

Testing Milk and Cream for Butterfat

By J. D. FOSTER, G. E. WILLIAMSON,
and J. B. BROWN

together with

The Administration of Kentucky's Creamery License Law



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University of Kentucky
Kentucky Agricultural Experiment Station
Lexington

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PAGE
..... 3 The purpose of this bulletin is to acquaint operators of the Babcock
..... 4 test with the proper methods of testing milk and cream, and to advise
..... 5 all concerned of the provisions of the Creamery and Tester's License
..... 12 Law. The requirements of this law and the regulations under it apply
..... 25 to persons engaged in the purchase of milk and cream on the basis of
..... 26 the quantity of butterfat contained therein.

..... 5 Verbal instruction in setting up the equipment and its proper use
..... 12 in operating the test is advisable. After this is done the new operator
..... 25 may test without further assistance but is not qualified to pass the
..... 26 examination for a license to test. He can, however, get the necessary
..... 27 information and training by study and practice. The required accuracy
..... 30 in testing cannot be attained by operators who, through lack of in-
..... 31 formation or desire to make a more rapid test, do not follow the ap-
..... 33 proved methods. It is believed that all necessary information in the
..... 34 operation of the Babcock test is included in the following pages. If,
..... however, other problems develop write to the Kentucky Agricultural
..... Experiment Station for information.

PRECAUTIONS TO BE OBSERVED BY OPERATORS

..... 30 Read carefully the instructions given in the following pages before
..... 31 beginning to test. Proceed slowly at first, avoiding rush or confusion.
..... Later, with experience, more speed can be attained. Efficiency de-
..... pends to a large degree on proper organization of the work and care-
..... ful attention to details.

..... 33 Where electricity is used for operating, the tester should call in an
..... electrician if any wires become exposed or trouble in the circuit de-
..... velops.

..... 34 Do not use a centrifuge with exposed gears.

..... Always be careful with acid so as not to spill or spatter it in your
..... eyes, on your face, hands or clothing. To counteract acid wash quickly
..... with plenty of water; then apply a solution of baking soda or of wash-
..... ing powder.

..... Always keep the centrifuge closed while it is in operation (bottles
..... sometimes break).

..... Keep the centrifuge bolted down securely to a firm, level base.

* Deceased July 11, 1960.

Gas (natural or artificial), gasoline and kerosene should burn with blue flame in the heater. A yellow flame indicates imperfect combustion with possible formation of carbon monoxide which is deadly even in a relatively small amount. Follow the directions of the manufacturer of your heater.

Do not allow a flame of any kind or anything that will produce an electric spark near open or spilled gasoline.

Be sure there is sufficient ventilation in the test room.

In handling heavy cans do not jerk or strain; when lifting do it with your leg muscles rather than your back. This is done by keeping your body upright, bending down at the knees.

EQUIPMENT NEEDED FOR MAKING THE BABCOCK AND OTHER TESTS

The following apparatus and materials are necessary for testing milk and cream:¹

A. Required for both milk and cream:

- A Babcock tester or centrifuge capable of developing the proper speed.
- A supply of clean, soft water and a heater for it.
- A water bath for test bottles, at least 6 inches deep, and a heater or hot water supply for it.
- A thermometer that registers to 212° F.
- Dividers or calipers that have sharp points and will hold the spread between the points.
- Commercial sulfuric acid of specific gravity 1.82-1.83.

B. In addition to those listed under "A," the following are required for cream tests:

- A cream stirrer of proper size and construction.
- A cream test scale (balance) sensitive to 30 mg and a firm, level base for it.
- A 9-gram weight stamped "S.G.K."²
- Cream test bottles, 6- or 9-inch, with 0.5% gradations, stamped "9 gram" and "S.G.K."
- Cream pipettes, 9 ml.
- Sample jars with tops, preferably 2 or 4 oz.
- An acid measure, 9 ml. or 17.5 ml.
- Glymol or other light-colored oil that will form a layer above the fat.

C. In addition to those listed under "A," the following are required for milk tests:

- A sample dipper or tube of proper size and construction.
- Sample bottles, 8- or 16-oz size, preferably rubber stoppered.
- Milk test bottles, 8%, with 0.1% gradations, stamped "S.G.K."
- Milk pipettes, 17.6 ml stamped "S.G.K."
- An acid measure, 17.5 ml.

D. A substitute test for the Babcock test is the TeSa test for butterfat in milk.

Testware used in making the TeSa test for butterfat in milk when used for pay

¹ The equipment and supplies may be purchased from dairy supply concerns.

² Milk test bottles, cream test bottles, 17.6 ml pipettes and 9-gram weights are required to be inspected for accuracy and stamped "S.G.K." (Standard Glassware Kentucky) by the Kentucky Agricultural Experiment Station.

purposes shall be tested for accuracy and those found accurate, stamped "S.G.K."

THE CREAM TEST

Weighing and Sampling the Cream

Weigh the cream and enter on the report the patron's name, sample number and gross weight. Accurate weights and records are required by law. Keep the scales on a firm, level place and balanced; that is, the beam swings center when the counterpoise is at zero.

Stir the cream thoroughly from bottom to top until of equal consistency throughout. Fat in cream rises to the top on standing; also, different lots that are added together may differ in content of fat. This makes it necessary to thoroughly mix the cream before taking the sample. Use the regular cream stirrer except on small lots. Force the stirrer from top to bottom then to the top again on the opposite side, removing thicker portions from the side of the container. Continue to stir until the cream is uniform in texture throughout, and free from lumps and thicker portions. Frozen cream must be thawed before sampling. Accurate tests depend upon correct sampling. Mixing cream is hard work, especially in cold weather, but must not be slighted.

Number the sample jar to correspond with the entry on the report and fill it about $\frac{2}{3}$ full (2 oz jar). Always take sufficient cream for 3 tests. Number all samples correctly and keep the tops screwed on so as to prevent evaporation, spilling, collection of dirt, etc.

After emptying and washing the can, weigh it and subtract its weight (tare) from the gross weight. This should be done each time unless certain of the weight of the can. Trusting to memory or estimating the weight of containers often causes errors.

Preparing the Sample and Weighing 9 Grams

Heat the sample in warm water, but not above 110° F. Thick samples should be warmed until they are thin enough to mix easily and flow readily from the pipette. The pipette, when full, should empty in 4 to 8 seconds. Do not heat over 110° F as so doing may cause "oiling off." The most satisfactory way is to use a warming pan large enough to contain several samples. In cold weather water cools rapidly, especially if a small container, as a pint cup, is used. Vary the amount and temperature of water and time to fit conditions but be sure to warm samples until the cream is thin enough to flow freely, but not warm enough to "oil off" the fat. (Oiled samples are those in which the fat has melted and collected on the surface as visible oil. They are difficult to test accurately.)

Number a test bottle the same as the sample and balance it accu-

rately on the test scale. After placing the bottle in the bottle-holder on the scale, release the locking knob and pull or push the balance rod until approximately balanced, then screw in or out until exactly balanced. The scale is balanced if when the locking knob is released, the pointer comes to rest in front of the center mark on the index.

The scale should be on a level, steady base, free of vibration, drafts and excessive moisture. Do not oil the inner mechanism. When the scale is balanced a drop of water or cream from the pipette on either bottle-holder or pan should cause the pointer to move about one space on the scale of the index. Also, when balanced and a weight is placed on either side to depress that side, the scale should return to balance when the weight is removed.

Use only clean test bottles free from grease. If they are emptied and washed before the fat is allowed to cool usually a brush is not necessary in cleaning them. Wash in a good cleansing solution of hot water, rinse in clear water and drain. Do not soak the test bottle in alkali solution as the enamel on the graduation marks will be ruined.

Place the 9-gram weight¹ on the scale pan opposite the test bottle. Keep the weight clean, dry and away from acid. Cream test bottles, milk test bottles, 9-gram weights and 17.6 cc milk pipettes are illegal in Kentucky unless stamped "S.G.K." (Standard Glassware Kentucky) by the Kentucky Agricultural Experiment Station. See Regulation 7, page 36.

The two-bottle scale operates on the same principle as the one-bottle scale; a bottle is placed in each bottle-holder, the scale balanced, then the weight is placed on the scale with the second bottle. After weighing 9 grams in the first bottle the weight is removed and 9 grams from the next sample is weighed into the other test bottle.

You must remember that failure to balance the bottle on the scale before weighing the cream gives an inaccurate test. Get the habit of examining the scale immediately before weighing to see that the bottle is balanced.

Shake and stir the sample thoroughly until uniform throughout. The fat rises to the top of the sample; therefore, it is necessary that it be uniformly mixed in order to get an accurate test. Pouring back and forth several times to another container is a recommended method of mixing. If the top fits tight and the container is not over $\frac{2}{3}$ full.

¹ The metric system of weights and measures is used in the Babcock test. In this system 1 cubic centimeter of water at 4° C weighs 1 gram. Milk and cream pipettes are marked 17.6 and 9 ml, respectively. ml is the abbreviation for milliliter which is the same as the cubic centimeter, i.e., ml = 1 cc. It is also well to remember that 1 teaspoonful = about 5 ml and 1 ounce (U.S. Fluid) = 29.6 ml.

shaking is the most effective method of mixing. With loose-fitting tops partial mixing with a rotary motion can be done. Many testers depend upon stirring with the pipette to mix the sample. It is doubtful if a uniform mixture is obtained this way. Blowing air into the cream is of little value. To draw cream into the pipette and blow it out several times is effective, provided the cream is thin (warm), and the pipette is filled from different parts of the sample and contents blown out vigorously.

To get best results with oiled samples it is necessary to use the method of drawing in and blowing out, together with vigorous stirring at the same time. The pipette must be filled for the test while the cream is in motion sufficiently great to keep the melted fat equally distributed. This requires considerable practice. Oiled samples should be tested in duplicate and the average of the two tests taken.

An electric mixer, such as is used for mixing malted milk, etc., is very effective for mixing cream samples. Since the amount used for the tests (9 gm) is weighed, incorporation of air is of little or no consequence.

Without delay transfer into test bottle with the pipette an amount to balance the 9-gram weight exactly. To save time in weighing, stop just short of 9 grams, then add a drop at a time until the pointer reaches the center. If too much is put into the bottle use a long stick or pencil and remove small amounts until balanced. After the scales have been in use for some time the cream often will not cause them to "break" or move toward balance; to counteract this sticking move slightly by pushing the pointer toward center, tap the test bottle with the pipette, or use the locking knob to cause the same effect.

Adding the Acid

Add about 8.5 ml of acid while rotating the bottle so as to wash down cream adhering to the neck; then shake with a rotary movement until uniformly mixed, being careful not to let any of the mixture splash out. The acid sets up a chemical action dissolving the casein (curd), generating heat and freeing the fat. The fat melts and being lighter comes to the top of the acid solution. The rapidity of the action depends upon:

- (a) Amount of acid used—more acid causes faster and further action.
 - (b) Strength of acid—when acid becomes weak action is slower.
 - (c) Temperature of acid and cream—higher temperatures cause faster action.
 - (d) Water added to the test before acid is added retards the action.
- Let the mixture become almost black with a tinge of brown or*

purple, then add immediately about 1 teaspoonful of hot water (135-160° F). A good, clear test depends upon getting the correct color of the mixture and then retarding further action by adding a small amount of hot water. The correct color is dark, almost black with a tinge or brown or purple. Best results are obtained when the factors given above are controlled so as to give this color in approximately 30 seconds. When this color is reached add at once about 1 teaspoonful (not over this) of hot water. Occasionally the layer of fat may be too dark, almost black, after adding the water; with such tests add more hot water and shake. Better results are obtained when the amount of acid is reduced or the temperature is lowered.

Remember in hot weather to use less acid, to cool the acid or cream or both, or add a small amount of water to the cream before adding the acid. In cool weather also, keep the acid as near 70° F as convenient, warm tests that become cool, and use slightly more acid than normal. Most important of all, get the correct color, and then add only a small amount of hot water.

Centrifuging

Place the test in the centrifuge, put another bottle or test equally filled opposite it to balance the machine and whirl for 5 minutes. The purpose of the centrifuge or tester is to bring the fat together in the cylindrical portion of the neck of the test bottle where it can be accurately measured. The centrifuge requires a level steady base to which it should be securely attached. Instructions for servicing should be followed if available; otherwise after each 20 hours (approximately) of operation, oil the bearings with light lubricating oil. Add only a few drops so as to prevent its overflowing onto the motor brushes. It is important for the centrifuge to revolve at the correct speed. (See page 19 for correct speeds for various size machines.) A tendency for the motor to be sluggish or not operate normally should be reason for further checks or repair or both. The presence of any visible fat (very small drops) in the bulb of the test bottle after whirling the proper length of time clearly indicates lack of sufficient speed. Periodically and in case of doubt a more positive check (for proper speed) should be made.

Stop the centrifuge and fill the bottle with hot water until all the fat is in the neck (temperature of water 135-200° F). Do not open the machine until it comes to a stop, as opening causes the test to cool off too much and may cause the bottles to break. The water should be at least 135° F. About 160° F is preferable. Use clean soft water, free of sediment. It is of considerable advantage to have the centrifuge heated to at least 135° F.

Whirl again for 3 minutes. The procedure of adding water to fill the bulb only, whirling 2 minutes, then adding water until all fat is in the neck and finally whirling 1 minute, is all right. This is the preferred method in testing milk. In testing cream the shorter method is generally used.

Since fat found in the centrifuge after a run must have come from the tests, those tests are incorrect. Throwing out of fat may occur when the centrifuge is brought to speed very quickly. We have found this characteristic of some belt-driven machines, especially those that attain sufficient speed in the 1st and 2nd revolutions to cause the bottles to take a horizontal position. Spilled tests are, of course, inaccurate and require retesting. The inside of the centrifuge should be kept clean, free of fat and when fat is found after a group of tests is centrifuged that group should be retested. A preventive is to fill the bottles not above the 45 percent mark (all fat must be in the neck of the bottle). Insofar as possible cause the centrifuge to gain speed gradually, without jerks. Machines that persist in throwing fat out of the tests should be repaired or replaced.

Reading the Test

Place the test in the hot-water bath at 135-140° F with water deep enough to cover the fat column, and let it remain 5 minutes. Use of the hot-water bath is required by law in Kentucky. When a separate burner for the bath is not used, a small bath or bucket may be set in the water in the tank. The water in the bath can then be kept at the correct temperature and depth by adding cold or hot water as needed. Setting the test in warm water too shallow to reach above the fat column or pouring water over the neck of the bottle is of little value and does not meet the requirements.

Add 3 to 6 drops of glymol so as to form an even layer above the fat column; keep the test bottle upright and with dividers measure the length of the fat column, extending from the dividing line with the water solution to the dividing line with the glymol (see Fig. 1; dividers A). Then place the lower point of the dividers on the zero mark and read the percent direct (Fig. 1; dividers B. This cream tests 25 percent). Retest all curdy, charred, opaque and spilled tests. It is best to add the glymol from an oil can which does not squirt. Do not drop it directly on the fat; let it run down the inside of the bottle neck. Put glymol on not more than 4 to 6 tests at one time as the oil will mix with the fat. Take the tests out of the water bath one at a time and read at once. To remove several tests from the bath and set them down causes the hot water bath's tempering to be lost as they will cool rapidly.

The test bottle should be held in an upright position (not slanted). If the bulb is set in the palm of the left hand the thumb of that hand can, to considerable advantage, be used to place and hold the lower leg of the dividers. It is also an advantage to sit at a table and rest the elbows on it. Persons with faulty eyesight should not attempt to test cream as the strain is too great and too many errors will be made. With normal eyesight a good light is necessary. Test bottles which have dim graduation marks (enamel worn off) should be rubbed with carpenter's chalk. It is inexpensive and can be bought at most general and hardware stores.

Figure 1 shows the position of the dividers in measuring (A) and

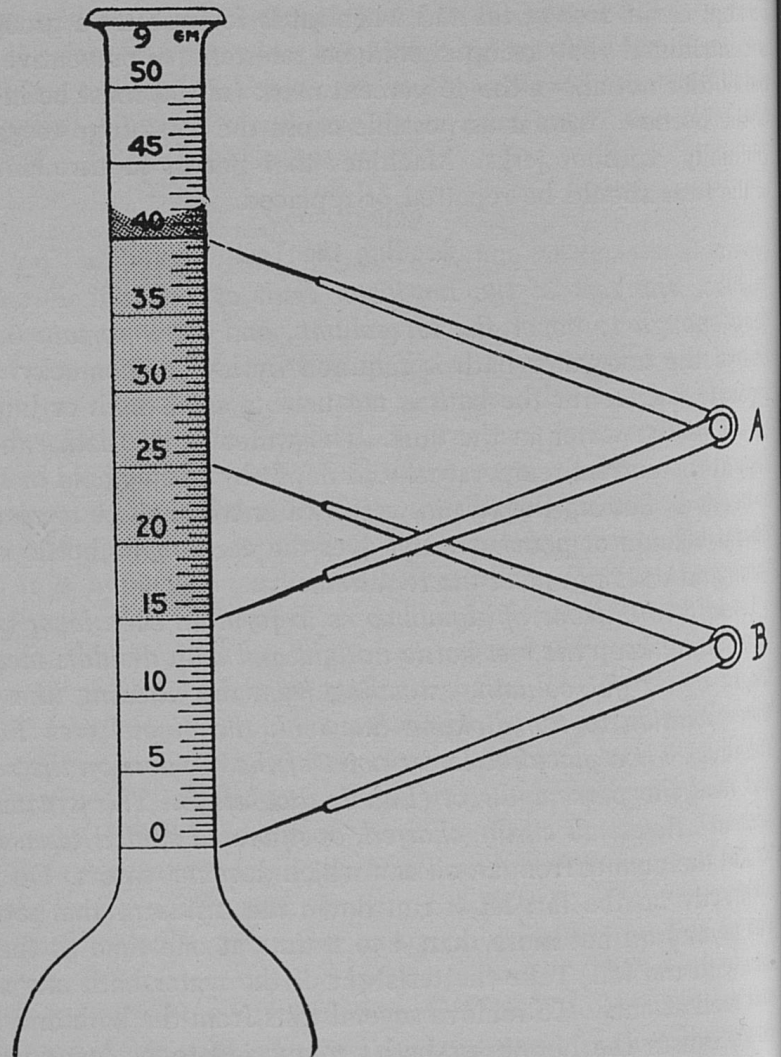


Fig. 1.—How to read the cream test.

reading (B) the test. Do not go above the average line formed by the fat and water solution or include any of the glymol in measuring the fat column. More accurate results are obtained by making this measurement on the side of the bottle neck which has no figures; i.e., opposite side from the graduations. After correctly measuring the fat column, the distance between the points of the dividers must not change until the test is read. From this it will be seen that dividers which are too loose to remain where they are placed must not be used. The reading must be done on the same bottle from which the measurement was taken. (To use a different bottle with more distinct figures is wrong, unless the graduations are exactly the same length on both.) Place the lower leg (pointer) of the dividers on the zero mark, that is, the lowest graduation on the bottle neck. The reading is taken from the position of the upper leg (pointer) of the dividers on the graduated scale. The shortest graduation marks represent $\frac{1}{2}$ percent. The longest graduation marks represent 5 percent, and have figures opposite them or just above them giving the reading of the scale from zero.

Tests containing more than 50 percent fat can be read as follows: Divide the fat column into two parts; measure and read from the 25 percent mark down, then from the 25 percent mark up; add these two readings together for the correct percentage. Correct readings can be made only when all the fat is in the cylindrical portion of the neck of the test bottle. If the neck will not hold it all then put part of the fat (and mixture) into another bottle, add hot water, centrifuge, temper in hot water bath, read both and add the readings together for the correct percent of fat.

Accept and read only tests with fat columns that are light yellow to dark amber in color, free of suspended particles, and without curd or char at the bottom. The fat column must be clear, semitransparent, with an even lower meniscus above a clear (water) solution. Curdy, opaque or off-colored tests usually are inaccurate. If the instructions are followed they should rarely occur. Since accurate results are required all such tests must be retested.

Farmers should be encouraged to have their cream test between 35 percent and 45 percent. Cream below 30 percent in fat has more milk in it than necessary and is more bulky to haul. There is a tendency to lose more fat in the skimmilk when the milk is separated so as to get cream testing over 50 percent. Also an accurate test is difficult on cream with so high a percentage of fat.

Calculations, Payments and Records

Record on the buying report the exact reading of the test. Five-point mistakes in reading will not occur if the figure on the nearest

five-point division is looked at sufficiently to read for certainty and not assumed or guessed at. There is no excuse for making mistakes in reading or recording tests if there is a good light, the figures are distinct and reasonable care is taken.

Multiply net weight of cream by the test and divide by 100 to get pounds of butterfat; multiply pounds of butterfat by price per pound to get the value; record results on report. Every operator should understand that the test represents the number of pounds of butterfat in 100 pounds of cream; therefore, the amount of fat in any quantity of cream is determined by multiplying the net weight of the cream by the test figure divided by 100. Thus, if a lot of cream weighs 12 pounds net and tests 40 percent, the calculation is: 12 times 0.40 equals 4.80 pounds. If the price is 30 cents per pound, the value is 4.8 times 0.30, or \$1.44. It is recommended that computers (suitable tables already calculated) be used in getting the pounds of fat and amount due. This method is usually quicker and causes fewer errors. These tables are simple to use; the most probable source of error is to look at the wrong figure. To avoid this use a ruler or other guide.

Copy the following items from the buying report to the check stub, or to the statement if cash is paid: date, customer's name or other identification, net weight, test, pounds fat, price and amount (\$). Make check or cash payment and statement to agree with buying report. Date and sign the records and keep on file for 12 months (carbon copy or original). Always complete the buying report of each patron before writing the check for his payment. Note that a statement covering each transaction is required (see Regulation 8, p. 36).

PROCEDURES REQUIRED FOR WEIGHING, SAMPLING, AND TESTING MILK IN KENTUCKY

Weighing Milk

The weigh tank shall be of such size and shape as to accomplish complete mixing of all the milk added. It shall be maintained in a satisfactory mechanical and sanitary condition, free from dents or bulges which may prevent adequate draining.

Scales shall be balanced daily. They shall be checked periodically, preferably monthly by a qualified service man. When there is no evidence of the scales having been checked within 6 months, the plant sampler and weigher and manager shall assist the inspector in making a check.

Sampling Milk From the Weigh Tank

Before sampling, the milk shall be thoroughly mixed to insure the withdrawal of a representative sample for testing.

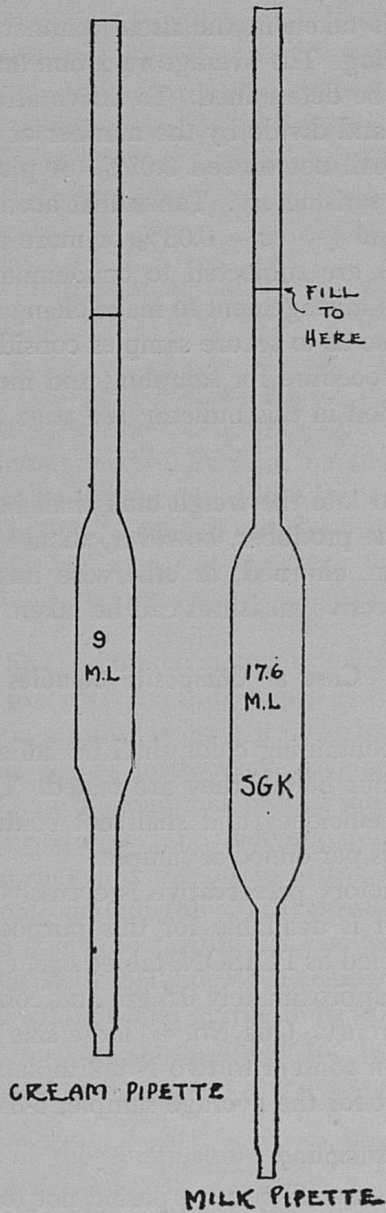


Fig. 2.—Pipettes.

All weigh tanks in which milk received from producers is dumped shall be checked; the plant samplers and weighers and the management shall assist the inspector in making check tests of the mixing tank. These checks shall be made on all tanks that have not been approved by the Kentucky Agricultural Experiment Station within the past 12 months. In these check tests including 20 or more compari-

sons, one sample is taken in the usual manner. The other is taken after thorough stirring. The average variation and the plus and minus balance shall both be determined. To arrive at the average variation, total all variations and divide by the number of comparisons (usually 20). The results shall not exceed 0.07%. A plus and minus balance of 0.03% or less is satisfactory. Tanks that according to these checks show a definite trend (+ or - 0.03% or more and average variation of 0.07% or more) are subjected to condemnation. It shall be the responsibility of the management to make changes within a reasonable time in such tanks so as to secure samples considered satisfactory.

The required procedure for sampling and measuring milk in farm bulk tanks is included in this bulletin; see page 27.

Abnormal milk

All milk dumped into the weigh tank shall be sampled unless it is severely frozen. The producer, however, should be notified promptly if his milk is frozen, churned, or otherwise unsuitable for thorough mixing, so that corrective measures can be taken.

Care of Composite Samples

Preservative

A preservative containing color shall be added to milk samples if they are likely to sour before they are tested. The preservative used shall be of proven efficiency and shall not contain in excess of 0.15 gm (2.3 gr) of solids per ounce of sample.

The most satisfactory preservative is corrosive sublimate (bichloride of mercury). It is available for this purpose from dairy supply concerns and is labeled as POISON, tablet size, etc. The No. 2 (small size) tablet weighs approximately 0.5 gm and contains 0.23 to 0.30 gm of bichloride of mercury. One No. 4 (large size) tablet is equivalent in weight and poison content to two No. 2 tablets. Two No. 2 tablets are usually sufficient for the average sample, 6-8 ounces.

Period of composite sampling

Composite samples shall cover a period not to exceed 16 days.

Composite samples shall be tested immediately after the compositing period ends. At plants receiving milk from a large number of patrons, arrangements must be made to care for and test all of the samples before they deteriorate sufficiently to affect the accuracy of the tests. Keeping all composite samples (except those being tested during the current day) at 50° F or under is required.

Quantity of milk to be taken

A minimum of 10 ml shall be taken from each producer's delivery

of milk. The quantity removed shall be the same for each day's production during a compositing period.

The total composite sample at the time of testing shall be not less than 100 ml. If, for example, a producer delivers milk only two days during a compositing period, then a minimum sample of 50 ml must be taken on each of the two days.

The sample bottles

Composite sample bottles shall have a capacity of not less than 8 ounces, be free from cracks, and be tightly fitted with an approved rubber stopper.

Each bottle shall be identified with a legible mark of identification.

Every sample bottle shall be clean and dry before the addition of a preservative and maintained in such a manner as to prevent the accumulation of moisture which may dilute the sample of milk.

Each milk plant shall be provided with at least two complete sets of sample bottles.

Method of sampling

When a dipper, thief, or similar manual device is used, it must be rinsed once prior to use with the milk which is to be sampled.

When an automatic sampler is used, it must be operated in accordance with the manufacturer's instructions, and must include the correct vacuum, no leaks in the line and proper slope in lines to permit prompt drainage. The sampler and weigher must operate the automatic sampler so the milk fills the dome to the line marked thereon for this purpose (about one-half full). It is possible for the automatic sampler to cause the check on mixing accuracy to be unsatisfactory. Inspectors are familiar with methods of checking automatic samplers.

If the weigh tank will not hold all the milk from any one producer without the level of milk extending above the bottom of the strainer box, the lot of milk shall be split into two equal portions and a sample taken from each lot.

On the first day of the compositing period, after the portion for that day has been put in the bottle, and after allowing for preservative to soften, the bottle shall be given a slight rotary motion to color the milk.

Storage conditions

The composite samples shall be stored away from strong light, in a clean sanitary cabinet maintained at a temperature between 35° and 50° F.

The samples shall not be kept at room temperature for longer than one hour each day during the compositing period.

Period held after testing

All milk samples on which tests have been completed and recorded shall be held for 7 days after testing. During this 7 days all samples must be kept at 35° to 50° F. The number expected to be tested that day may be kept out of refrigeration a maximum of 8 hours.

Tempering and preparing samples for testing

Place the sample bottles in tempering bath with the surface of the water slightly above the level of the milk in the bottles.

The temperature of the bath should not exceed 110° F at the time of placing the cold samples in it. Shortly thereafter the temperature should be adjusted as the temperature of the milk rises, so that the final temperature of both bath and samples is 100° F. (Two baths may be used, one for heating and one thermostatically controlled for holding at 100° F.)

Do not mix the milk in the sample bottles when at churning temperature (70° to 90° F).

Any sample which may become diluted with water must be discarded and a permanent record made of the date of accident and the identity of the sample.

Any cream adhering to the sides of the bottle and the stopper must be reincorporated with the contents by gently rotating and inverting the bottle. A rubber policeman or nylon bristle brush may be used if preferred.

Mixing before pipetting

The composite sample, after reaching 100° F is poured into a mixing container and back into the original sample bottle until at least two round trips are made. The mixing container shall be drained at least 15 seconds prior to re-use.

If the bottle is not over $\frac{2}{3}$ full, the sample may be mixed by shaking horizontally back and forth six round trips through a distance of about 6 inches within a period of 3 seconds. Care must be used to avoid churning when this procedure is used.

The sample for testing shall be pipetted immediately after mixing.

Temperature of milk for pipetting

The temperature of the milk at the time of pipetting shall be 100° F.

Pipetting

The tip of the milk pipette (calibrated to contain 17.6 ml of water at 20° C) should be at a level approximately equal to $\frac{1}{2}$ the height of the milk in the sample bottle. The pipette is then filled until the topmost surface of the milk is even with the graduation mark

on the pipette. The milk is then discharged into a test bottle by inserting the whole length of the long delivery tube of the pipette into the neck of the test bottle before releasing its contents. The lip of the test bottle must be vented to permit air to escape readily from the bottle, preferably by means of a grooved rubber washer at the base of the bulb of the pipette.

When the charge has drained, usually about 10 to 15 seconds after free flow has stopped, blow out the last drop or remove the pipette from the test bottle with a quick upward movement in order to remove the last drop from the tip of the pipette. Two pipettes, used alternately, may be found advantageous.

Testing Milk for Butterfat

A basic principle of the Babcock test

Sulfuric acid (H_2SO_4) is used in the test to break down or digest the protein (curd) and release the fat. In order to get proper acid action and acceptable tests, several conditions must be coordinated or adjusted in accordance with basic principles of chemistry. They include amount and strength of acid, temperature of acid and milk when combined, method of adding the acid, method and time of mixing acid and milk, and other conditions that may affect the test. Instructions specify that the finished test must have a clear translucent fat column, golden yellow to amber in color and free of foreign material such as char or curd. The implication and common impression is that all such tests otherwise properly handled, are accurate. This impression has been proven incorrect. (This statement is based upon experiments made by Creamery License Section and others.)

Proof of accuracy of any testing procedure is for the test results to agree with retest results obtained by using procedures known to be accurate.

Acid used in testing: specifications, strength, amount and temperature

Use acid labelled "commercial" or "technical grade" that has a specific gravity of 1.82 to 1.83 (66° Baumè often appears on the label). In purchasing acid it is advisable that a satisfactory source of supply of the proper grade and strength be found. Do not purchase or use "reagent" grade or chemically pure acid. Trial tests have proven it to be unsatisfactory for the Babcock test.

The amount required varies between 14 cc and 17.5 cc; about 16.5 is average (see paragraph below for adjusting to the proper amount).

The required temperature of acid when used is between 65° and 75° F (milk temperature 60° to 70° F). If necessary make several trial runs in order to get fat columns as described above. Ordinarily

it is better to vary slightly only the amount of acid used, keeping other factors the same. If two or more factors are varied from one run to another unacceptable tests are likely to be obtained.

Temperature of milk and acid when acid is added; how determined

In testing composite samples the temperature of the milk in test bottles when acid is added should be between 60° F and 70° F. The specified acid temperature is 65° to 75° F. When room temperature is above 75° F it will be necessary to cool the acid; usually it is also necessary to cool the measured portions of milk. In accomplishing the above, two thermometers are necessary. One of these may be the regular dairy floating thermometer. The other one shall be a small stem stainless steel dial (both thermometers should register to 212° F). The dial thermometer being metal is nonbreakable. There is one precaution in its use. After inserting it in a measured portion of milk in test bottle in lot being tested, a slight shaking is required in order to cause the thermometer to indicate the correct temperature of the milk. The primary objective is to develop a procedure that is satisfactory (uniform) on every "run." When measured portions are cooled in a refrigerator below 60° F there must be some uniform method devised to raise the temperature to between 60° and 70° F. Adding acid to measured portions below 60° F is contrary to these required procedures.

Method of adding acid

Hold the bottle at about a 45° angle, add acid so that it flows under the milk without mixing with it; the line between milk and acid should be narrow with only slight discoloration. A wide brownish line usually causes charred particles in or near the fat column.

Shaking procedures and precautions; forbidden procedures

The recommended procedure is to shake each test immediately after acid has been added. This procedure insures uniformity and usually increases accuracy. Using an automatic shaker accomplishes this and has other advantages also. The use of an approved automatic shaker is therefore highly recommended.

Delay: If acid is added to a run before any shaking is done, the time test number one sets (delay) is equal to the time required to add acid to the remainder of the run. Experiments have shown that a 10-minute interval (delay) between adding acid and shaking causes the test results to be lowered considerably.

If after adding acid, tests are set in water before shaking, the test results will be lowered appreciably. This practice is therefore forbidden.

With fresh milk not less than 30 seconds of shaking after all curd disappears is prescribed. With composite samples the shaking time should be lengthened—not less than 3 minutes is recommended.

As stated above, the criterion for any procedure is whether or not it can be proven accurate. When it is seen that the shaking procedure causes inaccuracy and must be changed (no automatic shaker available), an assistant may do the shaking, keeping close behind the adding of acid. If one man is testing, recommendations are: use an extra tray, add acid to not more than 4, shake by hand these 4 (or less) and place them in the extra tray; after second 4 is handled in the same manner put them in the tray and give the tray a brief shaking, continuing this until finished. (Note: the mixture in the test bottles when given a brief but vigorous shake will continue in motion for some time.)

The Fat Column: controlling its volume and the shape of its menisci

The centrifuge in use should be checked with a revolution counter occasionally to insure that its speed equals the minimum required. See table below. The diameter is measured from the bottom of opposite cups when held horizontally. Oil the centrifuge according to manufacturer's instructions. If revolution counter is not available have an electrician check the motor if it appears sluggish or otherwise below standard.

| Diameter of Wheel In Inches | Minimum Revolutions Per Minute |
|--------------------------------|-----------------------------------|
| 16 | 848 |
| 18 | 800 |
| 20 | 759 |
| 22 | 724 |
| 24 | 693 |

The temperature inside the centrifuge should be thermostatically controlled at between 140° and 150° F. An approved check for proper centrifuge temperature is to use one of the tests as a temperature indicator. When first test is removed from centrifuge before transferring it to hot-water bath, note the position of its upper meniscus. After it remains in hot water bath 3 minutes, note its position again. The meniscus should not rise or fall very much, but it is preferable to fall 0 to 0.2%. The lower meniscus should be slightly convex (∪), not sloping. (If sloping menisci are measured to the lowest point, the reading usually will be high.) Test bottles need to be well cleaned in order to obtain good menisci. Whirl all tests 8 minutes (5, 2 and 1).

The temperature of water added between whirlings should be at least 140° F. Be careful to prevent temperature decrease between reservoir (of water) and delivery at test bottle. The temperature of hot water bath is specified at 135° to 140° F, the water level maintained at a level not lower than the top of the highest fat column.

Reading tests

1. Sharp needle-pointed dividers or calipers shall be used for measuring the fat column. The bottle shall be held vertically and at eye level in front of a source of indirect light at the time of measuring.

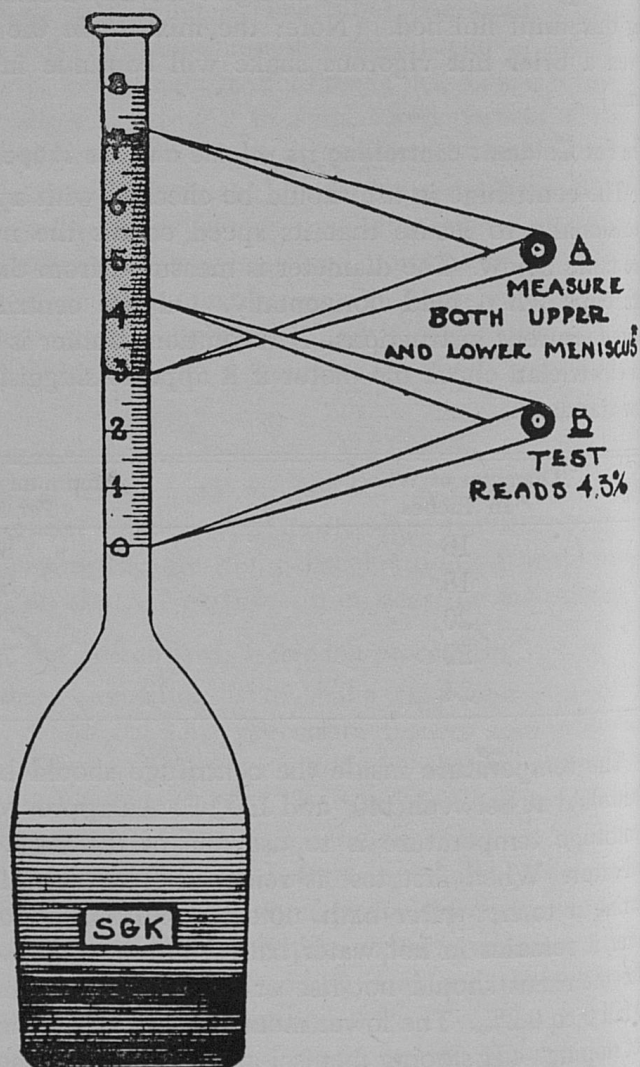


Fig. 3.—The correct way to read the fat column of the milk test.

* Meniscus is the curved upper and lower portion of the fat column.

One satisfactory type of illuminator is the "Fluorescent Titration Illuminator" manufactured by the Fischer Scientific Company. The use of a 5-inch magnifying lens as an aid in measuring the fat column is recommended.

2. The fat column shall be measured in its entirety from the bottom of the lower meniscus to the top of the upper meniscus. (The word "meniscus" refers to the saucer-shaped surface at each end of the fat column. The bottom of the meniscus would correspond to the bottom of the saucer and the top of the meniscus could correspond to the outer rim of the saucer.)

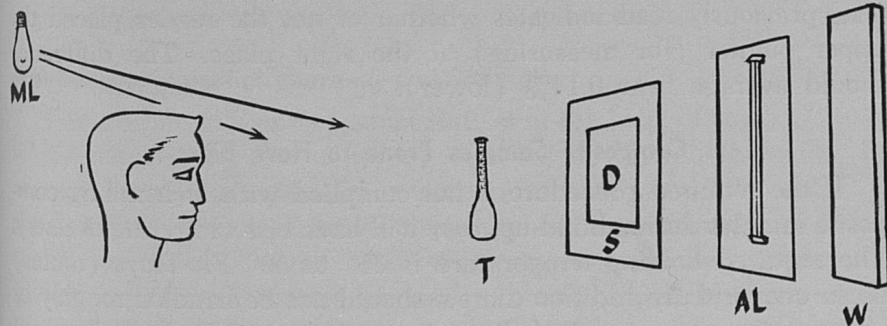
3. The fat column shall be measured on the ungraduated side of the neck and the test read from the graduated scale.

4. The fat test should be read to the nearest 0.1%.

5. Tests in which the fat column is foamy, burnt or curdy shall not be read.

Lights for reading tests

The upper meniscus when properly lighted is silhouetted and its top a distinct line. Proper lighting consists of having sufficient "over the shoulder" light and a suitable light coming from beyond the test. These conditions are described below.



ML — Main source of light
 T — Test being read
 S — Plywood board (screen)
 D — Diffusing glass

AL — Auxiliary light, fixture with 6-watt or 14-watt blue white fluorescent bulb
 W — Wall or other unlighted area

In constructing or assembling an auxiliary light, secure, if possible, a light meter that has a scale reading in foot candles. Experience has shown that most people strain their eyes rather than change the existing conditions. The light meter is therefore more reliable, but the opinion of several people when averaged will approximate the meter readings.

Recommendations for main light: a meter reading of 25 to 30 foot

candles when meter is placed at T. Eye test (for ML): to be able to see fine print well—the lines on the bottles, etc. Requirements for AL: with meter placed at eye position (16 inches in front of AL) with other lights turned off and windows well shaded, a meter reading of 5 to 10, depending upon the size of D opening—5 for opening of $1\frac{3}{4}$ " x 4", 10 for opening of 8" x 10". The larger openings are preferred. The eye test for AL is to be able to gaze into it for 1 minute or more without discomfort. For the AL a utility or wall light with 14-watt fluorescent bulb is suggested. For diffuser one of the following is suggested: white opal glass, "white flash glass," or "huewhite glass." These are sold by photographic supply stores or glass manufacturers' representatives. The brightness of the light may be decreased further by increasing the distance or by interposing filters such as fly screen or hardware cloth. Incandescent lights are not recommended as they are difficult to diffuse and have a yellow tinge.

After the brightness (intensity) of the auxiliary light has been decided upon, the reader should move back and forth in front of it with the test until the upper meniscus is clearly seen. Another solution is to move the light.

If reading tests is difficult, causing headache, then change the lighting set-up, have your eyes tested, or both.

Comparing readings of tests with glymol added with results of tests previously read indicates whether or not the reader placed the upper pointer (for measuring) at the right place. The difference should average near 0.14% (lower).

Composite Samples Prone to Have Bias

If the required procedure is not complied with in handling composite samples during build-up, they will have bias (lowering of tests). The required holding temperature is 35° to 50° F. Trays (routes) taken out for daily addition thereto should not be handled roughly or allowed to warm up. One hour is maximum time allowed out of refrigeration.

Steps in testing procedures that increase bias:

(a) Testers who take too long to complete testing. With a testing period longer than 3 days the holding temperature should not exceed 40° F.

(b) The samples are mishandled in warming, mixing, moving to and from refrigerator. The water in sample warming pan should not exceed 110° F when samples are put in it or any time thereafter. Gradual warming is preferred—warming up to near room temperature by setting out of the refrigerator ahead of time is recommended. After

putting in sample warming pan the thickened top layer of cream and any on inside of jar should be softened by giving the sample a gentle rotary motion. Do not mix or shake during churning temperature (70° to 90° F). Clean off cream on sides of jar with a policeman or nylon brush rather than by shaking. Mix just before pipetting at 100° F so as to distribute the fat, but not vigorously so as to cause churning. Samples that have been tested because they are warm are easily churned; therefore, they must be handled gently—not shaken or jostled in moving.

It is required that samples held for retest (including the 7 days held for inspectors) be kept at temperature between 35° and 50° F. To keep samples in the test room more than 8 hours after they are tested is contrary to the requirements.

When the inspector's retests are made on composite samples in excellent condition, then the tester's test and inspector's retests are compared directly. Often, however, as indicated above, the samples have deteriorated when the inspector's retests are made. Because of this it is usually a mistake to conclude that the tester's tests are high when the inspector's retests average below the tester's tests (\pm balance is plus). In other words, the lowering of the inspector's retests is due to bias that has built up in the samples. To get a true tester's error in such cases the amount of bias must be considered; accordingly this is done when the condition of the samples warrant it.

Bias caused by partial churning and "oiling"

Butterfat in milk in its normal state is in the form of small globules which after mixing are uniformly distributed through the milk. By excessive agitation, especially at temperatures between 70° and 90° F, some of these globules change physically and form granules of butter which are visible to the eye. With some composite samples the globules of fat will change physically to form liquid butterfat or oil under the following conditions:

- a. Held during build-up at temperature above 50° F.
- b. Kept out of refrigerator daily for more than 1 hour.
- c. Overheated too rapidly while tempering for pipetting.

Since this fat rises to the surface rapidly after warming and mixing, it is almost impossible to draw a representative portion into the pipette. Samples in this condition are unsatisfactory.

A "guide" sample to determine by comparison excessive "oiling" of composite samples may be made as follows: to 4 ounces of sweet milk add 4 drops of melted butterfat using a milk pipette, then add a preservative tablet for coloring. When warmed to 102° F and well

mixed, the droplets of fat rise to the surface and are visible if the sample is held so that a good light reflects from its surface.

The samples or method of preparing them for testing are to be considered unsatisfactory if on the first test 5% of the samples are "oiled off" equal to the guide prepared as described above.

"Oiled" composite samples

The required procedure in handling of samples and testing is designed so that "oiling off" of composite samples will be prevented. Because of this instructions for testing or retesting them are not usually given, the prescribed alternate being to take and test special samples. Testing an occasional "oiled" sample may be justified provided the following special instructions are followed.

Warm "oiled" samples to between 104° and 106° F; warm the pipette by holding it under a hot water faucet, immersing the top end in hot water (150° F) or pouring hot water over the upper part of it; drain inside and wipe off outside. The sample must set alone, as one hand is used for stirring and the other to control pipette. With a rubber policeman churn sample up and down without splashing or incorporating air; use an up-and-down cycle equal to about 100 per minute. While the milk is being kept in this up-and-down movement, fill the pipette, adjust to graduated line and quickly transfer measured portion to test bottle. (This procedure requires some practice.) The trick is to fill the warm pipette while the droplets of fat are small and evenly distributed, and to empty it before they rise, cool off and adhere to it.

From the above statements, it is concluded that composite samples in excellent condition give tests near the "true" test, i.e., the bias in them is normal and acceptable, but composite samples that are below excellent condition give tests below the "true" test and are therefore unsatisfactory.

Fixing Responsibility for Low Quality Samples

Although mold formation, souring, pronounced churning, oiling, etc., may be recognized in composite samples at any time, usually deterioration as considered here is more clearly demonstrated after the samples have been warmed to 100° F.

It should be noted that graded milk samples usually average considerably better than manufactured milk; however, the quality of manufactured milk has been improved during the past few years, and there is a necessity for further improvement. With the improvement in the quality of the milk, in order to give the producers of manufactured milk a square deal there must be improvement in the handling

of the samples so that the bias in them when they are tested will not be excessive.

In building up and testing composite samples, these licensed persons are responsible: the licensed sampler and weigher, the buyer, and the tester. Their various responsibilities are listed on inspection reports made by inspectors of the Creamery License Section. In this connection, the objective of the section or of inspectors representing it is to disseminate information, i.e., to cooperate with and educate those newly employed, to give information on new or improved methods, and when necessary, to enforce regulations and provisions of the law.

Licensed (and therefore responsible) persons should realize that they cannot expect satisfactory reports (tester's reports include grades) if they do not comply with regulations or make tests that vary from inspector's verified tests to an extent considered unsatisfactory (see Regulation 6, page 36).

THE PAY TEST FOR MILK

The Creamery and Tester's License Law and the Rules and Regulations in it are clear: each payment is to be made on basis of accurate tests on samples which accurately represent the milk from which they are taken. In other words, each patron's statement is required to report a test which is taken from and agrees with the licensed tester's record of test(s) for this patron for the period covered by the statement.

In order to verify certain tests it is required that if a current test varies considerably from the previous test on this same producer, a retest shall be made. In all cases when the variation is 0.3% or more the making of a retest is recommended.

The "office" should designate samples to be retested, and the tester should retest them without having before him records of his previous tests, as such records may influence him unduly. If two tests on the same sample agree within 0.2%, these results are considered as verifying each other and any other test (on this sample) is considered in error and is thrown out. When two tests on the same sample agree within 0.2%, the obvious procedure to follow is to average them and use this average as the "pay" test.

The foregoing procedure should establish the test for most patrons. Those for which it does not provide what is considered a satisfactory test may be grouped as follows:

- (1) The tester's record shows the composite sample as faulty, having noted: "sour," "churned," "not enough," etc.

(2) The testers records of tests and retests establish a verified test for this sample of the patron but the paymaster still has doubts, probably because previous tests are different. To justify his doubts, he may consider that the wrong sample was used or some accident happened to it.

Any patron who for any reason is not paid on the basis of the regular composite test(s) requires special attention including the sampling and testing of two or more days' production during the pay period or as soon after it ends as possible. These samples from two or more days' production may be composited. These special samples taken and tested for use in computing pay tests shall be held in condition suitable for retesting. If the number of patrons whose milk is specially sampled exceeds an average of 1 in 25, a scheduled holding period for them shall be arranged and the Experiment Station advised of it.

COOPERATIVE PRODUCERS' ASSOCIATIONS, CHECK TESTERS AND FEDERAL ORDERS

Federal orders require accurate tests, and the administrators usually assign the task of checking the buyer's tests to a cooperative (which employs check testers). In the case of non-members (i.e., producers selling on the market but non-members of the cooperative) the market administrator may himself employ and use check testers.

In order to insure accurate tests for their members some cooperatives take and test fresh samples.

At those plants which continue to take and test composite samples it is considered reasonable to allow the buyer to use these tests as basis for pay, provided their average is not more than 0.10% above or below the cooperative's average test.

Requirements for Check Testers of Cooperatives and Federal Order Check Testers

Check testers are required to: (1) secure and hold a license to test, (2) make tests in accordance with the required procedures for testing milk in Kentucky (page 12), (3) arrange a schedule of testing and holding samples and list the schedule on their application for license, (4) take and test samples from five or more days' production for each producer; the days on which samples are taken shall be fairly and evenly dispersed through the sampling period.

THE REQUIRED PROCEDURE FOR SAMPLING AND MEASURING MILK IN FARM BULK TANKS IN KENTUCKY

1. Necessary Equipment.

a. A *Sample Box or Separate Compartment* on each tank truck is required. This box or compartment must be constructed so that one sample for fat test for each patron and other required samples can be put in it, with sufficient ice or other refrigerant to maintain a temperature between 35° and 50° F. In case the samples are not kept in the immediate surveillance of the licensed sampler and weigher until delivered to the licensed tester at the milk plant, they are required to be kept under lock and key.

b. *Sample Bottles or Tubes.* For samples to be tested individually while fresh, the bottle or tube must hold enough for at least two tests, or a minimum of 40 ml, plus 1/2 inch airspace. Bottles or tubes for samples to be used to build up composites must hold not less than 35 ml, plus 1/2 inch airspace. Except for saving space, a 2- to 4-ounce sample bottle is preferred. Sample containers must have approved seals (stoppers) which will not permit leakage or dilution from melted ice.

c. *Sample Dipper* to be of stainless steel, easily cleaned. Recommended size: To deliver when full an amount equal to 1/5 to 1/4 of each sample. (Example, for 55 mm sample use a 10 mm dipper and take 5 portions.)

2. Steps to Follow in Measuring Milk.

a. If the milk in the tank is motionless when the sampler and weigher arrives at the farm, the measurement should be taken. If the milk is being agitated on arrival, the sampling is done first, then the agitator is turned off, and the milk surface allowed to become motionless before the measurement is made.

b. If there is any foam in the area of measurement, gently move it to one side with the end of the measuring stick.

c. Insert the rod into the milk very slowly and seat it firmly, without pounding. Any foam, splashing of milk or rough handling of the rod will give an inaccurate measurement.

d. Read the rod to the nearest graduation mark. Wipe the rod with clean, disposable material and make a second reading. If this reading is not the same as the first, take additional readings until it is certain that the result is correct. It would be helpful to note any unusual conditions on the weight ticket.

e. Having made the dip stick reading, refer to the conversion chart to get the amount in pounds. It is important to be accurate in making this conversion; therefore, recheck the reading. Note: Some milk plants

require that the measurement in inches and fractions thereof shown on the dip stick also be recorded on the weight ticket. This practice is recommended.

3. Taking and Transporting Samples for the Butterfat Test.

a. *Sampling.* Fat is distributed through the milk in small globules. Being the lightest component of milk, the fat rises to the surface of the milk and forms in clusters. In order to get a representative sample from the tank the fat must be redistributed through the milk by thorough mixing. After the agitator has run long enough to mix the milk thoroughly, with the agitator continuing to run, the sample is taken. In most instances, 3 to 5 minutes of agitation is sufficient. To eliminate moisture, rinse the dipper and sample bottle with milk. While the agitator is still in motion, take 4 or more dipperfuls from widely separated places in the tank and put them in the sample bottle. Do not start pumping the milk until sampling is completed. Fill the sample bottle or tube to near the top so as to prevent jostling or churning and be sure the cover is sealed so as to prevent leakage. The minimum amount to be taken is 35 ml for use in building up composites or 40 ml for individual tests. Each "pickup" of milk is required to be sampled unless a plan is followed which has been approved in advance by the Experiment Station.

b. *Identification.* The sample bottle or tube must be plainly labeled with the name or number of the patron. Keep the temperature of the samples below 50° F until they are delivered to the plant.

c. *Care of Samples.* Samples must be kept at a temperature between 35° and 50° F. The cover must be placed on the sample bottle or tube so that water from melted ice cannot get into it.

4. Transferring a Fresh Sample to a Composite.

a. The regulations permit payment for milk either on the basis of a sample taken from each "pickup" and tested while fresh or on the basis of a test on a composite sample. In either case the samples taken on the route must be delivered without delay to the person at the plant who is responsible for receiving them. If the milk is being paid for on the basis of tests on composite samples, each route sample must be thoroughly mixed and an appropriate amount transferred to an approved composite sample bottle. The requirements are:

(1) The composite at the end of the sampling period must fill to between $\frac{1}{2}$ and $\frac{3}{4}$ full an approved 8-ounce bottle. (Between 4 and 6 ounces.)

(2) Any regular portion added to the composite must not be less than 10 ml.

(3) The volumes of individual portions added to a composite must be in proportion to the respective volumes of milk they represent. (Thus a portion representing two days' production should be twice as large as a portion representing one day's production.)

5. Records.

Weight records are required to be made and accounted for in accordance with either (a), (b) or (c) below.

(a) A separate record or ticket must be made for each "pickup" (may be duplicated). This ticket must show the amount of milk in pounds, the date, and the signature of the person who measured and sampled the milk. These tickets must be taken to the plant with the milk they represent by the person who signed them and delivered by him to the person designated to receive them.

(b) If the weight record form is unsuitable for a signature being entered after each recorded amount of milk, the person who measures and samples it shall sign a certificate at the plant to cover the weight records for each load of milk. In this certificate he shall certify that he personally measured and sampled all of the milk in the load delivered on the said date. In addition, he shall date and sign the weight record at the end of the pay period.

(c) If the licensed sampler and weigher does not accompany the truckload of milk to the plant, he shall date and sign a separate certificate and send it to the plant with the weight records and milk they represent. The form for such a certificate follows:

"I certify that I personally sampled and measured all of the milk in the load delivered this date.
Date Signature
Delivered by Rec'd by"

Receipt to be left at the farm. A record of the amount of milk obtained at each "pickup" shall be left at the farm; this record shall be made in ink, indelible pencil, or by a permanent duplicating process, properly dated and authenticated.

6. General.

a. Composite samples when used must be kept refrigerated at a temperature not to exceed 50° F at all times except when the milk is being transferred from the daily sample to the composite. The composite samples are to remain at the milk plant, not to be carried on the tank truck.

b. The licensed sampler and weigher who takes the samples at the

farms is responsible for their accuracy and for their care until they are delivered to the person responsible to receive them.

c. The testing, holding after testing, and proper care of both daily samples (tested while fresh) and composite samples are required to conform to "Procedures Required for Weighing, Sampling and Testing Milk in Kentucky." (See page 12.)

PROCEDURE TO FOLLOW WHEN COMPOSITE SAMPLES FROM BULK TANK MILK ARE OF DOUBTFUL ACCURACY

Any test result that is questioned should be established as an accurate test, preferably by making a verifying retest. After this is done and the test is "off" (when compared with previous tests), then the accuracy of the sample may be doubted. Immediately after the questionable composite sample and tests on it are noted, test fresh sample(s) representing 4 or more milkings (2 days). When conditions warrant these special tests may be used instead of the doubtful composite test (see The Pay Test for Milk, page 25, and Regulations 9 and 10, pages 37 and 38).

If the number of questioned samples from a certain route are more than usual then proceed as follows:

1. Talk with the sampler and weigher and try to determine the cause for inaccurate samples. According to circumstances either instruct him in correcting errors, or if it is suspected that something done or left undone causes incorrect samples, then set out to show this to be the case. The following procedure is suggested:

a. Check one or more tank truck loads of milk (see below).
b. In addition to the special tests (paragraph 1 above), with those producers whose composite samples have been "off" make several check tests on fresh samples from their milk. Usually abnormal tests can be detected.

c. Go to producers' dairy and observe the measuring and sampling; also take duplicate samples for check testing.

To check a tank truck load of milk:

1. Weigh the loaded truck and later the empty truck to get net weight. (The net as determined by accurate metering may be used.)
2. Take two or more samples from the top of the truck immediately upon its arrival at the plant. (If it stands, the fat will rise.) Tanks that are very near full should not be checked, as some air space is necessary for adequate mixing during movement. A check sample can be taken from the milk that comes from the lower part of the tank. (If check sample is taken be sure discharge lines are washed out before taking the sample and do not take drippings from a pump as

such samples are inaccurate.) Test the samples and use the average test to determine the amount of fat in the milk in the truck. (Net wt. \times ave. test equals pounds fat in milk on truck.)

3. Test fresh samples for each shipper's milk on the truck; multiply amount in pounds on each ticket by corresponding test and total all lots on the truck to get amount of fat as determined by this method. The amounts of milk (total of tickets) vs. net per scales should agree within 4 pounds per 1,000 pounds. The butterfat as determined here when compared with that determined in 2 above should not differ more than the amount of fat as determined by multiplying the net weight by 0.1%.

REQUIRED PROCEDURE IN SAMPLING AND WEIGHING MILK RECEIVED IN CANS AT BUYING PLACES IN KENTUCKY

Scales are required to be tested for accuracy and kept balanced. In testing scales standard check weights are used. At least one 50-pound weight should be available together with other weights up to the capacity of the scales. Scales should be tested periodically, the interval depending upon the number of weighings made on them and other conditions likely to cause inaccuracy.

All scales have provisions for balancing (indicator at zero.) They should be balanced daily before and after the first weighing and when necessary thereafter.

Weighing is required to be accurate. When using dial scales or automatic recording scales, a reading taken while the indicator is moving cannot be considered accurate. (Momentary pauses at reversing points are considered as moving.) The correct procedure is to wait for the pointer to stop. The weigher should stand directly in front of the dial.

Weight records are required to be accurate and clear. The original weight records become permanent records; when made in long-hand they should be clearly written and kept clean. These original weight records are required to be properly dated and authenticated.

Loss to producers by spillage etc. must be prevented. In emptying cans they should be inverted so that all of the milk will flow out (none trapped). Any loss (spillage) beyond that which clings to the can should be prevented.

Weighing and sampling must not be timed too fast so as to cause inaccuracy. The requirement to make accurate weights and take accurate samples must not be slighted.

Composite samples must be handled carefully. Very little shaking or jostling may cause them to churn. Churned samples are unsuitable

for testing. Special care must be taken when samples are moved a considerable distance each day. They are very prone to churn if moved on racks with rollers over rough floors. In handling to make the daily addition to a composite sample, very little shaking gives the best results. The recommended procedure is to give the sample a slight rotary motion after the portion is added but not to get the cream or milk on the sides of the bottle (above the milk line) more than is necessary.

Samples must not be permitted to "warm up" when removed from the refrigerator for adding daily portions. To prevent this it may be necessary to put "local" samples in small trays or remove and return a few at a time. Regular route samples must not be removed from the refrigerator before they are needed or in large numbers. Also they must be returned to the refrigerator before they get warm.

Before each sample is taken the dipper must be drained or flushed out in the milk being sampled. If a dipper is inverted for several seconds it will drain sufficiently. If it is not drained, then the milk being sampled should be used to wash out any milk left from the previous lot.

Automatic samplers must be operated according to manufacturers' instructions. These instructions are furnished by the manufacturer. The main points must be memorized and followed by those using the device. These instructions must be available for reference at all times and used in making repairs or adjustments. Sampling devices require intelligent care and regular servicing. They must be checked periodically for proper functioning.

For composite samples the daily portion must be at least 10 ml, and the finished composite must be between 4 and 6 ounces. When deliveries are made every other day a larger (20 ml) sample dipper is necessary.

Milk must be thoroughly mixed before it is sampled. If this is not done the samples will be inaccurate. The testing for proper mixing by regular handling is required to be done under the supervision of the manager or plant superintendent. In case extra mixing is necessary and licensed samplers and weighers are instructed how to do the extra mixing, they must follow these instructions at all times.

APPENDIX

SUMMARY OF REQUIREMENTS OF THE KENTUCKY CREAMERY TESTERS, SAMPLERS AND WEIGHERS LICENSE LAW

(KRS 260.710 to 260.860 and 260.990)

The object and purpose of the law is that sampling, testing, weighing and/or measuring of milk and cream bought from producers shall be done accurately and fairly. It follows that fraudulent manipulation of tests or records, making inaccurate weights, and taking or using inaccurate, unfair samples are in violation of the law.

A LICENSE TO BUY is required to be secured and held at each place where milk or cream is received from producers and paid for on basis of weight, measurement, weight and test or measurement and test. These licenses are issued by the Kentucky Agricultural Experiment Station upon receipt of proper application and fee. The fee is shown on the application blank. (Application blanks will be furnished on request.)

A LICENSE TO TEST (or permit in lieu thereof) is required to be secured and held by each person who tests milk or cream when such tests are to be used as basis for pay for milk purchased from producers. Delegation of authority to test to another person is not permissible.

A LICENSE TO SAMPLE AND WEIGH is required to be secured and held by each person who samples and weighs milk or cream. Those who sample and measure milk in farmers' bulk tanks are included in this requirement. Note: A license to test authorizes its holder to sample and weigh as well as to test. Delegation of authority to another person is not permissible.

TESTER'S EXAMINATION. Before a license to test will be issued to any person, it is necessary that he or she pass a satisfactory examination on the operation of the Babcock test. In order that new operators may secure a permit to test before having taken an examination, they must furnish evidence that they have complied with one of the following conditions: (1) have successfully completed a recognized course in dairying; (2) have held a valid tester's license in another state; (3) have worked with a licensed tester at least two weeks and have a certification from this licensed tester that they are qualified to test; (4) have a certificate signed by a field representative of a cream company stating that the applicant is a cream station operator and has been properly instructed in testing procedures and is competent in performing milk or cream tests. To secure this permit it is necessary that application be made on the form furnished by the Experiment

Station and the fee called for on the application form paid. Licenses will be issued to holders of permits who pass satisfactory examinations.

RENEWAL OF LICENSES. All licenses expire on June 30 each year and are required to be renewed before July 1. (See Regulation 4.)

COMPLIANCE WITH REGULATIONS IS MANDATORY. The law provides that regulations when formulated through processes as prescribed have the force of law and must be complied with. The regulations under the Creamery License Law are included in this classification (see below).

REVOCAION OF LICENSES. Licenses issued to buyers, testers, samplers and weighers may be revoked by due process for reasons judged sufficient for such action. Before such action is taken the holder of the license in jeopardy is given the opportunity to appear before a hearing of the Examining Board to present his side of the case.

PENALTIES. (1) Any person violating or failing or refusing to comply with KRS 260.720 or 260.750 of this Act shall, upon conviction, be fined \$100 for the first offense and not less than \$100 nor more than \$1,000 for each subsequent offense. (2) Any creamery, milk shipping station, milk factory, cheese factory, condensery, ice cream factory, or other milk processing or manufacturing plant or person, or agent, firm, company, association or corporation violating, or failing, or refusing to comply with KRS 260.730, 260.740, 260.760, 260.770 and 260.800 of this Act shall be guilty of a misdemeanor, and upon conviction shall be fined no more than \$1,000, or imprisoned for no more than one year, or both.

SUMMARY OF ADMINISTRATIVE REGULATIONS UNDER THE KENTUCKY CREAMERY LICENSE LAW

Regulation 1. PUBLICATION CONTAINING REQUIREMENTS FOR SAMPLERS AND WEIGHERS, TESTERS AND BUYERS OF MILK IN KENTUCKY. Weighing or measuring, sampling, testing, making payments and record keeping of milk and cream shall be performed in accordance with the following parts of the Kentucky Agricultural Experiment Station Regulatory Bulletin No. 9-A, June 1960. This bulletin is incorporated in and filed with the official copies of these regulations. The parts of this bulletin (revised 1960) which are incorporated in these regulations are:

- a. The Cream Test.
- b. Procedures Required for Weighing, Sampling and Testing Milk in Kentucky.
- c. The Required Procedure for Sampling and Measuring Milk in Farm Bulk Tanks in Kentucky.

d. Required Procedure in Sampling and Weighing Milk Received in Cans at Buying Places.

All regulatory bulletins No. 9 except the 1960 revision shall be destroyed.

Regulation 2. LICENSES AND POSTER ARE REQUIRED TO BE PROMINENTLY DISPLAYED. A current license to buy and a current license to test (or permit in lieu thereof) and the poster headed "Accurate Weights, Tests and Records Required," shall be prominently displayed (posted separately) in each buying place. A copy of the latest edition of the Kentucky Agricultural Experiment Station Regulatory Bulletin No. 9-A, June 1960, shall be available for reference at each testing place at all times. The poster and the bulletin are furnished all applicants for license to buy, applicants for permits to test and applicants for permits to sample and weigh without request and to others on request.

Regulation 3. PERMIT TO SAMPLE AND WEIGH MILK AND CREAM. In order that new operators may legally sample and weigh milk or cream or sample and measure milk, they may secure a temporary permit in lieu of license. To secure this permit, it is necessary that application be made on the form furnished by the Experiment Station and the fee called for on the application form paid. Licenses will be issued to holders of permits who are judged as qualified. Permits held by samplers and weighers who fail to present themselves at a reasonable time and place and those found unqualified will be revoked after which their holders cannot legally sample and weigh.

Regulation 4. RENEWAL OF LICENSES. All licenses issued under the authority of this law expire on June 30 of each year. They are required to be renewed on or before July 1 by mailing an application properly filled out and signed with the required fee accompanying it. A notice to renew with application blank is sent to each current license holder on or about June 15. In case such application blank is not received by June 25, the license holder is directed to write to Creamery License Section, Kentucky Agricultural Experiment Station, Lexington, Ky., and request that one be sent. The renewal fee is shown on the application.

Regulation 5. MAINTENANCE OF SCHEDULE IN TESTING AND HOLDING SAMPLES FOR RETEST. Testers are required to maintain a regular schedule of days or dates on which they test and hold samples for retest. This schedule is required to be listed on the tester's application for license. If the schedule is changed a notice in writing to the Creamery License Section, Kentucky Agricultural Experiment Station, Lexington, Ky., is required to be made. Cream

samples are required to be held until 5 p.m. of the day they are tested. Milk samples are required to be held for 7 days following the last scheduled day for testing as is given on tester's application, or in accordance with a plan approved by the Experiment Station.

Regulation 6. THE MAKING OF INSPECTIONS, GRADES GIVEN THEREON AND OTHER ACTIONS INCIDENT THERE-TO. Testers, samplers and weighers are inspected and graded on the accuracy of their operations and on their compliance with requirements of and regulations under the law for which they are responsible. Grades given are:

- | | |
|----------------|---|
| A Excellent | D Unsatisfactory—Probation |
| B Good to Fair | E Case referred to Examining Board for a hearing. |
| C Poor | |

Buyers are inspected and rated on items for which they are responsible; notice is given to correct discrepancies; unsatisfactory compliance and violations are handled in accordance with provisions of the law. See also paragraphs headed REVOCATION OF LICENSE and PENALTIES.

Regulation 7. TESTWARE REQUIRED TO BE INSPECTED AND STAMPED. Before being used in making tests to be used as a basis for pay, the testware listed below is required to be inspected by the Kentucky Agricultural Experiment Station, Lexington, Ky. Those pieces found accurate are permanently stamped S.G.K. (Standard Glassware Kentucky). Those pieces within this list that are not stamped S.G.K. (i.e rejects and those not submitted for testing) are illegal for use in Kentucky. A fee of 3 cents each will be charged for inspecting and stamping.

STANDARD TESTWARE FOR USE IN KENTUCKY
APPROVED JUNE 1960

| Testware Required to be Stamped | Description of Types Approved |
|---------------------------------|---|
| cream test bottles..... | 50%, 9 gm, 6½ inch in 1/2%. |
| milk test bottles | 8%, 18 gm, 6½ inch in 1/10%. |
| 9 gram weights | solid brass or bronze, marked 9 gm. |
| 17.6 ml pipettes..... | to contain 17.6 ml, to meet specifications of National Bureau of Standards. |
| milk test bottles | 8%, 18 gm, 6⅞ inch in 1/10%. |

Regulation 8. BUYING REPORTS AND PRODUCERS' STATEMENTS OF CREAM PURCHASED. A buying report of cream pur-

chased is required. It shall be an accurate statement of (a) date received, (b) name of customer, (c) correct weight, (d) correct test, (e) pounds fat, (f) price, and (g) amount (\$). A statement in writing shall accompany the payment; this statement shall agree with the buying report and show name (or otherwise identified with entry on the buying report), date, net weight, test, pounds, price, amount and payee's signature or other identification. The buying report shall be made in duplicate by using a carbon paper or if no copy is made the report shall be made with indelible pencil or ink. These records shall be kept on file for at least 12 months, open to inspection by authorized representatives of the Experiment Station. If any cream (part of a can or rinse containing butterfat) is held over after any shipment is made, the amount of butterfat contained therein shall be determined by weight and test and record thereof entered on the daily report sheet.

Regulation 9. REQUIREMENTS FOR LEGAL MILK TEST RECORDS, SPECIAL SAMPLES AND SPECIAL TESTS.

Section 1. *Requirements for special samples and tests.* Special samples are those samples taken in emergencies to replace churned, spilled, soured or other regular samples determined as inaccurate. Two or more of these daily samples must be taken and tested; the samples may be composited or the results averaged. Results of tests on special samples are designated as *special tests*.

Section 2. *Legal Milk Test Records.* Records of tests to be used as basis for pay designated in these regulations as *legal test records* consist of:

- a. Records of tests made on composite samples.
- b. Records of daily tests made according to a plan approved in advance by the Kentucky Agricultural Experiment Station.
- c. Records of retests, and
- d. Records of *special tests*. (See Section 1 above.)

The requirements for these *legal test records* are:

- (1) They (a, b, c and d above) must be original, that is recorded as they are read. (Copies of the original are not acceptable.)
- (2) They (a, b, c and d above) must be recorded in ink or indelible pencil and each separate sheet dated and signed by a licensed tester.
- (3) Any changes or corrections to them (a, b, c and d above) must be made by drawing a line through the incorrect test and entering the correct test and tester's initials nearby. (Erasures and write-overs are forbidden.)

(4) Special tests and records of them (d above) must comply with requirements in Section 1 above.

(5) Records of retests (c above) and special tests (d above) must be made on record sheets other than the regular (original) test record sheets (a or b above).

(6) All test records (a, b, c and d above) must be kept on file for 12 months.

Each licensed tester is responsible for the accuracy of the tests he makes and the accuracy and completeness of the records of these tests. Anything done or left undone to the test records to cause their authenticity to be questionable and therefore illegal is contrary to this regulation.

Regulation 10. PAY TEST MUST AGREE WITH LEGAL TEST RECORDS; REQUIREMENTS FOR CONSOLIDATED PAY RECORDS, RELATED RECORDS AND PAYMENTS. The consolidated pay records are required to be made in a clear, permanent manner, properly arranged and identified. This consolidated record must be accurately compiled from the original weight records, legal test records, base price used and other factors affecting the price. A statement shall be supplied each producer with payment for each pay period. The pay record and statement are required to agree and both are required to show: dates covered by payment, amount of milk received and paid for, the average butterfat test of this milk, the price per cwt. paid, the gross value, deductions if any, and amount paid. Records including original weight records, pay records, test records and evidence of payments having been made, shall be kept on file for 12 months.

All tests used as basis for pay must be taken from and agree with the "legal test records" as described and specified in Regulation 9 above. It is illegal to "make up" tests, to raise or lower tests, to manipulate tests or records or to use any test not backed up by proper records.

Regulation 11. ALL MIXING TANKS IN WHICH MILK RECEIVED FROM PRODUCERS IS DUMPED SHALL BE CHECKED; the plant samplers and weighers and the management shall assist the inspector in making check tests of the mixing tank. These checks shall be made on all tanks that have not been approved by the Experiment Station within the past 12 months. In these check tests including twenty or more comparisons, one sample is taken in the usual manner. The other is taken after thorough stirring. The average variation and the plus and minus balance shall both be checked. To determine the average variation, total all variations and

divide by the number of tests (usually 20). The results shall not exceed 0.07%. A plus and minus balance of 0.03% or less is satisfactory. Tanks that according to these checks show a definite trend (+ or - 0.03% or more and average variation of 0.07% or more) are subjected to condemnation. It shall be the responsibility of the management to make changes within a reasonable time in such tanks so as to secure samples considered satisfactory.

Regulation 12. BUYERS MUST PURCHASE MILK TRANSFERRED FROM FARM BULK TANKS THAT IS SAMPLED AND MEASURED BY LICENSED SAMPLERS AND WEIGHERS ONLY. Buyers who purchase milk held in farm bulk tanks shall:

(1) Keep a sampler and weighers' license record file of all samplers and weighers who sample and measure milk in farm bulk tanks purchased by said buyer. This file must show for each such person: his name, address, signature, description and the status of his license or permit to sample and weigh.

(2) Require the licensed samplers and weighers who sample and measure milk from bulk tanks for purchase by said buyer to do one of the following: (a) date, sign and deliver to the buyer at the time the milk is delivered, all weigh tickets representing each load of milk; (b) if weigh records are unsuitable for a signature being entered after each recorded amount of milk, to sign a certificate at the plant in which he certifies that he personally measured and sampled all milk in the truckload delivered on date indicated; or (c) if the licensed sampler and weigher does not accompany the truckload of milk to the plant, to date and sign a similar but separate certificate with substitute driver's name listed and send it with the weigh records and truckload of milk to the plant.

(3) Check these weigh tickets or records and certificates daily to insure that they are in accordance with a, b, or c under (2) above, and keep them on file for 12 months.

This regulation does not abrogate the provision of the law which makes it illegal for any buyer to purchase milk that is not sampled and weighed or measured by licensed samplers and weighers. The object of the regulation is to set up aids and safeguards to insure compliance with the law.

Approved by the Director of the Kentucky Agricultural Experiment Station June 1960.