EXAMINATION OF FARM MILK TANKS

A Manual for Weights and Measures Officials

NATIONAL BUREAU OF STANDARDS
HANDBOOK 98

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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Malcolm W. Jensen

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Foreword

This publication is one of a number of Handbooks of the National Bureau of Standards designed to present in a compact form comprehensive technical guides for State and local weights and measures officials.

This particular Handbook is the first of a series that will treat the examination of individual types of measuring devices. The entire series will succeed National Bureau of Standards Handbook 45, *Testing of Measuring Equipment*, published in 1951 and now out of print. The decision to consider each of the several types of measuring equipment in a separate Handbook, rather than to publish a single revised version of Handbook 45, was based on the acknowledgement of the increased specialization in weights and measures supervision, the rapidly developing technological character of commercial measurement, and the ever-changing equipment utilized in the measurement process.

Authority for such activity on the part of the Bureau is found in basic legislation (64 Stat. 371) wherein the Bureau is authorized to undertake, among others, the following functions: "Cooperation with the States in securing uniformity in weights and measures laws and methods of inspection," and "The compilation and publication of general scientific and technical data resulting from the performance of the functions specified herein or from other sources when such data are of importance to scientific or manufacturing interests or to the general public, and are not available elsewhere * * *."

This Handbook has been published in "pocket" size to further its usefulness to the official in his field operations.

Although this Handbook is prepared primarily for use by weights and measures officials of the States, counties, and cities, it is believed that the information presented will be useful to manufacturers, calibrators, and others interested in farm milk tanks as measuring devices.

Contents

EXAMINATION OF FARM MILK TANKS

Malcolm W. Jensen

A manual for State and local weights and measures officials, describing the devices, testing equipment, gaging, inspecting and testing procedures, and reporting systems.

1. DEFINITION AND DESCRIPTION

1.1. Use.—A farm milk tank is of concern to the weights and measures official only when, and insofar as, it is used for purposes of commercial measurement. (Sanitary considerations are of importance, but are outside the field of authority of the weights and measures official.) One characteristic that distinguishes a farm milk tank from ordinary commercial measures is the normal limitation of its use to transactions between a single seller and a single buyer. The seller is the farmer or dairyman who supplies the product being sold, ordinarily raw whole milk, from a tank, which is installed and used on his premises. The buyer is the particular dairy, cheese factory, cooperative, or market-milk distributor to which the milk producer sells his product. In the code of specifications, tolerances, and regulations for farm milk tanks [1] it is stated: "This code applies to farm milk tanks, as defined, only when these are used, or are to be used, under an express contract between the producer and the purchaser and only on the premises of a single producer, for the commercial measurement of milk or other fluid dairy products."

1.2. Definition.—From the standpoint of measurement, a characteristic that distinguishes a farm milk tank from practically all other commercial measures is that, as customarily designed, such a tank is not of itself a complete measuring device. Certain separate accessories are required in order that measuring operations may be performed. So, for weight and measures purposes, a "farm milk tank" is defined as a composite comprising the tank itself and the necessary accessories, thus: A unit for measuring milk or other fluid dairy product, comprising a combination of (1) a stationary or portable tank, whether or not equipped with means

[1] National Bureau of Standards Handbook 44, *Specifications, Tolerances, and Regulations for Commercial Weighing and Measuring Devices, 2d Edition,* available by purchase from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402.

for cooling its contents, (2) means for reading the level of liquid in the tank, such as a removable gage rod or a surface gage, and (3) a chart for converting level-of-liquid readings to gallons; or such a unit in which readings are made on gage rod or surface gage directly in terms of gallons. Each compartment of a subdivided tank is considered to be a "farm milk tank."

A clear distinction should be made between two terms that will be used frequently in this discussion, "gaging" and "testing." The term "gaging" (and "regaging") refers to those volumetric determinations made for the purpose of assigning to certain of the graduations on the gage rod or surface gage the volumetric equivalents upon the basis of which the gallonage chart is prepared. The term "testing" refers to those volumetric determinations made for the purpose of verifying the accuracy of a previous gaging operation and of a gallonage chart based thereon.

1.3. Description.—The design of a farm milk tank and the materials of which it is made are selected largely on the basis of considerations of sanitation and the preservation of the quality of the product handled. At the time of milking, milk may pass directly from the milking machine to the tank,

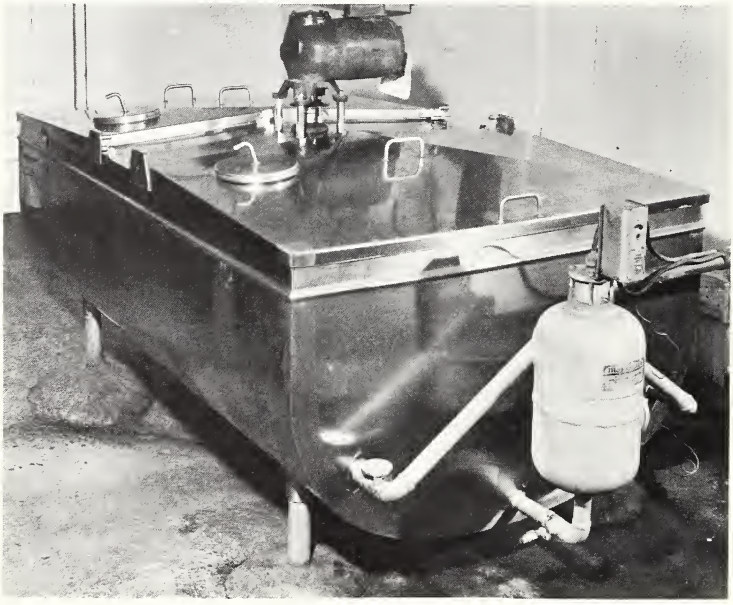


FIGURE 1. *Small tank—300-gallon capacity.*

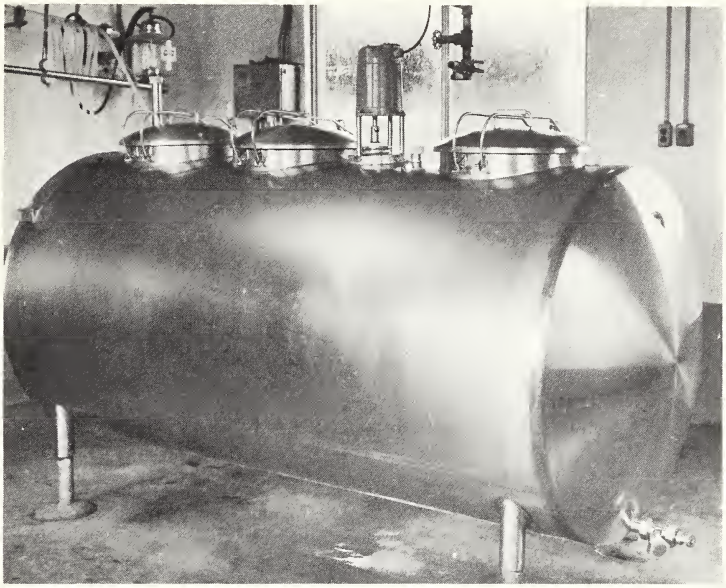


FIGURE 2. *Medium tank—550-gallon capacity.*

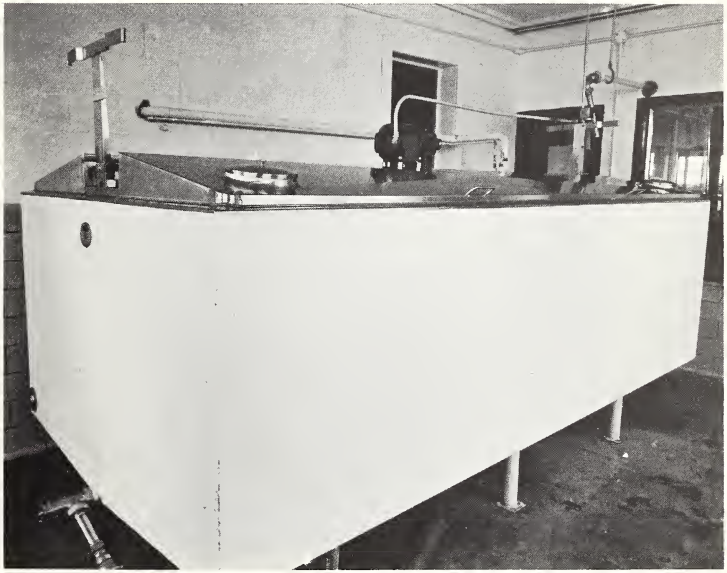


FIGURE 3. *Large tank—1,000-gallon capacity.*

where it is cooled, stored, and finally measured just prior to its transfer to a truck tank for delivery to the purchaser. In other cases the milk may be cooled before entering the tank, the tank then serving to hold the milk at a suitable temperature; such tanks may merely be insulated rather than being equipped with mechanical or other cooling means.

Tanks are constructed largely, or entirely, of stainless steel, to meet sanitary requirements. Tank capacities range upward to 2,500 gallons or more, but most of the tanks in service have capacities between 250 and 1,000 gallons. Some small tanks, having capacities of 100 gallons or less, and a few larger tanks are in the form of upright cylinders. More common forms are those with rectangular horizontal cross sections, longer than wide, height and width about the same, and with the bottom somewhat rounded. There also are some tanks in the form of horizontal cylinders. Mechanical means is usually provided for stirring or "agitating" the milk in the tank, to make the product uniform throughout the tank and to facilitate the cooling of the milk. Means is provided for covering the top of the tank to exclude foreign matter.

The means commonly employed for reading the level of the liquid in the tank is either a "gage rod" or a "surface

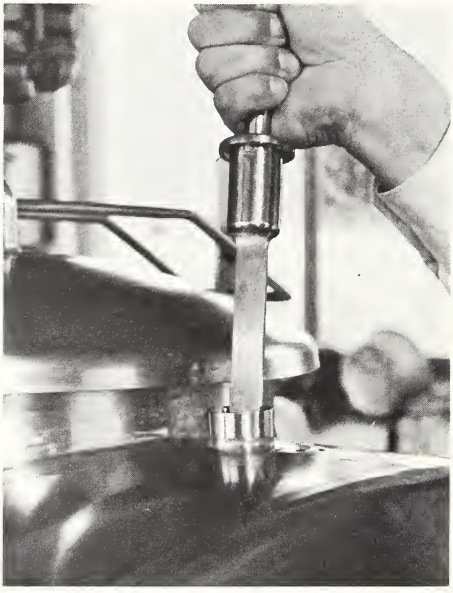


FIGURE 4. *Gage rod being lowered into tank.*

gage." The gage rod is designed to be lowered into the liquid until it rests firmly on a bracket or other suitable support, in which position the rod should be vertical. One face of the rod is graduated, usually into $\frac{1}{32}$-inch or $\frac{1}{16}$-inch divisions, and the graduations are suitably marked for identification. The gage having been lowered into position, its indication of liquid level is the line where the liquid surface crosses the graduated face of the rod. The rod is then removed from the tank for the purpose of reading its indication. After a tank has been gaged to fix gallonage values corresponding to the graduations on the gage rod, and a corresponding gallonage chart has been prepared (as hereinafter described), gage readings can be translated into gallonage readings by reference to the chart.

The surface gage (sometimes called a "probe") is a graduated member, usually with $\frac{1}{32}$-inch divisions, designed to be mounted in a bracket or other suitable support and lowered from above the liquid surface until its tip comes into contact with the liquid surface. The reading is made on the graduated scale by means of a stationary indicator. Gaging of the tank, preparation of the gallonage chart, and translation of gage readings to gallonage readings are the same as in the case of the gage rod. A surface gage currently available is a

FIGURE 5. *Gage rod with $\frac{1}{16}$-inch graduation.*

GALLONAGE CHART

Owner John Doe
Address County Trunk AA,
Type Gage Rod
Gage Serial No. 861A4
Gage Graduated in 1/16 inch

FARM MILK TANK

Capacity 165 gallons
Serial No. 861A4
Date Gaged 8/15/55
Gaged by R. N. Jones

Inches	1/16's	Gallons	Inches	1/16's	Gallons	Inches	1/16's	Gallons	Inches	1/16's	Gallons	Inches	1/16's	Gallons
0	0		4	0	20.0	8	0	43.6	12	0	69.2	16	0	96.5
	1			1	20.2		1	44.0		1	69.6		1	96.9
	2			2	20.4		2	44.3		2	70.0		2	97.3
	3			3	20.6		3	44.7		3	70.5		3	97.7
	4			4	20.8		4	45.0		4	71.0		4	98.0
	5			5	21.0		5	45.4		5	71.5		5	98.4
	6			6	21.2		6	45.8		6	72.0		6	98.8
	7			7	21.4		7	46.2		7	72.4		7	99.2
	8			8	21.6		8	46.6		8	72.8		8	99.6
	9			9	21.8		9	47.0		9	73.3		9	100.0
	10			10	22.0		10	47.4		10	73.7		10	100.5
	11			11	22.2		11	47.8		11	74.1		11	100.9
	12			12	22.4		12	48.3		12	74.5		12	101.3
	13			13	22.6		13	48.7		12	75.0		13	101.8
	14			14	22.8		14	49.0		14	75.5		14	102.2
	15			15	23.0		15	49.3		15	75.9		15	102.6
1	0		5	0	23.2	9	0	49.7	13	0	76.3	17	0	103.0
	1	5		1	23.4		1	50.0		1	76.7		1	103.5
	2	5.2		2	23.6		2	50.4		2	77.1		2	104.0
	3	5.5		3	23.8		3	50.9		3	77.5		3	104.4
	4	5.7		4	24.0		4	51.4		4	77.9		4	104.7
	5	5.9		5	24.2		5	51.9		5	78.3		5	105.0
	6	6.2		6	24.4		6	52.3		6	78.7		6	105.4
	7	6.5		7	24.6		7			7	79.		7	105.7

FIGURE 6. *Gallonage chart.*

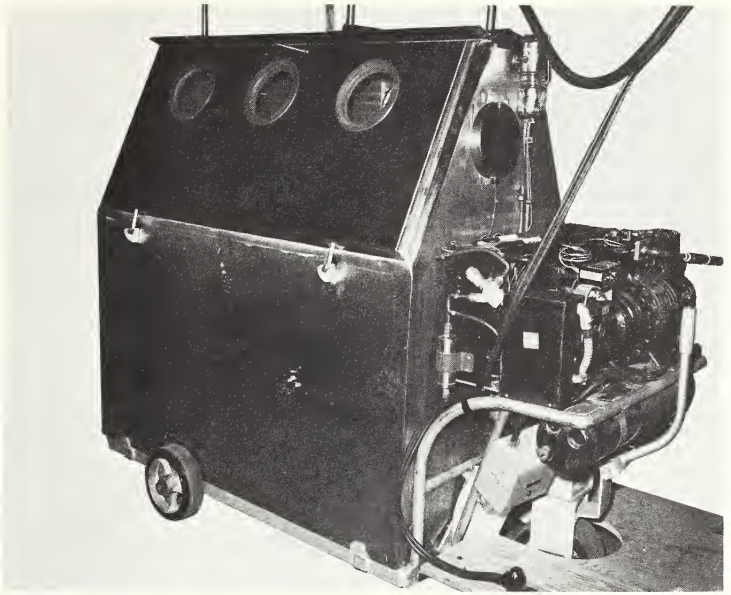


FIGURE 7. *Portable type farm milk tank.*

cylindrical plastic tube enclosing a graduated scale and having two sharp metal points at its lower end. One of these points is very slightly lower than the other. By means of an electrical connection to the gage, a characteristic light signal is given when just the lower point is in contact with the liquid, and this signal changes when both points are in contact with the liquid; thus the gage can be set quickly and accurately to the proper height.

During the operation of gaging a tank, the gage rod or surface gage is used to determine the level of liquid in the tank corresponding to each of a series of measured volumes of water. Usually these determinations are for each 5 gallons or for each 10 gallons throughout the graduated range of the gage rod or surface gage, up to the highest practicable liquid level in the tank. A gallonage chart is prepared, listing the designation of each graduation on the gage rod or surface gage up to the one corresponding to the tank capacity. To each graduation designation on the chart that corresponds to a measured volume of water, the appropriate gallonage value is assigned. Gallonage values are then assigned, by interpolation, to all intermediate graduation designations.

FIGURE 8. *Typical circular spirit level.*

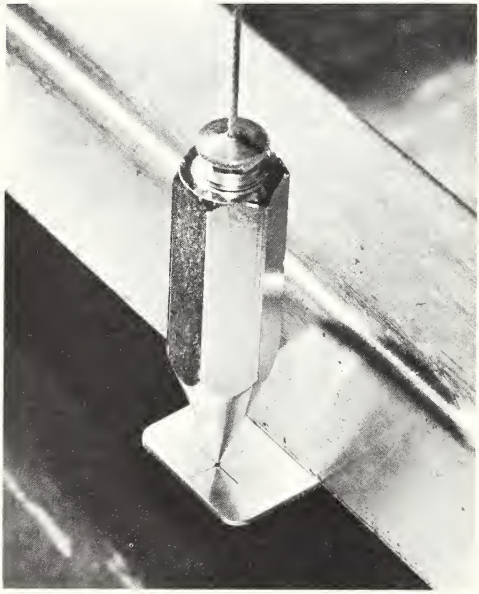


FIGURE 9. *Plumb bob with index point for determining level condition of tank.*

Thus the completed gallonage chart shows a gallon equivalent corresponding to each graduation on the gage rod or surface gage throughout the entire working range.

The majority of tanks in service are designed to be installed in a fixed position. However, portable tanks are in use. These should be of the center-reading type—that is, so designed that the gage rod or surface gage, when properly positioned for use, will be approximately in the vertical axis of the tank, centrally positioned with respect to the tank walls. A portable tank is intended to be moved from place to place in a milking barn.

The level of a stationary tank is a matter of importance, and suitable and sensitive level-indicating means should be provided. This level-indicating means may take the form of (1) a two-way or circular spirit level, (2) a plumb bob with appropriate index lines, or (3) two-way leveling lugs; or the top edges of the tank might be so constructed throughout as to provide an accurate reference for level determinations. On a portable tank the level-indicating means should be either a two-way or circular spirit level. If a tank has a nominal capacity greater than 500 gallons, two level-indicating means should be provided, in opposite positions on

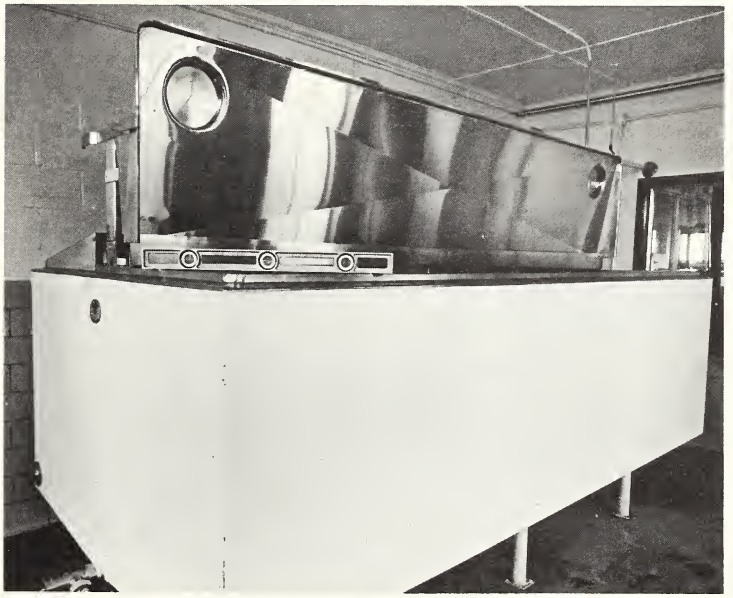


FIGURE 10. *Checking level of a tank with top edges as level reference.*

the tank. On a portable tank, the level-indicating means, or one such means if two are provided, should be readable by an observer from the position normally occupied when manipulating the gage rod or surface gage. A level, leveling lugs, or the support and reference index for a plumb bob should be permanently attached to the tank.

From the foregoing description, it should be clear that, as to its measuring characteristics, a farm milk tank is essentially a large-capacity vessel in which varying amounts of liquid are measured. This measurement is accomplished by determining in each case the level of liquid in the tank and converting the liquid-level reading into a volume reading by reference to a chart based on a volumetric gaging of the tank. It is obvious that, as the cross-sectional area of the tank increases at the point where a reading of liquid level is made, the precision of the reading and the accuracy of the volumetric results will tend to decrease. This holds true when the tank is gaged and the chart prepared, as well as when commercial measurements are being made. If the liquid-level readings are made elsewhere than at the center of the liquid surface, any change in the level of the tank will affect the readings; if readings are made at one end of a long tank, this effect in terms of gallons may be considerable. It is advisable, therefore, that tanks be designed so as to minimize this effect, by approaching as nearly as practicable to the center-reading type.

2. INSPECTION[2]

2.1.—Farm milk tanks should be individually inspected, and inspection should precede testing. The general principles of inspection should be observed, and special attention should be given to the suitability as to location and sensitiveness of the level-indicating means and to the stability of the level condition of stationary tanks.

3. TESTING APPARATUS

3.1. Gaging and Testing Policy.—The testing apparatus required by the official will depend to some extent upon his policy with respect to farm milk tanks. There are two principal schools of thought in this relation. Some officials, perhaps the majority, take the position that it is the responsi-

[2] For a discussion of the purposes and scope of "inspection" as distinguished from "testing," see section 4, pages 12–16 of NBS Handbook 44, *Specifications, Tolerances, and Regulations for Commercial Weighing and Measuring Devices.*

bility of the tank manufacturer or some other responsible agency to furnish a complete ready-to-use unit, just as do manufacturers of other types of measuring devices. This means that, in addition to supplying the tank and the measuring element—gage rod or surface gage—the manufacturer must have the tank gaged and must supply the gallonage chart, without which volumetric results cannot be obtained. These officials then consider it their duty only to make such tests as they consider necessary to verify the initial accuracy of the gallonage chart so furnished and to check from time to time on the continued accuracy of the complete unit.

Another group of officials takes the position that their responsibility includes the initial gaging of the tank, upon the basis of which the gallonage chart is to be prepared. They supply their gaging results to the tank manufacturer, who then prepares the gallonage chart and furnishes this to the purchaser of the tank. Still other officials take a sort of middle position on this matter. They assist in the gaging operation, or they are present to "witness" the gaging, after which official approval of one kind or another is issued with respect to the installation without further action in the form of official testing. Presumably, officials of both of these latter groups would make subsequent checks on the continued accuracy of the complete units, and would regage a tank, and require preparation of a new chart, if a test showed a chart to be no longer accurate.

The operations discussed in the preceding paragraph appear to go beyond the normal function of the weights and measures official and to introduce certain complications and dangers best avoided. In the first place, it is abnormal for a manufacturer to market an uncompleted commercial measuring (or weighing) device and for the weights and measures officer to undertake either its completion in whole or the performance of an operation necessary to such completion. The officer who gages a farm milk tank is engaging in a part of the normal manufacturing process. Participation in the manufacturing process is extended if the officer actually computes and constructs the gallonage chart. Assumption of such critical responsibilities by the official is of doubtful wisdom. Also involved in the consideration of these operations are such factors as the propriety of expending official time and public funds in carrying them out. and the advisability of promoting a situation in which, on subsequent testing, the officer is in the unenviable position of checking his own work.

3.2. Required Items.—The principal items of testing apparatus required are the volumetric standards with which the

FIGURE 11. *Volumetric standards—100, 10, 5, and 1-gallon gage-glass; ½-gallon, 1-quart, 1-pint, ½-pint, and 1-gill glass flasks, and 2-ounce graduated cylinder.*

tanks are to be tested for accuracy (or are to be gaged, if the official undertakes this operation). These standards must be clean, and not contaminated by having been used to measure any petroleum product. The minimum requirement is one 5-gallon standard, plus such small measures as may be necessary in certain circumstances described later in this discussion. For efficient and expeditious testing, one or more large-capacity standards of 25-gallon or 50-gallon capacity should be included. Another desirable addition, to simplify testing operations, is one 10-gallon standard. If the official must deal with tanks having capacities in excess of 1,000 gallons, the addition of a 100-gallon standard is desirable. Under certain gaging procedures some time may be saved by using two 5-gallon or 10-gallon standards alternately, one of these being filled while the contents of the other is being discharged. If very small tanks are to be gaged, a 1-gallon standard will be required; also, such a standard will be useful in making random spot tests. If tanks of any size are to be gaged by the measure-out method (see following paragraph), there will be required a 1-gallon standard, plus a 1-quart

standard of the type that is equipped with a gage glass and a double scale graduated in decimal and in binary subdivisions of a gallon.

There are two basic methods in use for gaging and testing tanks—(1) measuring the water *into* the tank and (2) measuring the water *out of* the tank. (See also section 4.4.)

Under either the measure-in or measure-out method, conventional standards with graduated necks may be used successfully. Provision should be made for mounting these on a level surface or for suspending them in such a way that they will hang plumb, so that accurate settings can be made. A rubber bulb and tube combination (such as is used to add water to storage-battery cells) or other type of transfer pipet will be found useful in adjusting the amount of water in the neck of the standard to give a precise reading of the nominal capacity of the standard. Physical effort will be reduced if the standards are equipped with discharge faucets. When "measuring in," a hose of suitable length should be attached to the faucet so that the discharge from the standard may be made below the surface of the liquid in the tank, thus avoiding undue agitation of that liquid. (Such a hose should, of course, be raised and drained into the tank prior to a liquid-level reading and should be held out of the water during such reading.)

If desired, standards of the slicker-plate type may be substituted for one or more of the standards having graduated necks. If used for "measuring out," such standards must be specially constructed with a suitable collar to catch any excess of water run into the standard and to retain this until it can be drawn up by means of a pipet and returned to the tank; or the collar can be provided with a drain cock through which the excess water may be drawn off into any convenient receptacle for return to the tank.

When using the measure-out method of testing a tank, it is a practical necessity to provide a pump that can be connected to the discharge line from the tank for transferring water from the tank to the volumetric standards. If such a pump is power-operated, it must be equipped with a bypass to permit circulation around the pump, or it must be designed to permit continuous operation, when the discharge line from the pump is closed off. The use of a transparent section in the pump discharge line is suggested to permit visual inspection for air bubbles.

Means will be required for dusting a gage rod prior to its insertion in a tank for a liquid-level reading. For this purpose a pounce bag can be made from several thicknesses of

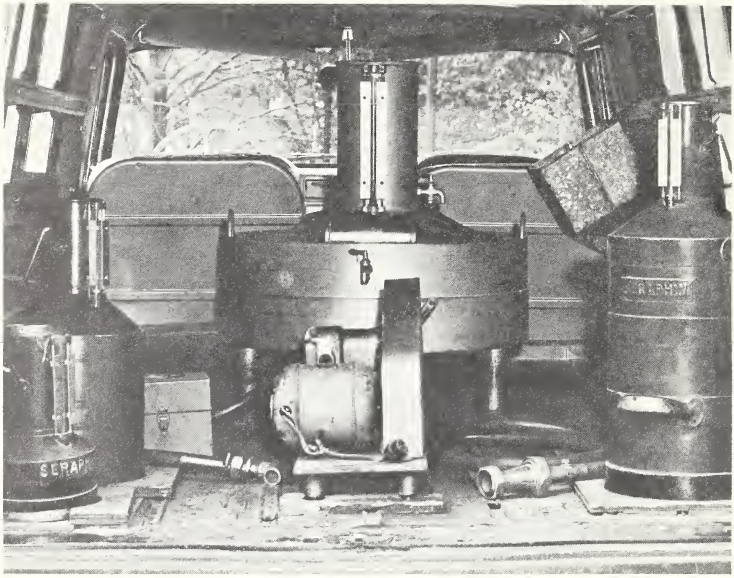
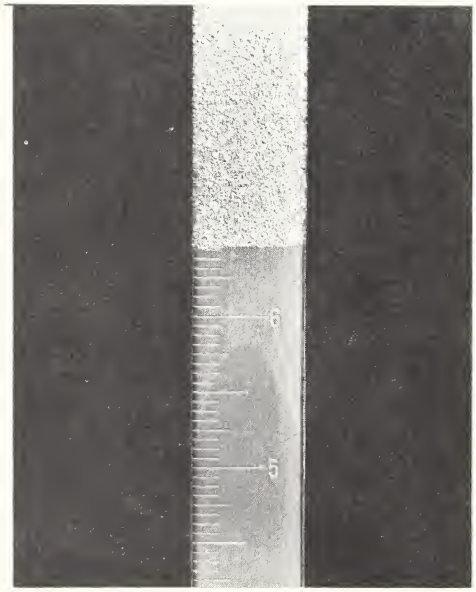


FIGURE 12. *Typical pump and standards used for measure-out method of tank testing.*



line of liquid level.
gage rod showing clear
FIGURE 13. *Powdered*

cheesecloth or other somewhat open-weave fabric and filled with powdered Bon Ami, or a sponge-rubber powder puff can be impregnated with powdered Bon Ami. (The commercial product Bon Ami is suggested, since this is the only generally available material thus far located that will give clear liquid level readings without influencing such readings. It should be noted that only nondetergent, nonchlorinated Bon Ami is satisfactory for this service.)

A liquid-in-glass thermometer should be available to determine the temperature of the water as it is measured and, from time to time, the temperature of the water in the tank.

It will be advisable to provide a sensitive spirit level at least 12 inches long for use on tanks equipped with leveling lugs and on those installations where the top edge of the tank is the reference for level indication.

4. GAGING AND TESTING PROCEDURES

4.1. Gaging.—It is not recommended that the weights and measures official undertake the gaging of farm milk tanks ation in his official capacity. However, it is considered that an understanding of the gaging process is necessary to a full understanding of the testing process. Accordingly, here and elsewhere in this Handbook, comment is made on the gaging process.

As previously indicated, gaging involves a complete series of liquid-level determinations at intervals sufficiently small that, when the gallonage chart is completed, the interpolated values will be essentially accurate. The water is added to or withdrawn from the tank in 5-gallon amounts in the case of tanks of small or medium capacities, and in 10-gallon amounts in the case of large tanks. On very small tanks—less than 100 gallons, perhaps—these amounts should be only 2 or 3 gallons. The important consideration is that, between graduations for which gallon equivalents are established by direct observation, there be only a reasonable number of graduations for which gallon equivalents must be computed; such number should not exceed ten, and preferably should be five or less. Thus, on a 250-gallon tank, for example, assuming that the end of the gage rod used with the tank reaches almost to the bottom of the tank and that the rod is graduated from its end, the gaging operation would involve some 50 separate liquid-level observations at 5-gallon intervals;

on larger tanks the required number of observations will be greater, ranging upward to several hundred for tanks of large capacity.

4.2. Testing.—A testing operation, on the other hand, need not involve anything like the same number of observations as were required when the tank in question was initially gaged. For example, 10 or 15 liquid-level observations are probably enough on a 250-gallon tank if good agreement or consistent disagreement is found between test observations and gallonage-chart values. These observations comprise a "spot check," and the measured amounts of water should represent a random scattering throughout all or a considerable part of the chart range. *Results of the test observations should be recorded and should be compared with the chart values at the conclusion of the operation or at the conclusion of a sizable group of observations, rather than being individually compared as each observation is made.* This procedure is advisable in order to avoid possible personal bias in deciding upon the proper reading of gage rod or surface gage in a particular instance. The importance of reaching independent decisions on the readings of gage rod or surface gage should continuously be kept in mind. It is very difficult to avoid prejudice if the observer deciding upon the value of a reading is already aware of a corresponding value assigned by someone else.

4.3. Tolerances.—It must be borne in mind that tolerances do not apply to the results of a gaging operation. Gaging is to be performed, and the gallonage chart is to be completed, with all practicable accuracy, and no element of tolerance enters into these operations. Tolerances do apply, however, to the results of a testing operation; here the values on the gallonage chart are required to agree, within the prescribed tolerances, with the values determined on the test observations.

4.4. Alternative Testing Methods.—It will be appropriate to discuss briefly at this point certain advantages and disadvantages of the measure-in and measure-out methods of testing. When measuring in, the principal advantages are that results will be obtained simply and directly in even gallons and in increasing amounts, and that no conversion of observed data will be required for checking the gallonage chart. Disadvantages are that a staging or other means must be provided for elevating the standards to such a height that they can be discharged readily into the tank, or the filled standards must be manually raised and emptied, and that, if provision is not made for discharging the standards

through a hose beneath the surface of the liquid in the tank, an appreciable period must be allowed for the liquid surface to come to rest before a reading can be taken.

When measuring out, the principal advantage is that the agitation of the surface of the water in the tank is reduced to a minimum, thus tending to reduce somewhat the necessary time lag between successive liquid-level observations. An additional saving of time may be accomplished by making advance arrangements with the tank owner to have the tank filled with water before the arrival of the official. On the other hand, under the measure-out method, certain disadvantages are found, as follows: (1) A portable pump and necessary fittings must be provided to fill the standards, and a full line must be established and maintained throughout the test from the tank discharge valve to the discharge valve in the line leading from the pump. (2) The last portion of the contents of the tank must be discharged after the pump has been disconnected. This portion must be separately measured. Measures of small denomination (not greater than $\frac{1}{10}$ gallon or 1 pint) or suitable graduates are necessary for this purpose. Except in rare, accidental cases, this amount will not measure out to any even gallon. The volume readings originally recorded must be reversed for use in constructing or checking a gallonage chart, being built up from the base of the final portion discharged from the tank. Unless the base amount happens to be an even-gallon value, no converted volume figure can have an even-gallon value, and to some extent this will complicate constructing or checking the gallonage chart. It should be satisfactory in most instances to determine this final base amount by rounding off to the nearest $\frac{1}{10}$ gallon or 1 pint. If the value is rounded off to the nearest pint, for example, there may be dropped or added anything up to $\frac{1}{2}$ pint. Whatever error is introduced by the rounding operation is reflected in every reconstructed value throughout the chart. (3) When a standard is filled, there may be withdrawn from the tank slightly more than the correct amount, and it then becomes necessary to adjust the amount in the standard to the correct amount, and return the excess to the tank before a gage reading is made.

4.5. Basis.—Tanks are originally gaged and officially tested "to deliver"; thus, if a tank is gaged or tested by the method of measuring-in, the inside tank walls must first be thoroughly wetted and the tank then drained for 30 seconds after the main drainage flow has ceased. The purpose of this wetting operation is to duplicate, in the gaging and testing

operations, insofar as practicable, the conditions of commercial use of the tank. Actually, it is not practicable to duplicate exactly commercial drainage when gaging or testing by either measuring in or measuring out; any differences, however, will be small, and relatively unimportant.

4.6. Testing Medium.—Water is used as the testing medium in gaging and testing tanks. The tank should be thoroughly clean and should be free of all traces of milk or milk fat before gaging or testing is begun.

4.7. Water Temperature.—Care should be exercised to avoid any considerable change in the temperature of the water during gaging or testing, in order to avoid introducing volume changes, and consequent errors, as a result of the expansion or contraction of the water subsequent to its measurement. This factor must be watched, particularly if the water used has been hauled in a vehicle tank exposed for some time to the sun. Thermometer readings should be made, as required, to be certain that these changes are not occurring. (A quantity of water measured at 60 °F will increase in volume by, roughly, 0.1 percent if its temperature is raised to 70 °F; the volume change caused by a temperature rise from 60 °F to 80 °F is, roughly, 0.25 percent. Some of this effect will be compensated for by the change in volume of the tank itself resulting from its expansion or contraction following temperature changes.)

4.8. Level Condition.—To establish a standard and reproducible condition, a stationary tank should be in level when it is gaged. It is a normal responsibility of the tank owner to maintain his tank in level, and before a tank is tested its condition of level should be determined and, if necessary, it should be brought back into level. The condition of level of a stationary tank should be the same whether the tank is empty or filled, and the level should be checked under both conditions of lading.

The term "in level" as used here is to be interpreted as follows: A tank is "in level" when the level-indicating means gives a "level" indication. This condition is fixed by the tank manufacturer when the level-indicating means is affixed to the tank or, in the alternative case, when the top edge or edges of the tank are brought into a horizontal plane as the accurate reference for level determinations. The "level" indication of the level-indicating means is the criterion for the proper positioning of a tank during a factory gaging operation, for the proper position of a tank when this is installed for use, and for the maintenance of a tank, after installation, in the proper position for use. Thus it is seen that it is the function

of the level-indicating means to make possible the reproduction and maintenance of the designed operating position of a tank.

If an official is investigating a complaint of inaccuracies in measurements obtained from a particular tank, and if the tank is found to be out of level, he may, of course, wish to test it "as found," in order to determine its performance in the out-of-level condition in which it was being used. Subsequently, after the tank had been brought back into level, a retest would be in order.

4.9. Factors Affecting Accuracy.—Accurate reading of the indications of a gage rod or surface gage requires studied care on the part of the observer. Good lighting is an essential; if adequate lighting is not provided, a supplemental light source may be required. Usually the testing of a milk tank is a two-man operation; in such cases it is recommended that all readings be made independently by each man. Each man should write down his reading without knowing the reading of his associate, after which the readings should be compared. If there is disagreement, the entire operation should be repeated; that is, the gage rod should be properly prepared and again inserted in the tank, or the surface gage should be reset, and two more independent readings should be made, one by each man. The complete reading should be made in every case, not just the last digit; it is very easy to make a mistake in reading upward or downward from a numbered graduation, and the observer should always check against the adjacent numbered graduations to verify his reading.

It is customary to record gage-rod and surface-gage readings to the nearest graduation only, water being added or withdrawn in accurately determined even-gallon amounts. When the indication lies between two graduations on rod or gage—as is the case in the large majority of observations—the reading should be recorded as that of the nearer graduation. If the indication appears to be precisely midway between two graduations, standard recording practice should be followed and the reading should be recorded as that of the graduation having an *even*—as opposed to *odd*—designation. For example, if the indication appears to be precisely midway between graduations whose designations are $10\frac{5}{32}$ and $10\frac{6}{32}$, the reading should be recorded as $10\frac{6}{32}$; similarly an indication halfway between graduations 340 and 341 should be recorded as 340.

It is very difficult to read the height of a water surface on a gage rod unless the graduated face of the rod is coated

in such a way as to bring out clearly, and to retain, the line formed by that water surface when the rod was lowered into the liquid. This line should be clearly defined and should extend straight and unbroken across the face of the rod; if such a line is not at first obtained, the operation of coating the rod should be repeated and the rod should again be inserted in the tank. Experience has shown that very satisfactory results can be obtained by lightly dusting the graduated face of the rod with powdered Bon Ami. Initially, the rod should be clean and dry. It is not necessary to dust the entire face of the rod; the powder need be applied only for a distance of an inch or two, such that the water surface will cut across the dusted area when the rod is lowered into position on its bracket or other support. A light tap or two with the pounce bag in this area will apply an adequate coating of powder, after which any excess should be blown off or removed by jarring the rod. A better indication is given if the powder coating is thin than if it is thick. Before the next reading, the face of the rod should be thoroughly dried in the area where the reading will be made, and dusted as before. Obviously, no such treatment as this is required for a surface gage.

It is stated in the preceding paragraph that "initially the rod should be clean and dry." Both cleanliness and dryness are essential to accurate readings. By "cleanliness" is meant freedom from all traces of oil or fat. If the surface of the rod is even only very slightly "greasy," the water line will tend to rise on the rod and the resulting reading will be inaccurate. A film of moisture on the rod will have the same effect. (These same causes will have similar effects in the measurement of milk.) It follows that for accurate readings a rod must be thoroughly cleaned to remove all traces of milk fat. If a detergent is used for cleaning purposes, it is recommended that the rod be thoroughly rinsed with hot water to remove all traces of the detergent. The rod should then be thoroughly dried. Thereafter, during a gaging or testing operation the rod should be wiped only with a clean dry cloth, paper towel, or other fat-free material.

It follows, too, that the temperature of a rod must be above the dew point of the atmosphere in which it is being used. That is to say, that the rod must be warm enough so that moisture from the atmosphere will not condense on the rod after it has been dried and dusted preliminary to insertion in a tank to make a reading of liquid level. (In the regular use of a farm milk tank, a rod should not be kept in the tank, where it will assume the temperature of the cold milk. When

not being used to make a reading, the rod should be stored outside of the tank.)

It has already been mentioned that the liquid surface must be quiet when a liquid-level reading is made. If a gage rod is being used, this should not be lowered into the liquid until the surface is quiet, and the rod should be so inserted that no surge is created, however minor; if the liquid "washes up" on the rod after it is seated in position on its bracket or support, a false, too-high line will be established across the dusted area. To repeat an observation, it is necessary, of course, to remove the rod, dry it, redust it as previously described, and again lower it into position on its bracket or support. The rod should be lowered straight down—not at an angle—and should be firmly seated, and it should then be withdrawn promptly for reading.

When using the two-tipped surface gage with light signal, the tips need not be dried off after each observation. Prior to a reading, the gage should be so positioned that the tips are above the liquid surface. The gage is then lowered slowly to such a position that the characteristic signal is just obtained, indicating that both tips have touched or pierced the liquid surface. The gage is then carefully raised a small amount, just sufficient to give the other characteristic light signal, indicating that only the lower of the two tips of the gage is in contact with the liquid. The gage is then read. It is advisable to check the light signal again after the reading has been made, to verify that the correct signal is still showing; otherwise the gage should be reset and the reading repeated. It should be noted that a blinking light signal is an indication that there is some surging of the liquid in the tank; in such a case, the reading should be delayed until a steady signal is obtained.

The surface gage is read in position, with reference to a fixed indicator which must be correctly seated in position when a reading is being made. The observer's eyes must be properly alined with the indicator to avoid parallax effects.

4.10. Gallonage Chart.—Although the weights and measures official should never be called upon actually to construct a gallonage chart, a brief discussion of this operation may be helpful to an understanding of certain problems encountered in checking such charts.

The purpose of a gallonage chart is to list a gallon equivalent for each graduation on the gage rod or surface gage used with a particular tank. Because a high degree of uniformity is not practicable in the manufacture of the tanks, each tank must be individually gaged with its own gage rod or surface

gage, and the resulting gallonage chart is individual to that particular tank.

The gaging operation that has been discussed produces direct gallon equivalents for some, but not all, of the graduations on rod or gage. Determinations are made, as previously stated, at 5-gallon or 10-gallon intervals, and values are assigned to those graduations corresponding most nearly to the various liquid levels established in the course of the gaging operation. These graduations for which gallon values are directly determined may be termed the "fixed points" on the graduated scale. By the mathematical process of interpolation, values are then calculated for each of the graduations intermediate between successive fixed points. The assumption is made that between successive fixed points the values of the graduated intervals are uniform. A most simple case could be as follows: Assume a graduation designated 133 with a fixed gallon equivalent of 35 gallons. Assume that the next fixed point is graduation 138 with a gallon equivalent of 40 gallons. There are 5 graduated intervals between these two fixed points and the total interval represents 5 gallons. So each graduated interval represents one-fifth of 5 gallons, or 1 gallon, and the computed values for the graduations intermediate between these two fixed points are 134=36 gallons, 135=37 gallons, 136=38 gallons, and 137=39 gallons.

Suppose, however, that graduation 133 has a fixed value of 35 gallons but that the next fixed point is graduation 136 with a value of 40 gallons. Here there are 3 graduated intervals between the two fixed points, and this total interval represents 5 gallons. Accordingly, each graduated interval is assumed to have a value in terms of gallons of 5 divided by 3, or 1⅔ (1.67) gallons. Before assigning values to intermediate graduations 134 and 135, a decision must be reached as to what fractional part of a gallon the graduation values throughout the chart are to be given; this should be uniform for the entire chart. It may have been decided beforehand that such values would be given to the nearest half-gallon (0.5 gallon); or the nearest quart (0.25 gallon); or the nearest tenth gallon (0.1 gallon). Whatever the basis, some rounding off of the computed values for the intermediate graduations will be necessary. In this example, assuming a basis of "to the nearest tenth gallon" for assignment of graduation values, graduation 134 would have a computed value of 35+1.67 (1⅔) gallons, or 36.67 gallons, which would be rounded off to 36.7 gallons for the assigned chart value. Similarly, graduation 135 would have a computed value of

35+1.67 (1⅔)+1.67 (1⅔) gallons or 38.34 (38⅓) gallons, and an assigned value of 38.3 gallons.

Studying this short series of fixed and assigned chart values, which reads 133=35 gallons, 134=36.7 gallons, 135=38.3 gallons, and 136=40 gallons, it is found that the first graduated interval (133 to 134) has a chart equivalent of 1.7 gallons, the second (134 to 135) has a chart equivalent of 1.6 gallons, and the third (135 to 136) has a chart equivalent of 1.7 gallons. This lack of agreement is characteristic, and illustrates one of the inevitable results of rounding off. The magnitude of the differences between the values of successive graduated intervals based on interpolated and rounded-off values for intermediate graduations is reduced by increasing the precision to which chart values are assigned. For example, in the series here under discussion, if the basis for the assignment of chart values were "to the nearest half gallon," the graduations in question would have chart values as follows: 133=35 gallons, 134=35+1⅔ gallons, or 36⅔ gallons, which would round off to 36½ gallons; 135=35+1⅔+1⅔ gallons, or 38⅓ gallons, which would round off to 38½ gallons, and 136=40 gallons. Here chart equivalents of the intervals between successive graduations of the series would be successively, 1½ gallons, 2 gallons, and 1½ gallons; the lack of agreement here is much greater than in the example of chart values given to the nearest tenth gallon.[3]

In addition to the advantage demonstrated above for the use of chart values to the nearest tenth gallon, it should be noted that values expressed decimally instead of by use of common fractions will facilitate all computations involved in chart preparation and in the commercial use of farm milk tanks. Interpolation between fixed points on a chart is more easily done decimally than by use of common fractions, and the resulting decimal values require less space on the chart than do corresponding common-fraction values. It is easier for the producer and the purchaser to total a series of decimal numbers (representing successive pickups of milk) than it is to total a series of numbers involving common fractions. If it is desired to convert gallons to pounds by multiplying by a decimal factor (8.6, for example), this is most easily accomplished if the number of gallons is expressed in decimal terms.

In further relation to the degree of uniformity in the chart values of graduated intervals, it should be kept in mind

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[3] See pages 24–27 of NBS Handbook 44 for a more detailed discussion of "rounding off."

that, as the varying contours of a tank produce varying effective inside horizontal cross-sectional areas between bottom and top, differences between actual values for successive graduated intervals will occur; it is only in those portions of the tank where the cross-sectional area remains uniform that there will be actual uniformity in the volume equivalents of successive graduated intervals.

The gallonage chart is required to show values at least to the nearest ¼ gallon for a tank of a nominal capacity of 250 gallons or less, at least to the nearest ½ gallon for a tank of a nominal capacity of 251 to 500 gallons, inclusive, and at least to the nearest 1 gallon for a tank of a nominal capacity of more than 500 gallons. This does not, of course, preclude the showing of values to lesser amounts than those specified. It is not realistic to carry the numerical precision of chart values to a point far beyond the precision obtainable in the use of a tank—to 0.01 gallon, for example—and it is recommended that the lower limit for precision be assignment of values to the nearest tenth gallon. At the same time it is suggested that assignment of chart values to the nearest tenth gallon is realistic and practical.

The fallacy of officially recognizing a "gallonage chart" that shows values in terms of pounds as well as in terms of gallons, or that shows values only in terms of pounds, should be clear when it is remembered that chart values are based entirely on *volumetric* determinations. The person gaging a tank and the official testing a tank operate on the basis of liquid measurement—not weight. Volumetric values can be converted to weight values only upon the basis of some *assumed* equivalent. The legality of official certification of weight values on the chart of a farm milk tank is open to grave doubt. Most States require that the chart "shall show gallonage values only." If a milk producer desires to have an auxiliary chart showing weight values based upon some equivalent mutually agreeable to him and to the buyer of his milk, no official objection probably would be raised to this, but this auxiliary chart would not be sealed or otherwise approved by the weights and measures official. A simpler method of converting to pounds would, however, be for all records to be kept in terms of gallons until the time arrives for payment for the milk, when a single multiplication by the agreed-upon factor (such as 8.6 pounds per gallons, for example) would effect the conversion.

4.11. Summary.—A brief summary of testing procedures is in order. Since weights and measures officials normally limit their official activities in connection with farm milk

tanks to testing them, the test of the tanks will be considered first. It will be assumed that the results of the inspection of the assembly have been satisfactory.

The objective of testing a tank is to determine whether or not liquid-level readings made with the gage rod or surface gage provided, and converted to gallons by the chart provided, are accurate within prescribed tolerances. If so, the combination of tank, liquid-level-measuring element, and gallonage chart—together comprising a "farm milk tank"—will be approved for use and sealed. If not, approval for use will be withheld, and regaging and preparation of a new chart will be ordered.

For purposes of illustration, assume that the tank being tested has a nominal capacity of 600 gallons, and that there is furnished a measuring rod or surface gage capable of giving a reading on the first 50 gallons of liquid added to the tank. (The principles illustrated here and in subsequent discussions can readily be applied to larger and to smaller tanks.) Assume further that the measure-in method is to be followed, and that standards are available only in capacities of 1, 5, and 50 gallons. First, the discharge valve of the tank is closed and the inside walls of the tank are thoroughly wetted with water, after which this water is drawn off, a 30-second period being allowed, after cessation of the main flow, for drainage. The tank discharge valve is then closed. A measured 50 gallons of water might then be added and a liquid-level reading made and recorded. (Water temperature should be observed and recorded at this point and intermittently throughout the testing operation. See 4.7.) Five (or more) 5-gallon increments of water might then be added, liquid-level readings being made and recorded after each addition. To bring in some of the "intermediate" points, 2 gallons of water might now be added and a liquid-level reading taken and recorded, followed by an additional 5 (or more) 5-gallon increments, liquid-level readings being made and recorded after each addition. Some 12 (or more) values now having been recorded, comparison of these recorded values with the chart values may now be made. In each case the difference between the test value and the chart value should not exceed the prescribed tolerance. It is repeated, for emphasis, that liquid-level readings should be made and recorded without consulting the chart until a group of such observations is completed, in order to avoid prejudicing results.

If the results of the test up to this point are such as to justify rejection, this action can properly be taken without

further observations. Assuming, however, that the results are acceptable—that is, that the performance is within the prescribed tolerances—observations should be continued on a random pattern. With 102 gallons of water already in the tank (according to the figures of the example), observations might be made after each of the following additions of water: 50, 50, 2, 50, 5, 5, 50, 1, 50, 50, 50, 5, and 5 gallons. The results of this second group of observations should now be compared with the chart values, and in each instance agreement should be required within the prescribed tolerance. As outlined here, 25 check observations have now been made, and a total of 475 gallons of water have been measured into the tank. If at all points so far checked the performance has been within tolerance, it would be reasonable to conclude that this particular farm milk tank can be approved and sealed. If, however, it is deemed advisable to make additional observations, the operation may be continued to the maximum chart values.

If this same 600-gallon tank were to be tested by the measure-out method, the first step would be to fill the tank with *unmeasured* water up to a point approximating the maximum liquid-level at which the tank might be used. With the lines to and from the pump properly connected, the pump is operated, pumping back into the farm milk tank, until all air is expelled from the system. A liquid-level reading is then made and recorded; this constitutes a sort of "zero" reading for the series of observations that will follow. Then, following a random pattern, a series of measured amounts of water will be withdrawn from the tank, a liquid-level reading being made and recorded after each such withdrawal.

For a positive check on the accuracy of the chart values, the withdrawals from the tank must be continued until all water has been withdrawn and measured; otherwise the test can only disclose the accuracy of the values computed from the chart for a series of graduated intervals between the points at which the test observations began and ended, no information being developed on the correctness of the values assigned to any of the graduations. Assuming that the test is continued until all water in the tank has been measured, a series of liquid-level readings corresponding to the individual withdrawals will have been built up. These are not directly comparable with chart values, but must be reversed and built up into a table similar to the chart. For the purpose of illustration, assume a series of recorded observations, for simplicity assigning purely arbitrary values as follows:

Withdrawals in gallons	Liquid-level readings
Start	680
5	670
50	570
5	560
5	550
5	540
50	440
50	340
50	240
5	230
5	220
50	120
50	20
5	5
3	Empty

Starting at the bottom of this series, it is found that at a liquid-level reading of 5 there remained in the tank 3 gallons; that it required a withdrawal of 5 gallons to change the liquid-level reading from 20 to 5; and so on. A series of results can be built up as follows:

Liquid-level reading	Gallons
5=	3
20=	8 (3+5)
120=	58 (8+50)
220=	108 (58+50)
230=	113(108+5)
240=	118(113+5)
340=	168(118+50)
440=	218(168+50)
540=	268(218+50)
550=	273(268+5)
560=	278(273+5)
570=	283(278+5)
670=	333(283+50)
680=	338(333+5)

The immediately foregoing list of spot checks is directly comparable to the values listed on the gallonage chart, and test values and chart values should agree within the prescribed tolerance.

Gaging procedure by either method—that is, by measuring in or by measuring out—is the same as the corresponding testing procedure described above for that method, except that all additions or withdrawals (except a final withdrawal) are uniform in amount (1 or 2 gallons for tanks less than 100 gallons in nominal capacity, 5 gallons for medium size tanks, and 10 gallons for tanks of perhaps 750 gallons or larger capacity), and that a continuous series of such additions or withdrawals is essential throughout the entire range of the chart. It is repeated for emphasis that the results of a gaging operation are accepted as correct for purposes of the construction of a gallonage chart, and that tolerances are not involved in this operation in any way.

5. TESTING OUTLINES

(For tests of farm milk tanks by weights and measures officials.)

NOTE: Each time a standard measure is emptied, it is to be drained for the standard drainage period—10 seconds for measures having capacities of 10 gallons or less, and 30 seconds for larger measures. Caution must be exercised with respect to water temperature (see 4.7.).

Case I.—Measure-in method:

1. Check the level of the tank and, if necessary, bring it into level.
2. Wet with water the insides of the hose line and funnel, if used, and drain for the standard drainage period.
3. Thoroughly wet with water the inside of the farm milk tank, and drain the tank for 30 seconds after the main drainage flow has ceased.
4. Tightly close the tank discharge valve.
5. Add measured water (measured to some even-gallon amount) in an amount approximating 10 percent of the tank capacity, or in such greater amount as may be necessary to raise the liquid-level to a point where it can be read on gage rod or surface gage.
6. If the means for reading the liquid-level is a gage rod, thoroughly clean the rod, dry, and lightly dust the appropriate area on the graduated face of the rod with Bon Ami powder, and remove any excess by blowing or by jarring the rod.
7. When the liquid surface in the tank has become quiet, read the liquid-level on the gage rod or surface gage, and record the reading and the corresponding measured volume of water in the tank. (A gage rod should be inserted in the water "straight down," the rod should be firmly seated on its bracket or support,

and the rod should then be withdrawn promptly for reading. A surface gage should be lowered from a position above the liquid surface, adjusted to correct position according to its design, and then read. It should then be raised high enough for its points to be above the liquid surface after the next addition of measured water.)

8. Add an increment of measured water—2 gallons for very small tanks, 5 gallons for small and medium tanks, and 10 gallons or more for large tanks.
9. If a gage rod is being used, dry and dust an appropriate area on the rod.
10. When the liquid surface has become quiet, read and record the liquid-level and the corresponding amount of measured water in the tank as in step 7.
11. Repeat steps 8, 9, and 10, successively, employing a random selection of measured amounts of water, until 10 or more sets of readings have been recorded. (For example, on a tank having a capacity of 600 gallons, the increments, including the initial increment, might be 50, 5, 5, 5, 5, 5, 2, 5, 5, 5, 5, and 5 gallons.)
12. Compare the series of recorded values with the values on the gallonage chart. (Do not consult the chart prior to this step.) Gallonage values on the chart should agree with recorded gallonage values of the test, for corresponding liquid-levels, within the prescribed tolerance.
13. At this point the tank may be rejected upon the basis of the test results so far obtained, or the test can be continued for another 10 or more observations, or until the capacity of the tank is reached, to obtain more comprehensive data.
14. Assuming that the test is to be continued, repeat steps 8, 9, and 10, successively, for another series of observations based on increments of random, but even-gallon, amounts.

    (For example, on a 600-gallon tank this second series of increments might be 50, 50, 2, 5, 5, 50, 1, 50, 50, 50, 5, and 5 gallons.) Do not consult the gallonage chart during this stage of the test.
15. Compare the second series of recorded values with the gallonage values shown on the chart, as in step 12.
16. If the farm milk tank is approved for use on the basis of all of the test results, apply the appropriate approval seals.

Case II.—Measure-out method:

NOTE: To expedite the test, it is advisable that arrangements be made to have the tank filled with water before the arrival of the official. Caution must be exercised during the test with respect to water temperature (see 4.7.).

1. Check the level of the tank, and, if necessary, bring it into level.
2. Fill the tank with *unmeasured* water to a point corresponding to approximately the normal tank capacity.
3. Connect the pump to the tank outlet, and operate the pump until all air has been expelled from the pump, the inlet line to the pump, and the discharge line from the pump. Normally allow the pump to continue in operation, without interruption, until the pump is disconnected in step 12. (There must be solid liquid from the tank discharge valve to the valve at the discharge end of the pump discharge hose at all times during the test until the pump is disconnected as in step 12.)
4. Wet with water the insides of all measures to be used, and drain each measure for the standard drainage period.
5. If the means for reading the liquid-level is a gage rod, thoroughly clean the rod, dry, and lightly dust the appropriate area on the graduated face of the rod with Bon Ami powder, and remove any excess by blowing or by jarring the rod.
6. When the liquid surface in the tank has become quiet, read the liquid-level on the gage rod or surface gage and record the reading. This liquid-level reading is a reference or "zero" reading for the series of observations to follow. (A gage rod should be inserted in the water "straight down," the rod should be firmly seated on its bracket or support, and the rod should then be withdrawn promptly for reading. A surface gage should be lowered from a position above the liquid surface, adjusted to correct position according to its design, and then read.)
7. Withdraw measured water in an amount of 2, 5, or 10 gallons, or more, depending upon the relative size of the tank under examination.
8. If a gage rod is being used, dry and dust an appropriate area.
9. Read and record the liquid-level and record the corresponding amount of water withdrawn in step 7.
10. Repeat steps 7, 8, and 9, successively, employing a ran-

dom selection of measured amounts of water, until 10 or more sets of readings have been recorded. (For example, on a tank having a capacity of 600-gallons, the withdrawals might be 5, 5, 50, 2, 5, 5, 50, 5, 5, 5, 1, and 5 gallons.)

NOTE: If the test is interrupted or observations discontinued at this point, there can be tabulated from the gallonage chart the differences in terms of gallons between the chart values for successive liquid-levels in the series of liquid-levels recorded during the test observations. Thus the chart values and the observed values, in gallons, for these *intervals* can be compared. If the gallonage values for corresponding intervals consistently fail to agree within the prescribed tolerance, the probability is that the chart is inaccurate; under these circumstances, particularly if the discrepancies are considerably in excess of the tolerance, the official may feel justified in rejecting the farm milk tank and requiring regaging, without carrying the test further. On the other hand, if there is agreement within tolerance, this agreement does not demonstrate chart accuracy, for nothing is yet known about the actual accuracy of the gallonage values assigned on the chart to particular liquid-levels—only gallonage *differences* have been determined and compared. Assuming satisfactory agreement between chart and observed differences, the test must be continued as outlined in steps 11, 12, 13, and 14 below, in order to determine whether or not to approve the installation.

11. Repeat steps 7, 8, and 9, successively, employing a random selection of measured amounts of water, until the liquid-level approaches the minimum level that can be read on gage rod or surface gage. *Caution:* The liquid-level must not be lowered to such a point as to create a vortex whereby air might be drawn into the pump lines. (For example, on a 600-gallon tank this second series of withdrawals might be 50, 50, 5, 5, 5, 50, 5, 50, 50, 2, 5, 50, 5, 5, and 5 gallons.)
12. This step consists of withdrawing, measuring to the nearest $\frac{1}{10}$ gallon (or 1 pint), and recording the total amount of the water remaining *in the tank* after completion of the final observation under step 11, *but not including the water in the pump or in the hose line leading to the pump or in the discharge line from the pump.* While there is still water in the tank, and before any vortex has been created, (a) close the valve at the discharge end of the pump discharge hose, (b) close the discharge valve of the tank itself, and (c) disconnect the pump and its inlet hose from the tank and *discard the water in the pump and its inlet and discharge lines.* Using the discharge valve of the tank, withdraw and measure and add to the water withdrawn before the pump was disconnected, the balance of the water in the tank, allowing

the customary 30-second drainage period. Record the total amount of water withdrawn, exclusive of what was discarded from the pump and its lines. (The total amount of water determined in this step is the amount required to fill the tank from an initially empty condition up to the final liquid-level determined in step 11.)

13. From the recorded test data, beginning with the amount of the final withdrawal from the tank and the last recorded liquid-level, and working backward from this point, construct a table of liquid-levels and corresponding gallonage values as determined by the test.
14. Compare the gallonage values of the table constructed in step 13 with the gallonage values for corresponding liquid-levels as shown on the chart. There should be agreement in each instance within the prescribed tolerance.
15. If the farm milk tank is approved for use on the basis of all of the test results, apply the appropriate approval seals.

6. SUPERVISION OVER USE

6.1.—In the absence of a complaint from one or the other (or both) of the two principals involved in the use of a particular farm milk tank—these principals being the milk producer and the milk buyer—there is little that the official need do in supervising the *use* of that tank. This policy of nonaction is justified by that unique characteristic of a farm milk tank that distinguishes it from other commercial measures—the limitation of its use to transactions between a single seller and a single buyer. A few officials carry this policy to the extent of not even testing farm milk tanks installed in their jurisdictions except upon request or complaint.

Most officials, however, take the position that the public interest is sufficiently involved in the commercial use of a farm milk tank to override its private-contract aspects and to justify the official testing of the tank for accuracy as soon as practicable after its installation. Thereafter, so long as buyer and seller remain satisfied that their respective interests are not being jeopardized, official supervision can be confined to the mechanical details of the installation, and supervision over use of the tank for quantity determination can be waived.

The needed mechanical supervision will be accomplished by periodic inspection. The maintenance of level is important,

and this condition should be checked. A tank should be examined for evidence of any mechanical deterioration or damage that might affect its accuracy. A gage rod or surface gage should be examined for possible damage and for the condition of its graduations and markings. The gallonage chart should be inspected for continued legibility.

Should the results of the inspection cast doubt on the probable accuracy of the installation, the tank should be tested.

If the official does receive a complaint of short measure, misuse, or abuse of a farm milk tank, he should make an investigation to develop the facts in the case and should institute corrective measures as dictated by the facts, proceeding under the general principles governing all weights and measures investigations. If any doubt exists regarding the accuracy of the farm milk tank involved, the tank should, of course, be tested or retested, as the case may be.

7. REPORT FORMS

7.1.—Suggested test record and report forms have been drawn up, and samples are appended. It is to be noted that these forms are designed for use only in connection with *testing* operations. The forms are recommended to weights and measures officials as guides.

The form designed to be used in connection with the measure-in method of testing is sufficiently simple that no explanation of its use is needed.

In reference to the form designed to be used in connection with the measure-out method of testing, the following instructions are considered appropriate:

1. Complete entry of data in columns (1), (2), and (3).
2. Transfer final figure in column (2) to first line in column (4). (This figure represents the total volume withdrawn from the tank.)
3. Subtract figure on second line in column (1) from figure on first line in column (4), and enter result on second line in column (4).
4. Subtract figure on third line in column (1) from figure on second line in column (4), to derive figure for third line in column (4).
5. Continue, as in step 4, to compute figures for column (4); final entry will be "0".
6. Enter in column (5) gallonage figures obtained from gallonage chart corresponding to gage readings in column (3).
7. From the figures in columns (4) and (5), compute errors and enter these in column (6).

Date _____ DEPARTMENT HEADING Test No. _____

FARM MILK TANK TEST REPORT
(MEASURE-OUT METHOD)

Name _____ Post Office Address _____

Tank Location _____

Kind _____ Make _____ Serial No. _____ Chart Capacity _____

Date Installed _____ Gager _____ Date Gaged _____ Where Gaged _____

1/32" Rod ☐ 1/16" Rod ☐ Surface Gage ☐ Level Indicating Means _____

Standards Used _____

TEST RESULTS

Gallons Out (Withdrawals)		Gage Reading	Corresponding		Chart Error (gallons)
Individual	Accumulation		Computed Gallonage	Chart Gallonage	
(1)	(2)	(3)	(4)	(5)	(6)

Action Taken: Approved ☐ Rejected ☐ Entry of data continued on reverse ☐

Recommendations: _____

Inspector:

Receipt of Report Acknowledged:
Owner or Operator

Date _____ DEPARTMENT HEADING Test No. _____

FARM MILK TANK TEST REPORT
(MEASURE-IN METHOD)

Name _____ Post Office Address _____

Tank Location _____

Kind _____ Make _____ Serial No. _____ Chart Capacity _____

Date Installed _____ Gager _____ Date Gaged _____ Where Gaged _____

1/32" Rod ☐ 1/16" Rod ☐ Surface Gage ☐ Level Indicating Means _____

Standards Used _____

TEST RESULTS

Gallons In		Gage Reading	Corresponding Chart Gallonage	Chart Error (gallons)	Gallons In		Gage Reading	Corresponding Chart Gallonage	Chart Error (gallons)
Individual	Accumulation				Individual	Accumulation			

Action Taken: Approved ☐ Rejected ☐
Recommendations: _____

Inspector:

Receipt of Report Acknowledged:
Owner or Operator

8. REFERENCES

8.1. Catalog Material.—Catalogs and circulars issued by manufacturers of farm milk tanks contain illustrations and informative text that will be found useful by the weights and measures official.

8.2. National Conference Reports.—The following references are to papers on the general subject of farm milk tanks, published in the Reports of the National Conference on Weights and Measures. Citations include the designation in the series of Miscellaneous Publications of the National Bureau of Standards, the number and year of the particular National Conference, and the page reference.

M206, Thirty-seventh Conference Report, 1952, pages 20–23.
M212, Thirty-ninth Conference Report, 1954, pages 44–50.
M216, Fortieth Conference Report, 1955, pages 112–116.

8.3. Code for Farm Milk Tanks.—For the information of those wishing to trace the development of the National Conference code of specifications, tolerances, and regulations for farm milk tanks, the following citations to Reports of the National Conference are given:

M209, Thirty-eighth Conference Report, 1953, pages 90–92.
M212, Thirty-ninth Conference Report, 1954, pages 82–86.
M216, Fortieth Conference Report, 1955, pages 119–120.
M219, Forty-first Conference Report, 1956, pages 166–168.
M235, Forty-fifth Conference Report, 1960, page 98.
M239, Forty-sixth Conference Report, 1961, pages 151–152.
M244, Forty-seventh Conference Report, 1962, pages 122–123.

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