (SC) of the appropriate laboratory. For maintenance by direct support or facility engineers, tools and general purpose supplies are normally supplied by the support organization. Specialized repair parts installed by support organizations should be stocked by the laboratory. Examples include replacement heating elements for water stills, flash-point apparatus, and gum baths.

Many repair parts for laboratory apparatuses are now available by national stock number (NSN) or part number. A listing of the current NSNs of major items in petroleum laboratories and their component repair parts, manufacturer codes, and related information are available in Petroleum/Chemical Laboratory Supplies, Equipment, and Related Technical Assistance Program, STSGPIM. This publication is available from the U.S. Army General Materiel and Petroleum Activity, New Cumberland Army Depot, New Cumberland, PA 17070.

Verifying and Reporting Deficiencies. If repairs can be performed at the unit level, DA Form 2404 is used to identify faults. If the senior technician/sergeant determines that repairs are beyond unit capabilities, it becomes necessary to request maintenance from supporting units by completing a Maintenance Request (DA Form 2407). DA Form 2404 accompanies the work order.

PART E - SPOT-CHECK OPERATOR MAINTENANCE PROCEDURES AND VERIFY MAINTENANCE IS DONE WITHIN GUIDELINES OF ENVIRONMENTAL LAWS, REGULATIONS, AND PROCEDURES

Conducting Maintenance. When operators and other personnel are performing maintenance on equipment and systems, they are required to conduct their activities in accordance with applicable environmental laws, regulations, and procedures.

SOP and Environmental/Legal Considerations. The maintenance and operating SOP should contain guidelines, procedures, and references to those laws, regulations, and procedures. These topics should cover:

- Laboratory conduct.
- Fire prevention.
- Handling chemicals and solutions.
- Handling and using equipment.
- First-aid procedures.
- Accident reporting.
- Hazardous-materials management.
- Spill prevention control and countermeasures.
- Maintenance, housekeeping, and inspection.

Quality Control and Safety. It is the responsibility of all personnel to follow correct maintenance procedures according to the applicable environmental laws, regulations, and procedures. It is also necessary for supervisory personnel to spot-check personnel activities to ensure compliance with these requirements. In

addition, laboratory maintenance SOP should be specific in addressing procedural steps to minimize safety risks to personnel.

PART F - CONDUCT FOLLOW-UP CHECKS ON DEFERRED MAINTENANCE AND PARTS ORDERS TO VERIFY THAT ACTION OCCURRED

DA Form 2407. Operators are required to complete DA Form 2407 for defective/faulty equipment. All copies of DA Form 2407 are sent with the faulty equipment to the support activity. The receipt copy is sent back to the owning organization where it is kept on file until the equipment is returned.

Status Checks and Follow-up. Support maintenance personnel are required to make annotations on the same DA Form 2407. They enter information concerning initial inspections, discovered faults, deficiencies, symptoms, parts ordered, the need for onsite or deferred maintenance, and final inspections. Laboratory personnel may check with the support maintenance unit or inspect the DA Form 2407 to determine the current status of the requested maintenance.

PART G - VERIFY PERSONNEL HAVE LICENSES TO OPERATE EQUIPMENT, IF APPLICABLE, AND CONDUCT TRAINING PROGRAMS TO LICENSE THOSE WHO DO NOT

Maintenance Training - External Considerations. The proper methodology for conducting general training programs is found in FM 25-100. Various external challenges have been identified that can spell success or failure for a proper maintenance training program. Some external factors the commander cannot influence are personnel turbulence, personnel shortages, key NCO inexperience, complexity of equipment, and first-term operator inexperience.

Maintenance Training - Internal Considerations. Internal challenges can be influenced by commanders. Their effects can be minimized to ease the effects of external challenges. Some internal factors include:

- Workload.
- Garrison maintenance only.
- Lack of operator maintenance.
- A poor maintenance training plan or none at all.
- Maintenance not system oriented.
- First-line leaders not involved in maintenance operations.
- First-line leaders with little or no maintenance training.
- Little or no operator/crew maintenance training.
- Personnel not having or using maintenance publications.
- Improper use of assigned personnel.
- Test, measurement, and diagnostic equipment (TMDE) not being used.
- Poor quality control procedures.
- Available training assistance not being used.
- Technical experts not consulted on maintenance problems.

Personnel Capabilities.

- No assumptions should be made about what the operator or supervisor/leader knows.
- All units must have their own testing and training programs.
- The company or unit commander must know what all equipment operators and their leaders know.
- All personnel must know what they are checking and what to do when they find a problem.
- The supervisor must know what the operator knows.
- Should additional training be required, the supervisor should give it or advise the unit commander that training assistance is required.
- Continual testing and training must be provided in order to provide confidence and improved competence of personnel.

Supervisor Responsibilities. The supervisor has specific responsibilities concerning maintenance training.

- Each supervisor must analyze their maintenance training.
- The maintenance training plan should then be developed from the analysis.
- Personnel skill shortfalls should be identified and the available training courses scheduled.
- NCOs must be trained to supervise and conduct the necessary maintenance training.
- Since maintenance begins with the equipment operators, supervisors who invest time in operator training will receive dividends in equipment availability.
- First-line leaders require training in inspection techniques for their equipment as well as its operation.
- Both formal and on-the-job training assistance is available from the following external sources:
  - Maintenance Assistance and Instruction Team (MAIT).
  - Direct Support (DS) maintenance unit.
  - Army Materiel Command (AMC) Logistics Assistance Office (LAO).
  - Exportable training packages.

Licensing.

The supervisor must verify that personnel have licenses for the equipment they are operating, if applicable. In the case of vehicles, instructions for completing licensing of vehicle operators should be incorporated in the unit SOP. AR 600-55 provides the basic requirements for a good licensing program. Use FM 21-305, FM 21-306, and FM 55-30 for more detailed information on licensing vehicle operators. Also consult these publications for procedures on how to fill out applicable forms.

LESSON 4

PRACTICE EXERCISE

The following items will test your knowledge of the material covered in this lesson. There is only one correct answer for each item. When you complete the exercise, check your answers with the answer key that follows. If you answer any items incorrectly, go back to the part of the lesson that contains the information involved and study again.

1. What are the major sections of the SOP?
   A. Maintenance intervals, schedule check sheets, and suspense folders.
   B. Purpose, scope, responsibilities, procedures, record keeping, equipment maintenance, miscellaneous, and references.
   C. DA Form 2407, DD Form 314, and DA Form 2404.
   D. First aid procedures, fire prevention, and laboratory conduct.

2. How many copies of the DA Form 2407 go to the support activity with the faulty equipment?
   A. None.
   B. Four.
   C. All.
   D. Two.

3. What are all of the possible codes that can be entered in the ID block of DA Form 2407?
   A. A, B, and C.
   B. A, C, and F.
   C. A, B, C, and P.
   D. A, C, D, and P.

4. Whose responsibility is it to keep the DA Forms 2404 current and accurate?
   A. Operators.
   B. Firstline leaders.
   C. Maintenance supervisors.
   D. All personnel.

5. On what form do maintenance support personnel make annotations concerning initial and final inspections of the faulty equipment?
   A. DA Form 2407.
   B. DA Form 2404.
   C. DD Form 314.
   D. DA Form 2402.

LESSON 5

STANDARDIZATION AND CALIBRATION OF LABORATORY EQUIPMENT
Critical task:
101-523-3405

OVERVIEW

Knowledge of the requirements for standardization and calibration of laboratory equipment, A-level calibration, and safety procedures is important for the petroleum laboratory NCO in developing a laboratory SOP.

Lesson Description:

During this block of instruction we will discuss the requirements for standardization and calibration of laboratory equipment, A-level calibration, and safety procedures.

Terminal Learning Objective:

Action: Acquire knowledge on identifying equipment requiring calibration, establishing a calibration schedule for each piece of equipment, establishing procedures for internal “C” level calibration, identifying external agencies for “A” level calibration, establishing safety and environmental procedures, and developing a laboratory equipment calibration SOP.

Condition: Given all required materials.

Standards: This task will be accomplished according to TB 43-180 and the current Annual Book of ASTM Standards.

INTRODUCTION

In order for petroleum laboratory measurements to be accurate, all instrumentation must be calibrated to standard. This ensures that the laboratory test measurements give an accurate account of the condition and quality of the samples being tested.

PART A - DEVELOP A LABORATORY EQUIPMENT SOP

Calibration Standard Operating Procedures: When establishing a calibration SOP, the following sections are included:

- Purpose: This section describes the purpose of preparing and maintaining the SOP.
- Scope: This section describes the broad concepts of equipment calibration, proper record keeping, and training of personnel.
- Responsibilities: This section describes the specific responsibilities of all personnel assigned to the laboratory.
- Procedures: This section describes the procedures to be followed concerning equipment calibration, identification of equipment that needs calibration, procedures for establishing calibration schedules, procedures for internal C level and external A level calibration, safety and environmental considerations to be addressed during operator calibration procedures, record keeping, and personnel training on a daily, weekly, monthly, etc., basis. Instructions for calibrating equipment are in the applicable TMs.
- Record Keeping: This section describes the purpose, use, instructions for completion, and disposition of forms and other record keeping systems that must be followed.
- Equipment Maintenance: This section lists the equipment and systems that must be calibrated on a periodic basis.
- Miscellaneous: This section contains other specifics such as definitions, when to use/not use specific forms, symbols, special instructions, and calibration of equipment.
- References: This section lists the references used to guide personnel in SOP procedures.

When implementing a calibration SOP, the following steps are included:

- Identification of equipment that requires calibration.
- Establishment of a calibration schedule for each piece of equipment.
- Establishment of procedures for internal C level calibration.
- Identification of external agencies for A level calibration.
- Identification of safety and environmental considerations to be addressed during operator calibration procedures.

PART B - IMPLEMENT A LABORATORY EQUIPMENT CALIBRATION SOP

Calibration requirements. These can be found in TB 43-180, applicable ASTM methods, (Military Standard) MIL-STD-978, and TB 750-25.

- Personnel requirements. According to AR 750-25, all petroleum laboratory personnel are responsible for ensuring all of the laboratory equipment listed in TB 43-180 is periodically calibrated.
- Calibration logs. Though not required, these have proven valuable in maintaining an equipment audit trail. They can then be used to schedule the C level calibration workload within the laboratory and A level calibration by the TMDE personnel.
- Calibration of test kits. In addition to petroleum laboratory equipment, components of the test kits may also require calibration. The sampling and gaging kit contains an innage tape and bob that must be periodically calibrated. Kits that contain thermohydrometers or thermometers and hydrometers will need calibration. Personnel responsible for the operation of these kits should contact the nearest mobile or base petroleum laboratory for C level calibration support. Most of the time, a one for one exchange of each item of equipment can be arranged. The captured fuels test kit does not require calibration.
- A level calibration. A level calibration is not performed by petroleum laboratory personnel. It is performed by personnel from a TMDE calibration center. Petroleum laboratories can either schedule a TMDE calibration laboratory team to perform A level calibration on site or send the equipment to a TMDE calibration and repair center, or a combination of both. The chosen method depends on the regulations and policies within the specific command. Laboratories sending equipment for calibration must have at least two sets of the equipment on hand. Never turn in both sets at the same time. Rotate them to keep a

calibrated set on hand. DA Form 2402 (Exchange Tag) is filled out and attached to each item of equipment that must be sent to a calibration facility. The sending petroleum laboratory files the bottom portion of the tag for accountability purposes.

- C level calibration. C level calibration (standardization) is performed at the petroleum laboratory by laboratory personnel using an A level calibrated set of equipment. Once an item of equipment has passed C level calibration, a completed DA Label 80 (US Army Calibrated Instrument) is either attached to the item of equipment or to the DD Form 314 and kept on file. Items of equipment which fail C level calibration should have a DA Form 2417 (US Army Calibration System Rejected Instrument) attached so that they will not be used. These items of equipment, along with items of equipment being returned from the A level calibration facility, should be turned in for repair or disposal.

Verification of requirements. It is necessary to verify that calibration requirements for laboratory equipment have been established in accordance with:

- TB 43-180.
- Applicable ASTM test methods.
- MIL-STD-978.
- Manufacturer Specifications.

PART C - CHECK CALIBRATION DUE DATES, REVIEW CALIBRATION SUSPENSE ACCORDING TO SCHEDULE ON DD FORM 314, AND FILE AND REVIEW C LEVEL PROCEDURES

Calibration due dates. DD Form 314 is used to record calibration due dates of petroleum laboratory equipment. These due dates are based on the manufacturers recommended calibration requirements.

Check calibration due dates. It is necessary to check DD Form 314 for each piece of equipment that requires periodic calibration. For the equipment that needs to be calibrated at another location, it is necessary to be sure that the turn-in procedures have been followed correctly.

Review calibration suspense file for completeness and accuracy. Calibration suspense files are used to track periodic calibration for various equipment. Be sure to review these suspense files regularly for accuracy and completeness.

Review laboratory internal C-level calibration procedures. DA Label 80 should be checked to ensure the calibration procedures are being completed in accordance with TB 750-25. It is necessary to verify that laboratory technicians follow calibration guidelines in the applicable TM or manufacturer's instructions for specified equipment.

LESSON 5

PRACTICE EXERCISE

The following items will test your knowledge of the material covered in this lesson. There is only one correct answer for each item. When you complete the exercise, check your answers with the answer key that follows. If you answer any items incorrectly, go back to the part of the lesson that contains the information involved and study again.

1. What is the purpose of the Scope section of the Calibration SOP?
   A. To describe the purpose, use, instructions for completion, and disposition of forms and other record keeping systems that must be followed.
   B. To describe the specific responsibilities of all personnel assigned to the laboratory.
   C. To describe the broad concepts of equipment calibration, proper record keeping, and training of personnel.
   D. To describe the purpose of preparing and maintaining the SOP.

2. Definitions are included in what section of the Calibration SOP?
   A. Scope.
   B. Record Keeping.
   C. References.
   D. Miscellaneous.

3. Internal C and external A calibration steps are found where in the Calibration SOP?
   A. Equipment maintenance.
   B. Procedures.
   C. Record Keeping.
   D. Responsibilities.

4. Once an item of equipment has passed C level calibration, what form must be completed and either attached to the item of equipment or to the DD Form 314 and kept on file?
   A. DA Label 80.
   B. DA Form 2402.
   C. DA Form 2404.
   D. DA Form 2417.

5. Which form is required to record calibration due dates of petroleum laboratory equipment?
   A. DD Form 314.
   B. DA Label 80.
   C. DA Form 2402.
   D. DA Form 2417.

LESSON 6

PETROLEUM LABORATORY SUPPLY
Critical task:
101-523-3400

OVERVIEW

Knowledge of breakage lists, requisitioning procedures, inventory schedules, and supply receipt and storage are important for the petroleum laboratory NCO when establishing and monitoring a petroleum laboratory supply program.

Lesson Description:

During this block of instruction we will discuss breakage lists, requisitioning procedures, inventory schedules, and supply receipt and storage for establishing and monitoring a petroleum laboratory supply program.

Terminal Learning Objective:

Action: Acquire knowledge on verifying that technicians are filling out the breakage list; establishing procedures to requisition supplies by completing DD Form 1348-6 for requesting non-National Stock Number (NSN) single line items not listed in the FEDLOG, by completing DA Form 2765-1 for requesting expendable, durable, or non-expendable single line items with NSNs listed in the FEDLOG; using the FEDLOG to verify equipment's NSN; developing an inventory schedule to generate a list of required supplies; and establishing procedures for receiving and storing requested supplies.

Condition: Given all required materials.

Standards: This task will be accomplished according to DA PAM 710-2-1.

INTRODUCTION

In order to ensure the smooth operation of the petroleum laboratory, detailed records must be maintained as they relate to supply use and replenishment. These details should be described in the petroleum laboratory SOP. The supervisors have the responsibility to maintain these records and ensure supplies are ordered promptly in order to carry out the mission.

PART A - ORDERING SUPPLIES

The following general procedures and comments need to be covered in detail in the appropriate section of the laboratory SOP.

- Via the laboratory SOP, each individual assigned to a base, mobile, or airmobile laboratory will be capable of ordering supplies for the laboratory.
- Supply requirements may vary due to the type of laboratory. Technical manuals list components and maintenance requirements for each type of laboratory. The appropriate technical manuals for the three types of laboratories are as follows:
  - Base Laboratory TM 5-6640-214-14.
  - Mobile Laboratory TM 5-6640-215-13.
  - Airmobile Laboratory TM 10-6640-216-13&P.
- Supply requirements for the laboratories are determined by Table of Organization and Equipment (TOE), Table of Distribution and Allowances (TDA), technical manuals, military and federal specifications, MIL-STD-3004, and military handbook MIL-HDBK-200.
- When ordering supplies, it is important to know the type of supplies being ordered. There are six major types:
  - Non-expendable - major pieces of equipment or nonperishable type items.
  - Expendable - perishable, emptied, or used up. Use a breakage list to keep track of items broken during laboratory operations.
  - Major end items.
  - Component parts - secondary pieces of equipment to a major end item (such as the test apparatus is to a mobile laboratory or tools in a tool kit).
  - Self-service supplies - perishable supplies such as paper, pens, toilet items, etc.
  - High dollar or controlled supplies - cost excessive controlled items such as fuel, ammunition, paint, etc.
- All supplies that need to be ordered should be identified in one of four ways:
  - National Stock Number (use FEDLOG to verify numbers).
  - Line item number (LIN) number.
  - Manufacturer.
  - Technical manual hand receipt.
- Laboratory supplies are ordered (requisitioned) using one of three forms:
  - DA Form 2765-1 (Request for Issue or Turn-In).
  - DD Form 1348 (DOD Single Line Item Requisition System Manual).
  - DA Form 3161 (Request for Issue or Turn In - Temporary Issue).
- When supplies are ordered and received, they are listed and annotated, respectively, on DA Form 2064 (Document Register for Supply Actions).
- A separate document register is kept for non-expendable and expendable items used in the laboratory.
- You must account for each piece of laboratory equipment. Usually, the officer in charge or person accountable for the equipment is the property officer.
- Numerous laboratory supply items (chemicals, solvents, and equipment) must be obtained through local supply sources. This is due to the rare requirement for the item. When there is no demand for the item, the Army will not keep the item in the supply system. Commercial catalogs may be obtained directly from the company or the supply officer.
- A record will be established for the replenishment of expendable laboratory supplies; therefore, when you are down to an established reorder point, you will requisition the quantity to replenish to the required stock level.

- Overpack supplies (mostly expendable, additional) are required by deployable laboratories. These supplies are used when deployed (usually 60 to 90 days of expendable supplies) until a supply channel can be established.

PART B - SUPERVISOR RESPONSIBILITIES

Verify that technicians are filling out the breakage list and establish procedures to:

- Requisition supplies.
- Use FEDLOG.
- Keep track of required supplies.
- Receive supplies.
- Store supplies.

LESSON 6

PRACTICE EXERCISE

The following items will test your knowledge of the material covered in this lesson. There is only one correct answer for each item. When you complete the exercise, check your answers with the answer key that follows. If you answer any items incorrectly, go back to the part of the lesson that contains the information involved and study again.

1. Cost excessive items such as fuel, ammunition, and paint are referred to as what type of supplies?
   A. Non-expendable.
   B. Major end items.
   C. Expendable.
   D. High dollar or controlled.

2. Which of the following is a form used to requisition supplies?
   A. DA Form 2765-1.
   B. DA Form 2064.
   C. DD Form 314.
   D. DA Label 80.

3. The mostly expendable, additional supplies required by deployable laboratories are referred to as what?
   A. Self-service supplies.
   B. Component parts.
   C. Overpack supplies.
   D. Major end items.

4. What form are supplies documented on when received?
   A. DD Form 1348.
   B. DA Form 3161.
   C. DD Form 2064.
   D. DA Form 2765-1.

5. When monitoring a petroleum laboratory supply program, supervisors are responsible for which of the following?
   A. Monitoring the supply channel.
   B. Verifying that technicians are filling out the breakage list.
   C. Performing PMCS on the laboratory equipment.
   D. Issuing required supplies to deployable laboratories.

LESSON 7

DIRECT MOBILE LABORATORY OPERATIONS
Critical task:
101-523-3404

OVERVIEW

The ability to verify PMCS actions, mobile petroleum laboratory inspections, and systems operational checks combined with the ability to review DA Form 1387-2 and MSDS is an important skill for the petroleum laboratory NCO when developing a mobile petroleum laboratory SOP.

Lesson Description:

During this block of instruction we will discuss verifying PMCS actions, mobile petroleum laboratory inspections, and systems operational checks and reviewing DA Form 1387-2 and MSDS.

Terminal Learning Objective:

Action: Acquire knowledge on selecting the site for the mobile petroleum laboratory and utilizing Global Positioning System (GPS) to coordinate the laboratory's movement to a selected site while addressing applicable safety procedures and environmental concerns.

Condition: Given all required materials.

Standards: This task will be accomplished according to TM 38-250, TM 10-6640-215-13, and TM 11-5825-291-13.

INTRODUCTION

For successful deployment of the mobile petroleum laboratory, it is critical to select an appropriate site, verify PMCS, ensure that the laboratory has been packed and secured, and develop a Mobile Laboratory SOP. These tasks will allow the operation to run smoothly and efficiently.

PART A - DEPLOYMENT/RE-DEPLOYMENT OF THE MOBILE PETROLEUM LABORATORY

The movement of the mobile laboratory (Fig. 7-1) requires numerous documents and coordinated procedures to ensure a smooth, safe, and organized operation.

Mode of transportation. The first step in planning the deployment or movement of the Mobile Laboratory is to determine the most mission effective form of transportation.

- Air (Military or commercial aircraft).
  - Base Laboratory C-130.
  - Mobile Laboratory C-141 or C-5A.
  - Airmobile Laboratory C-130.
- Water.
- Rail.
- Road.

Documentation. Procedures for shipping hazardous materials (part of Petroleum Laboratories) by military aircraft, are provided in TM 38-250. Other forms/documentation are as follows:

- DD Form 1387-2 (Special Handling Data/Certification).
- Air Shipping Papers.
- Waivers. Waivers are used during tactical or contingency operations. An example of an Air Force waiver can be found in FM 10-67-2.
- Request for Shipment by Military Aircraft, Headquarters (HQ) United States Air Force (USAF) or HQ Department of the Army (DA).
  - Reason for shipment.
  - Reason other modes of transportation cannot be used.
  - Date of movement.
  - Route.
  - Type of aircraft required.
  - Point of Contact at origin and destination.

Preparation of the Mobile Laboratory.

Equipment storage (TM 10-6640-215-13).

- Equipment stripped and put in drawers.
- Equipment drawers locked.
- Equipment doors taped.

Electrical Systems (TM 10-6640-215-13).

- All outlets checked.
- All power switched to OFF position.
- Main breaker in OFF position.
- All lights/glass items taped.

Testing Apparatus and Equipment (TM 10-6640-215-13).

- All baths drained and emptied.
- Apparatus secured to designated location.

Testing References.

- All references will be stored in the designated locations.
- The slide doors of the reference area will be taped closed.

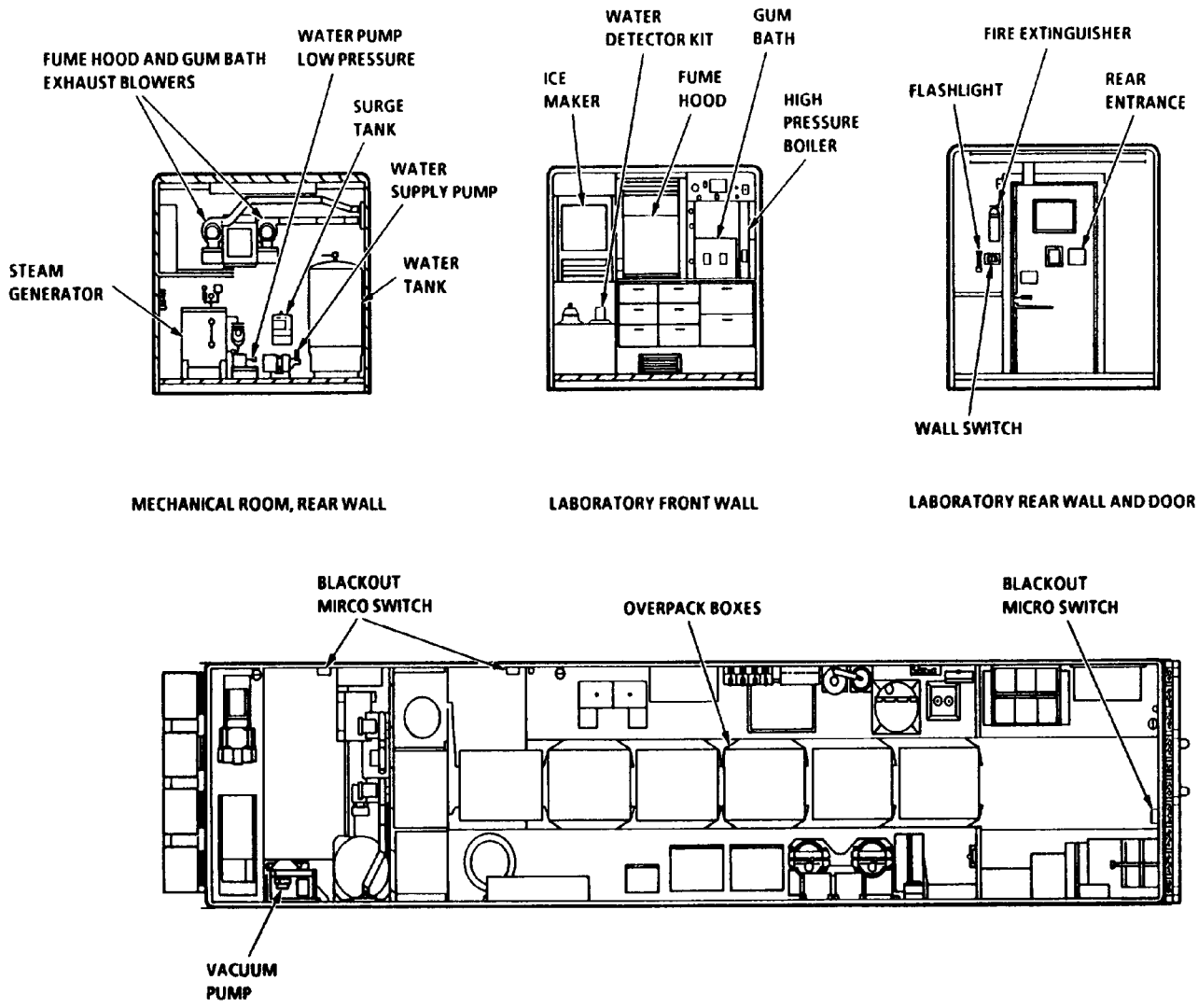

Fig. 7-1. Mobile Petroleum Laboratory.

Other Laboratory pre-deployment requirements.

- Weigh and center balance Mobile Laboratory.
- Inventory all equipment, chemicals, and reagents.
- Mobile Laboratory overpack.
- Final preparation for tiedown.
- Generator (60 kW or 30 kW).

Hazardous Materials Shipping and Safety Review.

- Review MSDS. The NCOIC of the base Petroleum Laboratory is responsible for ensuring that the Mobile Laboratory has applicable MSDS for each chemical, solvent, and reagent used and deployed with the Mobile Laboratory.
- Review DD Form 1387-2. The NCOIC is also responsible for the review of DD Form 1387-2.

PART B - DEVELOPMENT AND IMPLEMENTATION OF SITE SELECTION AND MOVEMENT CRITERIA DURING PRE-DEPLOYMENT

Select an appropriate site.

- Select a site that has ample space for maneuvering the laboratory and all support equipment.
- Avoid ground that is excessively sloped; excessive sloping could hamper leveling of the laboratory.
- Verify that the site is firm, has well-drained terrain, and is relatively free of surface rocks and large stones.
- At least 500 feet away from other areas of operation and not uphill or upstream from other facilities which might be in the path of escaping fuel or vapor.
- Not adjacent to low areas where dangerous vapors might collect.
- Near a stream or pond (minimum of 500 ft for environmental reasons) or an established water facility. This provides an outside water source for the petroleum laboratory water system.
- Easy access to road nets. At least one road should run in the vicinity of the petroleum laboratory.

Utilize GPS to coordinate movement to selected site IAW TM 11-5825-291-13.

- Perform set-up on the E-A.
- Initialize E-PLGR.
- Obtain a position.
- Enter a waypoint.
- Navigate to a waypoint.

PART C - MOBILE PETROLEUM LABORATORY PMCS

General PMCS procedures verification. Ensure that the following general procedures are accomplished by assigned personnel concerning PMCS of the mobile laboratory:

- Inspect the petroleum lab body exterior starting at the rear to cover rear, curbside, roadside, front, top, and bottom. Inspect for damage, tears, breaks, or corrosion.
- Service petroleum laboratory exterior IAW TM 9-2330-362-14&P.
- Inspect and service the Electronic Control Units (ECUs) in accordance with TM 5-4120-371-14.
- Remove the overpack boxes.
- Inspect laboratory for broken equipment or equipment that is loose and not secured.
- Close doors and vents to determine if light leak exists.
- Inspect doors for damaged or rotted seals and tightness of closure.
- Inspect interior for evidence of water damage, fungi, mildew, or corrosion.
- Inventory section contents against Components of End Item and Basic Issue Items Lists (TM 10-6640-215-13, Appendix C).
- Inventory consumable supplies contained in section (TM 10-6640-215-13, Appendix E).
- Ensure that any damage or discrepancies are reported IAW AR 735-11 and AR 735-11-2.

Operational Checks. Set petroleum laboratory up and conduct operational checks (to include Set-up, Power-up and Shut-down procedures) IAW Chapter 2 of TM 10-6640-215-13, when operators are available and power can be safely provided to the van body. Ensure that any damage or discrepancies are reported IAW AR 735-11 and AR 735-11-2.

PART D - VERIFYING THAT THE MOBILE LABORATORY HAS BEEN PACKED AND SECURED IAW TM 10-6640-215-13

Interior.

- Chemical/Hazardous Waste Storage.
- Loose Test/Support Equipment and Supplies.
- Drain and Clean Laboratory Equipment.
- Manometer, Recording Pressure Gage, and Barometer are properly secured.
- All gas systems/bottles turned off and properly secured.

- Ovens and Burn Out Furnace are clean and desiccant is removed from desiccating cabinets and stored.
- Analytical Balance is covered and secured to vibration mount.
- Shipping Straps and Brackets are used where required and retaining screws are tight.
- Contents of cabinets are properly stored for movement.
- Gas Alarm tested.
- All AC MAIN POWER PANEL Circuit Breakers set to OFF, except A1CB1, A1CB2, A1CB9, A1CB11, and A1CB13.
- Mechanical Room POWER PANEL NO. 2 Circuit Breakers set to OFF except for A15CB10.
- Water Tank, Steam Generator, High Pressure Boiler, and Air System Moisture Trap are all drained.
- POWER PANEL NO. 2 Circuit breaker A15CB10 set to OFF.
- Eight Overpack Boxes have been secured in the laboratory compartment with tie-down straps IAW the loading diagram.
- MAIN POWER PANEL Circuit Breakers A1CB1, A1CB2, A1CB11, and A1CB13 set to OFF.
- EMERGENCY LIGHT switches S17 and S18 set to OFF.

Exterior.

- Mechanical Room, Laboratory Compartment Access, and Rear Access Doors are closed and locked.
- External power at Generator Set is OFF.
- Main Power Cable is removed from Petroleum Laboratory Connector and Generator Set Connector, cleaned, and stored in roadside storage box. Ensure protective covers are installed on all electrical connectors.
- Grounding Cable is removed from Grounding Lug in Power Input Panel.
- Power Input Panel is Closed and Latched.
- Grounding Clamp and Cable removed from Grounding Rod.
- Grounding Rod and Driver/Puller removed from ground.
- Grounding Rod, Driver/Puller, Grounding Cable, and Clamp are cleaned and stored in roadside storage box.
- Drain Hoses are disconnected, cleaned, and stored in roadside storage box.
- Hose Adapters are stored and protective covers are installed on Deck Drains.
- UTILITIES box door closed and latched.
- Gum Bath/Fume Exhaust Door closed and latched.
- PURGE EXHAUST and INTAKE Doors closed and latched.
- ECU Canvas Covers rolled down and secure.
- Ladders removed from Rear Access and Laboratory Compartment Access, and mechanical Room Access Doors removed and stored IAW TM 9-2330-362-14&P.
- Rear Platform stored.
- ECU Maintenance Platform stored.

PART E - DEVELOPMENT OF A MOBILE PETROLEUM LABORATORY SOP

It is the responsibility of the Petroleum Laboratory Supervisor to develop a Mobile Laboratory SOP. The following content is required for an effective and efficient SOP.

- Preventive Maintenance Procedures. PMCS procedures for the Mobile Laboratory are provided in TM 10-6640-215-13, Chapter 4.
- Set-up, Power-up, and Shut-down procedures. Set-up, Power-down, and Shut-down procedures are provided in TM 10-6640-215-13, Chapter 2.
- Supply Replacement Procedures.
- Mobile Laboratory Storage procedures and overpack (TM 10-6640-215-13).
- Placarding procedures.

The recommended format for the Mobile Laboratory SOP can be found in FM 10-426, Appendix B.

LESSON 7

PRACTICE EXERCISE

The following items will test your knowledge of the material covered in this lesson. There is only one correct answer for each item. When you complete the exercise, check your answers with the answer key that follows. If you answer any items incorrectly, go back to the part of the lesson that contains the information involved and study again.

1. During deployment/re-deployment of a mobile petroleum laboratory, when is a waiver used?
   A. During tactical or contingency operations.
   B. Whenever hazardous materials are shipped.
   C. Whenever shipment is made by military aircraft.
   D. During NBC operations.

2. Which of the following should be avoided when selecting a site for the mobile petroleum laboratory?
   A. Firm, drained terrain.
   B. Ground near a stream or pond.
   C. Ground that is excessively sloped.
   D. Terrain near road nets.

3. What distance should the site be from other areas of operation?
   A. 25 feet.
   B. 500 feet.
   C. 100 feet.
   D. 50 feet.

4. When performing PMCS, doors and vents of the mobile petroleum laboratory are closed to determine what?
   A. If fungi or mildew is present.
   B. If equipment is loose and not secured.
   C. If the exterior needs to be serviced.
   D. If a light leak exists.

5. When verifying that the mobile laboratory has been packed and secured, which of the following should have been done to the exterior?
   A. The UTILITIES box door should be closed and latched.
   B. External power at generator set should be turned on.
   C. Grounding clamp and cable should be attached to the grounding rod.
   D. Drain hoses are laid out and connected.

Lesson 1 Practice Exercise Answer Key and Feedback

Item	Correct Answer and Feedback
1.	C. Part B, page 1-3
2.	B. Part A, page 1-2
3.	C. Part D, page 1-5
4.	D. Part E, page 1-6
5.	A. Part F, page 1-7

Lesson 2 Practice Exercise Answer Key and Feedback

Item	Correct Answer and Feedback
1.	D. Part A, page 2-2
2.	A. Part B, page 2-2
3.	B. Part B, page 2-3
4.	B. Part C, page 2-3
5.	C. Part C, page 2-3

Lesson 3 Practice Exercise Answer Key and Feedback

Item	Correct Answer and Feedback
1.	D. Part B, page 3-3
2.	B. Part A, page 3-2
3.	D. Part B, page 3-3
4.	A. Part C, page 3-3
5.	C. Part D, page 3-6

Lesson 4 Practice Exercise Answer Key and Feedback

Item	Correct Answer and Feedback
1.	B. Part A, page 4-2
2.	C. Part B, page 4-3
3.	D. Part B, page 4-5
4.	D. Part C, page 4-7
5.	A. Part F, page 4-10

Lesson 5 Practice Exercise Answer Key and Feedback

Item	Correct Answer and Feedback
1.	C. Part A, page 5-2
2.	D. Part A, page 5-2
3.	B. Part A, page 5-2
4.	A. Part B, page 5-3
5.	A. Part C, page 5-3

Lesson 6 Practice Exercise Answer Key and Feedback

Item	Correct Answer and Feedback
1.	D. Part A, page 6-2
2.	A. Part A, page 6-3
3.	C. Part A, page 6-2
4.	C. Part A, page 6-2
5.	B. Part B, page 6-3

Lesson 7 Practice Exercise Answer Key and Feedback

Item	Correct Answer and Feedback
1.	A. Part A, page 7-2
2.	C. Part B, page 7-4
3.	B. Part B, page 7-4
4.	D. Part C, page 7-4
5.	A. Part D, page 7-5

GLOSSARY

Section I Acronyms and Abbreviations

AC	alternating current
AMC	United States Army Materiel Command
AMDF	Army Master Data File
ANMC	anticipated not-mission-capable
APC	Account Processing Code
API	American Petroleum Institute
AR	Army Regulation
ASTM	American Society for Testing and Materials
AVIM	Aviation Intermediate Maintenance
BDAR	Battlefield Damage and Assessment Repair
BTU	British thermal unit
C	Celsius
CCR	Conradson carbon residue
DA	Department Of The Army
DD	Department Of Defense
DFP	decimal fractional purity
DOC NO	document number
DOD	Department Of Defense
DS	Direct support
DSU	direct support unit
ECOD	estimated cost of damage
ECU	Electronic Control Unit
EIC	end item code
etc.	etceteras
ft	feet
FTMS	Federal Test Method Standard
g	gram
GPS	Global Positioning System
GS	general support
GSU	general support unit
HQ	headquarters
IAW	in accordance with
ID	identification
IL	Identification List
in	inch
INOP	inoperable
kg	kilogram
kPa	kilo Pascal
kW	kilowatt
LAO	Logistics Assistance Office
LIN	line item number
lb	pound
LOGSA	AMC's Logistics Support Activity
m	meter
MAIT	Maintenance Assistance and Instruction Team
MCN	management control number
MEW	milli-equivalent weight
MIL-HDBK	military handbook
MIL-STD	military standard
mg	milligram
MIMS	Maintenance Information Management System
MJ	megajoules
ml	milliliter
mm	millimeter
MNT REQ	maintenance request
MSDS	Material Safety Data Sheets
MWO	Modification Work Order
NATO	North Atlantic Treaty Organization
NCO	noncommissioned officer
NCOIC	noncommissioned officer in charge
NMC	not-mission-capable
No	number
NSN	National Stock Number
ORGWON	organization work order number
RC	recoverability code
RCF	relative centrifugal force
RPM	revolutions per minute
SAMS	Standard Army Maintenance System
SC	supply catalogs
SMR	Source, Maintenance, and Recoverability
SOP	standard operating procedure
SPGR	specific gravity
TB	technical bulletin
TDA	Table of Distribution and Allowances
TM	technical manual
TMDE	Test, Measurement, and Diagnostic Equipment
TOE	Table of Organization and Equipment
US	United States of America
USAF	United States Air Force
WOLF	Work Order Logistics File

Section II. Terms

American Petroleum Institute (API) The institute represents and is supported by the petroleum industry. It standardizes the tools and equipment used by the industry and promotes the advancement of research in the petroleum field.

American Society for Testing and Materials (ASTM) A national scientific technical organization formed for the development of standards or characteristics performance of materials, products, systems, and services and the promotion of related knowledge.

API Gravity An arbitrary scale expressing the gravity or density of liquid petroleum products. The measuring scale is calibrated in terms of degrees API. The gravity of any petroleum product is corrected to 60°F (16°C).

bitumen A mixture of hydrocarbons of natural or pyrogenous origin, or both, which are frequently accompanied by their nonmetallic derivatives and which are completely soluble in carbon disulfide.

calibration The graduation of a measuring instrument. The determination of accuracy of graduation in a measuring instrument.

centrifugal pump An apparatus that builds up pressure head using centrifugal force as the principal means and angular velocity as the secondary means.

density Specific weight or mass of a substance per unit volume (pounds per cubic foot or gallon or grams per cubic centimeter). Specific gravity is the ratio of the mass of any volume of a substance to the mass of an equal volume of some standard substance (water in the case of liquids and hydrogen or air in the case of gases) at 40'C (104'F).

flash point The lowest temperature at which a liquid petroleum product gives off vapor in sufficient concentration to ignite (that is, flash) on application of a flame under specified conditions.

identification tests Selected tests applied to a sample to identify quickly the type or grade of material represented or to determine that the quality has not been altered by time or handling.

olefin One of a major series of hydrocarbons that appear chiefly in refinery operations. They have the general formula of naphthenes and the chain structures of paraffin, but they are unsaturated. Molecular structure and nomenclature correspond to paraffin having the same amount of carbon. Ethylene, or ethene, is the lowest, member of the olefins, and the series is sometimes called the ethylene series.