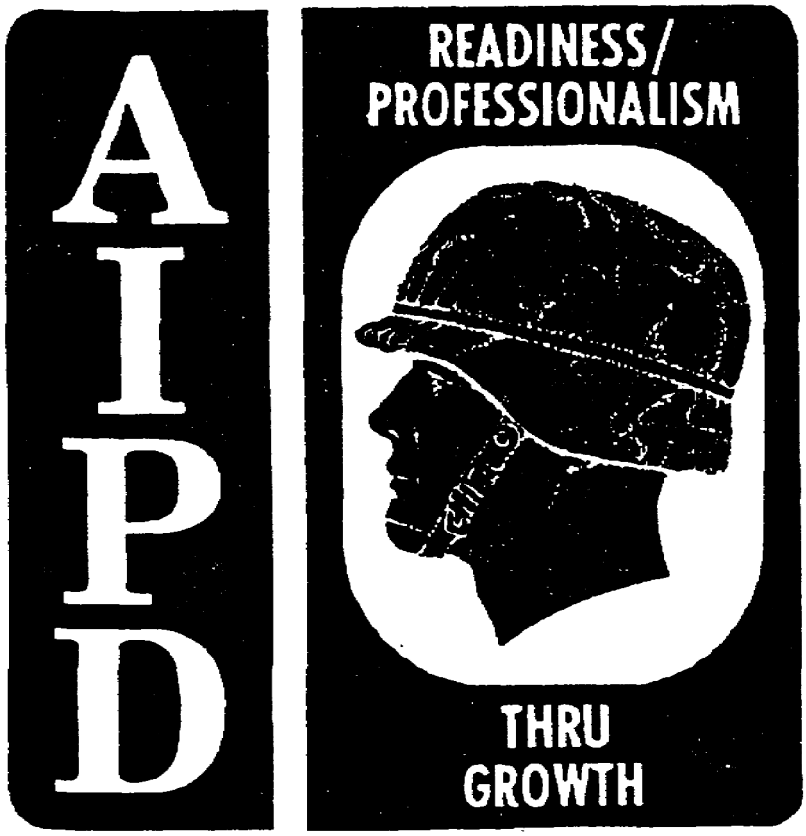
SUBCOURSE
QM3504

EDITION
A

DIRECT GAGING AND SAMPLING OPERATIONS



THE ARMY INSTITUTE FOR PROFESSIONAL DEVELOPMENT
ARMY CORRESPONDENCE COURSE PROGRAM

DIRECT GAGING AND SAMPLING OPERATIONS

Subcourse Number QM3504
EDITION A

United States Army Combined Arms Support Command
Fort Lee, Virginia 23801-1809

5 Credit Hours

Edition Date: September 1993

SUBCOURSE OVERVIEW

This subcourse is designed to teach you how to gage and sample petroleum tanks.

There are no prerequisites for this subcourse.

This subcourse 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: You will gage and sample petroleum tanks.

CONDITION: You will have information from AR 710-2, FM 10-18, FM 10-69, FM 10-70, and extracts from FM 10-18.

STANDARD: To demonstrate competency of this task, you must achieve a minimum of 70 percent on the subcourse examination.

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LESSON 1

GAGING PETROLEUM STORAGE TANKS

Critical task: 01-5103.00-0036

OVERVIEW

LESSON DESCRIPTION:

In this lesson, you will learn how to gage petroleum tanks.

TERMINAL LEARNING OBJECTIVE:

ACTION: Gage petroleum tanks.

CONDITION: You will be given information from AR 710-2, FM 10-18, FM 10-69, FM 10-70, and extracts from FM 10-18.

STANDARD: Gaging petroleum tanks will be in accordance with AR 710-2, FM 10-18, FM 10-69, and FM 10-70.

REFERENCES: The material contained in this lesson was derived from the following publications: AR 710-2, FM 10-18, FM 10-69, and FM 10-70.

INTRODUCTION

With the exception of the new light divisions, today's combat forces incorporate highly mechanized and mobile weapon systems that require vast amounts of fuel to operate. Many battalions have their own, in-garrison bulk petroleum storage and dispensing facility in addition to their fleet of bulk refuelers to satisfy their high daily demand rate. As a quartermaster officer, you may receive an assignment to one of those battalions and assume responsibility for the battalion's bulk petroleum storage tanks as part of your duties. You may transfer to a combat service support (CSS) battalion that handles millions of gallons of petroleum products a day. As a quartermaster officer, you must know how to accurately account for fuel. Although you rarely involve yourself personally in the actual process of gaging, you must know and understand the procedure to effectively supervise your petroleum personnel.

1. General.

Gaging measures the height of liquid level above the bottom of a tank (innage) or the height of a tank reference mark above the liquid level (outage) as part of determining the volume of the contents of the tank. You often handle bulk petroleum products many times before you use them. Make sure you rigidly account for them throughout this handling and that you maintain accurate records at all times. For accounting purposes, make sure that personnel gage products periodically to determine the quantity on hand, to verify the quantities issued or received, to detect leaks, and to determine the terminal capacity for receiving shipments.

2. Gaging Terms.

The following terms are used in discussing gaging:

- Innage.
- Outage (Ullage).
- Reference mark.
- Datum plate.
- Reference height.
- Tape cut.
- Bob cut.
- Tank truck capacity.
- Opening gage.
- Closing gage.
- Bottom sediment and water (BS&W).
- Total measured quantity.
- Gross quantity of product.
- Net quantity of product, corrected.

a. Innage. Innage is the depth (height of volume) of product in a tank measured or gaged from the surface of the product to the bottom of the tank.

b. Outage (Ullage). The outage (ullage) is a measurement of the free space above the surface of the product in a tank extending to the reference mark.

c. Reference Mark. The reference mark is a horizontal line put in the rim of the gaging hatch on a tank representing a fixed point from which measurements are made.

d. Datum Plate. The datum plate is a level metal plate at the tank bottom, directly under the reference mark. This plate provides a smooth, level surface for the innage bob to rest upon when taking an innage gage.

e. Reference Height. The reference height is the distance from the reference mark to the top of the datum plate. After you establish the reference height, stencil it in a conspicuous place adjacent to the gaging hatch.

f. Tape Cut. The tape cut is the line made on the tape measuring scale by the product being measured.

g. Bob Cut. The bob cut is the line made on the bob by bottom sediment and water (BS&W) being measured.

h. Tank Truck Capacity. Tank truck capacity is the amount of product in the vehicle when the product reaches an adjustable marker installed beneath the dome of each compartment. Adjust the marker in relation to the type of movement and highway or cross country.

i. Opening Gage. The opening gage is the gage of a product taken before the delivery, issue, or receipt of a product.

j. Closing Gage. The closing gage is the gage of a product taken after its delivery, issue, or receipt.

k. Bottom Sediment and Water (BS&W). BS&W is the amount of sediment and water measured in the bottom of a tank.

1. Total Measured Quantity. The total measured quantity is the volume of the product and the BS&W in a tank at the observed temperature of the product at the time of gaging. Usually, you obtain this measurement from the tank's capacity table or strapping chart.

NOTE: Engineers develop tank strapping charts when they construct the tank. Simply stated, strapping charts are conversion tables that convert linear measures taken from tape and bob readings to equivalent volumetric amounts. No two storage tanks have identical strapping charts because tanks of the same size vary in capacity.

m. Gross Quantity of Product. The total measured quantity minus the BS&W is the gross quantity of product (also known as the net quantity of product, uncorrected).

n. Net Quantity of Product. Corrected. The net quantity of product, corrected, is the measured quantity of the product minus BS&W at the observed temperature converted to an equivalent quantity at 60°F.

3. Gaging Equipment.

This paragraph describes the special equipment needed to measure bulk petroleum.

a. Tape and Bob. There are two types of tapes and bobs currently in use: an innage tape and bob and an outage tape and bob. Use them to measure the amount of product in a tank. Each consists of a metal bob connected by a harness snap to a steel tape graduated on one side to 1/8-inch divisions and housed in a reel.

(1) Innage Tape and Bob. The innage tape and bob is a steel tape with 1/8-inch graduations. The first whole number on the tape is 9 or 10. Consequently, it is 9 or 10 inches from the pointed tip of the conical bob to the first number on the tape. From the tip of the bob to the top of the eyelet is 6.6 inches. The bob is made of nonsparking metal and the zero point is at the bob's tip. Refer to Figure 1-1 for an illustration of an innage tape and bob. Use the innage tape and bob to determine the distance from the surface of the product to the bottom of the tank.

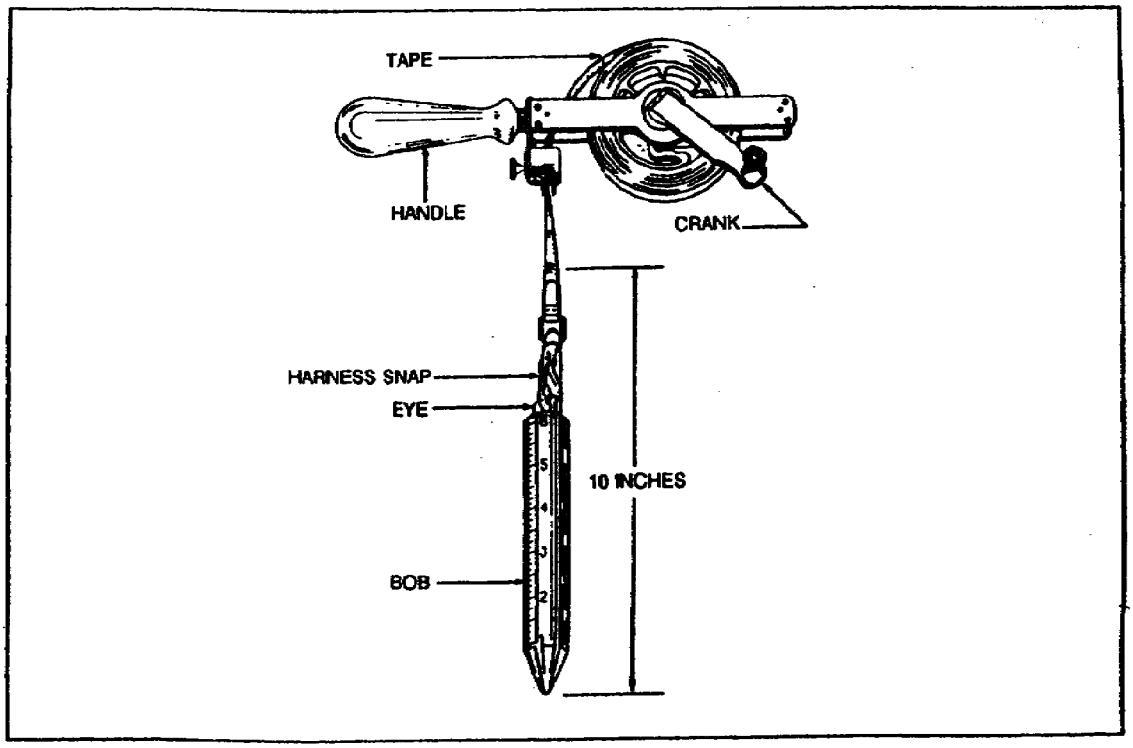

Figure 1-1. Innage tape and bob.

(2) Outage Tape and Bob. The outage tape and bob, shown in Figure 1-2, looks similar to the innage tape except that the readings begin at the 3-inch level on the tape. The zero reference is where the harness snap connects to the bob. The 6-inch long rectangular bob's 1/8-inch graduations start with the 6-inch mark at the bottom. You read it upward to one inch as the last whole number on the top. The outage bob has a flat nose and is made of nonsparking metal. Use the outage tape and bob to determine the distance from the surface of the product to the top of the tank.

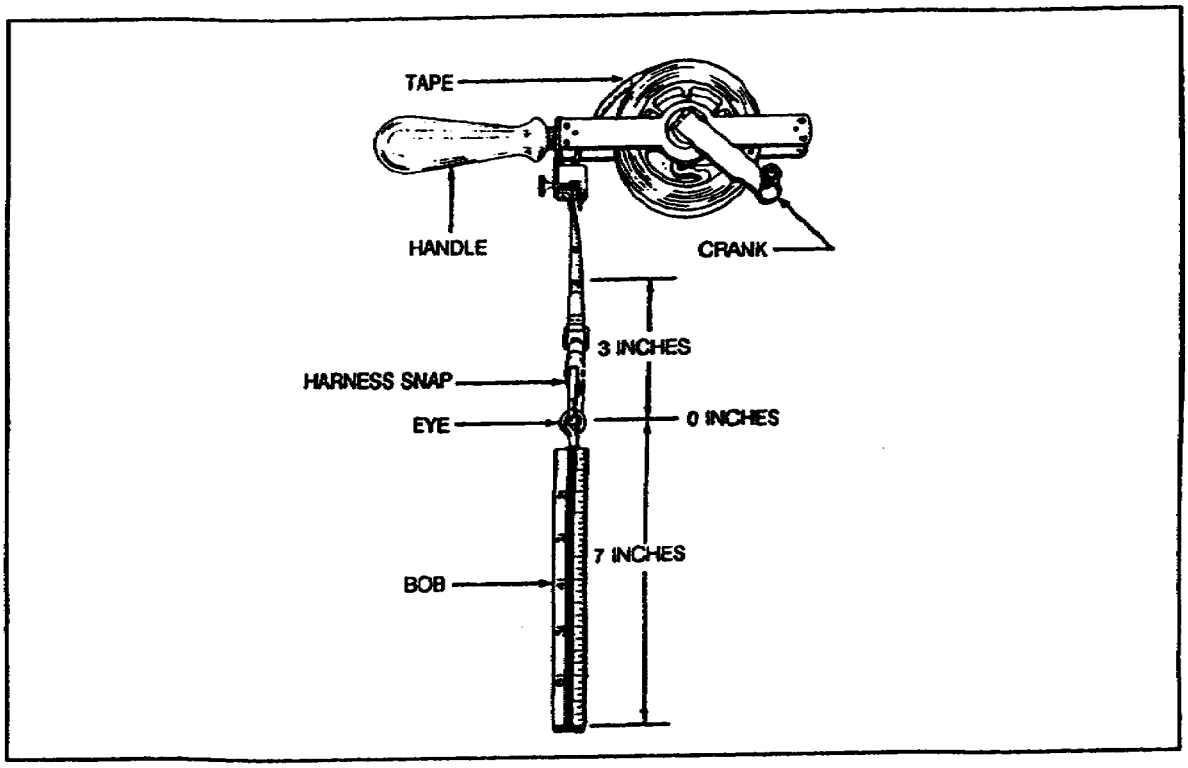

Figure 1-2. Outage tape and bob.

b. Indicating Pastes. Fuel and water indicating pastes assist you in determining the amounts of these respective liquids in petroleum storage tanks.

(1) Fuel-Indicating Paste. Fuel-indicating paste is a petroleum based paste used in measuring the amount of liquid petroleum in a storage tank. It changes color when it comes into contact with a petroleum product.

(2) Water-Indicating Paste. Water-indicating paste is a chemical paste used to differentiate between liquid petroleum products and water. The paste changes color when it comes into contact with water but is not affected by petroleum products.

c. Gaging Sticks. Use sticks to gage tank cars and tank vehicles.

(1) Tank Car Gage Stick. The tank car gage stick is a varnished piece of hardwood or other corrosion-resistant material, approximately 3 feet long. For outage gaging tank cars, the stick has two scales graduated in 1/8-inch divisions with a common zero 12 inches from the lower end. Attached to the stick is an angle. When you place the stick with the angle resting on the upper side of the tank car shell, the zero scale coincides with the underside of the shell.

(2) Petroleum Gage Stick. The gage pole or stick is a varnished piece of hardwood or other corrosion-resistant material used for innage gaging small, stationary tanks, tank cars, and tank trucks. Use a pole that is long enough to gage the tank (approximately 10 feet for a rail tank car). To prevent damage to wood poles, use an aluminum tip or cap. One side of the pole has a scale graduated in feet and inches to 1/8-inch divisions. The bottom of the tip is the zero point.

(3) Truck Vehicle Gage Stick. Each tank vehicle has its own gage stick graduated into 25-gallon divisions instead of feet and inches. If the product cut is between gallon divisions, you interpolate.

4. Gaging Precautions and Procedures.

Gage tanks according to AR 710-2. Observe gaging precautions and procedures during gaging.

a. Gaging Precautions. Follow these precautions in gaging a tank:

- Gage bulk storage tanks before and after any receipt, issue, or transfer operation.
- Ground the static electricity by touching a bare hand to the tank shell or handrail before climbing a tank to perform a task.
- Open the gage hatch and allow vapors to escape.
- Do not stand on the roof of the tank when gaging.
- Perform the gage from the side of the gaging hatch which has the wind to your back, if possible. Be careful not to breathe vapors from the contents of the tank.
- Never perform gaging during an electrical storm.

- Require the gaging personnel to stand at the same location on the roof for both the opening and the closing gages if they must gage while they stand on the tank's roof.

- Perform and record the gaging to the nearest 1/8 inch.

- Repeat the gaging until you get two identical readings.

- Be certain that the tape touches the rim of the gaging hatch at all times to ground static electricity during the gaging process.

- Wipe the tape clean and dry after every use.

- After discharging the product into a tank, let the product stand for at least 30 minutes to eliminate all static electricity before gaging it.

- Take the product temperature reading for volume correction before or after receiving or issuing Volumes of 3,500 gallons or more.

- Use the same tape and bob for opening and closing gages.

- If time permits, allow a two-hour settling period after adding fresh stocks to a storage tank.

- Gage all bulk deliveries for water bottoms before receiving the product. Drain off any water found.

b. Innage Gaging. Use the innage tape and bob to obtain the height of product in a tank. Follow these steps to obtain an innage gage, using an innage tape and bob:

- Direct the innage method of gaging for atmospheric and other nonpressure tanks.

- Raise the appropriate hatch cover and locate the reference point (shown in Figure 1-3 as point A).

- Apply the water-indicating paste to the bob (DO NOT apply on graduated portion) and apply the product-indicating paste to the tape at the level of the product in the tank. Apply the paste thinly and to the graduated side of the tape.

- Ensure that you hold the ungraduated side of the tape in contact with the metal rim of the gaging hatch at

the reference point as you lower the tape into the tank.

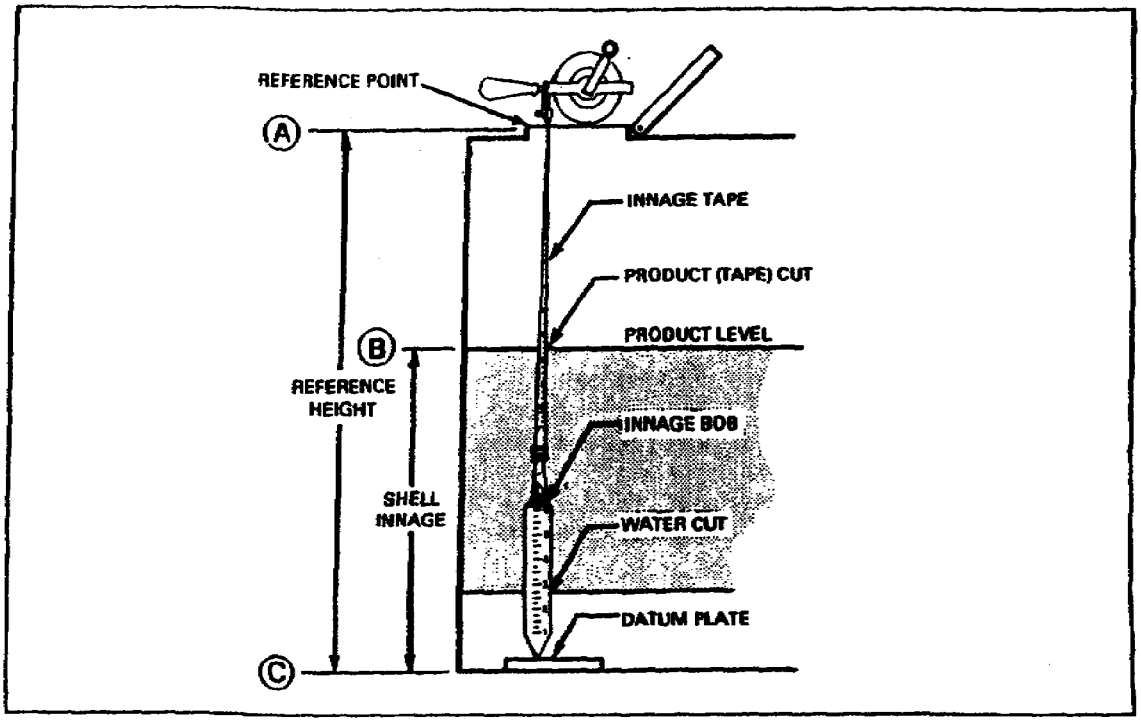

Figure 1-3. Taking an innage reading.

- Lower the bob and tape into the tank until the tip of the bob just touches the tank bottom or datum plate (the horizontal plane at the level of point C). If you lower the tape too far, the bob tilts and you obtain an incorrect gage reading. Compare the tape reading at the reference point (point A in Figure 1-3) to the reference height (the distance from point A to point C in Figure 1-3) of the container to ensure the gage's accuracy.

- Withdraw the tape after 30 seconds (at most) and read and record the product cut on the tape as the innage gage. Read and record the water cut on the bob as the BS&W cut.

- Ensure that you obtain two identical readings to get an accurate measurement. Use the same gaging equipment and gaging hatches in obtaining both the opening and the closing gages. Be sure you lower the tape to the same depth for both gages.

c. Outage Method. Use the outage method when gaging barges, tankers and tank EMRS. Also use the outage method to obtain the amount of space (ullage) remaining in the tank. Use all safety precautions. You may use this method on storage tanks when necessary.

To get an outage or ullage measurement using an outage tape and bob, follow these steps:

- Ensure that you apply product-indicating paste to the length of the bob.
- Hold the unmarked side of the tape against the metal rim of the gaging hatch at the reference point (point A in Figure 1-4).
- Lower the tape and bob into the tank until the bob touches the surface of the product (point B in Figure 1-4).
- Wait until the bob is motionless. Lower the tape slowly until the bottom of the bob is 2 or 3 inches below the product's surface (point B in Figure 1-4 represents the product's surface). Record the reading on the tape at the reference point (point A in Figure 1-4) as the tape reading.
- Withdraw the tape quickly. Record the product cut on the bob as the bob reading. Read the scale to the nearest 1/8 inch unless 1/4-inch readings are applicable. If the product cut is hard to read, put product-indicating paste on the bob and gage the tank again.
- Add the bob reading to the tape reading to get the outage gage.
- Subtract the outage gage from the reference height of the tank to convert outage gage to innage gage. The following example shows how to perform this step:

  EXAMPLE:

  NOTE: Use 1/4-inch readings.

Tape reading at reference point:	21 feet, 6 inches
Bob reading:	+ 3 3/4 inches
Outage gage:	21 feet, 9 3/4 inches

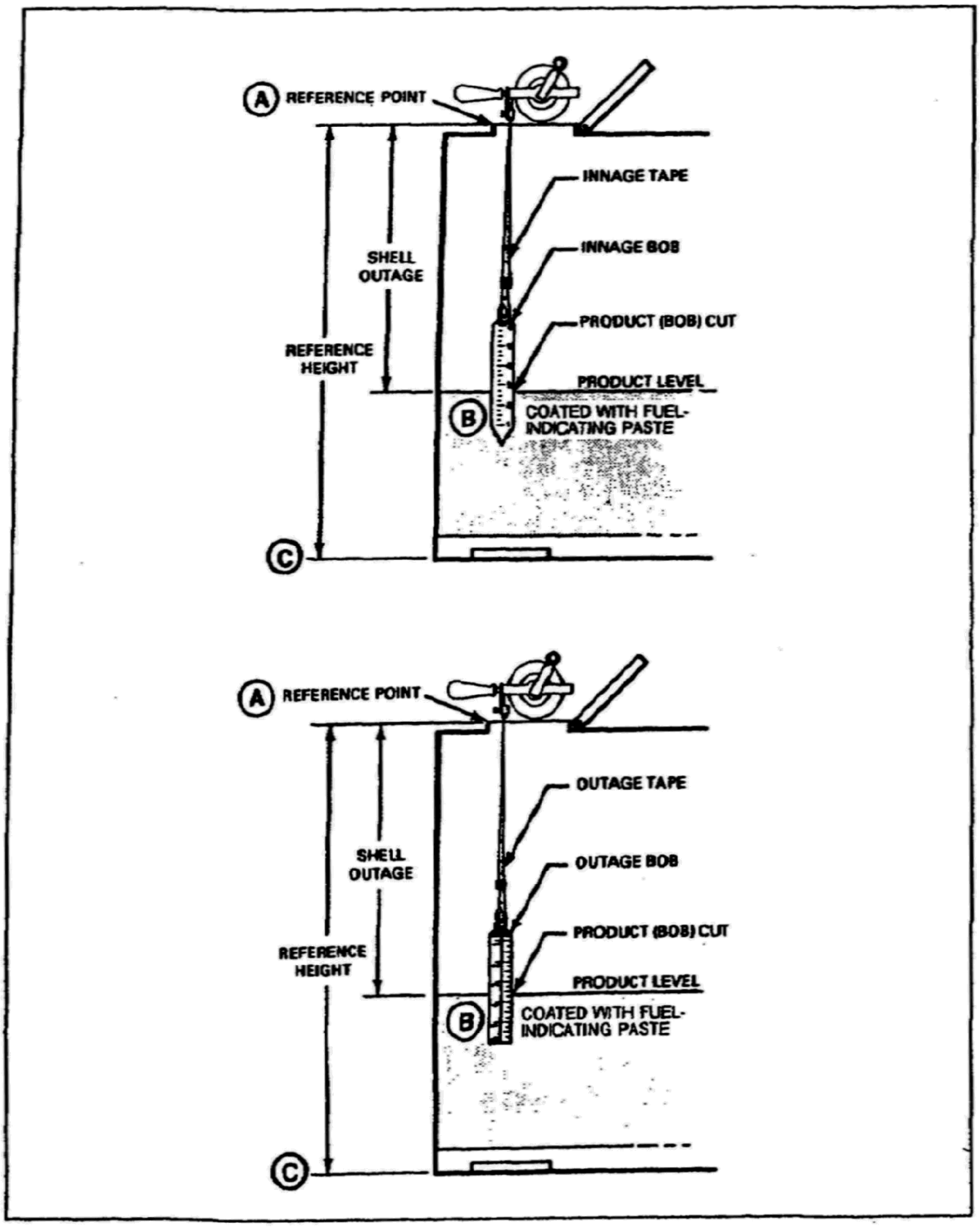

Figure 1-4. Outage gaging.

NOTE: If the tank being gaged is calibrated only in innage measurements, convert the outage gage to an innage gage using the following procedure:

- Use the outage gage above (21 feet, 9 3/4 inches) and an assumed reference height of 50 feet. (In actual practice, use the reference height of the tank being gaged.)

- The outage gage is 21 feet, 9 3/4 inches (point A to point B).The reference height is 50 feet (point A to point C). The innage gage is the distance from point B to point C.

- To convert outage to innage, simply subtract the outage from the reference point. An example of the procedure is as follows:

  EXAMPLE:

  Height - Distance = Innage gage
  50 feet - 21 feet, 9 3/4 inches = 28 feet, 2 1/4 inches

- Perform bob cuts for BS&W using the innage method and only use an innage bob.

5. Bottom Sediment and Water (BS&W) Measurements.

Storage tanks containing liquid petroleum products are measured for BS&W each time they are gaged to determine the actual amount of product. Figure 1-5 shows how to take BS&W measurements. BS&W often accumulate in different parts of a tank bottom. They usually accumulate on the side opposite a filling line or on either side of an outlet. When the tank has several hatches, gage from each hatch. Average them to get one BS&W gage for the whole tank. Follow these steps to measure the height of BS&W.

- Use water-indicating paste to determine the water cut. Put a thin, even coat of paste on the part of the bob that touches the point where water and product meet. Be careful not to put so much paste on the bob that it causes a false reading. If the depth of the water is greater than the length of the innage bob, apply water-indicating paste to the lower portion of the tape to measure water in the tank.

- Hold the side of the tape against the metal rim of the gaging hatch at the reference point.

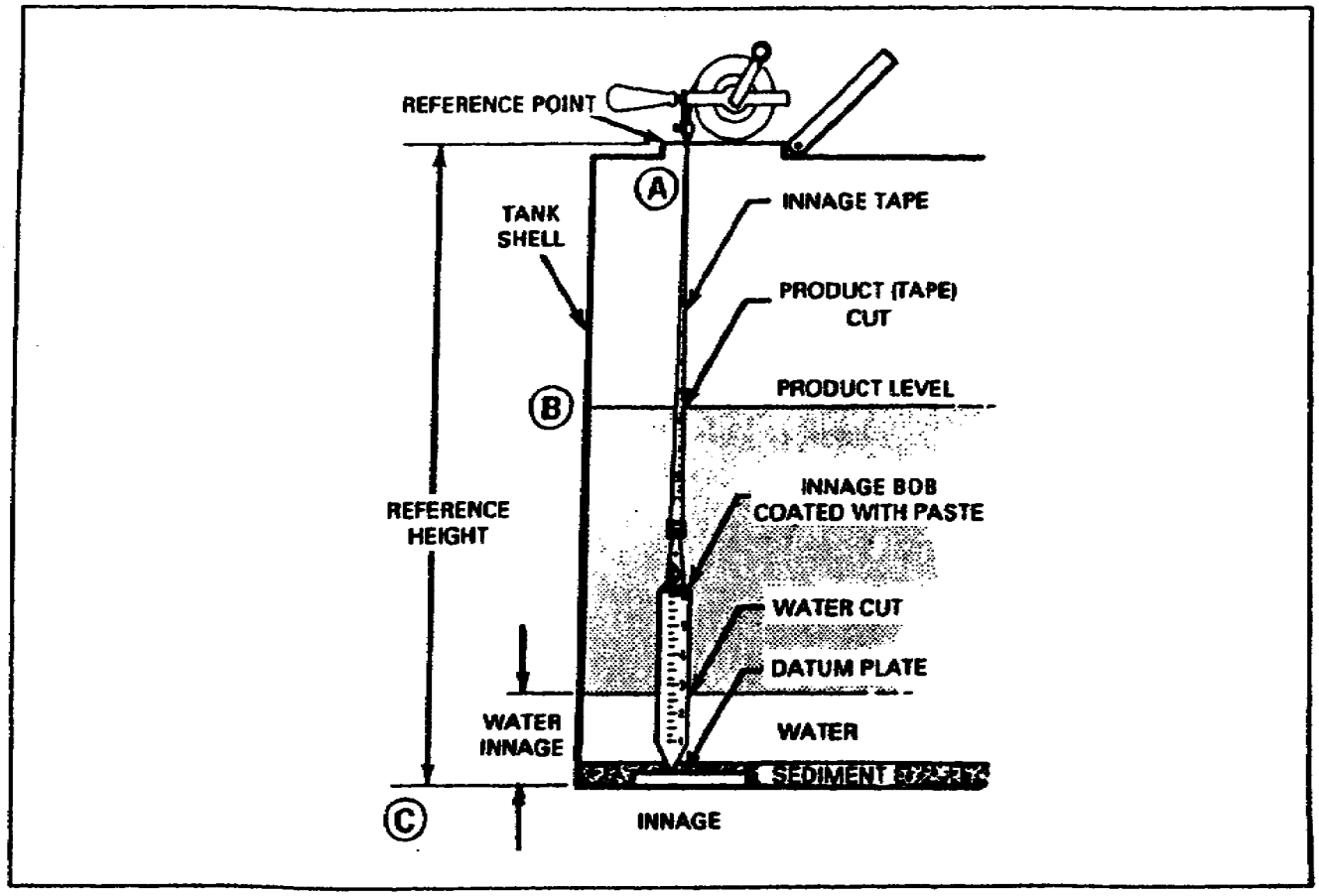

Figure 1-5. Taking BS&W measurement.

- Lower the tape and bob into the tank until the bob is a short distance from the bottom. Determine this by comparing the length of the unwound tape to the reference height of the tank.

- Unwind the tape slowly until the tip of the bob touches the tank bottom or datum plate. Do not let the bob rest on a rivet or other obstruction. Do not lower the tape so far into the tank that the bob tilts and causes an incorrect reading.

- Keep the tape and bob in the gaging position for 5 to 10 seconds for kerosene, gasoline, and other light products. Keep it in position 15 to 30 seconds for heavier products.

- Remove the tape and bob from the tank. The portion of the bob that was in the water should show discoloration. Record the water cut as BS&W.

6. Temperature Measurements.

Because the volume of petroleum products increases or decreases with temperature changes, an accurate measurement of the temperature of a product is taken when you gage it. You then correct the measured quantity to the standard temperature of 60°F for volumes over 3,500 gallons. When gaging large quantities, you take temperature readings at various levels and average them to determine the true temperature of the product. Figure 1-6 shows the number of readings necessary and the levels at which to place the tank thermometers.

DEPTH OF PRODUCT	MINIMUM NUMBER OF TEMPERATURE MEASUREMENTS	MEASUREMENT LEVELS
More than 15 feet	3	3 feet below top surface of product, middle of product, and 3 feet above bottom.
10 to 15 feet	2	3 feet below top surface of product, and 3 feet above bottom.
Less than 10 feet	1	Middle of product.

Figure 1-6. Petroleum product temperature measurements.

Use the cup-case thermometer (Figure 1-7) to measure the temperature of a product in a storage tank. The thermometer is attached to a hardwood backing with the base of the mercury column extending into the cup base. When filled with liquid under measurement, the cup case minimizes fluctuations of the reading when you suddenly withdraw the thermometer from the tank. Figure 1-8 shows the minimum immersion times for various fuels.

NOTE: To avoid long immersion times in measuring heavy petroleum fuels, leave the thermometers suspended in the tanks at all times.

Follow these procedures when you are measuring temperatures:

- Examine the mercury column for each cup-case thermometer for separations. Replace any thermometer having a faulty column. Mercury separations cause incorrect readings.

- Inspect the thermometers for accuracy. Expose them as a group to the same atmospheric temperature and compare the readings. Replace any thermometer with a reading that differs from the group by 1°F or more. Prove all tank thermometers against a reference standard each year.

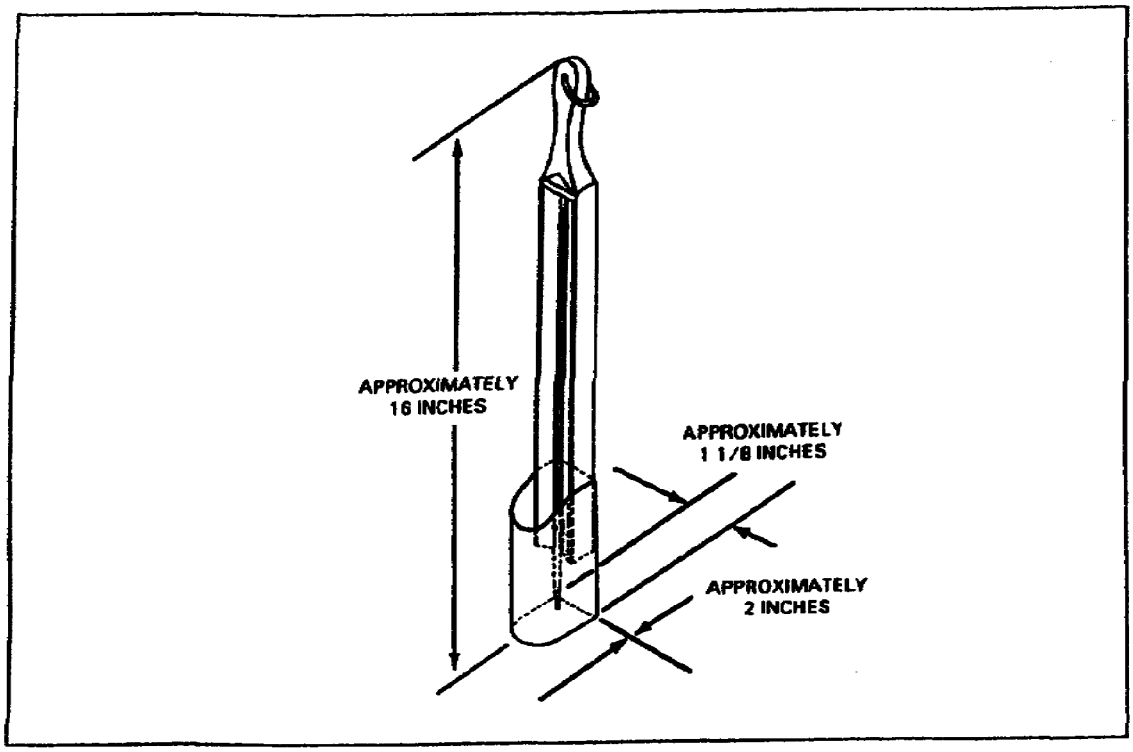

Figure 1-7. Cup-case thermometer.

PRODUCT	TIME (MINUTES)
Automotive gasoline (MOGAS), aviation gasoline (AVGAS), kerosene, diesel fuel, jet fuel, and grades 1 and 2 burner fuel oil.	5
Grades 4, 5, 6, and Navy Special burner fuel oil.	15

NOTE: This conforms to Table IV, Minimum Immersion Time for Cup-Case Assembly, API Standard 2543, ASTM Designation D 1086. Product listings are not comprehensive.

Figure 1-8. Minimum immersion times for the cup-case thermometer.

- Use Figure 1-6 to determine the minimum number of readings and the measurement levels required for the operation. Do this to find the true average temperature of the product.

- Attach the thermometer to the end of a gage tape, brass-coated chain, or cord. If you use a cord, tie knots in the cord so that the knots show when the thermometer reaches the required level.

- Lower the thermometer to the required level and leave it there for the amount of time shown in Figure 1-8.

- Take the thermometer out of the tank and read it at once. Shelter the cup below the hatch to reduce temperature changes caused by wind or atmosphere. Withdraw a full cup of product from the tank when taking the reading. Do not spill it. Record the temperature to the nearest degree Fahrenheit.

- When you gage large quantities, take several temperature readings at various depths. Add all the readings and divide the sum by the number of readings to get the true average temperature of the product. For example, assume a tank contains 20 feet of product. Take temperatures at 17 feet, 10 feet, and 3 feet or 3 feet below the top of the surface of the product, at the middle of the product, and at 3 feet above the bottom. Assume that you get readings of 82°F, 81°F, and 80°F. Add these readings and divide by three (the number of readings taken) to get the average true temperature of the product:

  82°F + 81°F + 80°F = 243°F divided by 3 = 81°F

  81°F is the true average temperature of the product in the example.

7. Volume Calculations.

Perform volume calculations on quantities of fuel of 3,500 gallons or more and on lesser quantities when directed by higher headquarters.

Follow these steps to calculate volume:

- Obtain the total measured quantity from the tank capacity tables.

- Obtain the BS&W measured quantity from the tank capacity tables.

- Subtract the BS&W measured quantity from the total measured quantity to obtain the net volume of the product, uncorrected.

- Measure the American Petroleum Institute (API) gravity with the appropriate hydrometer. Remember to convert the API gravity to the corresponding gravity at 60°F. (Paragraph 9 provides instructions on how to perform this conversion.)

Use the following fuel classification (API) gravity test procedures:

- Draw a 300 millimeter sample of fuel. Take the sample to a sheltered place to test it.
- Shake the sample to mix it.
- Slowly pour the sample into a clean, dry hydrometer cylinder, filling it about 3/4 full.
- Allow air bubbles to rise. Tap the cylinder top with a cupped hand to remove surface bubbles.
- Select the thermalhydrometer that has the range closest to the API gravity of the fuel.

- Gently lower the thermalhydrometer into the sample.
  - Spin the thermalhydrometer to get it to rest in the middle of the cylinder away from the sides.
  - With the thermalhydrometer floating freely (away from the side), read to the nearest scale division. Point your eye slightly below the level of the liquid and raise it slowly, until the surface of the liquid appears level. Record the reading.
  - Observe and record the temperature on the thermalhydrometer.
  - The two readings that you take from the thermalhydrometer are your observed API and temperature.

8. DA Form 3853-1 (Innage Gage Sheet}.

Use the DA Form 3853-1 shown in Figure 1-9 to record opening and closing gages of lineal reading and volumetric equivalent in gallons as well as the observed API used in correcting quantities at 60°F.

Keep this form on file for each gaging and each inventory as back-up data.

9. Observed Gravity Correction.

Measure the API gravity with the correct hydrometer listed in Figure 1-10. This hydrometer gives both the API gravity reading and the observed temperature reading of the sample. Convert the observed gravity reading to API gravity at 60°F using the tables prescribed in AR 710-2.

SAMPLE

INNAGE GAGE SHEET

(USING INNAGE TAPE AND BOB)

For use of this form, see FM 10-18; the proponent agency is TRADOC

UNIT	DATE	TIME
LOCATION	API GRAVITY	☐ OPENING ☐ CLOSING ☐ INVENTORY
TANK NO. / NOMINAL TANK CAPACITY	PRODUCT AND GRADE	

LINE NO.	PROCEDURE	LINEAL READING	VOLUMETRIC EQUIVALENT (Gallons)
1	Tape reading (innage)		
2	Bob reading (bottom sediment and water)		
3	Net volume of product, uncorrected for temperature (line 1 minus line 2)		
4	Average temperature		
5	Multiplier		
6	Net quantity of product at 60° F. (U.S. gallons) (line 3 multiplied by line 5)		

REMARKS (Include sample number)

NAME AND GRADE OF OPERATIONS OFFICER (Print)	NAME AND GRADE OF GAGER (Print)
SIGNATURE OF OPERATIONS OFFICER	SIGNATURE OF GAGER

DA FORM 3853-1

Figure 1-9. Blank DA Form 3853-1.

NSN	ITEM
6630-00-265-7610	Hydrometer, graduated scale, API 9 to 21 range, 190-mm long, 14-mm diameter, with thermometer.
6630-00-265-7611	Hydrometer, graduated scale, API 19 to 31 range, 190-mm long, 14-mm diameter, with thermometer.
6630-00-265-7758	Hydrometer, graduated scale, API 29 to 41 range, 190-mm long, 14-mm diameter, with thermometer.
6630-00-265-7759	Hydrometer, graduated scale, API 39 to 51 range, 190-mm long, 14-mm diameter, with thermometer.
6630-00-265-7764	Hydrometer, graduated scale, API 49 to 61 range, 190-mm long, 14-mm diameter, with thermometer.
6630-00-265-7765	Hydrometer, graduated scale, API 59 to 71 range, 190-mm long, 14-mm diameter, with thermometer.
6630-00-815-2267	Hydrometer, graduated scale, API 69 to 81 range, 190-mm long, 14-mm diameter, with thermometer.
6640-01-020-8801	Cylinder, ungraduated, 300-mm high, 28.6-mm outside diameter.
6685-00-239-4937	Cup-case thermometer.
6685-00-247-3739	Replacement thermometer.
6850-00-001-4194	Water-indicating paste.
6850-00-270-5526	Fuel-indicating paste.

Figure 1-10. Hydrometers.

10. Fuel Classification.

To classify fuels, use the following steps:

- Compare the corrected API gravity with the API gravity range for the particular product.
- If the corrected API gravity compares lower or higher than the product's gravity range, the test result indicates possible commingling of the product with heavier or lighter products.
- If the corrected API gravity is not within the range for the fuel being tested, isolate and mark the fuel container, sample the fuel, and send the fuel to the

supporting laboratory for analysis and disposition instructions. Do not use the fuel until you receive disposition instructions.

11. Volume Corrections.

The volume of liquid petroleum products changes because of changes in temperature. When the temperature of the product increases, the volume of the product increases. When the temperature of the product decreases, the volume of the product decreases. Therefore, you correct gaged volumes in excess of 3,500 gallons to account for this change of volume.

The standard temperature for volume measurements of petroleum products is 60°F. When you measure petroleum products in volumes exceeding 3,500 gallons, correct the measurement to what it would have been at 60°F. For example, for a temperature greater than 60°F, your measurement shows more product than it would at 60°F. Therefore, you adjust the measurement accordingly. Likewise, for a temperature less than 60°F, you measure less product than if the temperature were at the standard 60°F and you adjust the reading to that standard.

Follow these steps to make volume corrections:

NOTE: Gross volume is the quantity of the petroleum product and BS&W in a tank. Net uncorrected volume is the measured quantity of the product minus the BS&W at the observed temperature (before its conversion to the equivalent quantity at 60°F (15°C)).

- Make sure all tanks have individual strapping charts or calibration tables showing the volume of product in the tank per foot, inch, and even fractions of an inch (usually 1/8 inch.) Determine the total measured quantity in the tank (product and BS&W).

- Using the same strapping chart, be certain that the gage determines the volume of water in the tank. The volume, and only the volume, of the petroleum product is left. Remember, you subtract volume from volume, never inches from inches. The resulting figure is at the observed temperature, ready to be corrected to volume at 60°F.

- To determine the multiplier necessary to convert the volume at observed temperature to the volume at 60°F, you need an average tank temperature and the API gravity of the product.

- Use the following as an example for making volume corrections (innage gage):

Tank capacity:	500 barrels
Tape reading:	6 feet, 3 1/4 inches
Bob reading:	0 feet, 1 inch
Measured tank temperature:	67.5° F
API gravity at 60°F:	56.3 (JP-4)

- Convert gage readings to gallons.

- Refer to Figure 1-11 to convert the bob cut of 0 feet, 1 inch to 5.41 barrels. There are 42 gallons per barrel. To calculate the number of gallons, multiply 5.41 by 42. The result is 227.22 gallons.

  NOTE: In actual practice, refer to the chart for the specific tank being gaged.

- Refer to Figure 1-11 to convert the tape cut of 6 feet, 3 1/4 inches to 17,096.52 gallons. Since the figure does not list 6 feet, 3 1/4 inches, you read the quantities for 6 feet, then for 3 inches, and finally for 1/4 inch. Then, add all the quantities together. Figure 1-11 shows 389.48 barrels for 6 feet, 16.23 barrels for 3 inches, and 1.35 barrels for 1/4 inch. The sum of these measurements is 407.06 barrels or 17,096.52 gallons. (Again, in actual practice, you would use the chart for the particular tank being measured, not Figure 1-11.)

- Now that you have determined the uncorrected volume of the tank, find the tank's corrected volume. Find the volume correction factor in Figure 1-12. In order to use this factor, you must know the API gravity of your product at 60°F. (Round off to the nearest .5°F.) In this problem, the API gravity is 56.3°F. Round off this figure to 56.5°F. You also need the measured tank temperature, which is 67.5°F in this problem.

  - Locate the tank temperature of 67.5°F in the left-hand column of the volume correction table (Figure 1-12).

  - Go across from 67.5° to the rounded API gravity measure of 56.5°.

  - Read the volume correction factor from the table (at the point at which the temperature line and the API gravity column intersect).

  - The volume correction factor is .9950.

- Subtract the volume of BS&W (227.22) from the gross volume (17,096.52) to obtain the net uncorrected volume:

  17,096.52 Gross Volume
  - 227.22 BS&W
  16,869.30 Net Uncorrected Volume

- Multiply the net volume, uncorrected (16,869.30) by the volume correction factor (.9950):

  16,869.30 x .9950 = 16,784.953

- Round off to the nearest gallon and report 16,785 gallons as the corrected volume.

DEPTH	100 bbl[a]	250 bbl[a]	500 bbl[a]	1,000 bbl[a] or 3,000 bbl[b]	10,000 bbl[b]
1/4 in	0.24	0.69	1.35	2.57	8.81
1/2 in	0.49	1.38	2.70	5.15	17.62
3/4 in	0.73	2.07	4.06	7.72	26.43
1 in	0.98	2.76	5.41	10.30	35.23
2 in	1.97	5.52	10.82	20.59	70.47
3 in	2.96	8.28	16.23	30.89	105.70
4 in	3.95	11.04	21.64	41.18	140.94
5 in	4.94	13.80	27.05	51.48	176.17
6 in	5.93	16.56	32.46	61.77	211.41
7 in	6.92	19.32	37.87	72.07	246.64
8 in	7.91	22.07	43.28	82.36	281.88
9 in	8.90	24.83	48.68	92.66	317.11
10 in	9.89	27.59	54.09	102.96	352.35
11 in	10.88	30.35	59.50	113.25	387.58
1 ft 0 in	11.87	33.11	64.91	123.56	422.82
2 ft 0 in	23.76	66.22	129.83	247.09	845.64
3 ft 0 in	35.66	99.34	194.74	370.64	1,268.46
4 ft 0 in	47.54	132.45	259.65	494.19	1,691.28
5 ft 0 in	59.43	165.56	324.56	617.74	2,114.09
6 ft 0 in	71.32	198.67	389.48	741.28	2,536.91
7 ft 0 in	83.21	231.79	454.39	864.38	2,959.73
8 ft 0 in	95.10	[c]264.90	[c]519.30	988.38	3,382.55
9 ft 0 in	[c]106.99	[c]298.01	584.22	[c]1,111.93	3,805.37
10 ft 0 in	118.88	331.12	649.13	1,235.47	4,228.19
11 ft 0 in	130.77	364.24	714.04	1,359.02	4,651.01
12 ft 0 in	142.66	397.35	778.96	1,482.57	5,073.83
13 ft 0 in	154.55	430.46	843.87	1,606.12	5,496.64
14 ft 0 in	166.44	463.57	908.78	1,729.66	5,919.46
15 ft 0 in	178.33	496.69	973.69	1,853.29	6,342.28
16 ft 0 in	190.22	529.80	1,038.61	1,976.76	6,765.10
17 ft 0 in				2,100.30	7,187.92
18 ft 0 in				2,223.85	7,610.74
19 ft 0 in				2,347.40	8,033.56
20 ft 0 in				2,470.95	8,456.38
21 ft 0 in				2,594.49	8,879.19
22 ft 0 in				2,718.04	9,302.01
23 ft 0 in				2,841.59	9,724.83
24 ft 0 in				2,965.13	10,147.65

[a]One-ring tank.
[b]More than one-ring tank.
[c]Capacities greater than nominal size are produced by adding one additional ring. No more than one is permitted.

Figure 1-11. Gage data for military tanks.

	API GRAVITY AT 60°F											
TEMP	55.0	55.5	56.0	56.5	57.0	57.5	58.0	58.5	59.0	59.5	60.0	TEMP
F	FACTOR FOR CORRECTING VOLUME TO 60°F											F
60.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	60.0
60.5	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	60.5
61.0	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	61.0
61.5	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	61.5
62.0	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9986	0.9986	0.9986	0.9986	62.0
62.5	0.9984	0.9984	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	62.5
63.0	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9979	63.0
63.5	0.9977	0.9977	0.9977	0.9977	0.9977	0.9977	0.9976	0.9976	0.9976	0.9976	0.9976	63.5
64.0	0.9974	0.9974	0.9973	0.9973	0.9973	0.9973	0.9973	0.9973	0.9973	0.9973	0.9973	64.0
64.5	0.9970	0.9970	0.9970	0.9970	0.9970	0.9970	0.9970	0.9970	0.9969	0.9969	0.9969	64.5
65.0	0.9967	0.9967	0.9967	0.9967	0.9967	0.9966	0.9966	0.9966	0.9966	0.9966	0.9966	65.0
65.5	0.9964	0.9964	0.9964	0.9963	0.9963	0.9963	0.9963	0.9963	0.9963	0.9963	0.9962	65.5
66.0	0.9961	0.9960	0.9960	0.9960	0.9960	0.9960	0.9960	0.9959	0.9959	0.9959	0.9959	66.0
66.5	0.9957	0.9957	0.9957	0.9957	0.9957	0.9958	0.9958	0.9956	0.9956	0.9956	0.9956	66.5
67.0	0.9954	0.9954	0.9954	0.9953	0.9953	0.9953	0.9953	0.9953	0.9952	0.9952	0.9952	67.0
67.5	0.9951	0.9950	0.9950	0.9950	0.9950	0.9950	0.9949	0.9949	0.9949	0.9949	0.9949	67.5
68.0	0.9947	0.9947	0.9947	0.9947	0.9947	0.9946	0.9946	0.9946	0.9946	0.9945	0.9945	68.0
68.5	0.9944	0.9944	0.9944	0.9943	0.9943	0.9943	0.9943	0.9942	0.9942	0.9942	0.9942	68.5
69.0	0.9941	0.9941	0.9940	0.9940	0.9940	0.9940	0.9939	0.9939	0.9939	0.9938	0.9938	69.0
69.5	0.9937	0.9937	0.9937	0.9937	0.9936	0.9936	0.9936	0.9936	0.9935	0.9935	0.9935	69.5
70.0	0.9934	0.9934	0.9934	0.9933	0.9933	0.9933	0.9933	0.9932	0.9932	0.9932	0.9932	70.0
70.5	0.9931	0.9931	0.9930	0.9930	0.9930	0.9930	0.9929	0.9929	0.9929	0.9928	0.9928	70.5
71.0	0.9928	0.9927	0.9927	0.9927	0.9926	0.9926	0.9926	0.9926	0.9925	0.9925	0.9925	71.0
71.5	0.9924	0.9924	0.9924	0.9923	0.9923	0.9923	0.9922	0.9922	0.9922	0.9922	0.9921	71.5
72.0	0.9921	0.9921	0.9920	0.9920	0.9920	0.9919	0.9919	0.9919	0.9918	0.9918	0.9918	72.0
72.5	0.9918	0.9917	0.9917	0.9917	0.9916	0.9916	0.9916	0.9915	0.9915	0.9915	0.9914	
73.0	0.9914	0.9914	0.9914	0.9913	0.9913	0.9913	0.9912	0	0.9912	0.9911	0.991	
73.5	0.9911	0.9911	0.9910	0.9910	0.9910	0.9909	0.9909			0.9908		
74.0	0.9908	0.9907	0.990		0.9908	0.9906	0.99			0.9904		
74.5	0.9905	0.9904	0			0.9903						
	0.9901	0.9										
	0.9898											

Figure 1-12. Volume correction factors to 60°F.

LESSON 1

PRACTICE EXERCISE

The following items will test your grasp 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 item incorrectly, study again that part of the lesson which contains the portion involved.

Situation: You are the petroleum management officer. You are responsible for gaging petroleum storage tanks. For the purpose of this exercise, assume that you perform this task. In actuality, you will most likely delegate this task. Use this situation to answer questions 1 through 8.

1. In a storage tank, when you measure the depth of the product from the product's surface to the tank's datum plate, what are you measuring?

   A. Overage.
   B. Outage (ullage).
   C. Innage.
   D. Actual product on hand.

2. Which of the following is the measurement of a product taken before delivery, issue, or receipt?

   A. Opening gage.
   B. Closing gage.
   C. Net quality gage.
   D. Gross quantity gage.

3. You use a petroleum gage stick to innage gage a rail tank car. You ensure that the petroleum gage stick is at least how many feet long?

   A. 3.
   B. 5.
   C. 10.
   D. 15.

4. How do you ground static electricity before gaging a tank?

   A. Connect a grounding strap to the tank.
   B. Use a static compressor.
   C. Ground the tank using an approved grounding rod.
   D. Touch a bare hand to the tank shell or handrail.

5. When taking an innage measurement, how many times do you repeat the measurement?

   A. Until you get two identical readings.
   B. Until you get three identical readings.
   C. Until you get two readings within 1/8 inch of each other.
   D. Until you get three readings within 1/8 inch of each other.

6. When performing an innage gage, how do you use the datum plate?

   A. Read data from it for use in calculating innage.
   B. Stand on it while taking measurements.
   C. Put water-indicating paste on it to show the water level.
   D. Lower the innage bob to rest on it while taking the innage gage.

7. If the depth of the product in a tank is 10 to 15 feet, how many temperature measurements do you take?

   A. One.
   B. Two.
   C. Three.
   D. Four.

8. Refer to Figure 1-13. If the API gravity for a fuel is 58.4 at 60°F and the actual temperature is 68.7°F, what is the volume correction factor?

   A. 0.9923.
   B. 0.9937.
   C. 0.9939.
   D. 0.9942.

	API GRAVITY AT 60°F											
TEMP F	55.0	55.5	56.0	56.5	57.0	57.5	58.0	58.5	59.0	59.5	60.0	TEMP F
	FACTOR FOR CORRECTING VOLUME TO 60°F											
60.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	60.0
60.5	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	60.5
61.0	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	61.0
61.5	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	61.5
62.0	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9986	0.9986	0.9986	0.9986	62.0
62.5	0.9984	0.9984	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	62.5
63.0	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9979	63.0
63.5	0.9977	0.9977	0.9977	0.9977	0.9977	0.9977	0.9976	0.9976	0.9976	0.9976	0.9976	63.5
64.0	0.9974	0.9974	0.9973	0.9973	0.9973	0.9973	0.9973	0.9973	0.9973	0.9973	0.9973	64.0
64.5	0.9970	0.9970	0.9970	0.9970	0.9970	0.9970	0.9970	0.9970	0.9969	0.9969	0.9969	64.5
65.0	0.9967	0.9967	0.9967	0.9967	0.9967	0.9966	0.9966	0.9966	0.9966	0.9966	0.9966	65.0
65.5	0.9964	0.9964	0.9964	0.9963	0.9963	0.9963	0.9963	0.9963	0.9963	0.9963	0.9962	65.5
66.0	0.9961	0.9960	0.9960	0.9960	0.9960	0.9960	0.9960	0.9959	0.9959	0.9959	0.9959	66.0
66.5	0.9957	0.9957	0.9957	0.9957	0.9957	0.9958	0.9958	0.9956	0.9956	0.9956	0.9956	66.5
67.0	0.9954	0.9954	0.9954	0.9953	0.9953	0.9953	0.9953	0.9953	0.9952	0.9952	0.9952	67.0
67.5	0.9951	0.9950	0.9950	0.9950	0.9950	0.9950	0.9949	0.9949	0.9949	0.9949	0.9949	67.5
68.0	0.9947	0.9947	0.9947	0.9947	0.9947	0.9946	0.9946	0.9946	0.9946	0.9945	0.9945	68.0
68.5	0.9944	0.9944	0.9944	0.9943	0.9943	0.9943	0.9943	0.9942	0.9942	0.9942	0.9942	68.5
69.0	0.9941	0.9941	0.9940	0.9940	0.9940	0.9940	0.9939	0.9939	0.9939	0.9938	0.9938	69.0
69.5	0.9937	0.9937	0.9937	0.9937	0.9936	0.9936	0.9936	0.9936	0.9935	0.9935	0.9935	69.5
70.0	0.9934	0.9934	0.9934	0.9933	0.9933	0.9933	0.9933	0.9932	0.9932	0.9932	0.9932	70.0
70.5	0.9931	0.9931	0.9930	0.9930	0.9930	0.9930	0.9929	0.9929	0.9929	0.9928	0.9928	70.5
71.0	0.9928	0.9927	0.9927	0.9927	0.9926	0.9926	0.9926	0.9926	0.9925	0.9925	0.9925	71.0
71.5	0.9924	0.9924	0.9924	0.9923	0.9923	0.9923	0.9922	0.9922	0.9922	0.9922	0.9921	71.5
72.0	0.9921	0.9921	0.9920	0.9920	0.9920	0.9919	0.9919	0.9919	0.9918	0.9918	0.9918	72.0
72.5	0.9918	0.9917	0.9917	0.9917	0.9916	0.9916	0.9916	0.9915	0.9915	0.9915	0.9914	
73.0	0.9914	0.9914	0.9914	0.9913	0.9913	0.9913	0.9912		0.9912	0.9911	0.991	
73.5	0.9911	0.9911	0.9910	0.9910	0.9910	0.9909	0.9909			0.9908		
74.0	0.9908	0.9907	0.990		0.9908	0.9906	0.99			0.9904		
74.5	0.9905	0.9904				0.9903						
	0.9901	0.9										
	0.9898											

Figure 1-13. Volume correction factors to 60°F.

LESSON 1

PRACTICE EXERCISE

ANSWER KEY AND FEEDBACK

Item	Correct Answer and Feedback
1.	C. Innage. The depth of the product from the surface of the product to the tank bottom is the innage. This is a measurement of the amount of product in the tank. (Page 1-2, para 2a, c, and d)
2.	A. Opening gage. You take the opening gage before delivery, issue, or receipt of a product, and the closing gage after delivery, issue, or receipt of a product. (Page 1-3, para 2i)
3.	C. 10. Use a pole that is long enough to gage the tank (approximately 10 feet for a rail tank car). To prevent damage to wood poles, use a metal tip or cap. (Page 1-6, para 3c(2))
4.	D. Touch a bare hand to the tank shell or handrail. You cannot prevent static electricity, but you can dissipate it before it becomes dangerous. Touching a bare hand to the handrail or the tank shell dissipates any static buildup. (Page 1-6, para 4a)
5.	A. Until you get two identical readings. Gaging requires two identical readings. (Page 1-7, para 4a)
6.	D. Lower the innage bob to rest on it while taking an innage gage. The datum plate is a level metal plate at the bottom ofthe tank, directly under the reference mark. (Page 1-8, para 4b)

7. B. Two.

Figure 1-6 shows that a product depth of 10 to 15 feet requires two measurements, one 3 feet below the top surface of the product and another 3 feet above the bottom. (Page 1-13, Figure 1-6)

8. D. 0.9942.

Use the figure. Round off 58.4 to 58.5 and 68.7 to 68.5°F. Locate the point where 58.5 degrees API gravity and 68.5°F intersect and read the correction factor off the chart.
(Page 1-19, para 11 and page 1-22, Figure 1-12)

LESSON 2

SAMPLING PETROLEUM STORAGE TANKS

Critical task: 01-5103.00-0039

OVERVIEW

LESSON DESCRIPTION:

In this lesson, you will learn how to sample petroleum tanks.

TERMINAL LEARNING OBJECTIVE:

ACTION: Sample petroleum tanks.

CONDITION: You will be given information from AR 710-2, FM 10-18, FM 10-69, FM 10-70, and extracts from FM 10-18.

STANDARD: Sampling petroleum tanks will be in accordance with AR 710-2, FM 10-18, FM 10-69, and FM 10-70.

REFERENCES: The material contained in this lesson was derived from the following publications: AR 710-2, FM 10-18, FM 10-69, and FM 10-70.

INTRODUCTION

For the same reasons as those mentioned in the introduction to Lesson 1 of this subcourse, you, as a quartermaster officer, must be able to identify the different sampling procedures and determine which procedures to use for various situations. As a petroleum management officer, you must learn to supervise the sampling of various petroleum products. This lesson provides instruction in these areas.

1. General.

The importance of sampling cannot be overemphasized. Use samples to determine the quality of petroleum products. A sample is a small amount of petroleum which represents the whole product.

Refer to the extracts of FM 10-18 shown in Appendix B for requirements for testing and sampling petroleum products. This extract also includes the minimum frequency for such testing according to the product's bulk and packaging. As the extracts of FM 10-18 shown in Appendix B point out whenever you suspect a

product of being off specification, test and sample the product using test type A or test type B-2.

NOTE: After using sampling equipment to obtain representative samples of different petroleum products from various petroleum containers, ensure that personnel operating a base laboratory, a mobile laboratory, or a petroleum testing kit inspect and test the samples to determine whether or not they meet specifications.

2. Types of Samples.

This paragraph defines the following types of samples:

- Top.
- Upper.
- Middle.
- Lower.
- Bottom.
- All-levels.
- Spot.
- Composite.
- Single-tank composite.
- Multiple-tank composite.
- Outlet.
- Average.
- Drain.
- Continuous.

a. Top. Use a bottle or a beaker sampler to take a top sample about 6 inches below the surface of a tank's contents.

b. Upper. Use a bottle or a beaker sampler to take an upper sample from the middle of the top third of the product.

c. Middle. Use a bottle or a beaker sampler to take a middle sample from the middle of the product.

d. Lower. Use a bottle or a beaker sampler to take a lower sample from the middle of the bottom third of the product.

e. Bottom. Use a Bacon bomb thief sampler to take a bottom sample from material or product on the bottom of the tank.

f. All-Levels. To take an all-levels sample, submerge a closed bottle or beaker sampler as close as possible to the bottom of a tank or a container. Then, open the sampler and raise it at a uniform rate so that it is 75 to 85 percent full when it comes out of the liquid.

g. Spot. Take a spot sample at a specific place in the tank.

h. Composite. A composite sample combines individual samples that represent the bulk they came from. The samples can be a single-tank or a multiple-tank composite sample.

i. Single-Tank Composite. A single-tank composite sample is a blend of the upper, middle, and lower samples of the tank's contents. The blend has equal parts of the three cross sections from a tank with uniform cross sections. An upright cylindrical tank has uniform cross sections.

j. Multiple-Tank Composite. A multiple-tank composite sample is a blend of single, all-levels samples taken from tanker or barge compartments that contain the same product. The sample consists of parts in proportion to the volume of product in each compartment sampled.

k. Outlet. Use a bottle or a beaker sampler to take an outlet sample at the level of a tank outlet, whether fixed or swing line.

1. Average. An average sample is a sample that consists of proportionate parts from all sections of the tank.

m. Drain. Take a drain sample from the drawoff discharge valve.

n. Continuous. Take a continuous sample from a pipeline while allowing the product to collect slowly in a sampler during the entire flow time. A continuous sample represents the stream of the product during the period it was sampled.

3. Safety.

Due to the volatility of petroleum products, use caution when drawing samples. Draw samples only in the manner prescribed in this subcourse. Whenever you are working in a petroleum facility, always consider fire prevention.

4. Sampling Procedures.

Obtain a sample that represents the entire quantity of the product. Otherwise, an analysis of your sample will reflect the quality of only a portion of the whole substance, and the quality that is thus reflected may be better or worse than the true quality of the product as a whole.

Normally, you should collect a 1-gallon sample for a liquid product and a 5-pound sample for a semisolid product. Collect a 5-gallon sample for a specialty sample or a gasoline sample used to test the performance number by the super charger method. Also collect a 5-gallon sample of jet fuel to sample for thermal stability.

Use a standard sampler like those described in paragraph 5 and the one best suited for the product and its container or carrier. Use an improvised sampler when the sample opening is too small to use a standard sampler. In any case, be sure you have a clean sampler and it is made of material that cannot contaminate the sample. (Samplers are described later in this lesson.)

Clean the sampler and the sample container by rinsing them with the product being sampled. However, do not rinse these items with the product if you are taking samples for a particulate contaminant (sediment).

Protect the samples for shipment. Protect gasoline, jet fuel, and kerosene samples from direct sunlight by using brown bottles or cans or by covering clear bottles with paper or foil. Keep samples of gasoline and JP-4 cool (30°F to 40°F), if possible, to prevent the loss of light ends. Protect samples which contain lead additives from sunlight.

Assign a serial number to each sample and enter this number on the sample log. The last two digits of the calendar year and the sample number for that year make up this number. For example, number 88-1 is the first sample from an activity for 1988. Number 88-2 is the next sample. Keep a station log with a record of samples submitted to the designated testing laboratory.

Maintain a laboratory log as a permanent record of samples received for testing. Enter on the log--

- The date of receipt.
- The type of product.
- The unit sample number.
- The source of the sample.
- The quantity that the sample represents.
- The sampler's name.
- The date of the sample.
- The date of the completion of the test.

5. Sampling Equipment.

You obtain samples of liquid petroleum products in the following five types of samplers (see Figure 2-1):

- o Weighted beaker.
- o Drum thief.
- o Bacon bomb thief.
- o Weighted bottle.
- o Tulsa thief.

a. Weighted Beaker. The weighted beaker (weighted copper beaker sampler) consists of a copper bottle permanently attached to a lead base. Attached through the stoppers is a drop cord so that, with a quick jerk, you can open the sampler at any point beneath the surface of the product. Use this sampler to obtain a top, an upper, a middle, a lower, or an all-levels sample of liquid petroleum products from tank cars, tank trucks, barges, ship tanks, or shore storage tanks.

b. Drum Thief. The drum thief (plastic cylinder) is a tube-type sampler. It consists of a two piece or a single piece plastic tube which is 39 1/2 inches long and 1 1/2 inches in diameter. The tube has two finger rings at the upper end and may have three supporting legs at the bottom. Both ends taper and have openings. Use the drum thief to take spot samples or all-levels samples from drums and cans.

For spot samples, close the top opening with your thumb and totally submerge the sampler in the product. Then, remove your thumb from the opening and allow the product to fill the tube from the level desired. Use the drum thief in drums and cans.

For all-levels samples, remove your thumb from the opening and submerge the tube into the product. After the tube fills, place your thumb over the opening and withdraw the sample.

c. Bacon Bomb Thief. The Bacon bomb thief (tank car thief) is a nickel-plated brass cylinder tapered at the bottom end and fitted with an internal plunger valve. The valve opens automatically when the sampler strikes the bottom of a container. When you lift the sampler from the bottom, the valve closes automatically. You may attach a trip cord to make it possible to open the cylinder at any level. Use the Bacon bomb thief to take bottom samples and to take samples in storage tanks, tank cars,' and tank vehicles.

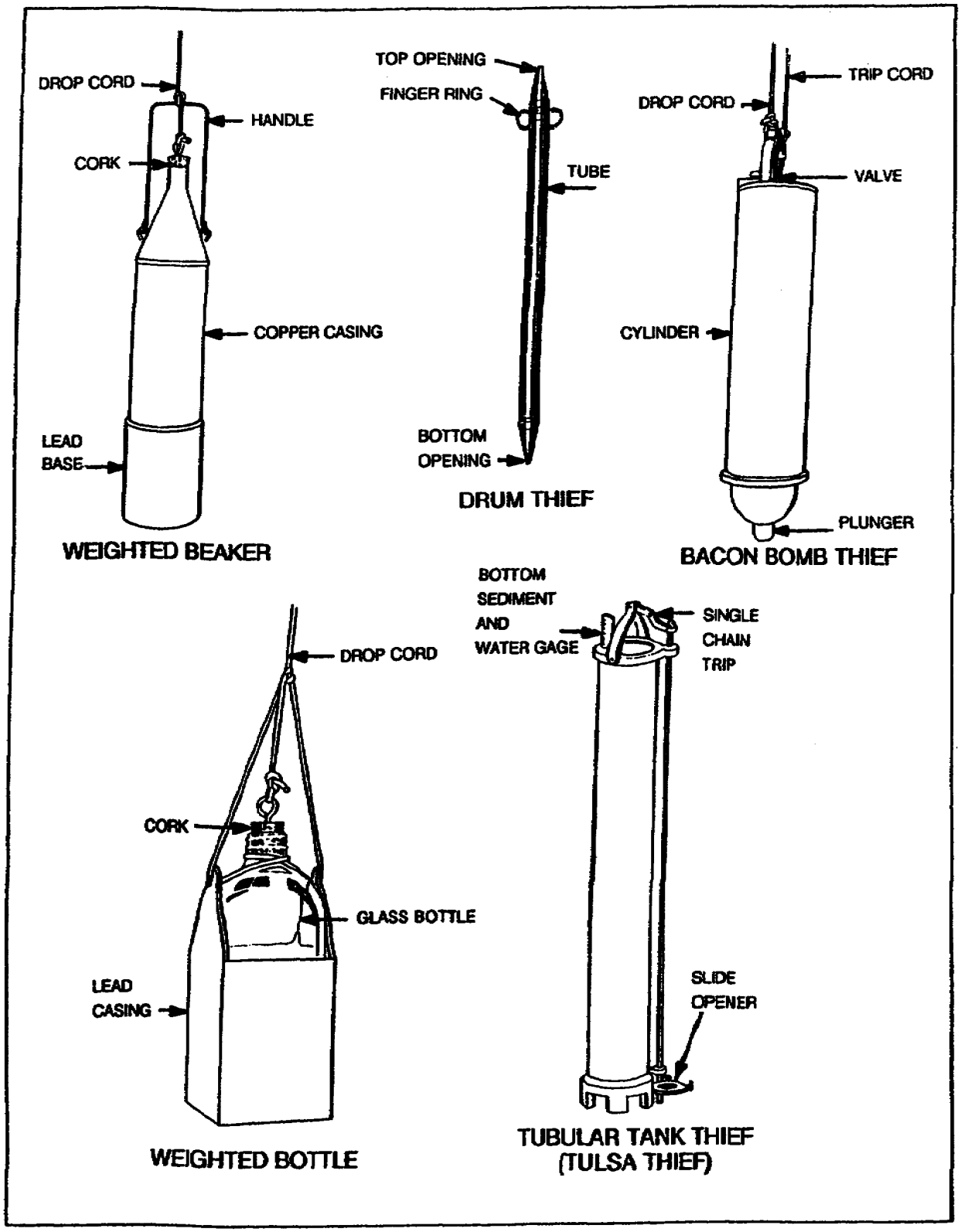

Figure 2-1. Petroleum product samplers.

d. Weighted Bottle. The weighted bottle (glass cylinder sampler consists of a glass bottle within a square, weighted metal holder. Attach a drop cord through a ring in the stopper. The weighted bottle and weighted beaker samplers are used in the same manner and for the same purpose. The only exception is the weighted bottle has a wide mouth and can be raised for sampling heavy and light products. The weighted beaker is used to sample only light products. Use the weighted bottle for all vapor pressure and oxidation stability samples.

e. Tubular Tank Thief (Tulsa Thief). The Tulsa thief is a metal cylinder open at both ends. When you activate the closure, you seal the bottom of the cylinder and trap the product in the cylinder. Activate the closing mechanism manually by tugging on the cord or automatically by touching the bottom of the sampler. Use the Tulsa thief sampler to take bottom samples in storage tanks, tank cars, and tank vehicles.

6. Sampling Containers.

For sampling containers, you may use clear or brown glass bottles or cans. Use the best suited type of sampling container for the product and for the purpose of the test.

As mentioned previously, the size of the liquid samples usually are 1 gallon, and semisolid samples usually are 5 pounds. For special samples (for example, those used to test for super-charged and thermal stability), use a sample that is at least 5 pounds, unless the sample size is otherwise specified.

7. Sampling Packaged Products.

For packaged products, you need a representative sample or shipment when testing is necessary. Although you can obtain guidance as to how much product constitutes a representative sample from your division materiel management center (DMMC), the critical concerns of dealing with packaged products is that you submit the right samples.

Packaged petroleum products are produced in batches. These batches are not equally divided by shipments. For example, one case of motor oil can contain more than one batch. Inspect each container so that you sample only affected batches. Your desired result is to send a representative sample from the affected batches and not from a good batch. Also, until you receive the test results concerning the samples, keep the affected stock away from the good products so that you do not issue the affected stock accidentally.

8. Portable Petroleum Testing and Measuring Kit.

Use the portable petroleum sampling and gaging kit (shown in Figure 2-2) at bulk storage facilities. Use it for the following purposes:

- o Gage tanks.
- o Measure product temperature.
- o Detect BS&W.
- o Make volume calculations.
- o Sample fuels.

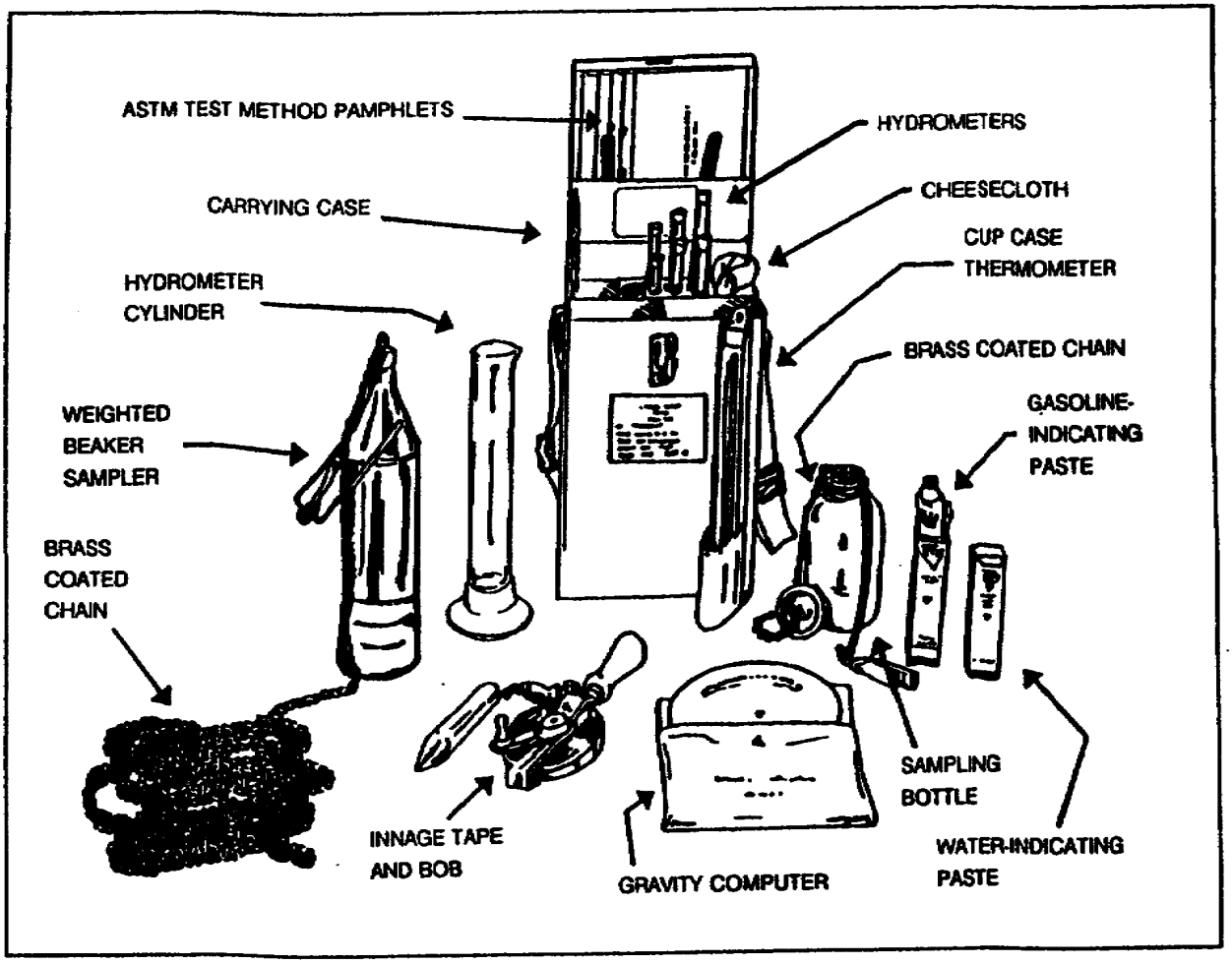

Figure 2-2. Portable petroleum sampling and gaging kit.

You can find the kit referenced in the supply catalog (SC) 6680-90-CL-N01. It weighs 22 pounds and consists of an aluminum carrying case fitted with measuring and sampling equipment. The major parts of the kit are:

- Olive-drab, aluminum carrying case.
- Cup-case thermometer, 11 to 180°F range.
- Innage tape and bob.
- Hydrometers, ranging from 19 to 81 API gravity.
- Hydrometer cylinder with removable base.
- Weighted beaker sampler.
- Wide-mouthed sampling bottle.
- Brass-coated chain.
- Gasoline-indicating paste.
- Water-indicating paste.
- Cheesecloth.
- Gravity computer with case.
- American Society for Testing and Materials (ASTM) Test Method pamphlets.

9. Sampling and Testing Requirements.

Outlined in MIL-HDBK-200 are the minimum sampling and testing requirements for determining the quality of petroleum and related products.

It is your responsibility, as the cognizant petroleum officer, to maintain strict quality surveillance. You may increase the frequency of testing.

Consider conditions of storage, age of stock, and type of product when concerned about whether increased testing conditions are warranted.

The types of tests used to test petroleum products stored in bulk and at installations and depots are:

- Type A
- B-1
- B-2
- B-3
- C
- Solids (Millipore)
- Flashpoint or Explosivity
- Visual Check

Refer to the publication extracts in Appendix B. Table A-1 displays the minimum frequency for testing various petroleum products. For example, Table A-1 shows that dormant bulk and packaged diesel fuels require testing every 12 months. Table A-2 provides information about the types of samples required, when

you finish sampling, and the type of test performed. The final page of Table A-2 briefly describes each type of test and provides additional information.

Use the appropriate type of test on a petroleum product when stipulation says that you must inspect the product at least annually or at the discretion of the owning or inspection authority having regard to the type of product, age of stock, and conditions of storage.

10. Procedure.

You cannot reduce sampling to a simple set of procedures because of the many differences in petroleum products, transportation, storage, and sampling tests. Contact your supporting laboratory for specific guidance. Use the following procedures as a minimum precaution:

- Use an approved sampler and approved containers.
- Ensure that personnel use clean sampling equipment and containers.
- Rinse samplers and containers with a portion of the product being sampled to ensure that the product is not contaminated with a previous material.

  NOTE: When samples are for sediment tests, use only sample containers that you previously rinsed with petroleum ether. Do not use the container if it was rinsed with the product being sampled.

- Clean samplers immediately after use.
- Before taking a continuous sample, draw enough to displace all the product in the sample lines and fittings.
- Take samples from hoses after you discharge about two times the volume capacity of the hose.
- Do not fill sample containers above 90 percent of their capacity. Seal them tightly.
- Use clean, dry cans or brown bottles to protect samples of gasoline, jet fuel, and kerosene from direct sunlight.
- Attach a completed DA Form 1804 (Petroleum Sample) tag to each container.

- Log each sample and its serial number in your facilities' informal sample log.

  NOTE: When you receive DA Form 2077 (Petroleum Products Laboratory Analysis Report) at your facilities, note it in your informal log. Comply with any remarks before filing the form for future reference.

LESSON 2

PRACTICE EXERCISE

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

Situation: You are the petroleum management officer. You are responsible for sampling petroleum storage tanks. For the purpose of this exercise, assume that you perform this task yourself. In actuality, you most likely delegate sampling tasks. Use this situation to answer questions 1 through 8.

1. What is the name of a small portion of a substance which you use to inspect or to determine the quality of the total substance?

   A. Sample.
   B. Gage.
   C. BS&W.
   D. Sludge.

2. When sampling a product to test its thermal stability, you use a sample that weighs at least how many pounds?

   A. 1.
   B. 2.
   C. 5.
   D. 10.

3. Which type of sampler do you use to take a bottom sample from a storage tank?

   A. Weighted beaker.
   B. Drum thief.
   C. Bacon bomb thief.
   D. Weighted bottle.

4. You inspect the contents of a portable petroleum sampling and gaging kit to ensure it contains all its components. Among the contents, you expect to find which of the following items?

   A. Cheesecloth.
   B. Cotton swabs.
   C. Sandpaper.
   D. Steel wool.

5. You determine whether increased testing of a product is warranted to ensure that it is of acceptable quality. In making your determination, you consider the age of the stock, the type of the product, and which of the following?

   A. Location of the storage tank.
   B. Use of the product.
   C. Cost of the product.
   D. Conditions of storage.

6. How often do you test bulk dormant stocks of diesel fuels?

   A. Every 6 months.
   B. Every 12 months.
   C. Every 24 months.
   D. Every 36 months.

7. For sediment test samples, you use only a container that was rinsed with which of the following liquids?

   A. Distilled water.
   B. Alcohol or glycerin.
   C. Gasoline or kerosene.
   D. Petroleum ether.

8. You take samples from a hose only after discharging about how many times the capacity of the hose?

   A. Two.
   B. Four.
   C. Six.
   D. Eight.

LESSON 2

PRACTICE EXERCISE

ANSWER KEY AND FEEDBACK

Item	Correct Answer and Feedback
1.	A. Sample. A Sample is a small amount of petroleum which represents the whole product. (Page 2-1, para 1)
2.	C. 5. The size of the liquid samples usually are 1 gallon, and semisolid samples usually are 5 pounds. For special samples (for example, those used to test for super-charged and thermal stability), use a sample that is at least 5 pounds, unless the sample size is otherwise specified. (Page 2-7, para 6)
3.	C. Bacon bomb thief. The Bacon bomb thief has an internal plunger valve that opens automatically when the sampler strikes the bottom of the tank. When lifting the sampler off the bottom, the valve automatically closes. (Page 2-5, para 5c)
4.	A. Cheesecloth. The portable petroleum sampling and gaging kit contains 13 components. Cheesecloth is one of these. (Page 2-9, para 8)
5.	D. Conditions of storage. Outlined in MIL-HDBK-200 are the minimum sampling and testing requirements for determining the quality of petroleum and related products. It is your responsibility, as the cognizant petroleum officer, to maintain strict quality surveillance. You may increase the frequency of testing as required. Consider conditions of storage, age of stock, and type of product when concerned about whether increased testing conditions are warranted. (Page 2-9, para 9)

6. B. Every 12 months.

According to Table A-1 (Appendix B), you test bulk diesel fuels every 12 months. (Page 2-9, para 9, and extracts in Appendix B)

7. D. Petroleum ether.

When samples are for sediment tests, use only sample containers that you previously rinsed with petroleum ether. Do not use the container if it was rinsed with the product being sampled. (Page 2-10, para 10 Note)

8. A. Two.

As a minimum precaution, take samples from hoses after you discharge about two times the volume capacity of the hose. (Page 2-10, para 10)