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Specialty Crops Program

Specialty Crops Inspection Division

AIM Inspection Series

Technical Procedures Manual

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“SCI moving forward in the 21st Century using technology, innovation, and old fashioned hard work”

Document Title
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INTRODUCTION

This document is designed to give guidance to Specialty Crops Inspection (SCI) Division personnel of the United States Department of Agriculture (USDA), and promote uniformity in the procedures covered. These procedures are an integral part of SCI services. If needed, contact your immediate supervisor for any situation not addressed in this manual.

Compliance with the Agricultural Marketing Service (AMS) guidelines does not excuse failure to comply with the Food, Drug, and Cosmetic Act or any other applicable Federal or State laws or regulations. SCI Division of the Specialty Crops Programs (SC), AMS is responsible for grading/inspecting, audits and standardization programs of fresh and/or processed fruits and vegetables and related products. The legal authority for grading, auditing and standardization activities are the Agricultural Marketing Acts of 1936 and 1946, as amended.

Applicants may obtain inspections of any fresh and/or processed fruit and vegetable and related products for which they have a financial interest. The inspection service is voluntary and self-supporting and is offered on a fee-for-service basis.

These procedures were developed for processed commodities and in some instances may be applied to fresh commodities when a procedure is not already established within a separate SCI document pertaining to fresh commodities (i.e. General Market Manual). When a procedure is established within a separate SCI document pertaining to fresh commodities, that procedure will be followed.

GUIDE FOR ELECTRONIC USAGE

The AIM system of instructional manuals is available electronically in Adobe Acrobat Portable Document Format (PDF) at the following intranet address: https://usdagcc.sharepoint.com/sites/ams/AMS-SCI/SitePages/Home.aspx.

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STANDARD LABORATORY PROCEDURES DOCUMENTS AND INDEX

The SCI Division Standard Laboratory Procedures Documents are a series of documents designed to standardize Division processed product laboratory practices. Included with these documents is an Index to associate the various products graded with the SCI Standard Laboratory Procedures Documents. The Index acts a quick reference to the Documents and are intended to work in harmony with current guidance. The Index allows for better uniformity and consistency among the various commodities and technical procedures SCI offices perform. Use of the Index and associated Standard Laboratory Procedures Documents whenever possible. The Documents may also be printed and posted at individual grading areas for quick reference when electronic access is not practical.

The SCI Division Standard Laboratory Procedures documents are available on the AIM Inspection site/Inspection Resources/AIM Inspection Series Processed Products/Inspection/SCI Standard Laboratory Procedures, and at the following intranet link: \\usda.net\ams\SCSCI\SCI-AIM\Inspection\LabSTP\SCI_Standard_Laboratory_Procedures.pdf.

ACID TITRATION

An acid is a substance that dissociates in a solution to give hydrogen ions. The higher the hydrogen-ion concentration, the stronger the acid; the lower the concentration, the weaker the acid.

Acids are sour to the taste and occur naturally in most fruits and vegetables. Acids are also added to processed products to inhibit the growth of mold and bacteria, and as flavor enhancers.

Total acidity is usually determined by titration with a weak base, such as 0.1N sodium hydroxide. This is a neutralization reaction resulting in the formation of water and "salts" derived from the particular acid involved. As the acid and base react, the hydrogen-ion concentration (pH) decreases until an equivalent amount of base has been added. At this point the pH value of the solution is not neutral (pH 7) as inferred by the name "neutralization reaction" but is slightly basic due to the hydrolysis of the salts. Using the neutralization reaction, total acidity may be measured visually with the use of an indicator, or potentiometrically with a pH meter.

Composition of Some Common Acids

Acid	**Molecular Wt.**	**Valence**	**Equivalent Wt.**	**Acid factor**
Acetic	60.05	1	60.1	.0601
Citric	192.12	3	64.0	.0640
Malic	134.09	2	67.0	.0670
Tartaric	150.09	2	75.0	.0750

A. Sample Preparation

Note: Use distilled or deionized water in the preparation of samples.

1. <u>Fruit and Vegetable Juices</u>

Review the appropriate U.S. grade standards and/or specifications to determine the following:

a. Are the results to be determined as weight/weight or weight/volume?

b. Are concentrated samples to be reconstituted before taking aliquot for analysis?

c. Which acid will results be expressed, e.g. malic, tartaric, citric?
Mix the sample thoroughly and pipette 10.0 ml (or weigh 10.0g) of the sample into a 250 ml beaker or flask and add approximately 100 ml of

water. Proceed with determination as described in "C. Procedures" on the following page.

2. Mustard and Sauces

Mix the sample thoroughly. Weigh 10.0g of the sample into a 200 ml volumetric flask and dilute to volume with water. Shake well and filter through a dry fluted paper filter. Determine acidity on 100 ml of filtrate using 0.1N NaOH and express results as acetic acid.

3. Mayonnaise, Salad Dressing and Dressings for Foods

Weigh 15.0g of the sample into a 500 ml Erlenmeyer flask and dilute with 200 ml of water. Shake until all lumps are thoroughly broken up. Determine acidity using the visual indicator method, titrating with 0.1N NaOH. To recognize the endpoint, you may wish to have a duplicate sample nearby so that the first color change will be evident by comparison. Express results as acetic acid.

4. Vinegar

Pipette 10.0 ml of the sample into a 500 ml Erlenmeyer flask and dilute with water until the vinegar is only slightly colored. Determine acidity using the visual indicator method, titrating with 0.5N NaOH. Express the results as acetic acid.

5. Vitamin C (Ascorbic Acid)

Ascorbic acid is a white or yellow crystal powder with a molecular weight of 176.12 grams. It is odorless but has a pleasant, sharp, acidic taste. Ascorbic acid is relatively unstable and is easily oxidized upon exposure to air and light. It occurs naturally in many fruits and vegetables and is abundant in freshly harvested produce.

The Division does not routinely test for ascorbic acid, and the reagents for this test are different from reagents for other acid titrations. If you are asked to perform a Vitamin C test, contact your supervisor for guidance.

B. Preparation of Phenolphthalein Indicator

Dissolve 1 gram (g) of phenolphthalein in 50 milliliters (ml) of 95% ethyl alcohol and add 50 ml of water.

C. Procedures

1. Visual Indicator Method

This method is useful for light colored samples that will allow the inspector to detect the faint pink end point color change of phenolphthalein.

a. Fill a clean burette with the appropriate standard NaOH solution.

b. Drain the solution meniscus to the 0.0 ml mark. Take readings with your eyes at the level of the meniscus, measuring at the lowest point of the meniscus.

c. Add two or three drops of phenolphthalein indicator to the prepared sample and place under the burette. If possible, the burette tip should be approximately 1 inch from the surface of the sample.

d. Titrate the sample by running the solution from the burette slowly but steadily while swirling or stirring the sample gently. Near the end point, the local color change diffuses more and more slowly through the sample. At this point, run the solution from the burette one drop at a time until the sample is a faint pink color, indicating that the end point has been reached.

e. Read the burette at the lowest point of the meniscus. Record this as the volume of NaOH used. Use this figure to calculate total acidity. See "D. Calculations" on the following page.

f. If the amount of NaOH used is less than 10 ml or more than 50 ml, adjust the sample size accordingly so that the titration will fall within that range.

g. At the discretion of the supervisor, the titration may be repeated and the results averaged. Titrations should agree within 0.1 ml.

2. Potentiometric Method (pH)

This method may be used for determining the acidity on any sample solution, regardless of color.

a. Standardize the pH meter according to the manufacturer's instructions using a commercial pH 7 buffer solution.

b. After standardizing the instrument, rinse the electrode thoroughly with water and submerge in the sample.

c. Fill the burette with the appropriate standard NaOH as shown in Visual Indicator Method, steps a, and b.

d. Stir moderately by hand or with a magnetic stirrer.

e. Add NaOH rapidly until near pH 6, and then slowly add until reaching pH 7.

f. After pH 7 is reached, titrate by adding NaOH very slowly, a few drops at a time. Allow the sample to mix before adding more.

g. Continue titrating to the end point of pH 8.1 (± 0.2); add NaOH one drop at a time because the pH will change more rapidly with each addition. (Procedural Reference - AOAC Official Method Acidity (Titratable) of Fruit Products)

Record the volume of NaOH used to reach pH 8.1, reading the burette at the lowest point of the meniscus. Use this figure to calculate the total acidity. See "D. Calculations." below.

h. Titrations should be between 10 ml and 50 ml. If not, adjust the sample size and re-titrate.

i. At the discretion of the supervisor, the titration may be repeated, and the results averaged. Titrations should agree within 0.1 ml.

D. Calculations

Total acidity is calculated as the predominant acid in the sample.

1. Total Acidity (weight/volume)

$$\text{Total Acidity, g/100 ml} = \frac{T \times N \times A \times 100}{V}$$

Where T = ml NaOH used
N = Normality of NaOH used
A = Acid factor
V = Volume of the sample

2. Total Acidity (weight/weight)

$$\text{Total Acidity, g/100 g} = \frac{T \times N \times A \times 100}{W}$$

Where T = ml NaOH used
N = Normality of NaOH used
A = Acid factor
W = Weight of the sample

Acid Conversion Chart for Fruit Juices

Acid content and Brix/acid ratio limits in most USDA grade standards for fruit juices are based on acid expressed as "grams per 100 grams of juice" (or percent by weight) rather than "grams per 100 ml of juice" (or percent by volume). When expressed in this manner, acid content calculated as wt/vol must be converted to wt/wt before determining acid compliance or calculating Brix/acid ratio. This may be accomplished by using a formula with the specific gravity of the juice.

The following conversion chart is based on this formula and provides a convenient means for converting the acid content of fruit juices from weight/volume to weight/weight.

A. How to Use the Chart

1. Determine the acid content (wt/vol) of the juice.

2. Determine the Brix value of the juice.

3. Find the acid wt/vol value on the chart. Following a straight line to the right, find the Brix Range columns containing the Brix value of the juice. (There are three sets of Brix Range columns on the chart.)

4. The corresponding acid wt/wt value is shown in the column to the right of the Brix Range columns.

Example: Acid after titration = 0.75 grams/100ml (wt/vol)

Brix of juice = 11.8°

Acid from the chart = 0.72 grams/100 grams (wt/wt)

The true Brix acid ratio would be as follows:

$$\frac{11.8}{0.72} = 16.4:1$$

The charts are abbreviated for convenience. If the acid wt/vol or Brix of the juice is not covered by these charts, the acid wt/wt may be obtained by the following formula:

$$\frac{\text{Acid Wt/Vol}}{\text{Specific Gravity of the juice}} = \text{Acid Wt/Wt}$$

The specific gravity of the juice may be obtained from the Brix reading by use of the "Sucrose Conversion Table" found in the "Brix" section of this instructional manual.

ACID CONVERSION CHART – FRUIT JUICES
From Grams/100 ML (WT/VOL) to Grams/100 Grams (WT/WT)

Acid wt/vol	Brix Range		Acid wt/wt	Brix Range		Acid wt/wt	Brix Range		Acid wt/wt
	Minimum	Maximum		Minimum	Maximum		Minimum	Maximum	
0.50	7.0	7.7	0.49	7.8	13.0	0.48	13.1	17.0	0.47
0.51	7.0	7.6	0.50	7.7	12.7	0.49	12.8	17.0	0.48
0.52	7.0	7.4	0.51	7.5	12.5	0.50	12.6	17.0	0.49
0.53	7.0	7.3	0.52	7.4	12.2	0.51	12.3	17.0	0.50
0.54	7.0	7.2	0.53	7.3	12.0	0.52	12.1	16.8	0.51
0.55	7.0	7.0	0.54	7.1	11.8	0.53	11.9	16.5	0.52
0.56	7.0	11.6	0.54	11.7	16.2	0.53	16.3	17.0	0.52
0.57	7.0	11.4	0.55	11.5	16.0	0.54	16.1	17.0	0.53
0.58	7.0	11.2	0.56	11.3	15.7	0.55	15.8	17.0	0.54
0.59	7.0	11.0	0.57	11.1	15.4	0.56	15.5	17.0	0.55
0.60	7.0	10.8	0.58	10.9	15.1	0.57	15.2	17.0	0.56
0.61	7.0	10.6	0.59	10.7	14.9	0.58	15.0	17.0	0.57
0.62	7.0	10.4	0.60	10.5	14.7	0.59	14.8	17.0	0.58
0.63	7.0	10.3	0.61	10.4	14.4	0.60	14.5	17.0	0.59
0.64	7.0	10.1	0.62	10.2	14.2	0.61	14.3	17.0	0.60
0.65	7.0	9..9	0.63	10.0	14.0	0.62	14.1	17.0	0.61
0.66	7.0	9.8	0.64	9.9	13.8	0.63	13.9	17.0	0.62
0.67	7.0	9.6	0.65	9.7	13.5	0.64	13.6	17.0	0.63
0.68	7.0	9.5	0.66	9.6	13.3	0.65	13.4	17.0	0.64
0.69	7.0	9.4	0.67	9.5	13.2	0.66	13.3	17.0	0.65
0.70	9.3	13.0	0.67	13.1	16.7	0.66	16.8	17.0	0.65
0.71	9.2	12.8	0.68	12.9	16.5	0.67	16.6	17.0	0.66
0.72	9.1	12.6	0.69	12.7	16.2	0.68	16.3	17.0	0.67
0.73	8.9	12.4	0.70	12.5	16.0	0.69	16.1	17.0	0.68
0.74	8.8	12.3	0.71	12.4	15.8	0.70	15.9	17.0	0.69
0.75	8.7	12.1	0.72	12.2	15.6	0.71	15.7	17.0	0.70
0.76	8.6	11.9	0.73	12.0	15.4	0.72	15.5	17.0	0.71
0.77	8.5	11.8	0.74	11.9	15.2	0.73	15.3	17.0	0.72
0.78	8.4	11.6	0.75	11.7	15.0	0.74	15.1	17.0	0.73
0.79	8.3	11.5	0.76	11.6	14.8	0.75	14.9	17.0	0.74
0.80	8.2	11.3	0.77	11.4	14.6	0.76	14.7	17.0	0.75
0.81	8.1	11.2	0.78	11.3	14.4	0.77	14.5	17.0	0.76
0.82	8.0	11.0	0.79	11.1	14.2	0.78	14.3	17.0	0.77
0.83	7.9	10.9	0.80	11.0	14.1	0.79	14.2	17.0	0.78
0.84	7.8	10.8	0.81	10.9	13.9	0.80	14.0	17.0	0.79
0.85	7.7	10.7	0.82	10.8	13.7	0.81	13.8	16.8	0.80
0.86	7.6	10.5	0.83	10.6	13.6	0.82	13.7	16.6	0.81
0.87	7.5	10.4	0.84	10.5	13.4	0.83	13.5	16.4	0.82
0.88	7.4	10.3	0.85	10.4	13.3	0.84	13.4	16/2	0.83
0.89	7.3	10.2	0.86	10.3	13.1	0.85	13.2	16.1	0.84
0.90	7.3	10.1	0.87	10.2	13.0	0.86	13.1	15.9	0.85

Acid wt/vol	Brix Range		Acid wt/wt	Brix Range		Acid wt/wt	Brix Range		Acid wt/wt
	Minimum	Maximum		Minimum	Maximum		Minimum	Maximum	
0.91	7.2	9.9	0.88	10.0	12.8	0.87	12.9	15.7	0.86
0.92	7.1	9.8	0.89	9.9	12.7	0.88	12.8	15.5	0.87
0.93	7.0	9.7	0.90	9.8	12.5	0.89	12.6	15.4	0.88
0.94	7.0	9.6	0.91	9.7	12.4	0.90	12.5	15.2	0.89
0.95	7.0	9.5	0.92	9.6	12.3	0.91	12.4	15.0	0.90
0.96	7.0	9.4	0.93	9.5	12.1	0.92	12.2	14.9	0.91
0.97	7.0	9.3	0.94	9.4	12.0	0.93	12.1	14.7	0.92
0.98	7.0	9.2	0.95	9.3	11.9	0.94	12.0	14.6	0.93
0.99	7.0	9.1	0.96	9.2	11.8	0.95	11.9	14.4	0.94
1.00	7.0	9.0	0.97	9.1	11.7	0.96	11.8	14.3	0.95
1.01	9.0	11.5	0.97	11.6	14.1	0.96	14.2	16.7	0.95
1.02	9.0	11.4	0.98	11.5	14.0	0.97	14.1	16.6	0.96
1.03	8.9	11.3	0.99	11.4	13.9	0.98	14.0	16.4	0.97
1.04	8.8	11.2	1.00	11.3	13.7	0.99	13.8	16.2	0.98
1.05	8.7	11.1	1.01	11.2	13.6	1.00	13.7	16.1	0.99
1.06	8.6	11.0	1.02	11.1	13.5	1.01	13.6	15.9	1.00
1.07	8.5	10.9	1.03	11.0	13.3	1.02	13.4	15.8	1.01
1.08	8.5	10.8	1.04	10.9	13.2	1.03	13.3	15.6	1.02
1.09	8.4	10.7	1.05	10.8	13.1	1.04	13.2	15.5	1.03
1.10	8.3	10.6	1.06	10.7	13.0	1.05	13.1	15.3	1.04
1.11	8.2	10.5	1.07	10.6	12.8	1.06	12.9	15.2	1.05
1.12	8.2	10.4	1.08	10.5	12.7	1.07	12.8	15.1	1.06
1.13	8.1	10.3	1.09	10.4	12.6	1.08	12.7	14.9	1.07
1.14	8.0	10.2	1.10	10.3	12.5	1.09	12.6	14.8	1.08
1.15	8.0	10.1	1.11	10.2	12.4	1.10	12.5	14.7	1.09
1.16	7.9	10.0	1.12	10.1	12.3	1.11	12.4	14.5	1.10
1.17	7.8	9.9	1.13	10.0	12.2	1.12	12.3	14.4	1.11
1.18	7.7	9.9	1.14	10.0	12.1	1.13	12.2	14.3	1.12
1.19	7.7	9.8	1.15	9.9	12.0	1.14	12.1	14.2	1.13
1.20	7.6	9.7	1.16	9.8	11.9	1.15	12.0	14.1	1.14
1.21	7.6	9.6	1.17	9.7	11.8	1.16	11.9	13.9	1.15
1.22	7.5	9.5	1.18	9.6	11.7	1.17	11.8	13.8	1.16
1.23	7.4	9.5	1.19	9.6	11.6	1.18	11.7	13.7	1.17
1.24	7.4	9.4	1.20	9.5	11.5	1.19	11.6	13.6	1.18
1.25	9.4	11.4	1.20	11.5	13.5	1.19	13.6	15.6	1.18
1.26	9.3	11.3	1.21	11.4	13.4	1.20	13.5	15.5	1.19
1.27	9.3	11.2	1.22	11.3	13.3	1.21	13.4	15.3	1.20
1.28	9.2	11.1	1.23	11.2	13.2	1.22	13.3	15.2	1.21
1.29	9.1	11.0	1.24	11.1	13.1	1.23	13.2	15.1	1.22
1.30	9.0	10.9	1.25	11.0	13.0	1.24	13.1	15.0	1.23
1.31	9.0	10.9	1.26	11.0	12.9	1.25	13.0	14.9	1.24
1.32	8.9	10.8	1.27	10.9	12.8	1.26	12.9	14.7	1.25

Acid wt/vol	Brix Range		Acid wt/wt	Brix Range		Acid wt/wt	Brix Range		Acid wt/wt
	Minimum	Maximum		Minimum	Maximum		Minimum	Maximum	
1.33	8.8	10.7	1.28	10.8	12.7	1.27	12.8	14.6	1.26
1.34	8.8	10.6	1.29	10.7	12.6	1.28	12.7	14.5	1.27
1.35	8.7	10.5	1.30	10.6	12.5	1.29	12.6	14.4	1.28
1.36	8.6	10.5	1.31	10.6	12.4	1.30	12.5	14.3	1.29
1.37	8.6	10.4	1.32	10.5	12.3	1.31	12.4	14.2	1.30
1.38	8.5	10.3	1.33	10.4	12.2	1.32	12.3	14.1	1.31
1.39	10.3	12.1	1.33	12.2	14.0	1.32	14.1	15.9	1.31
1.40	10.3	12.0	1.34	12.1	13.9	1.33	14.0	15.8	1.32
1.41	10.2	11.9	1.35	12.0	13.8	1.34	13.9	15.7	1.33
1.42	10.1	11.9	1.36	12.0	13.7	1.35	13.8	15.5	1.34
1.43	10.0	11.8	1.37	11.9	13.6	1.36	13.7	15.4	1.35
1.44	10.0	11.7	1.38	11.8	13.5	1.37	13.6	15.3	1.36
1.45	9.9	11.6	1.39	11.7	13.4	1.38	13.5	15.2	1.37
1.46	9.8	11.5	1.40	11.6	13.3	1.39	13.4	15.1	1.38
1.47	9.8	11.4	1.41	11.5	13.2	1.40	13.3	15.0	1.39
1.48	9.7	11.4	1.42	11.5	13.1	1.41	13.2	14.9	1.40
1.49	9.6	11.3	1.43	11.4	13.0	1.42	13.1	14.8	1.41
1.50	11.3	13.0	1.43	13.1	14.7	1.42	14.8	16.5	1.41
1.51	11.2	12.9	1.44	13.0	14.6	1.43	14.7	16.3	1.42
1.52	11.2	12.8	1.45	12.9	14.5	1.44	14.6	16.2	1.43
1.53	11.1	12.7	1.46	12.8	14.4	1.45	14.5	16.1	1.44
1.54	11.0	12.6	1.47	12.7	14.3	1.46	14.4	16.0	1.45
1.55	11.0	12.5	1.48	12.6	14.2	1.47	14.3	15.9	1.46
1.56	10.9	12.5	1.49	12.6	14.1	1.48	14.2	15.8	1.47
1.57	10.8	12.4	1.50	12.5	14.0	1.49	14.1	15.7	1.48
1.58	10.7	12.3	1.51	12.4	14.0	1.50	14.1	15.6	1.49
1.59	10.7	12.2	1.52	12.3	13.9	1.51	14.0	15.5	1.50
1.60	10.6	12.1	1.53	12.2	13.8	1.52	13.9	15.4	1.51
1.61	10.5	12.1	1.54	12.2	13.7	1.53	13.8	15.3	1.52
1.62	10.5	12.0	1.55	12.1	13.6	1.54	13.7	15.2	1.53
1.63	10.4	11.9	1.56	12.0	13.5	1.55	13.6	15.1	1.54
1.64	10.3	11.8	1.57	11.9	13.4	1.56	13.5	15.0	1.55
1.65	10.3	11.8	1.58	11.9	13.4	1.57	13.5	14.9	1.56
1.66	10.2	11.7	1.59	11.8	13.3	1.58	13.4	14.9	1.57
1.67	11.7	13.2	1.59	13.3	14.8	1.58	14.9	16.3	1.57
1.68	11.7	13.1	1.60	13.2	14.7	1.59	14.8	16.2	1.58
1.69	11.6	13.0	1.61	13.1	14.6	1.60	14.7	16.1	1.59
1.70	11.5	13.0	1.62	13.1	14.5	1.61	14.6	16.0	1.60
1.71	11.5	12.9	1.63	13.0	14.4	1.62	14.5	16.0	1.61
1.72	11.4	12.8	1.64	12.9	14.3	1.63	14.4	15.9	1.62
1.73	11.3	12.7	1.65	12.8	14.2	1.64	14.3	15.8	1.63
1.74	11.3	12.7	1.66	12.8	14.2	1.65	14.3	15.7	1.64

Acid wt/vol	Brix Range Minimum	Brix Range Maximum	Acid wt/wt	Brix Range Minimum	Brix Range Maximum	Acid wt/wt	Brix Range Minimum	Brix Range Maximum	Acid wt/wt
1.75	11.2	12.6	1.67	12.7	14.1	1.66	14.2	15.6	1.65
1.76	11.1	12.5	1.68	12.6	14.0	1.67	14.1	15.5	1.66
1.77	11.1	12.4	1.69	12.5	13.9	1.68	14.0	15.4	1.67
1.78	11.0	12.4	1.70	12.5	13.8	1.69	13.9	15.3	1.68
1.79	10.9	12.3	1.71	12.4	13.8	1.70	13.9	15.2	1.69
1.80	10.9	12.2	1.72	12.3	13.7	1.71	13.8	15.1	1.70
1.81	10.8	12.2	1.73	12.3	13.6	1.72	13.7	15.1	1.71
1.82	10.8	12.1	1.74	12.2	13.5	1.73	13.6	15.0	1.72
1.83	10.7	12.0	1.75	12.1	13.5	1.74	13.6	14.9	1.73
1.84	12.1	13.4	1.75	13.5	14.8	1.74	14.9	16.2	1.73
1.85	12.0	13.3	1.76	13.4	14.7	1.75	14.8	16.1	1.74
1.86	11.9	13.2	1.77	13.3	14.7	1.76	14.8	16.1	1.75
1.87	11.9	13.2	1.78	13.3	14.6	1.77	14.7	16.0	1.76
1.88	11.8	13.1	1.79	13.2	14.5	1.78	14.6	15.9	1.77
1.89	11.7	13.0	1.80	13.1	14.4	1.79	14.5	15.8	1.78
1.90	11.7	13.0	1.81	13.1	14.3	1.80	14.4	15.7	1.79
1.91	11.6	12.9	1.82	13.0	14.3	1.81	14.4	15.6	1.80
1.92	11.6	12.8	1.83	12.9	14.2	1.82	14.3	15.6	1.81
1.93	11.5	12.8	1.84	12.9	14.1	1.83	14.2	15.5	1.82
1.94	12.8	14.0	1.84	14.1	15.4	1.83	15.5	16.7	1.82
1.95	12.7	14.0	1.85	14.1	15.3	1.84	15.4	16.7	1.83
1.96	12.7	13.9	1.86	14.0	15.2	1.85	15.3	16.6	1.84
1.97	12.6	13.8	1.87	13.9	15.2	1.86	15.3	16.5	1.85
1.98	12.5	13.8	1.88	13.9	15.1	1.87	15.2	16.4	1.86
1.99	12.5	13.7	1.89	13.8	15.0	1.88	15.1	16.3	1.87
2.00	12.4	13.6	1.90	13.7	14.9	1.89	15.0	16.2	1.88

AFLATOXIN ANALYSIS OF PEANUT BUTTER AND OTHER PEANUT PRODUCTS

To ensure that peanut products are in compliance with the Food and Drug Administration (FDA) guidelines, aflatoxin testing must be done. **All Peanut Butter that is graded and all Peanut Products that are inspected for quality will be chemically tested for the presence of aflatoxin.** Peanut butter is the only processed peanut product for which a U.S. standard has been issued. However, neither the U.S. Standards for Grades of Peanut Butter, nor the Grading Manual for Peanut Butter makes a reference to aflatoxin. Other products such as roasted peanuts, peanut granules, peanut flour, etc. are inspected against the requirements contained in contracts, announcements, federal specifications, and other specifications or instructions. These documents may or may not include aflatoxin testing as a part of inspection.

FDA has an administrative guideline of a maximum of 20 parts per billion (ppb) in processed peanut products. Since good manufacturing practices will remove sufficient aflatoxin to result in a level of 20 ppb aflatoxin in processed peanut products, the Memorandum of Agreement between the Agricultural Marketing Service and FDA (MOU 225-96-2001 – which may be found at the following internet address: http://www.fda.gov/AboutFDA/PartnershipsCollaborations/MemorandaofUnderstandingMOUs/DomesticMOUs/default.htm permits a level of 25 ppb aflatoxin in raw peanuts.

Any product that fails to meet the FDA guidelines for aflatoxin shall be placed on hold for reexamination and/or possible destruction regardless of the source of the original samples. This includes product represented by samples submitted by the applicant. Under these circumstances, the product to be placed on hold would be the lot as declared by the applicant at the request for inspection. All samples for reexamination shall be officially drawn.

Sampling

Samples shall be drawn for quality in accordance with the regulations. Samples for analysis shall be composited from the sample units drawn for quality, provided sufficient product is available after inspection. If these sample units will not provide a sufficient quantity of product, parallel sample units shall be drawn. Composite samples shall be made as indicated in the table below, based on the number of sample units drawn for quality.

Sampling Rate for Aflatoxin

Sample Size (from the Regulations)	3	6	13	21	29
No. of Composite Samples (minimum)	1	1	2	3	4

The composite samples shall be made from approximately equal portions of each sample unit. The composite samples shall be of the following minimum size for each product:

Roasted peanuts – 48 pounds - Peanut granules – 48 pounds - Peanut Butter – 1 pound

Aflatoxin samples drawn should be sent to the AMS Science and Technology Programs (S&T) Aflatoxin Laboratory:

Blakely Laboratory 6567 Chancey Mill Road Blakely, GA 39823	Laboratory Supervisor Phone (229) 723-4570 Fax (229) 723-7251

Most specifications that include aflatoxin testing as a requirement state that aflatoxin must be negative. In no case may the specification permit a higher level of aflatoxin than permitted by FDA.

Certification of peanut products will be withheld until aflatoxin results are obtained from the laboratory.

Other Products

Inspection requests may be received for processed peanut products other than peanut butter, roasted peanuts, and peanut granules. In addition to peanut products, other nut products often have aflatoxin requirements. Under these circumstances, the Regional office should contact the National office for proper sampling and analysis procedures.

Aflatoxin Failure Re-inspection Procedure

A. The S&T aflatoxin laboratory notifies their Technical Services Branch (TSB) and the SCI Division field office of failed product. The notification may be given by telephone, with a follow-up in writing by fax or by email.

B. The SCI Division field office that graded the product will immediately notify the Inspection Operations in Washington, DC by telephone to report the following:

1. Contractor's name;
2. Plant location;
3. Product;
4. Date packed;
5. Codes;
6. Quantity; and
7. Reason for failure.

Verbal notification should be followed up with an email containing the same information. Send the email to Inspection Operations in Washington DC and (based on location) the Eastern, Central, or Western Regional office.

C. The SCI Division field office will complete Form SC-16, Notice for Hold for Reexamination, to notify the applicant that the product exceeds the FDA guidelines for aflatoxin.

D. If desired, the applicant will send a letter on company letterhead and signed by a company official to S&T, TSB to request retesting of the product. This letter must include:

1. Appeal for retesting with the lot broken down into sub-lots (normally a sub-lot is a pallet);
2. Product name;
3. Primary container code;

4. Case count, and number and size of containers per case (e.g. 480 cases 6/No 10 cans);

5. Current location(s) of product and amount of product at each site;

6. Method desired for shipment of samples to laboratory.

E. The TSB will send an email message or fax to Inspection Operations in Washington, DC containing the following information:

1. Applicant's name, location, telephone number, and fax number (if applicable);

2. Request for sampling on a sub-lot by sub-lot basis, or other sampling plan that is acceptable to SCI Division in the event of a claim for indemnification;

3. Product name;

4. Primary container code;

5. Case count, and number and size of containers per case (e.g. 480 cases 6/No 10 cans);

6. Current location(s) of product and amount of product at each site; and

7. Method of shipment to laboratory

F. Inspection Operations in Washington, DC will send an email message requesting sampling to (based on location) the Eastern, Central, or Western Regional office and also notify the Division Director. The message will contain all of the information shown in item 5 on the previous page along with any additional instructions that may be necessary.

G. Each sub-lot must be marked by some means so as to be separately identifiable. This is the responsibility of the applicant. However, if the applicant is acting in good faith and each pallet is marked the same, one acceptable way to mark the sub-lots is to stamp the cases with the USDA "Officially Sampled" stamp with a different lot number for each sub-lot. Case stamping procedures may be found in the AIM Inspection Series General Procedures Manual. The SCI Division field office will sample the product by sub-lot and will mark each sub-lot in a manner that will identify it from all other sub-lots. The field office will complete Form SC-637, Laboratory Sample Submittal Sheet, which may be found at the following intranet address: https://usdagcc.sharepoint.com/sites/ams/AMSFormsCatalog/Forms/AllItems.aspx to accompany the samples to the S&T laboratory. The samples will be clearly marked to indicate the sub-lot identification. Samples are shipped at the applicant's expense. The field office shall confirm with the plant how they prefer the samples to be shipped.

I. The SCI Division field office will bill the applicant for the sampling, stamping (if necessary), and travel.

J. The SCI Division field office will send an email message to Inspection Operations in Washington, DC notifying when the samples are to be shipped to the laboratory, with copies to (based on location) the Eastern, Central, or Western Regional office, TSB, and the laboratory.

K. When the samples arrive at the laboratory, the laboratory will notify TSB, the SCI Division field office, and Inspection Operations in Washington, DC by fax or email.

L. The laboratory will perform aflatoxin analysis in duplicate on each sample, and immediately report the analytical results to the SCI Division field office and to TSB by telephone, fax or email.

M. The TSB will send a fax or email message to the Inspection Operations in Washington, DC containing the applicant's name and the following information for each location:

1. Product name;

2. List of aflatoxin results (in ppb), and number of cases for each sub-lot;

3. The statement "Sub-lot No(s). ___________ exceed(s) FDA administrative guidelines of 20 ppb aflatoxin";

4. Number of cases (and pounds) that pass;

5. Number of cases (and pounds) that fail; and

6. Total number of cases (and pounds).

N. The S&T aflatoxin laboratory will notify the applicant by telephone or fax of average analytical results.

O. The laboratory will prepare the certificate of analyses in the usual manner with the following exceptions:

1. For each lot and each primary container code, all sub-lots <u>meeting</u> FDA guidelines will be reported on one certificate.

2. For each lot and each primary container code, all sub-lots <u>failing</u> FDA guidelines will be reported on one certificate.

3. In both cases (a. and b.), each sub-lot is listed separately with its corresponding

analytical result.

P. The laboratory will send a copy of each certificate prepared to TSB and the SCI Division field office and distribute the remainder of the certificates in the usual manner. The laboratory will bill the applicant for the analyses.

Q. The TSB will provide the Inspection Operations in Washington, DC with a photocopy of each certificate.

R. Failing product must be destroyed to the satisfaction of SCI Division, or the lot reported to FDA, per our Memorandum of Understanding (MOU).

S. Inspection Operations in Washington, DC will notify the Eastern, Central, or Western Regional office and field office that the product must be destroyed, and issue instructions for witnessing the destruction of the product by a USDA inspector. The instructions should consist of the following:

1. Notify the applicant that the product is not to be destroyed unless a USDA inspector is present. If an inspector is not present at time of destruction, FDA will be notified of the sub-lots in violation.

2. The field office is to notify Inspection Operations in Washington, DC, through (based on location) Eastern, Central, or Western Regional office, of how the applicant intends to destroy the product. If the method of destruction is acceptable to the National office, the field office will be advised.

3. During the destruction, the USDA inspector will record the following:

a. Date;

b. Applicant's name and address;

c. Truck identification (truck number or license number) used to transport the product;

d. Name and address of dump site;

e. Method of destruction;

f. Lot identification (primary container codes, sub-lot numbers);

g. Number of cases, size and kind of containers, and number of pounds of product; and

h. Certificate number(s) of aflatoxin analyses certificate(s) covering the product.

ATTRIBUTES

An attribute may be defined as a characteristic or quality of a thing, a food product in this case. As used in statistics, the term “attributes” refers to when a record shows only the number of articles conforming and the number of articles not conforming to any specified requirement.

Attributes standards are directed toward specific quality levels based on predetermined acceptable average numbers of defects per hundred units of product. Acceptable quality level (AQL), is defined as the average number of defects per hundred units of product in a lot that is acceptable for the grade. The emphasis in attribute standards is placed on the lot as a whole instead of the individual container or sample unit. The amounts of defects permitted for the various grades (specific quality levels) are expressed in terms of numbers of defects per hundred units, geared to a specified sample unit’s sizes and acceptable quality levels.

The current U.S. Standards for Sampling Plans are found in the Code of Federal Regulations (CFR) Title 7, Chapter 1, Part 43, 43.101, 43.102, 43.103, 43.104, 43.105, and 43.106 which are located at the following internet address: https://www.ecfr.gov/cgi-bin/ECFR?page=browse.

BRIX MEASUREMENT

The term "Brix" technically means the percent by weight of sugar solids in a pure sucrose solution.

Fresh Products

In fresh fruits it is generally referred to as soluble solids. Use the equipment and procedures in the General Market Manual for any fresh commodity that does not have an established procedure in the U.S. standards or inspection instructions. Products such as cantaloupes, table grapes, and watermelons have specific guidelines and instructions in determining soluble solids in their respective commodity inspection instructions.

Processed Products

In canned fruits, fruit juice, and similar products Brix is commonly used as a convenient term to express the percent by weight of all soluble solids in solutions. The solutions are generally not pure sucrose but contain sweeteners or mixtures of two or more types of sweeteners, and small amounts of other substances.

The instruments generally used for Brix measurement are Brix hydrometers and refractometers. These instruments are affected not only by the sugars present in a product but also by such substances as fruit acids, pectins, and minerals. Regardless of the composition of the solution, the Brix reading expresses the soluble solids content of the solution in terms of a Brix value corresponding to a pure sucrose solution of the same specific gravity.

The final Brix measurement of liquid packing media in canned fruit and similar products depends largely on four factors:

1. The soluble solids of the in-going fresh products.

2. The Brix of the in-going liquid medium.

3. The proportion of fresh product to packing medium, and

4. The extent to which the finished product (fresh product and liquid medium) has equalized.

Canned fruits are usually packed in a liquid medium, which may range from a water pack (no added sweetener), to a packing medium of natural juice, to a syrup of relatively high sugar content. The statement shown on the inspection certificate to indicate syrup density may be "syrup designation" or "Brix measurement." The appropriate statement to use when certifying canned fruits in a liquid media is described in the AIM Inspection Series Certification Manual.

Liquid Packing Medium

Most liquid packing media fall into one of the following categories or syrup designations:

1. Artificially sweetened.
2. In fruit juice(s).
3. In fruit juice(s) and water.
4. In water.
5. Slightly sweetened water, or extra light syrup, or slightly sweetened fruit juice(s) and water, or slightly sweetened fruit juice(s).
6. Light syrup, or lightly sweetened fruit juice(s) and water, or lightly sweetened fruit juice(s).
7. Heavy syrup, or heavily sweetened fruit juice(s) and water, or heavily sweetened fruit juice(s).
8. Extra heavy syrup, or extra heavily sweetened fruit juice(s) and water, or extra heavily sweetened fruit juice(s).

The Brix measurement for each designation varies with the product. Inspectors must refer to the applicable U.S. Standards for Grades, buyer's specification, and Division instructions for special certification criteria to determine the actual requirements.

Inspection and Certification Criteria

When certifying the liquid medium, inspectors shall consider certain Food and Drug Administration (FDA) mandatory requirements or U.S. Standards for Grades recommendations as to the following:

A. The Brix of a liquid packing medium is not evaluated as a factor of quality when applying the United States Standards for Grades. However, these standards do provide recommended or mandatory FDA syrup designations based on specified Brix measurements.

B. Brix determination for syrup designation is a definite requirement in many specifications for canned fruits. The requirement may also be incorporated in a procurement document or buyer's specification.

C. Drained weights are sometimes predicated upon specified syrup designations. For example, the recommended drained weight for Canned Red Tart Pitted Cherries packed in a sweetened medium differs from those packed in water.

D. The Brix measurement(s) shown on the certificate of quality and condition is the soluble solids determination made at the time of final examination. This must be after the equalization of the natural sugars in the fruit and the in-going liquid medium. See Equalization – Terminology.

Acceptance Criteria

Use the following guide to allow for a reasonable variation in syrup densities and at the same time be within the limits of good commercial practice. A lot will be considered as meeting a required, recommended, or declared syrup designation under the following conditions:

A. The average of the Brix measurements from all the sample units falls within the range for the designated syrup; and

B. No individual reading is below the range of the next lower syrup designation, or above the range of the next higher syrup designation. If no lower syrup designation exists, none may fall more than 2 degrees Brix below the minimum of the specified designation.

Preparation of Samples

A. Equalization – Terminology

To properly evaluate Brix readings, it is important that the product has reached equalization with the packing medium. In the case of canned fruits and vegetables packed in syrup, complete equalization may require several weeks. However, unless otherwise stated in the particular standard or specification, assume that equalization is completed 15 days after packing. Even though the product and packing media may not have completely equalized during this period, the process is sufficiently complete for inspection and certification purposes.

Complete equalization may be accomplished at any time by comminuting the product and packing medium using the proper equipment and techniques. This procedure is referred to as simulated equalization. It will yield results comparable to natural equalization without

requiring a 15 day delay in inspection.
The two basic categories of products on which Brix is measured:

1. Naturally equalized products (either by prolonged storage or by the nature of the product),

2. Non-equalized products.

Samples are to be taken from individual containers only. Composite samples are not to be used.

B. Procedure for Equalized Products

Mix the sample. Completely liquid products should be stirred while still in the original container. Liquid packing media of products such as canned fruits is recovered during or after the drained weight step, while the fruit remains on the sieve. The container collecting the drained liquid must be free from water and reasonably free from syrup adhering from previous samples. Containers used for syrup samples that are borderline, or in dispute, shall be cleaned and dried for each reading. Syrup collected in this manner is considered well mixed.

1. Transfer syrup to a standard laboratory glass cylinder and take the Brix hydrometer reading. Smaller containers with sufficient liquid content may be poured directly from the can into the cylinder.

2. Make temperature corrections (if needed).

3. If a refractometer is used, follow procedure as outlined in Section G of this subsection.

C. Procedure for Non-Equalized Products

Simulated equalization replicates the natural equalization of soluble solids in the fruit or vegetable ingredient and the packing media. The entire contents of the canned product are comminuted into a homogeneous liquid state, and the degrees Brix of this slurry is determined by refractometer. The degrees Brix found is considered equivalent to the Brix obtained by hydrometer on the liquid packing media of equalized product.

The following equipment is required to perform this procedure:

1. Blender or other similar machine with bowl size adequate to accommodate the contents of can sizes from a 2 ½ to a No. 10 can.

2. Refractometer, water cooled, and equipped with thermometer and suitable light source.

3. Temperature corrections chart for refractometer Brix scale (included on page 31 of this instruction).

4. Soft applicator such as plastic spatula or rod tipped with rubber policeman.

5. Filtering equipment:

   a. Funnel,

   b. Test tube,

   c. Filter paper.

Note: Nylon cloth or similar material may be used in lieu of filter paper provided comparable results can be obtained.

Perform the procedure as follows:

a. Pour entire contents of container into blender bowl. Whole, unpitted fruit should be carefully pitted, and pitted product should be checked for pits before comminuting. Transfer all of the fruit and liquid to the bowl.

b. Comminute the sample until homogeneous. This process should take from one to two minutes. Check efficiency of blending by occasionally pouring a sample onto a clean, dry pan and visually examining for lumps of fruit or vegetable flesh. Further mixing is needed if lumps are present. (It is usually not possible to completely liquefy maraschino cherries used in fruit cocktail and fruit mixes; however, final results are not adversely affected). Avoid excessive mixing since it overheats the sample. The inspector will come to know the correct mixing times with experience.

   An alternative method for overcoming any small container problem is the use of double-dilution with an equal part by weight of distilled water, comminuting and multiplying the result by 2.

c. Filter if necessary, discarding the first few drops. Avoid evaporation by covering the sample if not performing the reading immediately.

d. Apply about two drops of sample to the refractometer prisms.

e. Take the reading, make temperature correction if needed, and record results.

D. Selection of Brix Measuring Instrument

The following selections are recommended but not mandatory. A refractometer may be used in lieu of a Hydrometer if equivalent results may be obtained.

Use Hydrometer for

1. Naturally equalized canned fruit and canned vegetables (such as sweet potatoes in syrup) consisting of separate units in a liquid packing medium (including water and dietetic packs).

2. Canned, chilled and frozen single-strength fruit juices.

3. Frozen fruits (in-going syrups only).

4. Special products (such as pickles, pickle relish, molasses and table syrups) as specified in standards or specifications and instructions.

Use Refractometer for

1. Non-equalized canned fruits and canned vegetables (such as sweet potatoes in syrup) consisting of separate units in a liquid packing medium, including water and dietetic pack - after undergoing simulated equalization.

2. Canned fruit products such as purees, pulps, butters, jams, preserves and jellies.

3. Canned and frozen fruit juices other than single-strength.

4. Naturally equalized canned fruit and canned vegetables consisting of separate units in a liquid packing medium, where individual containers contain insufficient liquid medium to measure by hydrometer.

5. Frozen fruits.

6. Special products, such as honey, as specified in standards, specifications, or instructions.

E. Measurement Techniques

The Brix hydrometer or spindle is a glass instrument consisting of a hollow bulb which causes the hydrometer to float. Below this bulb is a section filled with shot which causes the instrument to float in an upright position. Above the bulb is a graduated stem from which the readings are taken. The extent to which the stem extends above the surface of the liquid depends upon the specific gravity of the liquid being tested.

The instrument is similar to any specific gravity hydrometer indicating degrees of liquid density. However, the graduations on the stem of this instrument are expressed in degrees

Brix and indicate the percentage of soluble solids in terms of sucrose equivalent. If the Brix hydrometer is immersed in a solution composed entirely of sucrose and water, the reading at proper temperature is exactly the percentage by weight of pure dry sugar (sucrose) in the solution. The degrees Brix is easy to determine, is a convenient measurement of the specific gravity in terms of the Brix scale, and reflects the total soluble solids in solution.

The hydrometer most often used in laboratories has a 10 degree range for each spindle with graduations in $^{1}/_{10}$ degrees. Most SCI Division laboratories are equipped with instruments to cover at least the range from 5 degrees to 40 degrees Brix.

F. Hydrometer Procedure

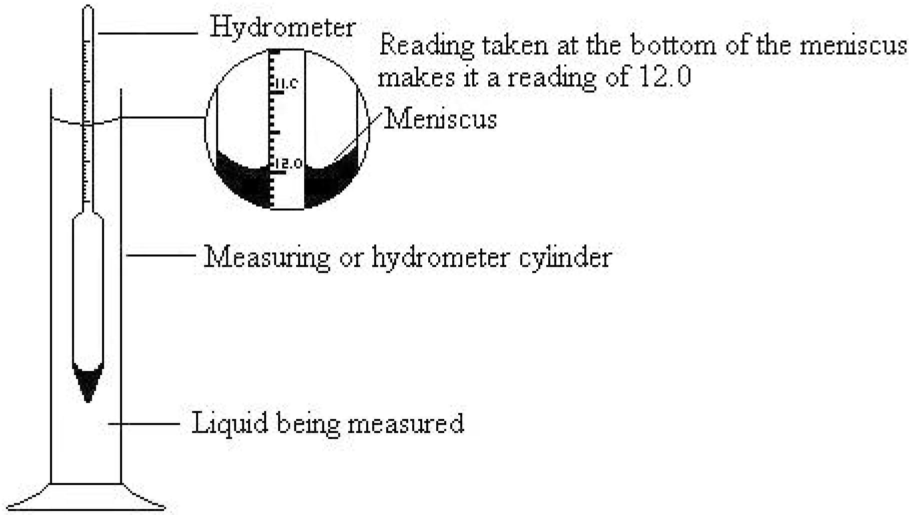
The Brix hydrometer should be checked periodically for accuracy. Please see the calibration of equipment section of this Manual for instructions.

Hydrometer usage:

1. Pour the liquid to be examined into a standard glass laboratory cylinder (approximately 1 ¼ inches inside diameter, 10 to 12 inches tall). Completely fill the cylinder, and allow to over flow slightly so as to float off any foam or bubbles.

2. Remove sufficient liquid from the cylinder to allow the hydrometer to float at a level of liquid slightly below the top of the cylinder. This is easy to gauge with a little experience. Slowly lower the clean, dry hydrometer into the liquid until it is very near floating position. Release spindle with a slight spinning motion. If it is dropped into the syrup, it will sink too far and when it rises some of the syrup will adhere to the stem. The weight of this adhering syrup will cause the hydrometer to float at a lower position than it should. Air bubbles in the syrup will also cause the hydrometer to float at an incorrect level.

3. Observe the reading on the stem after allowing the hydrometer to come completely to rest. The hydrometer should not touch the side of the glass cylinder. The eye should be on a level with the surface of the liquid. Where the liquid touches the stem, it rises a short distance to form a meniscus. The correct reading is taken at the true liquid level, not at the top of the meniscus. The meniscus layer is usually thin and the graduation marks can be seen through it. However, with very dark colored syrups it may be necessary to make a slight allowance for the meniscus factor.



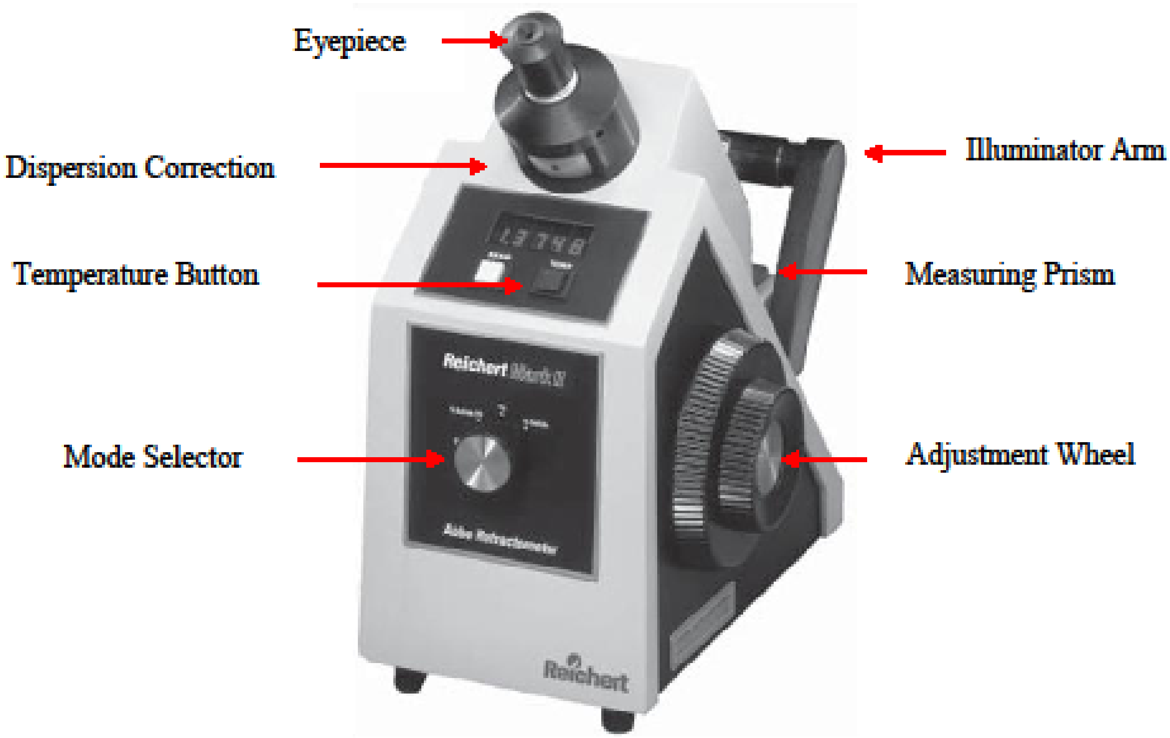
4. Record the temperature of the syrup, and refer to the Brix hydrometer temperature correction chart for any appropriate correction. The chart is self-explanatory, but note that the correction factor varies according to the specific gravity of the liquid as well as with the temperature. The correction factor is taken from the column nearest the degree Brix found. For example, if the hydrometer indicates a reading of 23.5 degrees Brix, the correction factor is taken from the vertical column headed 25 degrees Brix.

5. The Brix hydrometer is a very delicate and fragile instrument. It must be handled with care to avoid breakage and should be thoroughly cleaned and dried immediately after each use. Store it in an adequately cushioned container to protect it from damage.

G. Refractometer Procedure

The refractometer is an instrument that optically measures the density of a liquid. Light passes through the sample and is deflected in relation to the density of the sample. The instrument is calibrated in terms of refractive index and usually contains a scale in terms of degrees Brix.

A common type of refractometer consists of two prisms between which a portion of the test sample is placed. A mirror will reflect light through the prisms and test sample. A telescopic tube with cross-hairs is superimposed on the field of vision, correlating to a scale calibrated in terms of refractive index, degrees Brix, or both. There is also a compensator to correct for the chromatic dispersion of light, and a thermometer in the water circulating system. There may be some variation depending on the make and model of the individual instrument. Become familiar with your refractometer by studying its manual of instructions. Many small, hand-type refractometers are not sufficiently accurate for laboratory purposes, but may be used to estimate the soluble solids content of fresh fruit.



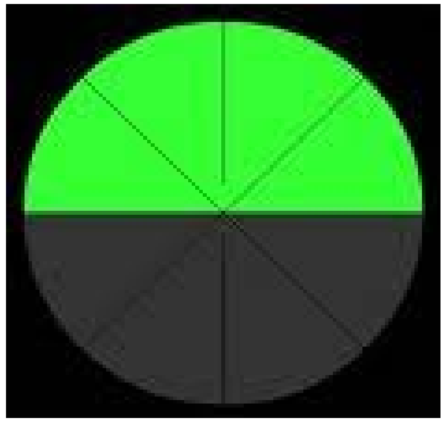
The refractometer should be checked for accuracy before use. This should be on a daily basis when in constant use, such as during in-plant inspections. The method of determining the instrument's accuracy of calibration will be specified in the refractometer manual. Please see the equipment section of this manual for calibration instructions.

Refractometer usage:

1. Apply one or two drops (amount may vary; be guided by your equipment manual) of the sample (filtered when necessary) to the lower prism. Be careful not to scratch the soft refractometer prisms in the process. Avoid using product that is too hot or too cold, as this could also damage the prisms.

2. Close and lock the prism chamber.

3. Apply the light source and view the shadow through the telescope, keeping the eye in the center of the eyepiece. Align the shadow edge (which should be sharp) exactly with the intersection of the cross-hairs.



An indistinct shadow edge may be caused by:

a. Insufficient or excessive sample on prisms.

b. Unfiltered sample of purees and slurries.

c. Improper chromatic dispersion adjustment indicated by a blue or red tinge in the shadow edge.

d. Insufficient or excessive light directed on the prisms.

e. Improper closing of prisms (too rapid closure of prisms, or prisms not locked securely).

f. Light stop that controls the amount of light transmitted to the prisms (present on some instruments) is not fully closed.

4. Read the degrees Brix from the Brix scale.

Caution: Incorrect readings may be caused by too much sample on the prism (causing the liquid to flow around onto the backside of a prism), or by water on the prism from incomplete drying from the previous sample.

5. Note the temperature indicated by the thermometer and make appropriate temperature correction.

Temperature greatly influences the Brix reading, and it is essential that the reading be corrected to the instrument's standard temperature (usually 20 degrees C/68 degrees F). This correction is made with a chart similar to the one developed for the Brix hydrometer shown at the end of this section. Temperature of the prisms should remain as close to standard temperature as practical by adjusting of the flow of water through the cooling system.

6. The refractometer must be kept clean and in proper working order at all times.

Clean and dry the prisms with soft, lint free tissues immediately after each reading. The prisms are soft and scratch easily; never touch them with hard objects such as spoons or glass rods. Place a small piece of soft paper or tissue between them when the instrument is not in use, and protect with a cover. Refer to the instruction manual for any specific storage or handling procedures.

Refractometers standardized at 20 degrees C are preferred by the Division. When sample temperatures are above or below the temperature at which the instrument is calibrated, corrections are based on the standard temperature of the instrument. Temperature correction charts included in this instruction are only for instruments standardized at 20 degrees C.

H. Reporting Results

After adjusting the reading for temperature variation, report results of Brix readings to the closest $^{1}/_{10}$ or 0.1 degree, or to the appropriate degree per the grading instructions. Corrections for the presence of fruit acids, minerals, and similar ingredients are not made unless specified in the standard or specification.

I. Percent Juice Declaration

FDA has declared that the use of standard minimum Brix levels will promote consistency in calculating the percentage of juice. Effective May 8, 1994, the FDA established minimum Brix levels for fruit and vegetable juices. To declare a fruit or vegetable juice prepared from concentrate to be 100 percent juice, the reconstituted juice must meet the minimum Brix level indicated in the table. If the Brix reading of a reconstituted juice is less than FDA's minimum required Brix, the product is not considered to be 100 percent juice. The processor must calculate the exact percentage of juice and declare the proper percentage of juice on the retail label.

Products packed in bulk containers are exempt from FDA's percent juice declaration requirement.

FDA Established Minimum Brix Levels

Juice	100 Percent Juice [1/]
Acerola	6.0
Apple	11.5
Apricot	11.7
Banana	22.0
Blackberry	10.0
Blueberry	10.0
Boysenberry	10.0
Cantaloupe Melon	9.6
Carambola	7.8
Carrot	8.0
Casaba Melon	7.5
Cashew (Caju)	12.0
Celery	3.1
Cherry, dark, sweet	20.0
Cherry, red, sour	14.0
Crabapple	15.4
Cranberry	7.5
Currant (Black)	11.0
Currant (Red)	10.5
Date	18.5
Dewberry	10.0
Elderberry	11.0
Fig	18.2
Gooseberry	8.3
Grape	16.0
Grapefruit	10.0 [3/]
Guanabana (soursop)	16.0

Juice	100 Percent Juice [1/]
Guava	7.7
Honeydew melon	9.6
Kiwi	15.4
Lemon	4.5 [2/]
Lime	4.5 [2/]
Loganberry	10.5
Mango	13.0
Nectarine	11.8
Orange	11.8 [3/]
Papaya	11.5
Passion Fruit	14.0
Peach	10.5
Pear	12.0
Pineapple	12.8
Plum	14.3
Pomegranate	16.0
Prune	18.5
Quince	13.3
Raspberry (Black)	11.1
Raspberry (Red)	9.2
Rhubarb	5.7
Strawberry	8.0
Tangerine	11.8 [3/]
Tomato	5.0
Watermelon	7.8
Youngberry	10.0

[1/] Indicates Brix value unless other value specified.
[2/] Indicates anhydrous citrus acid percent by weight.
[3/] Brix values determined by refractometers for citrus juices may be corrected for citric acid.

Note: The Brix levels shown in the above table do not apply to juices that are directly extracted from a fruit or vegetable (i.e. not concentrated or reconstituted). Such products are considered to be 100 percent juice and will be declared as 100 percent juice.

Example: To meet U.S. Grade A, the U.S. Standards for Grades of Frozen Concentrated Sweetened Grape Juice require that the reconstituted juice have a Brix of 13.0

degrees with a minimum of 50 percent of the solids coming from grape concentrate. Even with 100 percent grape solids, the 13.0 degrees Brix does not meet the FDA minimum Brix requirement of 16.0 degrees. In this case, the processor must declare the actual percent juice on the label. The in-plant inspector shall calculate the percentage of juice in the batch and verify that there is no discrepancy from the amount declared on the label.

Note: Since FDA has established a minimum Brix level, no deviants are allowed.

When a juice or juice beverage product fails the required reconstituted Brix, or fails to show the percent juice or the correct percent of juice on the label, document the score sheet accordingly, and flag the certificate under the grade statement. See the AIM Inspection Series, Certification Manual for examples.

When the product label bears an approved USDA identification mark and the product fails FDA's minimum Brix requirement, the lot will be placed on hold and may not be shipped. This would also apply to lots labeled incorrectly for percentage of juice. The processor has the option to rework the product to meet the Brix requirement; or use a label that states the proper percentage of juice.

Processors should contact the FDA (http://www.fda.gov/), if they have any questions regarding percentage juice labeling or nutritional facts that relate to the Nutritional Labeling Education Act (NLEA) regulations.

Identity labeling of food in packaged form, FDA regulations 21 CFR 101.30, https://www.ecfr.gov/cgi-bin/ECFR?page=browse,

Percentage Juice Declaration, and 21 CFR 102.33, https://www.ecfr.gov/cgi-bin/ECFR?page=browse,

Information on beverages that contain fruit and vegetable juice are available at the selection of internet addresses listed above.

TEMPERATURE CORRECTIONS FOR OBTAINING BRIX FROM REFRACTOMETER READINGS

Temp. Degrees C.	Degrees Brix										
	0	5	10	15	20	25	30	40	50	60	70
	Subtract from Brix Reading										
10	.50	.54	.58	.61	.64	.66	.68	.72	.74	.76	.79
11	.46	.49	.53	.55	.58	.60	.62	.65	.67	.69	.71
12	.42	.45	.48	.50	.52	.54	.56	.58	.60	.61	.63
13	.37	.40	.42	.44	.46	.48	.49	.51	.53	.54	.55
14	.33	.35	.37	.39	.40	.41	.42	.44	.45	.46	.48
15	.27	.29	.31	.33	.34	.34	.35	.37	.38	.39	.40
16	.22	.24	.25	.26	.27	.28	.28	.30	.30	.31	.32
17	.17	.18	.19	.20	.21	.21	.21	.22	.23	.23	.24
18	.12	.13	.13	.14	.14	.14	.14	.15	.15	.16	.16
19	.06	.06	.06	.07	.07	.07	.07	.08	.08	.08	.08
	Add to Degrees Brix Reading										
21	.06	.07	.07	.07	.07	.08	.08	.08	.08	.08	.08
22	.13	.13	.14	.14	.15	.15	.15	.15	.16	.16	.16
23	.19	.20	.21	.22	.22	.23	.23	.23	.24	.24	.24
24	.26	.27	.28	.29	.30	.30	.31	.31	.31	.32	.32
25	.33	.35	.36	.37	.38	.38	.39	.40	.40	.40	.40
26	.40	.42	.43	.44	.45	.46	.47	.48	.48	.48	.48
27	.48	.50	.52	.53	.54	.55	.55	.56	.56	.56	.56
28	.56	.57	.60	.61	.62	.63	.63	.64	.64	.64	.64
29	.64	.66	.68	.69	.71	.72	.72	.73	.73	.73	.73
30	.72	.74	.77	.78	.79	.80	.80	.81	.81	.81	.81

SUCROSE CONVERSION TABLE

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.3330	0.0	1.00000	8.322	0.000
1.3331	0.0	1.00039	8.325	0.008
1.3333	0.2	1.00078	8.328	0.017
1.3334	0.3	1.00117	8.331	0.025
1.3336	0.4	1.00156	8.335	0.033
1.3337	0.5	1.00194	8.338	0.042
1.3339	0.6	1.00233	8.341	0.050
1.3340	0.7	1.00272	8.344	0.059
1.3341	0.8	1.00312	8.348	0.067
1.3343	0.9	1.00351	8.351	0.075
1.3344	1.0	1.00390	8.354	0.084
1.3346	1.1	1.00429	8.357	0.092
1.3347	1.2	1.00468	8.361	0.100
1.3349	1.3	1.00507	8.364	0.109
1.3350	1.4	1.00546	8.367	0.117
1.3352	1.5	1.00585	8.370	0.126
1.3353	1.6	1.00624	8.374	0.134
1.3354	1.7	1.00663	8.377	0.142
1.3356	1.8	1.00702	8.380	0.151
1.3357	1.9	1.00741	8.383	0.159
1.3359	2.0	1.00780	8.387	0.168
1.3360	2.1	1.00819	8.390	0.176
1.3362	2.2	1.00859	8.393	0.185
1.3363	2.3	1.00898	8.396	0.193
1.3365	2.4	1.00937	8.400	0.202
1.3366	2.5	1.00977	8.403	0.210
1.3368	2.6	1.01016	8.406	0.219
1.3369	2.7	1.01055	8.409	0.227
1.3370	2.8	1.01094	8.413	0.236
1.3372	2.9	1.01134	8.416	0.244
1.3373	3.0	1.01173	8.419	0.252
1.3375	3.1	1.01213	8.423	0.261

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.3376	3.2	1.01252	8.426	0.270
1.3377	3.3	1.01292	8.429	0.278
1.3379	3.4	1.01331	8.432	0.287
1.3380	3.5	1.01371	8.436	0.295
1.3382	3.6	1.01410	8.439	0.304
1.3383	3.7	1.01450	8.442	0.312
1.3385	3.8	1.01490	8.446	0.321
1.3386	3.9	1.01529	8.449	0.329
1.3388	4.0	1.01569	8.452	0.338
1.3389	4.1	1.01609	8.456	0.347
1.3391	4.2	1.01649	8.459	0.355
1.3392	4.3	1.01688	8.462	0.364
1.3394	4.4	1.01728	8.465	0.372
1.3395	4.5	1.01768	8.469	0.381
1.3397	4.6	1.01808	8.472	0.390
1.3398	4.7	1.01848	8.475	0.398
1.3400	4.8	1.01888	8.479	0.407
1.3401	4.9	1.01928	8.482	0.416
1.3402	5.0	1.01968	8.485	0.424
1.3404	5.1	1.02008	8.489	0.433
1.3405	5.2	1.02048	8.492	0.441
1.3407	5.3	1.02088	8.495	0.450
1.3408	5.4	1.02128	8.499	0.459
1.3410	5.5	1.02168	8.502	0.468
1.3411	5.6	1.02208	8.505	0.476
1.3413	5.7	1.02248	8.509	0.485
1.3414	5.8	1.02289	8.512	0.494
1.3416	5.9	1.02329	8.515	0.502
1.3417	6.0	1.02369	8.519	0.511
1.3419	6.1	1.02409	8.522	0.520
1.3420	6.2	1.02450	8.526	0.529
1.3422	6.3	1.02490	8.529	0.537

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.3423	6.4	1.02530	8.532	0.546
1.3425	6.5	1.02571	8.536	0.555
1.3426	6.6	1.02611	8.539	0.564
1.3428	6.7	1.02652	8.542	0.572
1.3429	6.8	1.02692	8.546	0.581
1.3431	6.9	1.02733	8.549	0.590
1.3432	7.0	1.02773	8.552	0.599
1.3434	7.1	1.02814	8.556	0.607
1.3435	7.2	1.02854	8.559	0.616
1.3437	7.3	1.02895	8.563	0.625
1.3438	7.4	1.02936	8.566	0.634
1.3440	7.5	1.02976	8.569	0.643
1.3441	7.6	1.03017	8.573	0.652
1.3443	7.7	1.03058	8.576	0.660
1.3444	7.8	1.03098	8.580	0.669
1.3446	7.9	1.03139	8.583	0.678
1.3447	8.0	1.03180	8.586	0.687
1.3449	8.1	1.03221	8.590	0.696
1.3450	8.2	1.03262	8.593	0.705
1.3452	8.3	1.03303	8.597	0.714
1.3454	8.4	1.03344	8.600	0.722
1.3455	8.5	1.03385	8.603	0.731
1.3457	8.6	1.03426	8.607	0.740
1.3459	8.7	1.03467	8.610	0.749
1.3460	8.8	1.03508	8.614	0.758
1.3461	8.9	1.03549	8.617	0.767
1.3463	9.0	1.03590	8.620	0.776
1.3464	9.1	1.03631	8.624	0.785
1.3466	9.2	1.03672	8.627	0.794
1.3467	9.3	1.03713	8.631	0.803
1.3469	9.4	1.03755	8.634	0.812
1.3470	9.5	1.03796	8.638	0.821

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.3472	9.6	1.03837	8.641	0.830
1.3473	9.7	1.03879	8.644	0.838
1.3475	9.8	1.03920	8.648	0.848
1.3476	9.9	1.03961	8.651	0.856
1.3478	10.0	1.04003	8.655	0.866
1.3480	10.1	1.04044	8.658	0.874
1.3481	10.2	1.04086	8.662	0.884
1.3483	10.3	1.04127	8.665	0.892
1.3484	10.4	1.04169	8.669	0.902
1.3486	10.5	1.04210	8.672	0.911
1.3487	10.6	1.04252	8.675	0.920
1.3489	10.7	1.04293	8.679	0.929
1.3490	10.8	1.04335	8.682	0.938
1.3492	10.9	1.04377	8.686	0.947
1.3493	11.0	1.04418	8.689	0.956
1.3495	11.1	1.04460	8.693	0.965
1.3497	11.2	1.04502	8.696	0.974
1.3498	11.3	1.04544	8.700	0.983
1.3500	11.4	1.04585	8.703	0.992
1.3501	11.5	1.04627	8.707	1.001
1.3503	11.6	1.04669	8.710	1.010
1.3504	11.7	1.04711	8.714	1.020
1.3506	11.8	1.04753	8.717	1.029
1.3507	11.9	1.04795	8.721	1.038
1.3509	12.0	1.04837	8.724	1.047
1.3511	12.1	1.04879	8.728	1.056
1.3512	12.2	1.04921	8.731	1.065
1.3514	12.3	1.04963	8.735	1.074
1.3515	12.4	1.05005	8.738	1.084
1.3517	12.5	1.05047	8.742	1.093
1.3518	12.6	1.05090	8.745	1.102
1.3520	12.7	1.05132	8.749	1.111

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.3522	12.8	1.05174	8.752	1.120
1.3523	12.9	1.05216	8.756	1.130
1.3525	13.0	1.05259	8.759	1.139
1.3626	13.1	1.05301	8.763	1.148
1.3528	13.2	1.05343	8.766	1.157
1.3529	13.3	1.05386	8.770	1.166
1.3531	13.4	1.05428	8.773	1.176
1.3533	13.5	1.05470	8.777	1.185
1.3534	13.6	1.05513	8.781	1.194
1.3536	13.7	1.05556	8.784	1.203
1.3537	13.8	1.05598	8.788	1.213
1.3539	13.9	1.05641	8.791	1.222
1.3541	14.0	1.05683	8.795	1.231
1.3542	14.1	1.05726	8.798	1.241
1.3544	14.2	1.05769	8.802	1.250
1.3545	14.3	1.05811	8.805	1.259
1.3547	14.4	1.05854	8.809	1.268
1.3548	14.5	1.05897	8.812	1.278
1.3550	14.6	1.05940	8.816	1.287
1.3552	14.7	1.05982	8.820	1.297
1.3553	14.8	1.06025	8.823	1.306
1.3555	14.9	1.06068	8.827	1.315
1.3556	15.0	1.06111	8.830	1.325
1.3558	15.1	1.06154	8.834	1.334
1.3560	15.2	1.06197	8.837	1.343
1.3561	15.3	1.06240	8.841	1.353
1.3563	15.4	1.06283	8.845	1.362
1.3564	15.5	1.06326	8.848	1.371
1.3566	15.6	1.06369	8.852	1.381
1.3567	15.7	1.06412	8.855	1.390
1.3569	15.8	1.06455	8.859	1.400
1.3571	15.9	1.06499	8.863	1.409

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.3573	16.0	1.06542	8.866	1.419
1.3574	16.1	1.06585	8.870	1.428
1.3576	16.2	1.06629	8.873	1.437
1.3577	16.3	1.06672	8.877	1.447
1.3579	16.4	1.06715	8.881	1.456
1.3581	16.5	1.06759	8.884	1.466
1.3582	16.6	1.06802	8.888	1.475
1.3584	16.7	1.06845	8.891	1.485
1.3586	16.8	1.06889	8.895	1.494
1.3587	16.9	1.06933	8.899	1.504
1.3589	17.0	1.06976	8.902	1.513
1.3591	17.1	1.07020	8.906	1.523
1.3592	17.2	1.07063	8.909	1.532
1.3594	17.3	1.07107	8.913	1.542
1.3595	17.4	1.07151	8.917	1.552
1.3597	17.5	1.07194	8.920	1.561
1.3598	17.6	1.07238	8.924	1.571
1.3600	17.7	1.07282	8.928	1.580
1.3602	17.8	1.07325	8.931	1.590
1.3603	17.9	1.07369	8.935	1.599
1.3605	18.0	1.07413	8.939	1.609
1.3607	18.1	1.07457	8.942	1.619
1.3608	18.2	1.07501	8.946	1.628
1.3610	18.3	1.07545	8.950	1.638
1.3612	18.4	1.07589	8.953	1.647
1.3613	18.5	1.07633	8.957	1.657
1.3615	18.6	1.07677	8.961	1.667
1.3617	18.7	1.07721	8.964	1.676
1.3618	18.8	1.07765	8.968	1.686
1.3620	18.9	1.07809	8.972	1.696
1.3621	19.0	1.07853	8.975	1.705
1.3623	19.1	1.07898	8.979	1.715

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.3625	19.2	1.07942	8.983	1.725
1.3626	19.3	1.07986	8.986	1.734
1.3628	19.4	1.08030	8.990	1.744
1.3630	19.5	1.08075	8.994	1.754
1.3631	19.6	1.08119	8.997	1.763
1.3633	19.7	1.08164	9.001	1.773
1.3635	19.8	1.08208	9.005	1.783
1.3636	19.9	1.08252	9.008	1.792
1.3638	20.0	1.08297	9.012	1.802
1.3640	20.1	1.08342	9.016	1.812
1.3641	20.2	1.08386	9.020	1.822
1.3643	20.3	1.08431	9.023	1.832
1.3645	20.4	1.08475	9.027	1.842
1.3646	20.5	1.08520	9.031	1.851
1.3648	20.6	1.08565	9.034	1.861
1.3650	20.7	1.08609	9.038	1.871
1.3651	20.8	1.08654	9.042	1.881
1.3653	20.9	1.08699	9.046	1.891
1.3655	21.0	1.08744	9.049	1.900
1.3656	21.1	1.08789	9.053	1.910
1.3658	21.2	1.08834	9.057	1.920
1.3660	21.3	1.08879	9.061	1.930
1.3661	21.4	1.08923	9.064	1.940
1.3663	21.5	1.08968	9.068	1.950
1.3665	21.6	1.09013	9.072	1.960
1.3667	21.7	1.09058	9.076	1.969
1.3668	21.8	1.09103	9.079	1.979
1.3670	21.9	1.09149	9.083	1.989
1.3672	22.0	1.09194	9.087	1.999
1.3673	22.1	1.09239	9.091	2.009
1.3675	22.2	1.09284	9.094	2.019
1.3677	22.3	1.09329	9.098	2.029

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.3678	22.4	1.09375	9.102	2.039
1.3680	22.5	1.09420	9.106	2.049
1.3682	22.6	1.09465	9.109	2.059
1.3683	22.7	1.09511	9.113	2.069
1.3685	22.8	1.09556	9.117	2.079
1.3687	22.9	1.09602	9.121	2.089
1.3688	23.0	1.09647	9.125	2.099
1.3690	23.1	1.09693	9.128	2.109
1.3692	23.2	1.09738	9.132	2.119
1.3694	23.3	1.09784	9.136	2.129
1.3695	23.4	1.09829	9.140	2.139
1.3697	23.5	1.09875	9.143	2.149
1.3699	23.6	1.09921	9.147	2.159
1.3700	23.7	1.09966	9.151	2.169
1.3702	23.8	1.10012	9.155	2.179
1.3704	23.9	1.10058	9.159	2.189
1.3706	24.0	1.10104	9.163	2.199
1.3707	24.1	1.10149	9.166	2.209
1.3709	24.2	1.10195	9.170	2.219
1.3711	24.3	1.10241	9.174	2.229
1.3712	24.4	1.10287	9.178	2.239
1.3714	24.5	1.10333	9.182	2.250
1.3716	24.6	1.10370	9.185	2.260
1.3718	24.7	1.10425	9.189	2.270
1.3719	24.8	1.10471	9.193	2.280
1.3721	24.9	1.10517	9.197	2.290
1.3723	25.0	1.10564	9.201	2.300
1.3724	25.1	1.10610	9.205	2.310
1.3726	25.2	1.01656	9.208	2.320
1.3728	25.3	1.10702	9.212	2.331
1.3729	25.4	1.10748	9.216	2.341
1.3731	25.5	1.10795	9.220	2.351

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.3733	25.6	1.10841	9.224	2.361
1.3735	25.7	1.10887	9.228	2.372
1.3736	25.8	1.10934	9.232	2.382
1.3738	25.9	1.10980	9.235	2.392
1.3740	26.0	1.11027	9.239	2.402
1.3741	26.1	1.11073	9.243	2.412
1.3743	26.2	1.11120	9.247	2.423
1.3745	26.3	1.11166	9.251	2.433
1.3747	26.4	1.11213	9.255	2.443
1.3748	26.5	1.11260	9.259	2.454
1.3750	26.6	1.11306	9.263	2.464
1.3752	26.7	1.11353	9.266	2.474
1.3753	26.8	1.11400	9.270	2.484
1.3755	26.9	1.11447	9.274	2.495
1.3757	27.0	1.11493	9.278	2.505
1.3759	27.1	1.11540	9.282	2.515
1.3761	27.2	1.11587	9.286	2.526
1.3762	27.3	1.11634	9.290	2.536
1.3764	27.4	1.11681	9.294	2.547
1.3766	27.5	1.11728	9.298	2.557
1.3768	27.6	1.11775	9.302	2.567
1.3769	27.7	1.11822	9.305	2.578
1.3771	27.8	1.11869	9.309	2.588
1.3773	27.9	1.11916	9.313	2.598
1.3775	28.0	1.11963	9.317	2.609
1.3777	28.1	1.12010	9.321	2.619
1.3778	28.2	1.12058	9.325	2.630
1.3780	28.3	1.12105	9.329	2.640
1.3782	28.4	1.12152	9.333	2.651
1.3784	28.5	1.12199	9.337	2.661
1.3785	28.6	1.12247	9.341	2.672
1.3787	28.7	1.12294	9.345	2.682

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.3789	28.8	1.12342	9.349	2.693
1.3791	28.9	1.12389	9.353	2.702
1.3792	29.0	1.12436	9.357	2.714
1.3794	29.1	1.12484	9.361	2.724
1.3796	29.2	1.12532	9.365	2.735
1.3798	29.3	1.12579	9.369	2.745
1.3800	29.4	1.12627	9.372	2.755
1.3801	29.5	1.12674	9.376	2.766
1.3803	29.6	1.12722	9.380	2.776
1.3805	29.7	1.12770	9.384	2.787
1.3807	29.8	1.12817	9.388	2.798
1.3809	29.9	1.12865	9.392	2.808
1.3810	30.0	1.12913	9.396	2.819
1.3812	30.1	1.12961	9.400	2.829
1.3814	30.2	1.13009	9.404	2.840
1.3816	30.3	1.13057	9.408	2.851
1.3818	30.4	1.13105	9.412	2.861
1.3820	30.5	1.13153	9.416	2.872
1.3821	30.6	1.13201	9.420	2.883
1.3823	30.7	1.13249	9.424	2.893
1.3825	30.8	1.13297	9.428	2.904
1.3827	30.9	1.13345	9.432	2.914
1.3829	31.0	1.13394	9.436	2.925
1.3830	31.1	1.13442	9.440	2.936
1.3832	31.2	1.13490	9.444	2.947
1.3834	31.3	1.13538	9.448	2.957
1.3836	31.4	1.13587	9.452	2.968
1.3838	31.5	1.13635	9.456	2.979
1.3839	31.6	1.13683	9.460	2.990
1.3841	31.7	1.13732	9.464	3.000
1.3843	31.8	1.13780	9.468	3.011
1.3845	31.9	1.13829	9.472	3.022

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.3847	32.0	1.13877	9.477	3.033
1.3848	32.1	1.13926	9.481	3.043
1.3850	32.2	1.13974	9.485	3.054
1.3852	32.3	1.14023	9.489	3.065
1.3854	32.4	1.14072	9.493	3.076
1.3856	32.5	1.14120	9.497	3.087
1.3858	32.6	1.14169	9.501	3.097
1.3860	32.7	1.14218	9.505	3.108
1.3861	32.8	1.14267	9.509	3.119
1.3863	32.9	1.14316	9.513	3.130
1.3865	33.0	1.14364	9.517	3.141
1.3867	33.1	1.14413	9.521	3.151
1.3869	33.2	1.14462	9.525	3.162
1.3871	33.3	1.14511	9.529	3.173
1.3872	33.4	1.14560	9.533	3.184
1.3874	33.5	1.14609	9.537	3.195
1.3876	33.6	1.14658	9.541	3.206
1.3878	33.7	1.14708	9.546	3.217
1.3879	33.8	1.14757	9.550	3.228
1.3881	33.9	1.14806	9.554	3.239
1.3883	34.0	1.14855	9.558	3.250
1.3885	34.1	1.14904	9.562	3.261
1.3887	34.2	1.14954	9.566	3.272
1.3889	34.3	1.15003	9.570	3.283
1.3891	34.4	1.15052	9.574	3.293
1.3893	34.5	1.15102	9.578	3.304
1.3894	34.6	1.15151	9.583	3.316
1.3896	34.7	1.15201	9.587	3.327
1.3898	34.8	1.15250	9.591	3.338
1.3900	34.9	1.15300	9.595	3.349
1.3902	35.0	1.15350	9.599	3.360
1.3904	35.1	1.15399	9.603	3.371

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.3906	35.2	1.15449	9.607	3.382
1.3908	35.3	1.15498	9.611	3.393
1.3909	35.4	1.15548	9.616	3.404
1.3911	35.5	1.15598	9.620	3.415
1.3913	35.6	1.15648	9.624	3.426
1.3915	35.7	1.15698	9.628	3.437
1.3916	35.8	1.15747	9.632	3.448
1.3918	35.9	1.15797	9.636	3.459
1.3920	36.0	1.15847	9.640	3.470
1.3922	36.1	1.15897	9.645	3.482
1.3924	36.2	1.15947	9.649	3.493
1.3926	36.3	1.15997	9.653	3.504
1.3928	36.4	1.16047	9.657	3.515
1.3930	36.5	1.16098	9.661	3.526
1.3931	36.6	1.16148	9.665	3.537
1.3933	36.7	1.16198	9.670	3.549
1.3935	36.8	1.16248	9.674	3.560
1.3937	36.9	1.16298	9.678	3.571
1.3939	37.0	1.16349	9.682	3.582
1.3941	37.1	1.16399	9.686	3.594
1.3943	37.2	1.16449	9.691	3.605
1.3945	37.3	1.16500	9.695	3.616
1.3947	37.4	1.16550	9.699	3.627
1.3949	37.5	1.16601	9.703	3.639
1.3950	37.6	1.16652	9.707	3.650
1.3952	37.7	1.16702	9.712	3.661
1.3954	37.8	1.16752	9.716	3.673
1.3956	37.9	1.16803	9.720	3.684
1.3958	38.0	1.16853	9.724	3.695
1.3960	38.1	1.16904	9.728	3.706
1.3962	38.2	1.16955	9.733	3.718
1.3964	38.3	1.17006	9.737	3.729

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.3966	38.4	1.17056	9.741	3.741
1.3968	38.5	1.17107	9.745	3.752
1.3970	38.6	1.17158	9.749	3.763
1.3972	38.7	1.17209	9.754	3.775
1.3794	38.8	1.17260	9.758	3.786
1.3976	38.9	1.17311	9.762	3.797
1.3978	39.0	1.17362	9.766	3.809
1.3980	39.1	1.17413	9.771	3.820
1.3982	39.2	1.17464	9.775	3.832
1.3984	39.3	1.17515	9.779	3.843
1.3986	39.4	1.17566	9.783	3.855
1.3988	39.5	1.17618	9.788	3.866
1.3989	39.6	1.17669	9.792	3.878
1.3991	39.7	1.17720	9.796	3.889
1.3993	39.8	1.17772	9.801	3.901
1.3995	39.9	1.17823	9.805	3.912
1.3997	40.0	1.17874	9.809	3.924
1.3999	40.1	1.17926	9.813	3.935
1.4001	40.2	1.17977	9.818	3.947
1.4003	40.3	1.18029	9.822	3.958
1.4005	40.4	1.18080	9.826	3.970
1.4007	40.5	1.18132	9.831	3.982
1.4008	40.6	1.18183	9.835	3.993
1.4010	40.7	1.18235	9.839	4.004
1.4012	40.8	1.18287	9.843	4.016
1.4014	40.9	1.18339	9.848	4.028
1.4016	41.0	1.18390	9.852	4.039
1.4018	41.1	1.18442	9.856	4.051
1.4020	41.2	1.18494	9.861	4.063
1.4022	41.3	1.18546	9.865	4.074
1.4024	41.4	1.18598	9.869	4.086
1.4026	41.5	1.18650	9.874	4.098

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.4028	41.6	1.18702	9.878	4.109
1.4030	41.7	1.18754	9.882	4.121
1.4032	41.8	1.18806	9.887	4.133
1.4034	41.9	1.18858	9.891	4.144
1.4036	42.0	1.18910	9.895	4.156
1.4038	42.1	1.18962	9.900	4.167
1.4040	42.2	1.19014	9.904	4.179
1.4042	42.3	1.19062	9.908	4.191
1.4044	42.4	1.19119	9.913	4.203
1.4046	42.5	1.19171	9.917	4.215
1.4048	42.6	1.19224	9.921	4.226
1.4050	42.7	1.19276	9.926	4.238
1.4052	42.8	1.19329	9.930	4.250
1.4054	42.9	1.19381	9.935	4.262
1.4056	43.0	1.19434	9.939	4.274
1.4058	43.1	1.19486	9.943	4.285
1.4060	43.2	1.19539	9.948	4.298
1.4062	43.3	1.19591	9.952	4.309
1.4064	43.4	1.19644	9.956	4.321
1.4066	43.5	1.19697	9.961	4.333
1.4068	43.6	1.19749	9.965	4.345
1.4070	43.7	1.19802	9.970	4.357
1.4072	43.8	1.19855	9.974	4.369
1.4074	43.9	1.19908	9.978	4.380
1.4076	44.0	1.19961	9.983	4.393
1.4078	44.1	1.20013	9.987	4.404
1.4080	44.2	1.20066	9.992	4.416
1.4082	44.3	1.20119	9.996	4.428
1.4084	44.4	1.20172	10.000	4.440
1.4086	44.5	1.20226	10.005	4.452
1.4088	44.6	1.20279	10.009	4.464
1.4090	44.7	1.20332	10.014	4.476

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.4092	44 .8	1.20385	10.018	4.488
1.4094	44.9	1.20438	10.022	4.500
1.4096	45.0	1.20491	10.027	4.512
1.4098	45.1	1.20545	10.031	4.524
1.4100	45.2	1.20598	10.036	4.536
1.4102	45 .3	1.20651	10.040	4.548
1.4104	45.4	1.20705	10.045	4.560
1.4107	45.5	1.20758	10.049	4.572
1.4109	45.6	1.20812	10.054	4.585
1.4111	45.7	1.20865	10.058	4.597
1.4113	45.8	1.20919	10.063	4.609
1.4115	45.9	1.20972	10.067	4.621
1.4117	46.0	1.21026	10.071	4.633
1.4119	46.1	1.21080	10.076	4.645
1.4121	46.2	1.21133	10.080	4.657
1.4123	46.3	1.21187	10.085	4.669
1.4125	46.4	1.21241	10.089	4.681
1.4127	46.5	1.21295	10.094	4.694
1.4129	46.6	1.21349	10.098	4.706
1.4131	46.7	1.21402	10.103	4.718
1.4133	46.8	1.21456	10.107	4.730
1.4135	46.9	1.21510	10.112	4.743
1.4137	47.0	1.21564	10.116	4.755
1.4139	47.1	1.21618	10.121	4.767
1.4141	47.2	1.21673	10.125	4.779
1.4143	47.3	1.21727	10.130	4.791
1.4145	47.4	1.21781	10.134	4.804
1.4148	47.5	1.21835	10.139	4.816
1.4150	47.6	1.21889	10.143	4.828
1.4152	47.7	1.21943	10.148	4.841
1.4154	47.8	1.21998	10.152	4.853
1.4156	47.9	1.22052	10.157	4.865

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.4158	48.0	1.22106	10.161	4.877
1.4160	48.1	1.22161	10.166	4.890
1.4162	48.2	1.22215	10.170	4.902
1.4164	48.3	1.22270	10.175	4.915
1.4166	48.4	1.22324	10.179	4.927
1.4169	48.5	1.22379	10.184	4.939
1.4171	48.6	1.22434	10.189	4.952
1.4173	48.7	1.22488	10.193	4.964
1.4175	48.8	1.22543	10.198	4.977
1.4177	48.9	1.22598	10.202	4.989
1.4179	49.0	1.22652	10.207	5.001
1.4181	49.1	1.22707	10.211	5.014
1.4183	49.2	1.22762	10.216	5.026
1.4185	49.3	1.22817	10.220	5.039
1.4187	49.4	1.22872	10.225	5.051
1.4190	49.5	1.22927	10.230	5.064
1.4192	49.6	1.22982	10.234	5.076
1.4194	49.7	1.23037	10.239	5.089
1.4196	49.8	1.23092	10.243	5.101
1.4199	49.9	1.23147	10.248	5.114
1.4201	50.0	1.23202	10.252	5.126
1.4203	50.1	1.23257	10.257	5.139
1.4205	50.2	1.23313	10.262	5.152
1.4207	50.3	1.23368	10.266	5.164
1.4209	50.4	1.23423	10.271	5.177
1.4212	50.5	1.23478	10.275	5.189
1.4214	50.6	1.23534	10.280	5.202
1.4216	50.7	1.23589	10.285	5.214
1.4218	50.8	1.23645	10.289	5.227
1.4220	50.9	1.23700	10.294	5.240
1.4222	51.0	1.23756	10.299	5.252
1.4224	51.1	1.23811	10 .303	5.265

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.4226	51.2	1.23867	10.308	5.278
1.4228	51.3	1.23922	10.312	5.290
1.4230	51.4	1.23978	10.317	5.303
1.4233	51.5	1.24034	10.322	5.316
1.4235	51.6	1.24089	10.326	5.328
1.4237	51.7	1.24145	10.331	5.341
1.4239	51.8	1.24201	10.336	5.354
1.4241	51.9	1.24257	10.340	5.366
1.4243	52.0	1.24313	10.345	5.379
1.4245	52.1	1.24369	10.350	5.392
1.4248	52.2	1.24425	10.354	5.405
1.4250	52.3	1.24481	10.359	5.418
1.4252	52.4	1.24537	10.364	5.431
1.4254	52.5	1.24593	10.368	5.443
1.4256	52.6	1.24649	10.373	5.456
1.4258	52.7	1.24705	10.378	5.469
1.4260	52.8	1.24761	10.382	5.482
1.4262	52.9	1.24818	10.387	5.495
1.4265	53.0	1.24874	10.392	5.508
1.4267	53.1	1.24930	10.396	5.520
1.4269	53.2	1.24987	10.401	5.533
1.4271	53.3	1.25043	10.406	5.546
1.4273	53.4	1.25099	10.410	5.559
1.4275	53.5	1.25156	10.415	5.572
1.4278	53.6	1.25212	10.420	5.585
1.4280	53.7	1.25269	10.425	5.598
1.4282	53.8	1.25325	10.429	5.611
1.4284	53.9	1.25382	10.434	5.624
1.4286	54.0	1.25439	10.439	5.637
1.4288	54.1	1.25495	10.443	5.650
1.4291	54.2	1.25552	10.448	5.663
1.4293	54.3	1.25609	10.453	5.676

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.4295	54.4	1.25666	10.458	5.689
1.4297	54.5	1.25723	10.462	5.702
1.4299	54.6	1.25780	10.467	5.715
1.4301	54.7	1.25836	10.472	5.728
1.4304	54.8	1.25893	10.476	5.741
1.4306	54.9	1.25950	10.481	5.754
1.4308	55.0	1.26007	10.486	5.767
1.4310	55.1	1.26064	10.491	5.781
1.4312	55.2	1.26122	10.495	5.793
1.4315	55.3	1.26179	10.500	5.807
1.4317	55.4	1.26236	10.505	5.820
1.4319	55.5	1.26293	10.510	5.833
1.4321	55.6	1.26350	10.515	5.846
1.4323	55.7	1.26408	10.519	5.859
1.4326	55.8	1.26465	10.524	5.872
1.4328	55.9	1.26522	10.529	5.886
1.4330	56.0	1.26580	10.534	5.899
1.4332	56.1	1.26637	10.538	5.912
1.4334	56.2	1.26695	10.543	5.925
1.4337	56.3	1.26752	10.548	5.939
1.4339	56.4	1.26810	10.553	5.952
1.4341	56.5	1.26868	10.558	5.965
1.4343	56.6	1.26925	10.562	5.978
1.4345	56.7	1.26983	10.567	5.991
1.4348	56.8	1.27041	10.572	6.005
1.4350	56.9	1.27098	10.577	6.018
1.4352	57.0	1.27156	10.581	6.031
1.4354	57.1	1.27214	10.586	6.045
1.4356	57.2	1.27272	10.591	6.058
1.4359	57.3	1.27330	10.596	6.072
1.4361	57.4	1.27388	10.601	6.085
1.4363	57.5	1.27446	10.606	6.098

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.4365	57 .6	1.27504	10.610	6.111
1.4368	57.7	1.27562	10.615	6.125
1.4370	57.8	1.27620	10.620	6.138
1.4372	57.9	1.27678	10.625	6.152
1.4374	58.0	1.27736	10.630	6.165
1.4376	58.1	1.27794	10.635	6.179
1.4379	58.2	1.27853	10.640	6.192
1.4381	58.3	1.27911	10.644	6.205
1.4383	58.4	1.27969	10.649	6.219
1.4385	58.5	1.28028	10.654	6.233
1.4388	58.6	1.28086	10.659	6.246
1.4390	58.7	1.28145	10.664	6.260
1.4392	58.8	1.28203	10.669	6.273
1.4394	58.9	1.28262	10.674	6.287
1.4397	59.0	1.28320	10.678	6.300
1.4399	59.1	1.28379	10.683	6.314
1.4401	59.2	1.28437	10.688	6.327
1.4403	59.3	1.28497	10.693	6.341
1.4406	59.4	1.28555	10.698	6.355
1.4408	59.5	1.28614	10.703	6.368
1.4410	59.6	1.28672	10.708	6.382
1.4412	59.7	1.28731	10.713	6.396
1.4415	59.8	1.28789	10.718	6.409
1.4417	59 .9	1.28849	10.722	6.422
1.4419	60.0	1.28908	10.727	6.436
1.4422	60.1	1.28966	10.732	6.450
1.4424	60.2	1.29025	10.737	6.464
1.4426	60.3	1.29084	10.742	6.477
1.4428	60.4	1.29143	10.747	6.491
1.4431	60.5	1.29023	10.752	6.505
1.4433	60.6	1.29262	10.757	6.519
1.4435	60.7	1.29321	10.762	6.533

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.4437	60.8	1.29380	10.767	6.546
1.4440	60.9	1.29439	10.772	6.560
1.4442	61.0	1.29498	10.777	6.574
1.4444	61.1	1.29559	10.781	6.587
1.4447	61.2	1.29618	10.786	6.601
1.4449	61.3	1.29677	10.791	6.615
1.4451	61.4	1.29736	10.796	6.629
1.4453	61.5	1.29796	10.801	6.643
1.4456	61.6	1.29855	10.806	6.656
1.4458	61.7	1.29915	10.811	6.670
1.4460	61.8	1.29975	10.816	6.684
1.4463	61.9	1.30034	10.821	6.698
1.4465	62.0	1.30093	10.826	6.712
1.4467	62.1	1.30153	10.831	6.726
1.4470	62.2	1.30212	10.836	6.740
1.4472	62.3	1.30273	10.841	6.754
1.4474	62.4	1.30334	10.846	6.768
1.4476	62.5	1.30393	10.851	6.782
1.4479	62.6	1.30453	10.856	6.796
1.4481	62.7	1.30513	10.861	6.810
1.4483	62.8	1.30573	10.866	6.824
1.4486	62.9	1.30633	10.871	6.838
1.4488	63.0	1.30694	10.876	6.852
1.4490	63.1	1.30754	10.881	6.866
1.4493	63.2	1.30815	10.886	6.880
1.4495	63.3	1.30875	10.891	6.894
1.4497	63.4	1.30936	10.896	6.908
1.4500	63.5	1.30994	10.901	6.922
1.4502	63.6	1.31055	10.906	6.936
1.4504	63.7	1.31117	10.911	6.950
1.4507	63.8	1.31177	10.916	6.964
1.4509	63.9	1.31237	10.921	6.978

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.4511	64.0	1.31297	10.926	6.993
1.4514	64.1	1.31359	10.931	7.007
1.4516	64.2	1.31418	10.936	7.021
1.4518	64.3	1.31479	10.941	7.035
1.4521	64.4	1.31540	10.946	7.049
1.4523	64.5	1.31600	10.951	7.063
1.4525	64.6	1.31661	10.956	7.078
1.4528	64.7	1.31723	10.961	7.092
1.4530	64.8	1.31784	10.967	7.107
1.4532	64.9	1.31845	10.972	7.121
1.4535	65.0	1.31905	10.977	7.135
1.4537	65.1	1.31966	10.982	7.149
1.4539	65.2	1.32028	10.987	7.164
1.4542	65.3	1.32089	10.992	7.178
1.4544	65.4	1.32150	10.997	7.192
1.4546	65.5	1.32210	11.002	7.206
1.4549	65.6	1.32271	11.007	7.221
1.4551	65.7	1.32332	11.012	7.235
1.4553	65.8	1.32393	11.017	7.249
1.4556	65.9	1.32455	11.022	7.263
1.4558	66.0	1.32516	11.027	7.278
1.4561	66.1	1.32577	11.033	7.293
1.4563	66.2	1.32638	11.038	7.307
1.4565	66.3	1.32699	11.043	7.322
1.4568	66.4	1.32759	11.048	7.336
1.4570	66.5	1.32820	11.053	7.350
1.4572	66.6	1.32884	11.058	7.365
1.4575	66.7	1.32945	11.063	7.379
1.4577	66.8	1.33007	11.068	7.393
1.4580	66.9	1.33068	11.073	7.408
1.4582	67.0	1.33129	11.079	7.423
1.4584	67.1	1.33192	11.084	7.437

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.4587	67.2	1.33254	11.089	7.452
1.4589	67.3	1.33315	11.094	7.466
1.4591	67.4	1.33377	11.099	7.481
1.4594	67.5	1.33438	11.104	7.495
1.4596	67.6	1.33500	11.110	7.510
1.4599	67.7	1.33562	11.115	7.525
1.4601	67.8	1.33625	11.120	7.539
1.4603	67.9	1.33686	11.125	7.554
1.4606	68.0	1.33748	11.130	7.568
1.4608	68.1	1.33810	11.135	7.583
1.4611	68.2	1.33872	11.140	7.597
1.4613	68.3	1.33935	11.146	7.613
1.4615	68.4	1.33997	11.151	7.627
1.4618	68.5	1.34059	11.156	7.642
1.4620	68.6	1.34121	11.161	7.656
1.4623	68.7	1.34183	11.166	7.671
1.4625	68.8	1.34245	11.172	7.686
1.4628	68.9	1.34309	11.177	7.701
1.4630	69.0	1.34371	11.182	7.716
1.4632	69.1	1.34433	11.187	7.730
1.4635	69.2	1.34495	11.192	7.745
1.4637	69.3	1.34558	11.198	7.760
1.4640	69.4	1.34621	11.203	7.775
1.4642	69.5	1.34684	11.208	7.790
1.4644	69.6	1.34746	11.213	7.804
1.4647	69.7	1.34809	11.218	7.819
1.4649	69.8	1.34871	11.224	7.834
1.4652	69.9	1.34934	11.229	7.849
1.4654	70.0	1.34997	11.234	7.864
1.4657	70.1	1.35060	11.239	7.879
1.4659	70.2	1.35123	11.245	7.894
1.4661	70.3	1.35186	11.250	7.909

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.4664	70.4	1.35248	11.255	7.924
1.4666	70.5	1.35311	11.260	7.938
1.4669	70.6	1.35375	11.265	7.953
1.4671	70.7	1.35438	11.271	7.969
1.4674	70.8	1.35501	11.276	7.983
1.4676	70.9	1.35564	11.281	7.998
1.4679	71.0	1.35627	11.286	8.013
1.4681	71.1	1.35691	11.292	8.029
1.4684	71.2	1.35754	11.297	8.043
1.4686	71.3	1.35817	11.302	8.058
1.4688	71.4	1.35881	11.308	8.074
1.4691	71.5	1.35944	11.313	8.089
1.4693	71.6	1.36008	11.318	8.104
1.4696	71.7	1.36072	11.323	8.119
1.4698	71.8	1.36135	11.329	8.134
1.4701	71.9	1.36198	11.334	8.149
1.4703	72.0	1.36261	11.339	8.164
1.4706	72.1	1.36324	11.345	8.180
1.4708	72.2	1.36389	11.350	8.195
1.4711	72.3	1.36452	11.355	8.210
1.4713	72.4	1.36516	11.360	8.225
1.4716	72.5	1.36579	11.366	8.240
1.4718	72.6	1.36643	11.371	8.255
1.4721	72.7	1.36707	11.376	8.270
1.4723	72.8	1.36771	11.382	8.286
1.4725	72.9	1.36836	11.387	8.301
1.4728	73.0	1.36900	11.392	8.316
1.4730	73.1	1.36964	11.398	8.332
1.4733	73.2	1.37028	11.403	8.347
1.4735	73.3	1.37092	11.408	8.362
1.4738	73.4	1.37156	11.414	8.378
1.4740	73.5	1.37220	11.419	8.393

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.4743	73.6	1.37283	11.424	8.408
1.4745	73.7	1.37347	11.430	8.424
1.4748	73.8	1.37411	11.435	8.439
1.4750	73.9	1.37476	11.440	8.454
1.4753	74.0	1.37541	11.446	8.470
1.4756	74.1	1.37605	11.451	8.485
1.4758	74.2	1.37669	11.456	8.500
1.4760	74.3	1.37733	11.462	8.516
1.4763	74.4	1.37798	11.467	8.531
1.4765	74.5	1.37864	11.473	8.547
1.4768	74.6	1.37928	11.478	8.563
1.4770	74.7	1.37993	11.483	8.578
1.4773	74.8	1.38057	11.489	8.594
1.4776	74.9	1.38122	11.494	8.609
1.4778	75.0	1.38187	11.499	8.624
1.4781	75.1	1.38252	11.505	8.640
1.4783	75.2	1.38316	11.510	8.656
1.4786	75.3	1.38381	11.516	8.672
1.4788	75.4	1.38445	11.521	8.687
1.4791	75.5	1.38510	11.526	8.703
1.4793	75.6	1.38575	11.532	8.718
1.4796	75.7	1.38640	11.537	8.734
1.4798	75.8	1.38705	11.543	8.750
1.4801	75.9	1.38770	11.548	8.765
1.4803	76.0	1.38835	11.554	8.781
1.4806	76.1	1.38902	11.559	8.796
1.4808	76.2	1.38967	11.564	8.812
1.4811	76.3	1.39032	11.570	8.828
1.4814	76.4	1.39097	11.575	8.843
1.4816	76.5	1.39162	11.581	8.859
1.4819	76.6	1.39228	11.586	8.875
1.4821	76.7	1.39293	11.592	8.891

Refractive Index at 20 Degrees C	Percent Sucrose or Degrees Brix	Apparent Specific Gravity @ 20/20 Degrees C	Weight/Gal. in air at 20 Degrees C	Pounds Solids per Gallon
1.4824	76.8	1.39358	11.597	8.906
1.4826	76.9	1.39423	11.602	8.922
1.4829	77.0	1.39489	11.608	8.938
1.4831	77.1	1.39554	11.613	8.954
1.4834	77.2	1.39619	11.619	8.970
1.4836	77.3	1.39685	11.624	8.985
1.4839	77.4	1.39750	11.630	9.002
1.4841	77.5	1.39816	11.635	9.017
1.4844	77.6	1.39882	11.641	9.033
1.4847	77.7	1.39949	11.646	9.049
1.4849	77.8	1.40014	11.652	9.065
1.4852	77.9	1.40080	11.657	9.081
1.4854	78.0	1.40146	11.663	9.097
1.4857	78.1	1.40211	11.668	9.113
1.4860	78.2	1.40277	11.673	9.128
1.4862	78.3	1.40344	11.679	9.145
1.4865	78.4	1.40409	11.684	9.160
1.4867	78.5	1.40475	11.690	9.177
1.4870	78.6	1.40541	11.695	9.192
1.4873	78.7	1.40607	11.701	9.209
1.4875	78.8	1.40674	11.706	9.224
1.4878	78.9	1.40740	11.712	9.241
1.4880	79.0	1.40806	11.717	9.256
1.4883	79.1	1.40872	11.723	9.273
1.4886	79.2	1.40938	11.728	9.289
1.4888	79.3	1.41005	11.734	9.305
1.4891	79.4	1.41072	11.740	9.322
1.4893	79.5	1.41138	11.745	9.337
1.4896	79.6	1.41204	11.751	9.354
1.4899	79.7	1.41270	11.756	9.370
1.4901	79.8	1.41337	11.762	9.386
1.4904	79.9	1.41404	11.767	9.402
1.4906	80.0	1.41471	11.773	9.418

CALIBRATION OF EQUIPMENT

Accurate results from equipment rely on standardized procedures and properly calibrated equipment. Equipment such as refractometers or thermometers should be calibrated before use instead of set intervals if usage is infrequent. Calibration logs have been established to record these readings and to document the calibration process. The calibration logs noted below are guides and may be used for photocopying and maintaining as documentation of inspectors' results.

Any equipment that cannot be calibrated within specified guidelines should be "tagged" and removed from usage. Equipment without serial numbers or some other means of identification should be labeled with a property decal.

Thermometers

Fresh Products

Refer to the Thermometer sections of the General Market Manual for guidelines regarding proper use and calibration of thermometers used in the inspection of fresh products.

Processed Products

Thermometers used for checking the temperatures of food products should be tested every week, or as often as each inspection if any potential abuse has ensued (such as carton penetration). The test is made by immersing the thermometer in an ice and water bath.

Fill an appropriate size beaker with ice and then water. Stir for 2 minutes and then immerse the thermometer for 2 minutes in the center of the mixture. Do not permit the thermometer bulb to rest against the side of the container. The thermometer may be held vertically by fitting it through a perforated piece of cardboard positioned across the top of the beaker. The thermometer should read within 1° ± of +32°F (0°C). Record results on the Thermometer Checks log in APPENDIX I.

There may be a need to test the thermometer at other temperatures. For calibration at temperatures from 0° to -5°F., use a brine mixture consisting of 1 part of salt and 3 parts chipped ice. Compare the thermometers being tested with a thermometer that is known to be accurate, i.e. traceable to the National Institute of Standards and Technologies (NIST). Insert both thermometers into the brine mixture with the stems next to each other. Do not permit either of the thermometer bulbs to rest against the side of the container. Wait 2 minutes and compare and record readings on the Thermometer Checks log in APPENDIX I.

Scales

Fresh Products

Refer to the Scales section of the General Market Manual for guidelines regarding proper use and calibration of scales used in the inspection of fresh products.

Processed Product

The scales used for checking net weights and drained weights should be calibrated weekly or more often as recommended by the owner's manual and the results recorded on the appropriate log. The scales used for analytical weighing are generally calibrated yearly by a service technician.

A. Gram Scales

a. Complete value readings with an NIST class weight, preferably 10 g and 100 g weights. Record results to the 0.0 g.

b. Tare scale to zero reading.

c. Add the 10 g weight.

d. Record reading; adjust as necessary per the owner's manual. Record on the Weekly Gram Scale Checks log in APPENDIX II.

e. Reweigh 10 g if necessary.

f. Add 100 g weight.

g. Record reading; adjust as necessary per the owner's manual. Record on the Weekly Gram Scale Checks log in APPENDIX II.

h. Reweigh 100 g if necessary.

i. Return to zero and recheck calibrations if adjustments were made.

B. Ounce Scales

Follow the above procedures using a NIST class weight, preferably 10-ounce and 80-ounce weights. Recording results to the 0.0 ounce. Record on the Weekly Ounce Scale Checks log in APPENDIX III.

Refractometer

Fresh Products

Refer to the General Market Manual for guidelines regarding general use of a refractometer when not specifically covered within an commodity grading manual for fresh product.

It is important that the refractometer be properly adjusted before use. Otherwise it will be impossible to make an accurate determination of the sugar content. It will be found most convenient to adjust the instrument to read zero with distilled water at the temperature at which the test will be made. As the temperature changes during the day it will be necessary to readjust the instrument. A small supply of distilled water should be kept on hand for this purpose, and precautions taken to keep it clean. Tap water should not be used because it frequently contains enough minerals in solution to materially affect the reading. Distilled water may be obtained from drug stores, grocery outlets, chemical supply houses, or laboratories.

The refractometer must be clean or the accuracy of the reading will be affected. It must be thoroughly cleaned (tap water should be used) after each use, as juice allowed to remain and dry on the instruments will materially affect the accuracy of the next test made. Care should be taken not to scratch the surface of the prism or the hinged plate.

Processed Products

The refractometer must be checked daily for compliance by using distilled water or a solution of known refractive index and the results recorded on the Refractometer Checks log in APPENDIX IV. However, calibration of the refractometer should be done with the test prism (if applicable) provided with the instrument.

A. Equipment

1. Test prism
2. Thin rod with well-rounded end
3. Soft lint-free cloth or lens paper
4. Solvent (isopropyl alcohol)
5. Monobromonaphthalene
6. Square-headed screwdriver supplied with refractometer
7. Distilled water

B. Standardizing the Refractometer

The refractometer should be checked for accuracy before use. It must be checked daily when in constant use, such as during in-plant inspection and the results recorded on the Refractometer Checks log in APPENDIX IV.

Frequent daily checks may be made with distilled water. The distilled water checks supplement less frequent checks with the test prism, and are performed as follows:

1. Clean and dry prisms carefully.

2. Apply one or two drops of distilled water to prisms.

3. Compare observed refractive index and prism temperature with the appropriate refractive index for the same temperature (see Refractive Index of Distilled Water

chart). If the refractive index reading differs ± 0.0003, repeat steps a and b until a total of three readings are obtained. If the refractive index of the last reading still differs from the table ± 0.0003, check the refractometer with the standard test prism. If the reading still differs plus or minus 0.0003, recalibrate the refractometer.

Caution: Recalibration of the refractometer should be done by an experienced SCI Division inspector or plant official. If the plant's quality control representative performs the calibration, the USDA inspector should observe to assure accuracy.

REFRACTIVE INDEX OF DISTILLED WATER

Temperature		Refractometer	Temperature		Refractometer
Degrees F	Degrees C	Reading	Degrees F	Degrees C	Reading
59.0	15	1.3334	71.6	22	1.3328
60.8	16	1.3334	73.4	23	1.3327
62.6	17	1.3333	75.2	24	1.3326
64.4	18	1.3332	77.0	25	1.3325
66.2	19	1.3331	78.8	26	1.3324
68.0	20	1.3330	82.4	28	1.3322
69.8	21	1.3329	86.0	30	1.3320

C. Checking for Accuracy

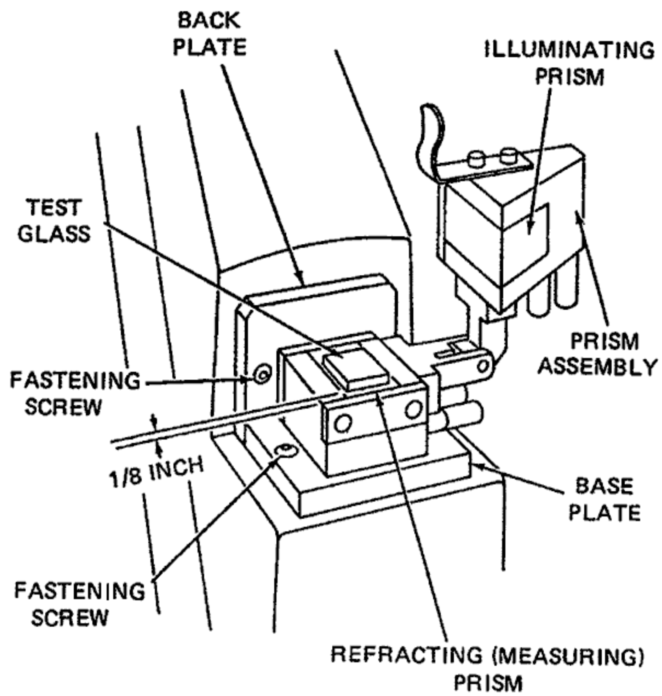
1. If feasible, adjust the refractometer prism temperature as close as possible to the standard temperature (20° C).

2. Clean the lower refractometer prism face with a solvent such as isopropyl alcohol, and dry with a soft lint-free cloth or lens paper, making sure no dust fibers adhere to the prism face.

3. Clean the test prism in the same manner as step b.

4. Using a thin rod with a well-rounded end, carefully place a drop of monobromonaphthalene on the large polished face of the test prism. <u>The drop should not be larger than 1 mm in diameter.</u>

5. Place the test prism longitudinally in the middle of the lower refractometer prism, with its large polished face downward, and small polished face outward toward the light source.



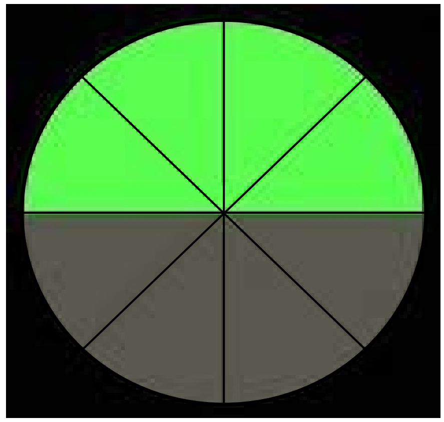
6. The correct quantity of monobromonaphthalene can be checked by pressing the test prism lightly against the refractometer prism face. If any of the solution leaks from under any of the test prism edges, the reading will be incorrect, and this procedure must be started again from step a. Perform the procedure again if any bubbles are trapped under the test prism, as this will also cause an incorrect reading.

7. When the test prism is correctly placed, position the light source so that it is directly in line with the small polished face of the test prism. A blue glass filter or tissue paper may be held in front of the light source so that the best contrast is obtained between the two halves of the field of vision.

8. Look through the refractometer eyepiece. Locate the shadow edge. Be sure that the line does not shift with motion of the light source. Any color fringe on the shadow edge can be eliminated by adjusting the chromatic compensator, also known as the dispersion correction wheel. This is a rotating drum located on the front of the refractometer housing beneath the eyepiece on the Abbe 3L Bausch and Lomb type (see illustration on page 25). Refer to the instruction manual if you are unsure how to adjust the chromatic compensator of your refractometer.

9. Reading the scale:

   a. On the Bausch and Lomb or Abbe type, the scale is read by depressing the switch on the side of the instrument. Release the switch and bring the shadow edge to line up at the intersection of the crosshairs as shown below.



10. Read the refractive index and compare to the one shown on the test prism. If the average of at least three (3) readings differs by more than two units on the fourth decimal place, the refractometer must be adjusted.

D. Calibration or Adjustment

Follow the steps in your refractometer's instruction manual.

pH Meter

Most pH meters require daily calibration and standardization to two endpoints (usually pH 4 and pH 7, or pH 7 and pH 10) before use. Calibration checks must be documented on at least a monthly basis when the pH meter is used infrequently.

Certified accurate endpoint pH buffer solutions can be purchased from a scientific supply source.

1. Check the electrodes for freedom from crystals or damage.

2. Follow the owner's manual or instructions provided on the meter.

3. Check meter in two buffer solutions, and record values on the Daily pH Meter Checks log in APPENDIX V.

Analytical Glassware

Calibration should be performed prior to being placed into service. Glassware can be taped or tagged as to calibration. Enter a serial number and date calibrated on the Analytical Glassware Checks log in APPENDIX VI.

Example: 25 ml Pipette/25 ml Burette

1. Tare a 50 ml beaker on a previously calibrated gram scale.

2. Pipet distilled water up to fill line marked on the pipette.

3. Place pipette over beaker and empty contents into the beaker.

4. Record scale readout. 25 ml = 25 grams.

5. Results should be within ± 0.1 g. If accuracy is less than listed, contact your immediate supervisor. Procedures are the same for smaller and larger size pipettes and burettes.

Hydrometer

A certified accurate hydrometer can be purchased from a scientific supply company. If you have a hydrometer(s) with no certification, it can be checked against a certified hydrometer by inserting both spindles in the same cylinder of liquid and cross checking the references value. Cross checking can also be done with a calibrated refractometer.

Brix hydrometers should be checked for accuracy monthly or before use if usage is infrequent, and the results reported on the Hydrometer Checks log in APPENDIX VII. Two methods are suggested:

A. Comparison of the hydrometer reading of a sample of syrup with the reading of another hydrometer of known accuracy on the same syrup sample; or,

B. Testing the hydrometer in a specially prepared sucrose solution which contains a known percentage by weight, of pure, dry sucrose. For all practical purposes a good grade of dry commercial cane or beet sugar will be sufficiently pure for standardization of hydrometers. Observe the following guidelines:

1. Select a value approximately midway on the spindle to be tested. For example, a hydrometer in the range of 15 to 20 degrees can be tested in a syrup of 18°.

2. Prepare a sugar solution of the required density by dissolving a weighed quantity of dry, free-running sugar in a weighed quantity of distilled water.

Example: To prepare 1000 grams of 18° syrup, tare a beaker or other suitable receptacle on a gram scale and add exactly 180 grams of dry sugar. Then add sufficient water to bring the weight of the mixture (sugar and water) to exactly 1000 grams. This solution will give a reading of 18° Brix with an accurate hydrometer at the proper temperature.

Note: 18° Brix is 18% by weight of sugar solids, which is 18 grams per 100 grams of solution, not 18 grams made up to 100 ml. Do not prepare the solution by making up to volume in a volumetric flask.

4. Mix the sugar and water well by transferring the contents back and forth between two large beakers to assure proper mix.

5. Cool solution down to about 1 degree below the temperature at which the instrument is calibrated.

6. Transfer syrup to a cylinder and equalize to the temperature at which the instrument was calibrated. If necessary, immerse in a water bath of the proper temperature.

7. When the syrup has reached the proper temperature, immerse the hydrometer and observe the reading in accordance with the procedure below.

8. Take a series of readings by removing the hydrometer and cleaning and drying it before each immersion. If the hydrometer reads within $^{1}/_{10}$ of a degree of the proper reading, it can be considered sufficiently accurate for our purposes. If the error is $^{2}/_{10}$ degree, the correction should be recorded, and each reading with this instrument adjusted accordingly. If the error in the instrument exceeds $^{3}/_{10}$ degree, replace the instrument.

9. For more precise calibration, the instrument can be standardized at more than one check point.

C. Procedure

1. Pour the liquid into a standard glass laboratory cylinder approximately 1 ¼ inches inside diameter, 10 to 12 inches tall. Completely fill the cylinder and allow to overflow slightly so as to float off any foam or bubbles.

2. Remove sufficient liquid from the cylinder to allow the hydrometer to float at a level of liquid slightly below the top of the cylinder. This is easy to gauge with a little experience.

3. Slowly lower the clean, dry hydrometer into the liquid until it is very near floating position. Release spindle with a slight spinning motion. If it is dropped into the syrup it will sink too far and when it rises, some of the syrup will adhere to the stem. The weight of this adhering syrup will cause the hydrometer to float at a lower position than it should. Air bubbles in the syrup will also cause the hydrometer to float at an incorrect level.

4. Observe the reading on the stem after allowing the hydrometer to come to a complete rest. It must not touch the side of the cylinder. Where the liquid touches the stem, it rises a short distance to form a meniscus. Looking at the surface level of the liquid, take the reading from the bottom of the meniscus at the true liquid level (refer to the Reading Through The Meniscus illustration).

5. Record the temperature of the syrup and refer to the Brix hydrometer temperature corrections chart below to make any needed correction. Note that the correction factor varies according to the specific gravity of the liquid as well as with temperature. The correction factor is taken from the column nearest the degrees Brix. For example, if the hydrometer indicates a reading of 23.5 degrees Brix, the correction factor is taken from the vertical column headed "25 degrees Brix."

TEMPERATURE CORRECTIONS -- BRIX HYDROMETERS
(Standardized at 20 degrees C and reported to the nearest 1/10th degree)

	Degrees Brix														
Temp. Degrees C	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**
Subtract From Observed Reading															
0	.3	.5	.7	.8	.9	1.0	1.1	1.2	1.3	1.4	1.4	1.4	1.4	1.5	1.5
5	.4	.5	.6	.7	.7	.8	.9	.9	1.0	1.0	1.1	1.1	1.1	1.1	1.1
10	.3	.4	.4	.5	.5	.6	.6	.6	.7	.7	.7	.7	.8	.8	.8
11	.3	.4	.4	.4	.5	.5	.6	.6	.6	.6	.7	.7	.7	.7	.7
12	.3	.3	.4	.4	.4	.5	.5	.5	.5	.6	.6	.6	.6	.6	.6
13	.3	.3	.3	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5	.6
14	.2	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5
15	.2	.2	.2	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4
16	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
17	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
18	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2
19	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
Add to Observed Reading															
21	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
22	.1	.1	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2
23	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
24	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
25	.3	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4	.4	.4
26	.3	.3	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.5
27	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6
28	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6	.6	.6	.6	.6	.6
29	.5	.6	.6	.6	.6	.6	.7	.7	.7	.7	.7	.7	.7	.7	.7
30	.6	.6	.6	.7	.7	.7	.7	.8	.8	.8	.8	.8	.8	.8	.8
35	1.0	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
40	1.4	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.7	1.7	1.7

<u>Salometer</u>

A salometer is a hydrometer used to measure the concentration of sodium chloride (NaCl) in water based on specific gravity. Two types of salometers are used in inspection procedures. A description of the two types of salometer follows; instructions for their calibration are provided in separate sections as follows.

A. One type of salometer measures the “percent by weight” of NaCl in water at 60 degrees Fahrenheit. A saturated solution contains 26.5 percent salt, and the salometer scale ranges from 0 to 26.5 percent. This type of salometer is used for brine solutions when testing the maturity of peas. For ease of identification in these instructions, this type of salometer will be referred to as **Type I**.

B. A second type of salometer measures the “percent saturation” of NaCl in water at 60 degrees Fahrenheit. Readings are recorded as “degrees salometer.” The full scale ranges from 0 to 100, but this type of salometer can be purchased in selected ranges. When using a salometer with a partial range, the expected readings should be midpoint on the scale, and scale divisions should be no greater than 0.2 increments. These salometers may be purchased with internal thermometers which are used to apply temperature corrections. This type of salometer is called a “combined form” salometer. The “percent saturation” salometer is used to measure the amount of NaCl in the brine of canned ripe olives. For ease of identification in these instructions, this type of salometer will be referred to as **Type II**.

C. Instructions for Checking the Calibration of **Type I** Salometers (used for brining Peas)

1. Visually examine the salometer before each use, and remove any damaged salometers from service. Inspect the salometer for:

    a. Cracks, chips, etching, or any other signs of damage;

    b. Loose pieces of ballast or other foreign material within the instrument;

    c. Proper alignment of paper scale within the stem, which should be straight without any twists;

    d. Alignment of paper scale with scale slippage indicator; and,

2. Clean and dry the salometer before starting verification procedures.

3. Prepare a standardized brine solution using the following procedures:

    a. Prepare a 13 percent brine solution by measuring 130 grams of pure, dry NaCl (such as kosher salt, <u>not</u> iodized salt) and 870 grams of distilled water.

b. Mix brine thoroughly.

c. A 13 percent salt solution is made up by weight, not volume. Do not use a volumetric cylinder to make up these solutions.

4. Verify the accuracy of the salometer using the following procedures:

a. Test the salometer in a specially prepared brine solution which contains a known percentage, by weight, of dry NaCl (see c. above).

b. Select a hydrometer cylinder appropriate for the size of the salometer:

(1) It must be deep enough that the salometer floats freely at least 25 mm (1 inch) above the inside bottom; and,

(2) It must be wide enough that there will be at least 12.5 mm (½ inch) between the inner wall and all surfaces of the immersed salometer. The salometer should not touch the sides of the cylinder.

c. The cylinder and salometer must both be clean and dry.

d. The temperature of the test brine should match the calibration temperature of the salometer. Use a water bath if necessary.

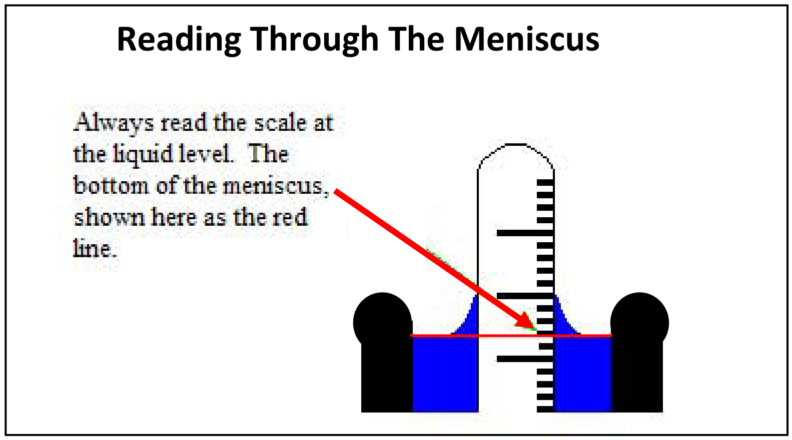
e. Completely fill the cylinder by pouring the brine inside and allowing it to overflow slightly so as to float off any foam or bubbles.

f. Remove sufficient liquid from the cylinder to allow the salometer to float at a level of liquid slightly below the top of the cylinder. This is easy to gauge with a little experience. Slowly lower the clean, dry salometer into the liquid until it is very near floating position.

g. Release the spindle with a slight spinning motion. If it is dropped into the solution, it will sink too far and some of the salt solution will adhere to the stem, which can affect the reading. Dropping the salometer may also damage it. Any bubbles present will also cause the salometer to read incorrectly.

h. Observe the reading on the stem after allowing the salometer to come completely to rest. The salometer should not touch the side of the glass cylinder.

i. Read the salometer by observing a point slightly below the plane of the liquid surface and raising the line of vision until level with the surface of the liquid. Where the liquid touches the stem, it rises a short distance to form a meniscus. The reading will be inaccurate if taken at the top of the meniscus rather than at the true liquid level. (See illustration below.) The meniscus layer is usually thin and the graduation marks can be seen through it.



j. Record calibration results on the Salometer Calibration log in APPENDIX VIII. Include the brine temperature reading.

k. Remove inaccurate salometers from service.

D. Instructions for Checking the Calibration of **Type II** Salometers (used for grading Canned Ripe Olives)

1. To comply with these instructions, each grading lab will need **grading salometers** and a **reference standard salometer** for calibrating the grading salometers. Salometers for grading require a manufacturer's certificate of conformance. The accuracy of all grading salometers will be verified weekly against the reference standard salometer, which must have a National Institute of Standards and Technology (NIST) traceable certificate of calibration.

   This NIST certificate of calibration references the serial number of the NIST Standard used for calibration, and the actual readings taken at three points. The NIST traceable reference standard salometer is ONLY used for calibration (verifying accuracy) of the grading salometers; <u>it is not to be used for grading</u>. Store all salometers with copies of their corresponding certificates.

   Contact the Eastern, Central, or Western Regional office for Type II grading salometers used to measure the "percent saturation" of NaCl in water at 60 degrees Fahrenheit. Type II salometers require daily and weekly calibration checks when they are in use. (See paragraphs e and f.)

2. Visually examine salometer before each use. Inspect the salometer for:

a. Cracks, chips, etching, or any other signs of damage;

b. Loose pieces of ballast or other foreign material within the instrument;

c. Proper alignment of the paper scale within the stem, which should be straight without any twists;

d. Alignment of paper scale with scale slippage indicator.

Remove any damaged salometers from service.

3. Clean and dry the salometer before calibrating (verifying accuracy) and before each reading. A buildup of salt, oil, or olive particles will affect the accuracy of readings.

4. Verify accuracy by testing the grading salometer:

a. Daily - using distilled water; and,

b. Weekly - by comparing the readings of the grading salometer(s) against the readings of the reference standard salometer in the same solution of canned ripe olive brine.

5. Daily Calibration. Verify the accuracy of the grading salometers daily using distilled water, and record on the Salometer Checks log in APPENDIX VIII.

a. Clean and dry both the cylinder and the grading salometer.

b. Select a (cylinder) appropriate for the size of the salometer.

(1) It must be deep enough that the salometer floats freely at least 25 mm (1 inch) above the bottom; and

(2) It must be wide enough that there will be at least 12.5 mm (½ inch) between the inner wall and all surfaces of the immersed salometer. The salometer should not touch the sides of the cylinder.

c. Completely fill the cylinder by pouring distilled water inside and allowing it to overflow slightly so as to float off any foam or bubbles.

d. Remove sufficient liquid from the cylinder to allow the salometer to float at a level of liquid slightly below the top of the cylinder. Slowly lower the clean, dry grading salometer into the water until it is very near the zero reading.

e. Release the grading salometer with a slight spinning motion. If it is dropped into the solution, it will sink too far and cause the stem to become wet, which can affect the reading. It may be damaged if it strikes the bottom of the cylinder. Any bubbles present will cause the salometer to read incorrectly.

f. Observe the reading on the stem after allowing the grading salometer to come completely to rest. The salometer should not touch the side of the glass cylinder.

g. Read the grading salometer through the meniscus as for the Type I salometer (refer to the Reading Through The Meniscus illustration). The reading should be zero.

h. Apply any corrections for temperature using Appendix H, Grading Manual for Canned Ripe Olives.

i. Record calibration results on Salometer Checks log in APPENDIX VIII. Include temperature reading.

j. Remove inaccurate salometers from service.

k. Repeat steps (1) through (10) to check all grading salometers in use.

6. Weekly Calibration. A weekly calibration is performed at the beginning of each week. It includes all steps for the daily calibration using distilled water, followed by a second phase. The second phase is to compare the readings of the grading salometer against the NIST certified reference standard salometer in the same sample of canned ripe olive brine:

a. The sample of brine should be well-mixed.

b. Clean and dry the **reference standard salometer.** The cylinder must be either clean and dry, or completely rinsed with a well-mixed sample of the brine to be read.

c. Completely fill the cylinder by pouring the canned ripe olive brine into the cylinder and allowing it to overflow slightly so as to float off any foam, bubbles, olive particles or olive oil in the sample.

d. Remove sufficient liquid from the cylinder to allow the grading salometer to float at a level of liquid slightly below the top of the cylinder. This is easy to gauge with a little experience. Slowly lower the clean, dry grading salometer into the brine until it is very near the anticipated reading.

e. Release the reference salometer with a slight spinning motion. If it is dropped into the brine, it will sink too far and some of the brine will adhere to the stem and affect the reading. Any bubbles present will also cause the salometer to read incorrectly.

f. Observe the reading on the stem after allowing the grading salometer to come completely to rest. The salometer should not touch the side of the glass cylinder.

g. Read the reference salometer through the meniscus as for the Type I salometer (refer to the Reading Through The Meniscus illustration).

h. Record the calibration results, including the temperature reading on the salometer calibration log in APPENDIX VIII. Apply corrections for temperature using Appendix H, from the Grading Manual for Canned Ripe Olives.

i. Remove the reference salometer from the hydrometer cylinder.

j. Repeat steps (1) through (9) for all **grading** salometers in use.

Note: Use the same brine for the reference standard salometer and the grading salometer(s). Save some of the original brine to add to the cylinder if any is lost while taking readings. Reading will be inaccurate if brine, oils, or olive particles collect on salometers during grading.

k. The readings for the grading salometer(s) and reference salometer should agree.

l. Remove any inaccurate salometers from service.

Colorimeters

Detailed instructions for calibration should be provided with your model. Recommended calibration timetables are as follows. For Hunter models below, light bulb changes are recommended at approximately 150 hours of use.

Record results on the appropriate colorimeter calibration log.

A. Hunter D45 - weekly zero adjustment. Use log in APPENDIX IX

B. Hunter D45D2 - daily zero adjustment. Use log in APPENDIX X

Modified units require calibration only when the bulb is changed
Computer controlled units have no manual zero adjustments

C. D45D2 - weekly tile check.

Modified units require calibration only when the bulb is changed.
Computer controlled units require calibration only when the bulb is changed.

CONTAINER INFORMATION

Sizes of metal containers

The following table may be used as a reference for the various can sizes and capacities. Any individual container may vary from the figures given in these tables as the result of normal variations in manufacture and variations in closure. Capacities will also vary with the profile of the ends. The dimensions and capacities given are generally recognized as standard measurements.

The practical method for the determination of a fill such as "not less than 90 percent of the capacity of the container" is by means of the headspace gauge. The headspace allowance of 10 percent (or for a 90 percent fill) shown in the Capacity - Sizes of Metal Containers table contained in this section, is calculated for the can size. To calculate Headspace for containers other than those shown, or for Headspace allowances other than 10%, calculate from the formula given below under Headspace.

The following terms are used in the Capacity-Sizes of Metal Containers table.

Avoirdupois: A system of weights (or mass) based on a pound of sixteen ounces. It is the everyday system of weight used in the United States, and will be referred to in these instructions in term of the appropriate English system weight, i.e. ounces, pounds, etc.

Designation: The common name of container.

Dimensions: The overall measurements, given in terms familiar to the industry. The left-hand digit gives the whole inches and the two right-hand digits give the additional fraction expressed in sixteenths of an inch. The first set of numbers represents the diameter and the second set of numbers represents the height. Example: 211 x 304 means 2 $^{11}/_{16}$ inches in diameter, 3 $^{4}/_{16}$ inches in height.

Water Capacity: The weight of distilled water at 68 degrees F that a sealed container will hold when filled to $^{3}/_{16}$ inch from the top. Capacity of containers is expressed in ounces. See the section titled Procedure to Determine the Water Capacity in section F for instructions.

Headspace: measured from top of double seam in sixteenths of an inch, calculated as follows:

Overall height less both seams, times 10%, plus top seam = headspace of 10%

Example: [(4 $^{11}/_{16}$ inches minus $^{6}/_{16}$ inch) x 10%] + $^{3}/_{16}$ inch = $^{9.9}/_{16}$ inch, or,
[($^{75}/_{16}$ - $^{6}/_{16}$) x (0.10)] = $^{69}/_{16}$ x 0.1 = $^{6.9}/_{16}$ + $^{3}/_{16}$ = $^{9.9}/_{16}$ (rounded to $^{10}/_{16}$ inch).

Cans per Case: Although other packs may be used, most of those listed are typical of the industry by representatives of box manufacturers, canners, other interested parties, and by the National Institute of Standards and Technology (NIST).

Capacity - Sizes of Metal Containers

Designation	Dimensions	Water Capacity (Ounces)	Fluid Measure (fl. ounces)	Headspace of 10 Percent (sixteenths of an inch)	Cans Per Case
5 oz	202 x 214	4.8	4.6	7	12-24-48
6 oz	202 x 308	6	5.8	8	24-48
	202 x 314	6.75	6.5	8.6	24
	211 x 200	4.9	4.7	5.6	24
No. 211 baby food	211 x 210	6.75	6.5	6.6	48
4 oz mushroom	211 x 212	7.15	6.85	6.8	12-24
8 oz short	211 x 300	7.9	7.6	7.2	24-36-48 72-96
8 oz tall	211 x 304	8.65	8.3	7.6	24-36-48-72
No. 1 picnic	211 x 400	10.9	10.45	8.8	24-48
No. 211 cylinder	211 x 414	13.55	13	10.2	24-36-48
Pint (Olive)	211 x 600	16.96	16.25	12	12-24
4 oz pimiento	300 x 108	4.2	4.05	4.8	
7 oz pimiento	300 x 206	7.5	7.2	6.2	
12 oz (or 8 oz mushroom)	300 x 400	13.55	13	8.8	24
No. 300	300 x 407	15.2	14.6	9.5	24-36-48
	300 x 411	16.1	15.5	9.9	48
No. 300 cylinder	300 x 509	19.4	18.6	11.3	24
No. 1 flat	301 x 208	8.2	7.85	6.4	24
No. 1	301 x 400	13.98	13.4	8.8	24
No. 1 tall	301 x 411	16.6	15.95	9.9	24-48
No. 1 square	300 x 308 x 308	17.27	16.6	8	24-48
No. 303	303 x 406	16.85	16.2	9.4	12-24-36
No. 303	303 x 504	20.55	19.75	10.8	24

No. 303 cylinder	**303 x 509**	**21.85**	**21**	**11.3**	**12-24**
No. 2 vacuum	**307 x 306**	**14.7**	**14.1**	**7.8**	**24**
No. 2 short	**303 x 400**	**17.75**	**17.05**	**8.8**	**24**
No. 2 western	**307 x 408**	**20.2**	**19.4**	**9.6**	**24**
No. 2 standard	**307 x 409**	**20.5**	**19.7**	**9.7**	**12-24**
Jumbo	**307 x 510**	**25.7**	**24.7**	**11.4**	**12-24**
No. 2 cylinder	**307 x 512**	**26.35**	**25.3**	**11.6**	**24**
No. 2 tall	**307 x 604**	**28.8**	**27.65**	**12.4**	**12-24**
No. 1-1/4	**401 x 207.5**	**14.44**	**13.87**	**6.4**	**24**
No. 2-1/2	**401 x 411**	**29.75**	**28.55**	**9.9**	**12-24**
No. 2-1/2 square	**300x308x604**	**32.47**	**31.2**	**12.4**	**24**
No. 3 vacuum (or squat)	**404 x 307**	**23.85**	**22.9**	**7.9**	**24**
No. 3	**404 x 414**	**35.05**	**33.65**	**10.2**	**24**
No. 3 cylinder	**404 x 700**	**51.7**	**49.61**	**13.6**	**12**
No. 5	**502 x 510**	**59.1**	**56.75**	**11.4**	**12**
No. 10	**603 x 700**	**109.45**	**105.1**	**13.6**	**6**
No. 12	**603 x 812**	**138.35**	**132.85**	**16.4**	**4-6**
No. 12	**610 x 800**	**145.7**	**139.85**	**15.2**	**6**

Explanation of Dimensional Food Can Standards

Metal can sizes used in industry in the U.S.A. are derived from nominal outside dimensions. Measurements are made of the empty round can before seaming on the packers' end.

While such dimensions may be expressed in inches, the custom is to use a conventionalized method in which three-digit numbers are used to express each dimension. The first digit indicates the number of whole inches in a dimension, and the second and third digits indicate the fractional inches as sixteenths of an inch. Therefore:

303 x 406 means $3\text{-}^{3}/_{16}$ x $4\text{-}^{6}/_{16}$ inches
307 x 512 means $3\text{-}^{7}/_{16}$ x $5\text{-}^{12}/_{16}$ inches
603 x 700 means $6\text{-}^{3}/_{16}$ x 7 inches

The first three-digit number describing a round can indicates the diameter measured across the outside of the chime on the seamed end. The second three-digit number indicates the overall height of the can with one end on.

Outside dimensions are used to designate the dimensions of oval or round cans. The dimension of the opening is stated first, followed by the height. For oval cans, this results in three sets of figures, the first two being the long and short axis of the opening. Their interpretation in inches and sixteenths of an inch is the same as with round cans. An oval can might have the size given as 402 x 304 x 612, which would mean that the oval opening was 4-$^{2}/_{16}$ x 3-$^{4}/_{16}$ inches and the height was 6-$^{12}/_{16}$ inches.

In the table below the "No. 2 Equivalent" indicates the number of No. 2 cans equal to each of the cans designated in the first column.

Dimensional Food Can Standards

Name	Dimensions	Total capacity avoir oz. of water at 68 degrees F	No. 2 Can equivalent
6 oz	202 x 308	6.08	0.295
8 oz Short	211 x 300	7.93	0.386
8 oz Tall	211 x 304	8.68	0.422
No. 1 (Picnic)	211 x 400	10.94	0.532
No. 211 Cylinder	211 x 414	13.56	0.660
No. 300	300 x 407	15.22	0.741
No. 300 Cylinder	300 x 509	19.40	0.945
No. I Tall	301 x 411	16.70	0.813
No. 303	303 x 406	16.88	0.821
No. 303 Cylinder	303 x 509	21.86	1.060
No. 2 Vacuum	307 x 306	14.71	0.716
No. 2	307 x 409	20.55	1.000
Jumbo	307 x 510	25.80	1.2537
No. 2 Cylinder	307 x 512	26.40	1.284
No. 1¼	401 x 206	13.81	0.672
No. 2½	401 x 411	29.79	1.450
No. 3 Vacuum	404 x 307	23.90	1.162

No. 3 Cylinder	404 x 700	51.70	2.515
No. 5	502 x 510	59.10	2.8744
No. 10	603 x 700	109.45	5.325
The capacity of a 16-oz. glass jar is approximately the same as a No. 303 can.			
The capacity of a No. 2½ glass jar is approximately the same as a No. 2½ can.			

Net contents and fluid measure

Labeling requirements under the Federal Food, Drug, and Cosmetic Act require certain foods to be labeled in terms of weight, and others in terms of liquid measure. In general, the statement is in terms of liquid measure if the food is liquid, and in terms of weight if the food is solid, semisolid, viscous, or a mixture of solid and liquid. Some exceptions include canned pickles (expressed in volume) and canned mushrooms (labeled according to the recommended minimum drained weight for the container capacity).

In reporting net contents in containers of products such as juices and other commodities customarily labeled and marketed in terms of volume, inspection certificates should record contents in fluid measure.

In determining the net volume (or fluid measure), it is sometimes more rapid and accurate to determine the net weight as usual, and convert ounces to fluid ounces by the following formula:

$$\text{Fluid ounces} = \frac{\text{ounces x } 0.9614}{\text{specific gravity of product}}$$

Degrees Brix may be converted directly to specific gravity in accordance with instructions found in the Brix section of this manual, Sucrose Conversion Tables. Products may be carefully measured into a suitable and accurately graduated receptacle if it is difficult or inconvenient to determine the specific gravity. If requested by the applicant, the net contents may be reported in terms of both weight and volume

Conversion factors for canned foods

The following table designates common conversion factors that are applicable to most canned fruit and vegetable products. If an exact conversion does not exist, choose the closest can size.

Columns "A" and "B" indicate the number of cans equal to each of the cans designated in the "Can Size" column.
Columns "C", "D" and "E" apply to the case equivalents for the can sizes, and the common packing per case.

Conversion Factors

		A	B	C	D	E
Factors For Converting						
Can Size	# per case	No. 2 cans	No. 2 ½ cans	Cases 24/2	Cases 24/2 ½	Cases 6/10
5 oz	48	0.235	0.162	0.47	0.324	0.352
6 oz	48	0.295	0.203	0.590	0.406	0.440
8 oz short	48	0.385	0.266	0.770	0.532	0.576
8 oz tall	48	0.422	0.291	0.844	0.582	0.632
No. 1 picnic	48	0.532	0.367	1.064	0.734	0.800
No. 1 1/4	48	0.704	0.485	1.408	0.970	1.060
No. 300	48	0.740	0.500	1.480	1.200	1.112
No. 1 tall	48	0.810	0.559	1.620	1.118	1.224
No. 303	24	0.821	0.566	0.821	0.566	0.616
No. 1 square	24	0.843	0.581	0.843	0.581	0.632
No. 2	24	1.000	0.690	1.000	0.690	0.750
No. 2 ½	24	1.450	1.000	1.450	1.000	1.087
No. 2 ½ square	24	1.585	1.093	1.585	1.093	1.188
No. 3	24	1.710	1.179	1.710	1.179	1.284
No. 3 cylinder	12	2.516	1.735	1.258	0.868	0.943
No. 5	12	2.882	1.987	1.441	0.994	1.080
No. 10	6	5.336	3.680	1.334	0.920	1.000
No. 12	6	6.745	4.652	1.686	1.163	1.264

Examples:

1. To find the equivalent number of No. 2 ½ cans:

   100,000 cans No. 2 size = (100,000 x 0.690) = 69,000 No. 2½ size cans

2. To find the number of cases 24/2 ½:

   7,000 cases 24/2 = (7,000 x 0.690) = 4,830 cases 24/2½
   10,000 cases 6/10 = (10,000 x 0.920) = 9,200 cases 24/2 ½

<u>Sizes of glass containers</u>

Net weights for canned fruits and vegetables in glass are not mandatory. Federal and various State laws require that a statement of net contents be given on the label, but none of these laws specify what the weights must be. Label weights shown on these products generally state the contents for what is considered normal fill for the product. Variations in weights are to be expected. The following weights represent an approximate average weight of the product and packing medium inside the container.

Capacity of Glass Containers

Designation	Glass Containers (overflow) Fluid oz.	Metal Container oz.	Designation and Size of Equivalent	Can Size
Baby Jar	5.1	4.9	5 oz	211 X 200
Junior Jar	8.1	7.9	8 oz short	211 X 300
16 oz. Jar	17	16.6	No. 1 tall	301 X 411
No. 303 Jar	17	16.85	No. 303	303 X 406
No. 2½ Jar	28.4	29.75	No. 2½	401 X 411
46 oz. Jar	49	51.62	No. 3 cylinder	404 X 700

Packing of Glass Containers

Capacity of Glass Containers (fluid ounces)	Maximum Number of Units per Box	Number of Tiers per Box
8 ounces or less	48	2
over 8 oz. to 17 oz.	24	1
over 17 oz. to 40 oz.	12	1
over 40 oz. to 70 oz.	6	1
over 70 oz. to 1 gallon	4	1

Calculating drained weight for unpublished container sizes

A. Drained weights in the United States grade standards are generally published and applied by USDA for common container sizes. To determine the recommended minimum drained weight for unpublished container sizes on a proportional basis, use the following procedure as a guideline:

1. Refer to tables for Capacity-Sizes of Metal Containers for metal containers, or Capacity of Glass Containers for glass containers to find the water capacity of the unpublished container. For container sizes not listed in these tables, determine the water capacity of the target container by following the procedure in Procedure to Determine the Water Capacity in section F.

2. After obtaining the water capacity of the target container, find the water capacity of the next closest container given in the standard.

3. Divide the recommended minimum drained weight of the closest container by its water capacity to get the proportional water capacity.

4. Multiply the water capacity of the target container by the proportional water capacity of the nearest container to establish the new recommended minimum drained weight for the target container. Round to the nearest tenth of an ounce, rounding up for digits ending in 5 or greater, rounding down for digits ending in numbers less than 5. Record both the range of results and the drained weight average on certificates. Refer to the AIM Inspection Series, Certification Manual for questions on certification.

   Use this equation:

   $X = A \times B \div C$; where,

X = Recommended minimum drained weight of unknown container,

A = Recommended minimum drained weight of closest container size,

B = Water capacity of the target container, and

C = Water capacity of the closest container.

Example: Canned Tomatoes in No. 12 cans (603 x 812)

The water capacity of the No. 12 can is to be 138.35 ounces. (See Capacity-Sizes of Metal Containers) The closest can size given in the standard is the No. 10 can, which has a water capacity of 109.45 ounces. The drained weight for canned tomatoes in the No. 10 can is 63.5 ounces for U.S. Grades A and B. The corresponding drained weight of tomatoes in a No. 12 can is calculated as follows:

X = unknown drained weight, A= 63.5 oz., B= 138.35 oz., C= 109.45 oz., so,

X = 63.5 oz. x 138.35 oz. ÷ 109.45 oz.; X = 63.5 x 1.26; X = 80.3 oz. for A or B grade Canned Tomatoes in No. 12 cans.

Procedure to Determine the Water Capacity

This procedure applies to several types of primary containers: cans, glass, and plastic (except polyethylene or other thin plastic film). Use three containers to determine the water capacity, unless the weight of the primary container is a very small percentage of the gross weight and is quite uniform. If this is the case, use a single container from the lot to determine water capacity.

The following is an excerpt from 21 CFR, 130.12, "General Methods for Water Capacity and Fill of Containers" which may be found at the following internet address: https://www.ecfr.gov/cgi-bin/ECFR?page=browse.

A. To determine the water capacity of a container:

1. If the container has a lid attached by a double seam, cut out the lid without removing or altering the height of the double seam.

2. Wash, dry, and weigh the empty container.

3. Fill the container with distilled water at 68 degrees Fahrenheit to $^{3}/_{16}$ inch vertical distance below the top level of the container. If the container has a lid attached other than by double seam, remove the lid and fill the container to the level of the top.

4. Weigh the filled container.

6. Subtract the container tare weight from the full container weight. The difference is the weight required to fill the container.

Containers for frozen fruits and vegetables

Common consumer size containers for frozen fruits and vegetables are 10 ounce, 12 ounce, 14 ounce, and 16 ounce packages, depending upon the commodity. Some products are also packed in larger containers for institutional purchases. Vegetables packed in 2 ½ pound and 5 pound packages, and fruits in 2 ½ pound, 10 pound, 15 pound, and 30 pound containers are the most common.

The percentage figures for losses in preparation of raw product for freezing are approximate and are only given for estimates.

Containers for Frozen Vegetables

Vegetables	Common Packages and Usual Packing Per Case	Approximate Losses in Preparation of Raw Product for Freezing
Asparagus	12-2 ½ lb. 12-8 oz. 24-12 oz. 24-10 oz.	54%
Beans, Lima	12-2 ½ lb. 24-12 oz.	63%
Beans, Green	12-2 ½lb. 24-12 oz. 24-10 oz.	21%
Broccoli	8-4 lb. 12-2 lb. 24-10 oz.	45%
Brussels Sprouts	8-4 lb. 12-2 lb. 24-10 oz.	45%
Carrots	12-2½ lb.	50%
Cauliflower	8-4 lb. 12-2 lb. 24-10 oz.	70%
Corn	12-2 ½ lb. 24-12 oz. 24-10 oz.	76%
Peas	6-5 lb. 12-2 ½ lb. 24-12 oz. 24-10 oz.	60%
Carrots and Peas	12-2 ½ lb. 24-12 oz.	60%
Spinach	12-3 lb. 12-2 ½ lb. 24-14 oz.	45%
Squash, Pumpkin	24-1 lb.	35%
Succotash	24-12 oz. 24-11 oz. 24-10 oz.	35%
Mixed Vegetables	12-2 1/2 lb. 24-12 oz.	35%

Containers for Frozen Fruits

Fruits	Common Packages and Usual Packing Per Case	Approximate Losses in Preparation of Raw Product for Freezing
Apples	30 lb.	50%
Apricots	30 lb. 10 lb. 24-1 lb.	22%
Blackberries	Barrels 30 lb.	5%
Blueberries	Barrels 30 lb.	5%
Cherries	Barrels 30 lb.	25%
Peaches	30 lb. 10 lb.	33%
Prunes and Plums	Barrels 30 lb.	15%
Raspberries	Barrels 30 lb.	15%
Rhubarb	30 lb. 24-16 oz.	15%
Strawberries	Barrels 30 lb.	7%
Youngberries, Loganberries, Boysenberries	Barrels 30 lb. 10 lb.	5%

Approximate shipping weights

Shipping weights include the gross weight of the product, primary container, shipping container, and any incidental packaging material. Gross shipping weights may be used in determining the approximate number of cases that common carriers or transportation lines allow per freight car or truck. These weights are also required on bills of lading or manifests.

The approximate shipping weights shown are for guidance only and are common weights for most processed fruits and vegetables.

Approximate Gross Weights per Case

Type of pack	Fruits (Canned)	Vegetables (Canned)
	Metal Containers, Fiber Cartons	
48 - 8 oz.	35 lb.	35 lb.
48 - No. 1 tall	64 lb.	---
48 No. 1 picnic	---	43 lb.
24 No. 2	39 lb.	39 lb.
24 No. 2 ½	56 lb.	55 lb.
6 No. 10	49 lb.	48 lb.
	Fruits (dried)	
	Packages and Fiber Cartons	Wood Boxes
48 - 16 oz.	50 lb.	---
36 - 16 oz.	40 lb.	---
36 - 11 oz.	31 lb.	---
25 lb.	---	28 lb.
30 lb.	---	33 lb.
50 lb.	---	55 lb.

Length-Inches and Millimeters-Equivalents of Decimal and Binary Fractions of an Inch in Millimeters

1/2's	1/4's	8th's	16th's	32nd's	64th's	Milli-meters	Decimals of an inch	Inch	1/2's	1/4's	8th's	16th's	32nd's	64th's	Milli-meters	Decimals of an inch
					1	0.397	0.015625							33	13.097	0.515625
				1	2	0.794	0.03125						17	34	13.494	0.53125
					3	1.191	046875							35	13.891	0.546875
			1	2	4	1.588	0.0625					9	18	36	14.288	.5625
					5	1.984	0.078125							37	14.684	0.578125
				3	6	2.381	0.09375						19	38	15.081	0.59375
					7	2.778	0.109375							39	15.478	0.609375
		1	2	4	8	3.175	0.125				5	10	20	40	15.875	0.675
					9	3.572	0.140625							41	16.272	0.640625
				5	10	3.969	0.15625						21	42	16.669	0.65625
					11	4.366	0.171875							43	17.066	0.67875
			3	6	12	4.762	0.1875					11	22	44	17.462	0.6875
					13	5.159	0.203125							45	17.859	0.703125
				7	14	5.556	0.21875						23	46	18.256	0.71875
					15	5.93	0.234375							47	18.653	0.734375
	1	2	4	8	16	6.350	0.25			3	6	12	24	48	19.050	0.75

1/2's	1/4's	8th's	16th's	32nd's	64th's	Milli-meters	Decimals of an inch	Inch	1/2's	1/4's	8th's	16th's	32nd's	64th's	Milli-meters	Decimals of an inch
					17	6.747	0.265625							49	19.447	0.76525
				9	18	7.144	0.28125						25	50	19.844	0.78125
					19	7.541	0.296875							51	20.241	0.796875
			5	10	20	7.938	0.3125					13	26	52	20.638	0.8125
					21	8.334	0.328125							53	21.034	0.828125
				11	22	8.731	0.34375						27	54	21.431	0.84375
					23	9.128	0.359375							55	21.828	0.859375
		3	6	12	24	9.525	0.375				7	14	28	56	22.225	0.875
					25	9.922	0.390625							57	22.622	0.890625
				13	26	10.319	0.40625						29	58	23.019	0.90625
					27	10.716	0.421875							59	23.416	0.921875
			7	14	28	11.112	0.4375					15	30	60	23.812	0.9375
					29	11.509	0.453125							61	24.209	0.953125
				15	30	11.906	0.46875						31	62	24.606	0.96875
					31	12.30	0.48475							63	25.003	0.984375
1	2	4	8	16	32	12.700	0.5	1	2	4	8	16	32	64	25.400	1.000

ENZYME INACTIVATION

Inactivation of the peroxidase and catalase enzymes is achieved by the proper blanching of vegetables prior to freezing. These enzymes would otherwise cause development of off-flavors, loss of color and loss of vitamin A and C during storage after freezing. Blanching also tends to fix the characteristic color of vegetables. Better color retention is attained by blanching at a higher temperature for a short time, rather than through lower temperatures for a longer time. Over-blanching may cause dull color, flavor loss, sloughing, and poor texture.
For the majority of vegetables, inactivation of catalase alone does not indicate adequate blanch. Inactivation of the peroxidase enzyme is considered necessary to minimize future deterioration in quality. Consequently the Peroxidase test is considered the official Division test for enzyme inactivation. For properly blanched products, test results are **negative**.

Lot Inspection Procedures

Products inspected under lot inspection will not routinely be tested for enzyme inactivation. The peroxidase test will be made on all condition inspections, or if required by Federal or buyer's specifications, or if requested by the applicant. In addition, the peroxidase test will be run during inspections of frozen vegetables if there is organoleptic evidence of under-blanch such as off-colors, off-flavors and toughening.

When specifications call for catalase or tests other than the peroxidase test, or specify methods other than the USDA methods contained in this technical manual, such tests should be performed as required by the specification.

When required, the minimum rate that enzyme inactivation tests be performed:

Quality Sample Size	Number of Tests
3	1
6	1
13	3
21	3
29	4

Additional tests should be made if organoleptic inspection indicates the possibility of inadequate blanching.

In-Plant Inspection Procedures

All vegetables processed and frozen under in-plant inspection (except onion rings, sweet peppers, rhubarb, French fried potatoes, and cooked squash) are to be tested for peroxidase inactivation. Where required by Federal, buyers, or other specifications, testing for catalase inactivation must be in addition to the peroxidase test. Testing using methods outlined in specifications is permissible in lieu of the USDA method when inspection and certification are based on such specifications. Samples from each blancher are to be tested at the beginning of every processing period. Additional sample units should be tested whenever there is an indication that the blanch may have changed. Tests should also be made at least hourly throughout the shift.

Quality Control Testing – Unofficial

The official peroxidase test and other enzyme inactivation tests are useful quality control tools. For example, blanch temperature may be adjusted so that a peroxidase test will show no color development within three and a half minutes but will show color development within eight minutes. It is most useful to test the larger units of product for peroxidase activity. Depending upon the variation in product unit size, if there is color development in two and a half or three minutes, the product may be considered neither under nor over blanched, and official tests with units representative of all unit sizes may remain negative.

Indications of possible under blanching include low initial blanch temperature, drops in temperature, increased volume of product, or increase in unit size of product, which suggests the need for additional quality control checks. Quality control tests from isolated portions of production can and should be made for those plants relying on the inspector for help in quality control. This should be noted on the score sheet, but not be considered the official routine peroxidase test unless representative of the production. Similarly, quality control tests on larger units may be recorded on the score sheets, but this should be noted as being a restrictive test and not one of the routine representative tests for the hour.

Quality control tests may be made on the cut surface of an individual unit of product, but these are not considered official tests. Pieces of the product can be tested with 0-tolidine paper and hydrogen peroxide (H_20_2) to show the extent of any unblanched area in a piece of product, and to show variations among pieces of the same size in judging the uniformity of the blanch.

Special Tests for Certain Products

A. Broccoli:

For quality control purposes, test the top center portion of the heads of the large stocks where enzyme activity will be concentrated, if present. This may give quality control additional information but is not to be considered an official test.

B. Brussels Sprouts

Quality control checks can include the development of pink centers soon after freezing and storage, or the rapid development of pink color after about 15 seconds with the addition of ½ to 3 percent H_20_2 to the cut surface immediately after blanching. Correlation of one of these tests with the official test should provide a rapid quality control check.

C. Corn-on-the-Cob

When testing corn-on-the-cob, use only the kernels removed from the cob. Scrapings taken from the cob at the base of the kernels may show residual peroxidase activity even though the product is adequately blanched.

Size, Collection and Handling of Sample Units

Use a 200-gram sample that is representative of the variation in piece sizes. If some pieces are very large, all pieces shall be cut in quarters, and a quarter from each piece used for the 200 gram sample.

Blanched, cooled, unfrozen samples should be taken just before entering the freezer. Test within ½ hour, or quickly cool to 35 degrees F in ice water or in a freezer compartment and run the test within 2-3 hours.

Frozen samples should be water thawed in tap water at no more than 86 degrees F until units can be easily separated. Do not perform test on completely frozen sample units. **Enzyme tests must be completed within 30 minutes of thawing**.

Peroxidase Testing Procedure

A. Reagents

1. Distilled Water.

2. 0.5 percent guaiacol in either 50 percent ethyl alcohol solution or a 50 percent 2-propanol (isopropyl alcohol) solution.

3. 0.08 percent hydrogen peroxide (2.8 ml of 30 percent hydrogen peroxide made up to a liter with distilled water). Keep in refrigerator in a dark bottle and replace each week or two.

B. Apparatus

1. Test tubes - ¾ or 7/8 inch diameter

2. Funnels - 3 or 4 inch diameter

3. Cotton milk filters - 6 or 7 inch diameter or SS 604 filter paper or similar quality, 18.5 cm. in diameter.

4. Mechanical blender

5. Graduated cylinder - 50 ml

6. Pipettes - 1 ml and 2 ml

7. Timer or watch with second hand

8. Test tube rack

9. Balance with an accuracy of ± 0.1 gram

C. Procedure

1. The test must be completed within 30 minutes after the product is thawed.

2. Weigh out a representative 200 gram sample. (See 89.)

3. Place in blender with 600 ml of water.

4. Macerate for 1 minute at high speed.

5. Filter through cotton milk filter. If cotton milk filters are not available, SS 604 filter paper may be used. Discard the first 5-10 ml of filtrate.

6. Prepare a blank by adding 21 ml of distilled water to 2 ml of filtrate in a test tube. Add 1 ml of ½ percent guaiacol solution without mixing. Do not add any hydrogen peroxide to this tube.

7. Prepare the sample by adding 20 ml of distilled water to 2 ml of filtrate in a second test tube. Add 1 ml of ½ percent guaiacol solution without mixing.

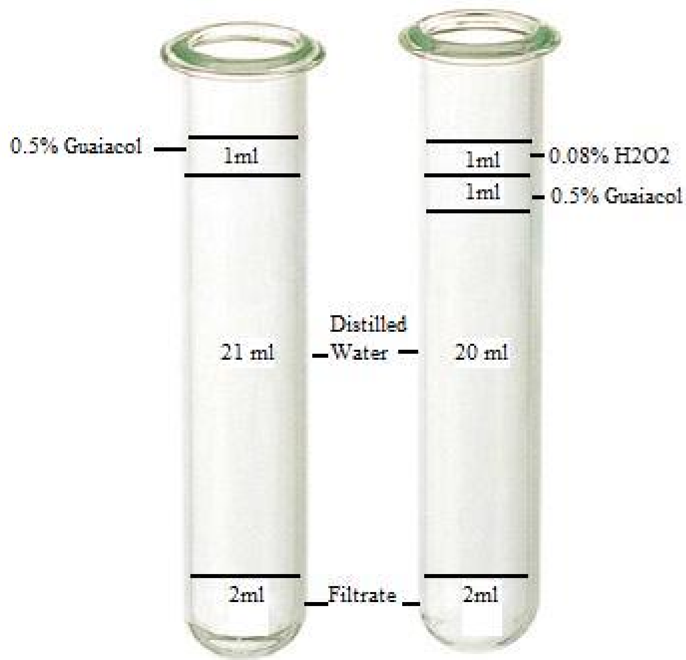
8. Add 1 ml of 0.08 percent hydrogen peroxide to the second test tube without mixing. See illustration.

9. While wearing gloves, mix contents of both tubes thoroughly by inverting each 3 times and returning to test tube rack. Watch for development of any color in the sample tube to which hydrogen peroxide was added. Use the blank tube containing guaiacol, water and filtrate for comparison. Any color change in the sample tube that is in obvious contrast to the blank is considered a positive test. If no such color contrast develops in 3 ½ minutes*, consider the test negative and the product adequately blanched. If color develops after 3 ½ minutes, it is to be disregarded, and the test still considered negative.

   Zucchini Squash: 1 minute.

   Brussels Sprouts: 2 ½ minutes; however, consider test results on the lot as meeting if no more than 1 of 3 sample units tested changes after 2 minutes. A lot fails if any sample units change color before 2 minutes.

PEROXIDASE TEST



Number 1 (Blank) **Number 2 (Test Sample)**

Note: Use only 3/4 or 7/8 inch diameter test tubes.

<u>Catalase Testing Procedure</u>

A. Reagents

1. Distilled water

2. Calcium carbonate ($CaCO_3$)

3. 3 percent hydrogen peroxide (10 ml of 30 % hydrogen peroxide per 100 ml of distilled water). Keep in refrigerator in a dark bottle.

B. Apparatus

1. Mechanical blender

2. Footed fermentation tube with vertical tube graduated from 0 to 5 ml in $^{1}/_{10}$ ml graduations (Kimble 46162, or similar).

3. Funnels - 3 or 4 inch diameter

4. Cotton Milk filters - 6 or 7 inch diameter, or SS 604 filter paper or similar quality, 18.5 cm. in diameter.

5. Pipettes - 1 ml, 5 ml, and 10 ml

6. Balance with accuracy of ± 0.1 gram.

7. Timer or watch with second hand.

C. Procedure

1. Comminute a 100-gram portion of vegetable material together with 100 ml of water and about 2 grams of calcium carbonate.

2. Filter slurry through cotton milk filter.

3. Add 2 ml of distilled water to the fermentation tube (See illustration on the following page).

4. Pipet 2 ml of filtrate into tube.

5. Add 8 ml of 3 percent hydrogen peroxide to tube.

6. Invert tube in such a manner as to completely fill the calibrated column. Tap gently to dissipate any bubbles that result from mixing the solution.

7. Return to upright position and allow contents to generate for 3 ½ minutes.

8. At the end of 3 ½ minutes, record the volume of gas formed.

9. A reading of 0.1 ml or less is considered negative for the catalase enzyme; any reading of more than 0.1 ml is considered positive.

Catalase Fermentation Tube

Air bubbles collect here. Read from the bottom of the collection.

Certification

Official peroxidase or catalase tests that are representative of a production period or lot are shown on the score sheets for the item, but are not reported on a certificate unless:

1. Requested by the Applicant.
2. Required by Federal, Buyer's or other Specification.
3. Inspection is for condition of the product, and some of the samples are positive.

Refer to the [AIM Inspection Series Certification Manual] for appropriate statements to be shown in the "Body" and/or "Grade" section of a certificate.

FROZEN AND REFRIGERATED PRODUCT

SCI Division offices periodically get requests for inspecting and reporting the temperature and condition of refrigerated and frozen foods. Normally requests for this type of restricted inspection are from packers, buyers, or carriers; they may be either the result of dispute or rejection of deliveries because of alleged high temperatures upon arrival at terminal warehouses; or the interested party is using the data as a part of a quality control program. Many times condition inspection will involve small lots of commodities not assigned to the Fruit and Vegetable Program. Do not examine or report conditions of commodities other than those assigned to our Division. Temperatures on such commodities may be taken and reported when they are part of a mixed load. Contact your immediate supervisor if you question the assignment of a commodity.

Inspection Request

It is very important to obtain sufficient information when taking applications for condition inspections on refrigerated and frozen products.

- If frozen, has the lot been thawed? If so, is it now refrozen?
- Does the applicant want the certificate restricted to condition and/or product temperature?
- Does the applicant want certification of quality, condition, and/or product temperature?

When taking the application, be sure the applicant understands the various options available.

- Inspection and certification may be restricted to temperature only. Inspection and certification may be restricted to condition only, condition meaning condition of containers and packaging, condition of product (no grade determination), and temperature of product.
- Inspection and certification may include a quality determination in addition to all of the condition criteria previously stated, except that no quality evaluations will be made on frozen product unless the product is frozen. See the AIM Inspection Series Certification Manual for conditions under which certification may be applicable.

Sampling

For Condition of Containers, follow sampling procedures outlined in the AIM Inspection Series Condition of Food Container Manual. For product quality, condition, and temperature, as a minimum use the single sampling plan in the regulations. Increase sample size as needed. Fill out the certificate of sampling as directed in the AIM Inspection Series, Sampling Manual with the following special notes:

- Record the time the product is sampled and temperature noted;
- Record pertinent information obtained from the rail car or truck temperature recording devices, thermometers, and any other useful information from the shipping documents;
- If the product is in a cold storage room and has recently been transferred from a “hot” carrier, attempt to locate documentation that may corroborate when the transfer took place; and
- Record the condition of the primary and secondary containers, especially noting stains, wetting, collapsed cases, etc.

Equipment used for Checking Temperatures

The quality of frozen foods changes with time and the temperature of storage. Packers, shippers, carriers, distributors, retailers and regulatory agencies are interested in the maintenance of proper temperatures for the protection of frozen products. One measure of control is to check the product at various points in the distribution channel to assure maintenance of proper temperatures.

A. Temperature quality control starts with the use of an accurate, reliable thermometer. There are various thermometers and instruments available to take temperatures of frozen foods. The most common types are:

   1. Metal dial thermometer, with the following characteristics:

      a. A pointed stainless steel stem, approximately 5 inches in length.

      b. A temperature range of at least -20 degrees F. to +120 degrees F. The high end of the range is suggested, so that, if desired, a record may be made of the ambient (outside) temperature at the time the commodity temperature is taken. Markings on the scale should be in 1 degree or 2-degree divisions.

      c. A hermetically sealed dial.

      d. A pocket carrying case to protect the thermometer.

   2. Electronic instrument, capable of registering temperatures very quickly. Most of these instruments have instantaneous adjustments that recalibrate in a matter of seconds.

B. Thermometers used for checking the temperatures of food products should be tested every week, or as often as is necessary to ensure their accuracy. See the "Calibration of Equipment" section of this manual for instructions on calibrating thermometers. Thermometer s must be handled carefully and should not be bent, dropped, handled roughly, or exposed to temperatures beyond those shown on it. Do not use a thermometer as a tool or probe. See the AIM Inspection Series, Sanitation and Safety Manual for sanitizing procedures for probes and thermometers.

Selecting Representative Samples

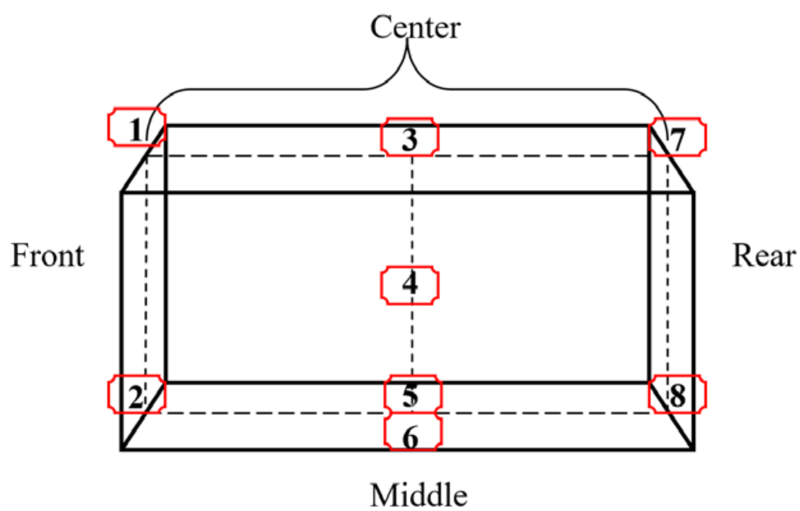
A. Warehouse Lots.

   Draw the number of samples specified in the single sampling plans as shown in the Regulations. Select the samples in accordance with the sampling procedures in the AIM Inspection Series Sampling Manual.

B. Railroad Car or Truck Lots

   At time of loading, test the product in several packages in the warehouse before the packages are loaded into the car or truck. Selecting the test packages is a matter of judgment; select them in such a way that their temperatures will be representative of the entire load.

When product is being unloaded, test the product in packages taken from the locations shown in the illustration on the next page. These packages should give product temperatures representative of the load. Additional packages may be tested if warranted, depending upon the type of product, appreciable cold or hot weather enroute, or other circumstances.



Suggested locations to select test packages in the car or truck:

1. Top, front, center
2. Bottom, front, center
3. Top, middle center
4. Half way up, middle, center
5. Bottom, middle, center
6. Bottom, middle, side (next to door if there is a side door)
7. Top, rear, center
8. Bottom, rear, center

Method I - Measuring Temperatures by Opening Samples

This method is recommended for precise product temperature measurement. It is sometimes referred to as "destructive" testing since some of the product is sacrificed during the process. However, in critical cases, the loss of product is small compared to the potential loss of the entire lot. Method I is always recommended for products in cans because it is difficult to obtain a firm contact between the thermometer probe and sidewall surfaces of the containers.

A. Use a probe to make a hole in the sample

Make a hole in frozen products with an ice pick, hand drill, or other pointed tool into which to insert the thermometer. The tool should be slightly larger (approximately 1/64 inch larger) in diameter than the diameter of the thermometer stem. This tool will be referred to hereafter as a probe.

B. Equalizing the thermometer

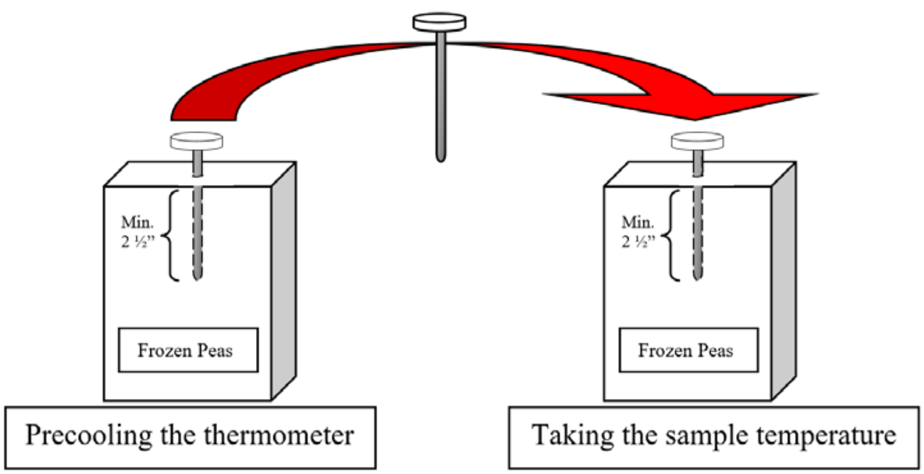
At least 5 minutes before using, place the thermometer and probe inside the car, truck, or warehouse where the product is stored in order to equalize their temperatures with the air surrounding the product. Because it may give a misleading temperature reading, avoid inserting a warm thermometer into a test package. Select a package at random from the load to precool the thermometer (referred to as the precool package). The product in this package is used to chill the thermometer stem before each insertion into a test package.

C. Taking the product temperature

Gently insert the point of the thermometer into the center of the precool package. If the thermometer cannot be inserted into the product by gentle pressure, use the probe to make a hole to the center of the product.

Leave the thermometer in the center of the product for at least 30 seconds. Do not remove it until you are ready to insert it into the test package.

Then remove the thermometer from the precool package and immediately insert it a minimum of 2 ½ inches to the center of the product in the test package (see illustration below). Wait at least 2 minutes and read the temperature. If several packages are being tested, the thermometer can be left in each test package until the next package is ready for testing.



Method II – Measuring Temperatures without Opening Samples

This method is sufficiently accurate for routine temperature checks. Whenever exact product temperatures are necessary, or in the case of any doubt or controversy, Method I should be used in lieu of Method II.

A. Equalizing the thermometer

Follow the same procedure as specified for Method I, Step No. 2.

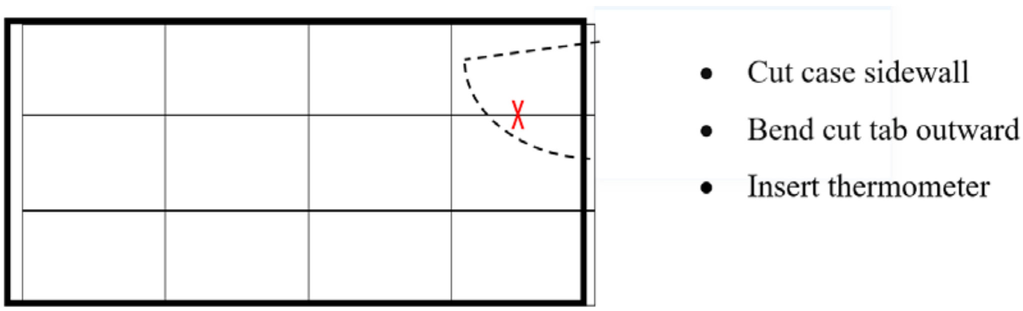
B. Selecting cases

Select 7 cases of frozen foods from the lot in question. Stack any 3 of the 7 on the floor area of the cold environment in which the lot is held.

C. Taking the temperature

Cut sidewall of the top case at one end with a sharp knife. Bend the cut tab outward. Insert probe of the temperature measurement device at about the center of the first stack of packages, and between the first and second layers of packages so that the entire sensing element is in firm contact with package walls (see illustration below). For poly bags, insert probe in the same direction as the length of the bag, deep enough for firm contact between bags. Stack the other 4 cases on top of the case containing the thermometer.

Read and record the temperature observed when the needle gives a steady reading. This is generally 5 minutes or less for a dial thermometer. Close and tape the cut sidewall area of the case.



Side View of Case Showing 12 Primary Cartons Within

Thawing Procedures

Frozen fruits and vegetables must be thawed to properly evaluate the characteristics of the product. Take care that during the thawing process the product is not damaged or exposed to abuse that will alter its true characteristics.

Frozen fruits are more susceptible to abuse during thawing than frozen vegetables. Red cherries and light colored fruits such as peaches and apricots will oxidize quite readily and should be examined for color while some ice crystals still remain in the product. Some fruits show breakdown in texture or "bleed" when thawed. When preparing the product for examination, rapid thawing under controlled conditions is ideal.

There are three general methods for thawing frozen fruits and vegetables:

A. Air Thawing
B. Water Thawing; and
C. Microwave Thawing.

Water and Microwave Thawing are faster but may not be suitable for all products. Products thaw at different rates. Frozen peas or broccoli thaw much faster than frozen leafy greens. Consequently, no specific time can be designated to accomplish adequate thawing. Through experience, the inspector will learn to judge the best procedure and time requirement for each commodity.

When air thawing is used, it may be desirable to speed the process by placing the cartons on a table so they are well separated by air space, and directing a stream of air from a fan on the packages.

A. Air thawing

1. Frozen Fruits

Fruits in closed containers may be air thawed until the product is sufficiently free from ice that individual units may be readily separated and handled. Rapid thawing is most desirable; a fan should be used to speed the process. Do not air thaw in open containers. Do not over-thaw.

2. Frozen Vegetables

Air thawing is an alternate procedure to water thawing for frozen vegetables. The air thawing method is suggested if there is suspicion of off flavors or odors. It should also be considered for products susceptible to insect infestation or sand and silt. Do not over-thaw.

B. Water thawing

1. Frozen Fruits

Fruits may be thawed in a water bath if they are in tightly sealed containers. Temperature of the water should not exceed 86ºF. Thaw only until the product is sufficiently free from ice that individual units may be readily separated and handled. A water bath should be used to thaw large bulk containers.

2. Frozen Vegetables

Most frozen vegetables can be thawed directly in water without degrading the product. Remove the product from the package and place it directly in the water at a temperature not to exceed 86ºF. As soon as the product is sufficiently thawed to permit easy separation of the units, drain on a suitable 8 mesh screen to remove excess water, and place the product on a tray for examination. Do NOT soak the product past the point of sufficient thawing. This is particularly important for products such as cut corn.

Some preliminary checking of frozen vegetables may be necessary if there is any indication or suspicion of an off flavor or odor. If a sample is questionable, do not use direct water thawing since any suspect flavor might be diluted by the water. Such product may be water thawed in tightly sealed containers or air thawed. Place any suspect sample in a covered cooking pan and cook for analysis of flavor and odor.

Some vegetables are susceptible to insect infestation, such as aphids and thrips, or sand and silt. In such cases, thaw the product in a suitable container, saving the water. Filter the water through a milk filter disk or white toweling and examine the filter for any extraneous matter present. Combine any material found in the thawing water with any additional material found by other means.

Note: Some vegetables have Defect Action Levels based on standard sample unit sizes and procedures. If so, use the standard procedure.

C. Microwave thawing

Microwave thawing is not recommended as a standard procedure for either fruits or vegetables because all or part of the sample unit may be changed in color or character by "hot spots." However, certain products, such as shredded hash browns and preformed potatoes can be quickly thawed to facilitate examination for defects and foreign material. After other factors have been evaluated, cherries may be completely thawed and warmed in this manner to facilitate pit determination.

If microwave thawing is used as a standard thawing procedure, it should only be done after careful experimentation with time and power settings to assure that no undesirable changes will take place.

D. Thawing Frozen Strawberries

These instructions are for thawing and sampling an entire institutional size container (weighing more than 10 pounds) of frozen strawberries. The product may be whole or sliced frozen strawberries, with or without packing medium. These instructions are <u>not</u> for individually quick frozen (IQF) strawberries.

1. In accordance with regulations, select containers to be used for samples. Allow all containers to thaw <u>unopened</u> following the procedures outlined in section G, “Thawing procedures”.

2. Leave the containers <u>unopened</u> until the strawberries are thawed. When the strawberries are sufficiently free from ice crystals and readily separable, stir the contents of the containers using a large spoon or ladle, being careful not to damage the strawberries.

3. After the contents of the containers are thoroughly mixed, draw a sample unit

weighing approximately three pounds from each container.

4. Follow the instructions in the current Grading Manual for Frozen Strawberries for the amount of strawberries to be used for quality and analytical testing.

Note: Determining the grade as soon as possible after thawing minimizes the risk of oxidation.

Verification of Frozen Sample Units

Under certain conditions, SCI Division inspectors may be called upon to inspect, grade and certify frozen fruits or vegetables using unfrozen sample units drawn from the production line. This is applicable to products packed in silos, drums, or bulk institutional size containers (over 10 pounds), and situations where frozen samples are examined at a later date, or where no frozen samples are examined.

Note: Frozen verification sample units must be examined for all retail and small institutional size packages (less than 10 pounds).

See the AIM Inspection Series, General Procedures Manual and Certification Manual for procedures to follow.

As a prerequisite to assigning the grade to frozen fruits and vegetables, the U.S. Standards state: “frozen in accordance with good commercial practice and maintained at temperatures necessary for the preservation of the product." Specific temperature limits are not prescribed, although it is generally recognized that proper storage temperatures for frozen foods should be zero degrees F or lower. A tolerance of 5 or 10 degrees must be made for conditions encountered during distribution in which the product may be temporarily held or handled in a manner that allows the product temperature to rise above zero degrees F. Private buyers and government agencies may have either more stringent or less stringent requirements.

While having no authority to prescribe freezing and storage temperatures, the Division supports the concept of "zero degrees F or lower". We recognize that we are often called upon to certify products in which the freezing process is not entirely completed and the product has not been reduced to a temperature of zero degrees F. In the absence of specific instructions otherwise, we will not certify the grade of a frozen product if the temperature is in excess of 15 degrees F. This does not mean that we condone temperatures above zero degrees F. It is merely an administrative allowance to facilitate inspection and certification prior to the completion of the freezing cycle.

A final U.S. grade shall not be assigned to a production lot until frozen product sample units have been officially drawn and evaluated, regardless of how many line check sample units have been taken. The total number of sample units examined must equal or exceed the minimum number required for the single sampling plan or time sampling plan for each lot size of one grade, style, container size, etc. To meet this requirement, it may be necessary to grade additional frozen sample units from the cold storage.

If an insufficient number of line check samples were drawn during production, a number of frozen sample units must be completely graded to meet the minimum number of samples required. However, if sufficient line check sample units were drawn to meet the minimum number of samples for the lot size, then the frozen sample units need only to be evaluated for those factors which may change during freezing, such as, color, character, and flavor. Frozen verification samples should be properly thawed following the procedures in Section G, "Thawing Procedures." The units should be separated to determine whether product deterioration was due to oxidation, crystallization, or other causes.

A. Sampling

The verification sample units should be drawn as duplicates of the line check sample units. The duplicate sample units should be marked for identification with the line check and to assist in retrieval from the cold storage. The verification subsamples should be handled, transported, and stored in the same manner as the bulk containers in the lot that it represents.

Note: The above procedure is not applicable to drums and other large containers where verification subsamples are taken from the processing line.

When verification results indicate product condition is abnormal or product quality has been impaired, the line check results cannot be considered reliable. Samples must be drawn from the cold storage for complete grading at the sampling rate indicated in the Regulations, and the AIM Inspection Series Sampling Manual.

If specific instructions indicate that the examination of more frozen sample units is necessary, follow those instructions.

B. Sample size

When the cold storage is located where the product is produced, and the freezing results in product that retains its initial quality characteristics, then the minimum sample size for verification of frozen product is one frozen sample unit per shift from each lot of a single grade, style, and container size, regardless of the size of the lot.

When the cold storage is located at a different location from the processing plant, and conditions under which the product is transported and stored are not known, then the sample size for verification of frozen product shall be in accordance with the table below.

Sample Size for Verification of Frozen Products

Sample Size Drawn for Quality	3	6	13	21	29
Sample Units Drawn for Verification	1	2	3	4	5

C. Recording verification results

When there is a U.S. grade standard, product verification results will be recorded as score point values, or quantity and type of defects found, or by letter grades. If there is no U.S. grade standard, use the appropriate descriptive terms to describe a quality level (see AIM Inspection Series General Procedures Manual).

E. Re-inspection of affected lots

When temperatures of affected lots are reduced to acceptable levels in storage, they may be sampled, re-inspected and certified as to grade. The normal sampling rate for such re-inspections will be determined from the appropriate table in the Regulations.

After three consecutive lots have been re-inspected using the normal sampling rate, a reduced rate may be considered. This rate will be based on the inspector's knowledge of the product, and the ability of the processor to reduce high temperature production to certifiable levels quickly without detrimental effects on product quality. In any event, the inspector must sample and completely inspect a sufficient number of sample units to assure the correct certification of the lots as "frozen".

F. Approved identification

It is necessary to protect the integrity of production that has been packaged under "Approved Identification," marks. In this case, a lot with temperatures 16 degrees F or higher must be placed on "hold" until a final grade can be determined. Should this lot be found to be substandard or a lower grade than indicated, the marks must be removed before the product leaves the plant. (See the AIM Inspection Series General Procedures Manual, and the Regulations.)

G. Cautions and exceptions

These instructions do not apply when inspection and certification are based on a specification or exceptions which conflict with the temperature limits set forth.

Examples of such conflicts are:

1. The temperature limit of + 5 degrees F that is required for frozen concentrated citrus products,

2. The temperature requirement of zero degrees F that is established in the standards of identity for frozen peas,

3. The requirements that are established by either USDA or DSCP for purchases of frozen foods, or

4. The following on-line temperature exception for frozen french fried potatoes. This exception does not apply to frozen hash brown potatoes. When temperatures of frozen french fried potatoes checked off the line are between 16 and 19 degrees F, the product may be given a final grade and certified only if:

   a. It has been placed in zero degrees F (or less) storage temperatures for a minimum of 24 hours.

   b. The inspector verifies storage temperatures on a daily basis.

Cooking Procedures

Final examination of many frozen products requires preparation by cooking, particularly frozen vegetables. In some cases, cooking is required for product examination of texture, tenderness or maturity. In other cases there may be a question regarding the flavor of the prepared product.

Most frozen vegetables are blanched or partially precooked during preparation for freezing. The freezing process softens the tissues, and frozen vegetables require only from one-third to one-half as much cooking time as does the fresh product. Take care to neither overcook nor undercook the product.

When checking flavor, take care to prevent dilution of any off or objectionable flavors by exposure to excessive water. Suspect containers can ordinarily be identified by odor as the package is opened and prepared for inspection. If an off-odor is noted, the container(s) should be evaluated for flavor.

A. Sample selection

Generally, we do not take a separate set of samples strictly for cooking purposes. The exception might be in the case of bulk or institutional type containers, when enough product is available that a portion of each container can be allocated for visual examination, chemical or physical tests, and (in the frozen state) for cooking. Usually the inspector will only have the same samples used to evaluate other product characteristics available for cooking. With this in mind, complete testing can be performed by careful segregation and planning during the process of product examination.

In the case of retail size packages (16 ounces or less), all of the container packages may be partially or completely air thawed and checked for suspect off-odors and flavors. Portions of suspect samples should be cooked for further odor and flavor evaluation. If the odor of the thawed product is normal, proceed with product examination and cook representative portions of the samples for whatever checks may be required. If the packages are very small, it may be desirable to draw additional containers for cooking purposes only.

Note: Inspectors shall note on the applicable tally sheet or score sheet which sample units were cooked.

B. Seasonings

For the purpose of laboratory testing, it is recommended that seasonings such as salt, sugar, butter, vinegar, or spices be avoided; such additives may cover up undesirable or off-flavors that may be present.

C. Cooking method

Most vegetables are cooked without thawing. However, for inspection purposes, it may be necessary to cook a product that is partially or completely thawed since portions of the sample may have been used for other examinations or tests. Be guided by the standard for the product.

The following steps will assure uniformity in the cooking of frozen vegetables for test purposes:

1. Using a two-quart saucepan, bring about 180 ml of water to a boil and add approximately 8 ounces (225 grams) of product to the pan.

2. Bring contents to a rapid boil and continue to heat sufficiently to maintain a rolling boil.

3. Start timing the cook from the moment the water returns to a boil after the vegetable is added.

4. During the cooking process, keep a reasonably tight-fitting cover on the pan to avoid excessive loss of water.

5. Continue the cooking for the period of time specified for the product (see the recommended cook times).

Note: Cooking time may vary within range specified depending upon variety, maturity, size of pieces, and degree of blanching. See label cook time.

6. At the end of the cooking period, drain any excess water and place the cooked product on a tray.

7. Allow to cool sufficiently to be comfortably warm and make the required organoleptic tests.

D. Recommended cook times:

The following table is the recommended cook time for various products:

Product	Time (Minutes)
Asparagus, small and medium sizes	5 to 7
Asparagus, large and very large sizes	7 to 9
Green Beans	8 to 10
French Cut Green Beans	4 to 6
Italian Green Beans	4 to 6
Lima Beans (thin seeded)	15 to 18
Lima Beans (thick seeded)	12 to 15
Broccoli	5 to 7
Brussels Sprouts	8 to 10
Carrots	6 to 8
Cauliflower	3 to 5
Corn (whole kernel)	2 to 4
Corn-On-The-Cob	3 to 5
Leafy Greens:	
Collards, Kale, Mustard, Turnip	20 to 25
Spinach (leaf)	3 to 4
Spinach (chopped)	2 to 4
Mixed Vegetables	9 to 12
Okra	8 to 10
Peas	3 to 5
Black eye or Field Peas	40 to 45
Peas and Carrots	6 to 8
Squash (summer)	5 to 7
Succotash	8 to 10

Fruit – Sugar Ratio

Determination and certification of proportion of fruit to packing medium is an important element in the inspection and certification of frozen fruits. This is valuable data for both the seller and buyer, especially if the product is intended for further processing into jam or preserves. For these products, it is essential that the user know the fruit content (or proportion of fruit to packing media) in order to adjust the formula to meet mandatory Food and Drug Standards of Identity. These require a minimum of 45 parts of fruit ingredient (exclusive of added sweeteners) to each 55 parts of sugar solids.

The fruit and sugar content of frozen fruits and berries is not a requirement of the United States Standards, and an official form for calculating Fruit-Sugar ratios, or noting observations that confirm the ratio being packed has not developed. However the product needs to be packed in accordance with good commercial practice, and must also conform to provisions of the Federal Food, Drug, and Cosmetic Act with respect to labeling. Even for products not covered by mandatory standards, it is important for the user to have reasonable assurance of the fruit content of the frozen fruit ingredient as well as the quality of the finished product.

Many buyers specify a proportion of fruit to sugar as a part of their requirements. Berries and fruits are packed with varying amount of added sugar, ranging from a "straight pack" with no added sugar, to what is known as 7 + l, 6 + l, 5 + l, 4 + l , 3 + l, etc. Unless otherwise specified, these ratios are understood to mean a dry sweetener rather than a liquid packing medium, and sucrose rather than other sweeteners. The first number indicates the proportion of fruit and the second number the proportion of sugar. For example, a 3 + 1 pack means 3 parts by weight of fruit and 1 part by weight of dry sugar.

Some fruits are packed with a liquid sweetened packing medium and may be labeled to indicate the proportion of fruit to liquid media as "5 parts fruit to l part 60 degrees Brix syrup." These ratios such as 5 + 1 could be expressed as “5 to 1”, “5 x 1”, or “5 : 1,” all meaning the same thing.

Assuming the merchandise is accurately labeled or represented, the buyer or receiver can readily ascertain the weight of fruit ingredient and the weight of sugar in a given container or lot.

For example, the proportion of ingredients in a 400-pound barrel of frozen berries packed with different declared proportions of fruit and sugar is calculated as follows:

Example: If declared as 5 + 1 (5 parts fruit, 1 part sugar), then $^{5}/_{6}$ of the contents is fruit and $^{1}/_{6}$ is sugar.

Fruit = ($^{5}/_{6}$) (400) or 333 $^{1}/_{3}$ pounds
Sugar = ($^{1}/_{6}$) (400) or 66 $^{2}/_{3}$ pounds

Example: If declared as 3 + 1 (3 parts fruit l part sugar), then $^{3}/_{4}$ of the contents is fruit and $^{1}/_{4}$ is sugar.

Fruit = ($^{3}/_{4}$) (400) or 300 pounds
Sugar = ($^{1}/_{4}$) (400) or 100 pounds

Example: If declared as 4 parts fruit and 1 part 60 degrees Brix syrup, then $^{4}/_{5}$ of the contents is fruit and $^{1}/_{5}$ is packing medium.

Fruit = ($^{4}/_{5}$) (400) or 320 pounds
Syrup = ($^{1}/_{5}$) (400) or 80 pounds

Calculate the amount of added sugar in the packing media as follows:

60 degrees Brix syrup means 60 percent sugar solids.

(80) (0.60) = 48 pounds of sugar solids, and the remaining 32 pounds is water from the liquid packing medium.

However, the precision of these figures depends on the accuracy of the packer in maintaining the correct fruit and sugar proportions during processing. Direct observation of the processing operation is the most reliable method for determining fruit-sugar ratio.

Verification of Fruit – Sugar Ratio: In-Plant Inspection

Processors may need to ascertain the fruit-sugar ratio of products in order to formulate for various receivers, or to meet mandatory FDA requirements. The proportion of fruit to sugar or liquid packing medium may be determined and certified under the following conditions:

A. When packed under USDA In-Plant Inspection, with the inspector present to make suitable checks verifying the declared fruit-sugar ratio during the entire packing operation of the specific lot;

B. When the plant facilities are such that suitable checks can be made during packing operations; and

C. When a sufficient number of checks are made to certify the ratio with a reasonable degree of reliability.

Inspectors must determine and verify the proportion of fruit to sugar or liquid sweetener under the following circumstances:

D. Whenever the containers are labeled to indicate a specified ratio, and in addition bear approved identification marks. The USDA has put its stamp of approval on the product, not only for quality but also for fruit-sugar ratio.

E. When an inspector is assigned to plants packing jams (preserves). Frequent checks should be made on the raw material to determine the fruit-sugar ratio or proportion of fruit to liquid packing media.

F. Whenever a lot is offered on a government contract requiring that the fruit-sugar ratio be determined.

It is optional for the packer to determine fruit – sugar ratio on containers of less than or equal to 10 pounds that are not labeled to indicate a specific ratio.

USDA inspection certificates including the label declaration for fruit-sugar ratio may be misinterpreted by the trade to mean that the USDA inspector has verified that declaration, particularly if he or she is in-plant during the packing operation. When such verifications are not made, the inspection certificate should state that the fruit-sugar ratio was not determined.

Even if an applicant does not require a certification of fruit-sugar ratio, inspectors assigned to plants should ascertain that the fruit is properly drained, and that there is no unreasonable deviation in compliance with the declared or indicated fruit-sugar ratio.

G. Checks for fruit – sugar ratio under in-plant inspection

Inspection and certification of fruit-sugar ratio should be based upon numerous determinations made during processing to allow for reasonable variation between individual containers. These are to be expected, even under carefully controlled packing conditions. The in-plant inspector should use the method or combination of methods that will best work with that particular plant's processing system. Whenever possible, checks should be made by more than one method.

Checks should start with observing that the fruit or berries are well drained after washing.

Checks may include:

1. Physical checks of the amount of fruit, sugar or packing media (or both) being packed into individual containers. Procedures will depend upon the plant's operations.

   a. If dry sugar is being used and the fruit and sugar are being weighed separately, check the accuracy of the scales or metering devices by periodic observations of the weighing operation, and by physically weighing the amount of each product being dispensed by such devices.

   b. If a liquid packing medium is being added, check the actual weight of fruit in numerous containers prior to the addition of syrup. Determine the proportion of fruit to syrup based on weight of fruit in relation to the weight of the entire container.

2. Check of the amount of sugar used and number of containers packed over a given interval of time. If the fruit is being mixed with dry sugar in a continuous mixer, check the number of containers packed out from a given number of bags or other measured quantity of sugar over a reasonable time interval. Determine the fruit-sugar ratio based on number of containers packed, and quantity of sugar used during that period. Even though there will be variation between individual containers, this will represent an average value for the entire quantity packed.

3. Checks of the soluble solids. If direct measurements of fruit and sugar cannot be made, the ratio can be determined with the soluble solids of both the in-going fruit prior to adding sugar, and that of the finished product.

See APPENDIX XII for an example of an Optional Worksheet for Fruit/Sugar Ratio.

IN ALL CASES, IT IS IMPORTANT THAT THE INSPECTOR IS ASSURED THAT THE FRUIT OR BERRIES ARE PROPERLY DRAINED AFTER WASHING PRIOR TO MIXING WITH SUGAR.

H. Estimation based on direct measurement of fruit or packing media in individual containers

Some plants weigh out a specified quantity of fruit in each container and then add a measured amount of sugar or syrup to make up the required net weight. In such instances, observe the operation at unannounced intervals and make periodic checks on the weighers.

Some plants may layer the fruit into the container together with sugar added by means of a measured scoop rather than by weight. In such instances, the sugar is generally received in 100 pound bags and dumped into a tub or vat located adjacent to the filler. The fruit-sugar ratio may be assessed by counting the number of bags of sugar and the number of containers packed over a specified interval. For example:

Over a 5-minute period, 400 pounds of sugar were used in packing 50 containers of fruit in 50 pound cans of a specified 5 + 1 ratio.

50 cans at 50 pounds each = 2500 pounds finished product.
5 + 1 ratio means $^5/_6$ fruit and $^1/_6$ sugar.
($^1/_6$) (2500) = 416 $^2/_3$ pounds of sugar.

Therefore, the packer is complying reasonably close to the declared ratio since the theoretical quantity of sugar needed is 416 $^2/_3$ pounds, and the packer actually used slightly less, or 400 pounds. To look at it from another perspective, 2083 ⅓ pounds of fruit was needed, but 2100 pounds of fruit was used.

In the case of fruit packed with a liquid packing media, the fruit content can best be determined by periodically checking containers prior to the addition of the syrup. Generally the fruit is added to the container and then passed beneath a syruper which adds a measured quantity of syrup. For example, frozen raspberries packed in 10 pound cans with a declared ratio of 4 parts fruit and 1 part syrup would be expected to contain a fruit weight of 8 pounds ($^4/_5$ x 10) per container.

I. Estimation based on soluble solids

The use of soluble solids as a means of estimating the fruit-sugar ratio is not as reliable as direct checks on the amount of fruit used in relation to the amount of sugar used. However when these direct checks cannot be made, the soluble solids method is probably the best alternative procedure. This method does have potential disadvantages:

1. It may be difficult to obtain a sample of the finished product that can be positively identified as originating from fruit of a specific soluble solids reading. However, if the fresh fruit does not vary substantially during the packing period, this error is not significant.

2. Numerous samples to determine fruit content must be checked because of the variation in the proportion of the fruit and sugar that can be expected from container to container.

3. As is true of any method of estimation, excess water adhering to the berries after washing will lower the Brix value of the finished product, and tend to distort the true fruit-sugar ratio. When water is calculated as part of the fruit component, the results indicate more fruit content than was actually provided.

   Despite the potential for error, the ratio of fruit to sugar may be estimated with a reasonable degree of accuracy. The more samples taken throughout the day, the more the average ratio obtained will compensate for errors in individual samples. Follow this procedure:

   a. Obtain a representative one-pound sample of the in-going fruit before processing. If the fruit is washed, select the sample immediately before mixing with the sugar. Do not drain the sample any more than is normally accomplished during processing.

   b. At approximately the same time, obtain a sample of the finished product prior to freezing. This sample should be selected and prepared as follows:

      (1) If retail size containers, select a sufficient number simultaneously from the line to make an approximate 2 pound composite (e.g. three 10-ounce cartons or two 16-ounce cartons).

      (2) If institutional size (e.g. No. 10 cans), thoroughly mix the entire container and select a representative 3 pound subsample.

      (3) If bulk containers, such as 30 pound cans or barrels, catch approximately 15 pounds from the filler, mix thoroughly, and select a representative 3 pound subsample. This method can only be used with continuous or pre-mixing filling operations, not independent or layered fill.

   c. Place the finished product sample above in a blender or other mechanical mixer, and comminute until it is thoroughly mixed and homogeneous.

d. Place a drop of the filtrate from this comminuted mixture (filtered through a rapid filter paper if needed) on the refractometer prism, and determine the Brix reading. Make any necessary temperature correction.

e. Follow steps 3 and 4 above to determine the soluble solids of the in-going fruit obtained before mixing with sugar.

f. Knowing the soluble solids of both the in-going fruit and the finished product, calculate the proportion of fruit to sugar as follows:

$$R = \frac{100 - Ps}{Ps - Fs}$$ in which

R = Ratio of fruit to sugar.

Ps = Soluble solids of finished product (fruit plus sugar).

Fs = Soluble solids of in-going fruit.

Example:

The soluble solids of fresh peaches is 12.2. The soluble solids of the finished product (peaches plus dry sugar) is 31.8.

The fruit-sugar ratio is calculated as follows:

$$R = \frac{100 - 31.8}{31.8 - 12.2}$$

$$R = \frac{68.2}{19.6}$$

R = 3.48

If the product were labeled or specified as a 3.5 to 1 ratio, the actual proportion of fruit to sugar (3.48 to 1) would meet requirements.

J. Ratio determination frequency guidelines (in plant)

If the fruit and sugar (or liquid sweetener) are being weighed or metered into individual containers, the inspector should check samples for accuracy at approximate hourly intervals for each line. If the results remain satisfactory, this frequency should be adequate.

If the fruit and sugar are being mixed in a continuous type mixer and the determination is based on soluble solids, samples of the fresh fruit should be checked at approximate hourly intervals.

Samples of finished product should be checked according to the following schedule:

First 8,000 pounds	3
Each additional 8,000 pounds	1

For example, if a line is capable of producing 10,000 pounds per hour for an 8-hour shift (80,000 lbs), check 3 samples for the first 8,000 pounds, and check 9 samples during production of the next 72,000 pounds, for a total of 12 samples for the shift.

These are minimum sampling rates and should be increased if warranted. Keep in mind that the more frequent the checks, the more reliable the lot estimate.

Verification of Fruit – Sugar Ratio: Lot Inspection

As a general rule, fruit-sugar ratio will not be determined or certified under lot inspection. Fruit-sugar ratio results based solely on the finished product are not fully reliable. However, if specifically requested by the applicant, the ratio may be estimated as follows:

A. If the lot can be identified as having been packed under In-Plant Inspection, the fruit-sugar ratio may be certified, if the records compiled at time of packing substantiate the declared ratio. See the section on In Plant Inspection for key measurements for ratio determination. Information may be obtained from the SCI Division field office involved.

B. If there is no history on the lot, the fruit-sugar ratio can be estimated using the average natural solids for the specific fruit. The reliability of this testing depends upon the degree to which the in-going fruit conforms to average values established for that fruit, as well as the integrity of the packer in observing good commercial practice during processing. Certification will be restricted to finished product examination only.

Particularly for retail packs, some buyers base their specifications on finished soluble solids and not on a specified ratio. For example, the buyer's specification may indicate that the finished product solids must be in the range 25 to 28 degrees Brix. In these instances, determine the solids and report the findings in terms of soluble solids with no conversion to fruit-sugar ratio.

If the applicant requests a fruit-sugar ratio on the finished product, the most reliable means of checking the fruit content is by measuring the soluble solids. See In Plant Inspection., Estimation based on soluble solids for the procedure and formula used for calculating the theoretical fruit-sugar ratio. Under these circumstances, a figure representing the average solids of the fresh fruit is substituted for the soluble solids of in-going fruit, since the actual solids of the in-going fruit is unknown.

This procedure involves comminuting the entire container for the solids test, and checking a representative number of containers to estimate the ratio with reasonable accuracy. The applicant should be informed ahead of time that full containers must be taken for the test, and the inspection will be lengthy due to the time it takes to prepare the samples.

C. The "authentic values" referred to in this section are based on Food and Drug data prepared by examining numerous samples of the respective fruits or berries, and is summarized in the Journal of the AOAC, Vol. XXI, No. 3, August 1938.

Average Authentic Values for the Most Common Fruits and Berries

Apples	13.7
Apricots	14.4
Blackberries	10.0
Cherries	13.9
Crabapples	15.4
Currants	10.6
Figs	19.0
Gooseberries	8.2
Guavas	7.6
Loganberries	10.6
Grapes	14.1
Peaches	11.8
Pineapples	14.6
Plums	14.8
Raspberries (red)	10.5
Raspberries (black)	11.2
Strawberries	8.0

Example of calculation for frozen strawberries:

Ps (soluble solids of product) = 28.4

Fs (soluble solids of authentic fruit) = 8.0

$$R = \frac{100 - 28.4}{28.4 - 8.0}$$

$$R = \frac{71.6}{20.4} \text{ or } \mathbf{3.50}$$

1. There are limitations and potential errors in using soluble solids as an estimation of fruit content:

   a. The entire contents of container must be comminuted, leading to destruction of the product. In addition, this can be time consuming especially in the case of bulk containers.

b. If the fresh fruit varies materially from the established authentic values, results will be questionable.

c. Improper draining of washed fruit, or the addition of water materially affects the ratio. This is a very significant factor, as shown by the following example.

Assume a processor is packing strawberries to a declared ratio of 4 + 1, that the strawberries have a soluble solids of 8.0 percent, and that for each 100 pounds of finished product, 8 pounds of water is unintentionally added through improper draining.

(1) For each 100 pounds there should be 80 pounds of berries and 20 pounds of dry sugar.

80 lbs. fruit at 8 percent solids = 6.4 lbs
20 lbs. sugar at 100 percent solids = 20.0 lbs
Theoretical solids of finished product = **26.4** lbs.

Applying the formula in Section B., Estimation based on soluble solids, this ratio is: $\frac{100 - 26.4}{26.4 - 8}$ or $\frac{73.6}{18.4}$ or **4.0:1**

(2) However there will actually be 72 pounds of berries, 8 pounds of water, and 20 pounds of dry sugar.

72 lbs. fruit at 8 percent solids = 5.76 lbs
8 lbs. water at 0 solids = 0 lbs
20 lbs. sugar at 100 percent solids = 20 lbs
Finished productsolids = **25.76** lbs.

Rounding up and applying the formula as above, this ratio is:

$\frac{100 - 25.8}{25.8 - 8}$ or $\frac{74.2}{17.8}$ or **4.2**:1

From the soluble solids values, this makes it appear that the packer is being generous with the fruit, while he has actually substituted 8 pounds of water for 8 pounds of fruit. This illustrates the importance of checking that the fruits used in processing are properly drained.

D. Ratio determination frequency guidelines (lot inspection)

If an estimate is required on lot inspection and there is no previous history of the lot, entire containers must be checked. For lots of 20,000 pounds or less, make a minimum of 6 determinations. For lots in excess of 20,000 pounds, make a minimum of 13 determinations. If the lot is very large, increase the number of determinations at the rate of 6 for each approximate 50,000 pounds in excess of 100,000 pounds.

In the case of large containers, this sampling rate may appear rather high. However, it is necessary to assure a reliable estimate.

Determining Lot Acceptance

Depending upon the product and packing practices, a reasonable deviation in fruit-sugar ratio between individual containers is to be expected. Lot acceptance is based on the average value of numerous ratio determinations. However, there is also a limit on individual sample deviation. To be in compliance with the declared or specified ratio, the following criteria must be met.

A. For the average of all samples, allow a tolerance of 0.2 ratio below declared or specified ratio, and 0.2 ratio above declared or specified ratio.

B. All individual determinations must be within the range of plus or minus 4 degrees of the soluble solids value corresponding to the declared or specified ratio, except:

1. Individual checks that exceed the 4 degrees limitation is allowed at a tolerance equal to the deviant rate (1 in 6, 2 in 13, etc), provided:

(a) No individual determination is more than plus or minus 8 degrees of the soluble solids value corresponding to the specified ratio.

Example: Frozen Strawberries packed to a 4 plus 1 ratio, fresh fruit solids of 8 percent. The theoretical solids of the finished product of a 4 + 1 ratio should be 26.4.

- the average of all the determinations must be not less than 3.8 nor more than 4.2 ($4 \pm .2$ for the ratio);
- no more than 1 in 6, 2 in 13, etc. may be less than 22.4 degrees nor more than 30.4 degrees soluble solids (26.4 ± 4 degrees); and
- no individual may be less than 18.4 degrees nor more than 34.4 degrees soluble solids (26.4 ± 8 degrees).

These guides are intended to allow for reasonable variations under normal packing procedures. For products that are closely controlled by direct measurement, this allowance for individual samples may seem rather liberal. However, in the case of products like frozen strawberries, experience has shown that a reasonable tolerance must be permitted. This doesn’t mean that packers should be permitted to continually fall below requirements or take advantage of the administrative guides outlined above. If the inspector finds that the plant has a tendency to be slightly low on the amount of fruit used relative to sugar or packing medium, this deviation should immediately be called to the attention of plant management for correction.

GOOD COMMERCIAL PRACTICES

Counts

Unless otherwise specified, when either a count range or a specific count (even if qualified by the word "approximately") is declared on a label or specified by a purchaser, criteria for "good commercial practice" shall apply.

A lot will be considered as complying with requirements of good commercial practice under the following conditions:

- Average of all sample units meet the declared or required count; and

- Fifty percent or more of the sample units meet or exceed the declared or required count.

Range of Counts Guide for Good Commercial Practice

A. When a range of counts is specified or declared, counts in all sample units must fall within this range. Sample units with counts not falling in this range are allowed as deviants as specified in the Regulations (in addition to quality deviants), provided these counts do not exceed the limits outlined below.

1. Sliced Pineapple

a. Counts up to 20 Slices or 40 half Slices

Allow 1 slice or 2 half slices less than the lower end of the range, or more than the upper end of the range.

b. Counts Over 20 Slices or 40 Half Slices

Allow 5 percent by count less than the lower end of the range, or more than the upper end of the range.

2. Other Processed Products

a. Counts up to 20 Units

Allow 2 units less than the lower end of the range, or more than the upper end of the range.

b. Counts over 20 Units

Allow 10 percent by count less than the lower end of the range, or more than the upper end of the range.

Specific Count Guide for Good Commercial Practice

A. When a specific count is declared or specified, count in sample units may vary above and below this number within the limits shown below. Sample units with counts that deviate from these limits are considered deviants (in addition to quality deviants) as specified in the Regulations. If the deviation is considered excessive for current packaging practices, then a 1 in 48 allowance should be applied.

1. Sliced Pineapple

a. Counts up to 20 Slices or 40 Half Slices

Allow 1 slice or 2 half slices less than the specific count.
Allow 2 slices or 4 half slices more than the specific count.

b. Counts over 20 Slices or 40 Half Slices

Allow 5 percent by count less than the specific count.
Allow 10 percent by count more than the specific count.

2. Other Processed Products

a. Counts up to 20 Units

Allow 1 whole or half unit less than the specific count.
Allow 2 whole or half units more than the specific count.

b. Counts Over 20 Units

Allow 5 percent by count less than the specific count.
Allow 10 percent by count more than the specific count.

DRAINED WEIGHT

Although generally not a factor of quality, drained weight of processed fruit and vegetable products is an important marketing consideration. It indicates the amount of fruit or vegetable ingredient in relation to packing media, and sometimes the degree to which a product may have disintegrated during processing and handling.

A. Drained weight considerations:

1. Most U.S. standards for canned fruits and vegetables contain a recommended drained weight consistent with good commercial practice;

2. Drained weight can be a requirement in purchase specifications (i.e., USDA Commodity Specifications);

3. Drained weight may be a requirement in a buyer-seller contract;

4. Drained weight is a limiting quality factor in Canned Tomatoes;

5. Drained weight is a Food and Drug mandatory requirement in the standard of fill for Canned Fruit Cocktail, Mushrooms, Canned Tomatoes, and Canned Crushed Pineapple;

6. Drained weight is the common labeled statement of contents for a few products, such as Canned Olives and Canned Mushrooms; and

7. Drained weight requirements or recommendations may vary for the same product in the following cases:

   a. Maturity - as in Canned Whole Kernel Corn

   b. Count - as in Canned Pears and Canned Plums

   c. Size of units - as in Canned Green and Wax Beans

Limits of Good Commercial Practice

Unless specified in the U.S. Standards for Grades or other inspection documents, compliance with the minimum drained weight recommendations will be determined by the following criteria.

- The average of all sample units in the lot must meet the minimum; and

- There shall be no unreasonable shortage in any individual container.

Determination of "Unreasonable Shortage"

Unless specifically covered by an inspector’s instruction or a U.S. standard, the following administrative guide applies to all canned fruit and vegetable products. The drained weight of no container may be as follows, whichever is the lesser drained weight.

- Less than 45% of the container’s water capacity, or

- More than the weight of one average size unit of product below the recommended or required minimum

Averaging Drained Weights of Codes within a Lot

Drained weight averages for individual codes, shifts, or portions of shifts in a lot may be less than the required minimum average but may not be unreasonably low. Averages failing the criteria below are considered unreasonably low.

A. Limits for low average drained weights:

1. No. 2 ½ can size and smaller

   95% of the minimum requirement or 0.5 ounces low, whichever is the lesser weight.

2. Containers larger than No. 2 ½ can size

   97% of minimum requirement or 1.0 ounce low, whichever is the lesser weight.

Procedures for Frozen Products In-Plant or Lot Inspection

A. Drained weight is not taken routinely on frozen food. However, it may be determined upon request of the applicant, and it should be taken where there is evidence that the product may contain excessive ice.

1. Retail Packages

   After obtaining gross weights, allow containers to thaw at room temperature (approximately 70 ºF), or immerse the packages in water circulated and maintained at 68 ºF plus or minus one degree. If packages are not watertight, place in a suitable plastic bag, remove as much excess air as possible and tie off. Avoid agitation of packages during thawing by using clamps or weights if necessary. When the center of package reaches approximately 30 ºF, remove from bath, blot off adhering water, and open with minimum agitation.

   Tare a No. 8 mesh sieve. Use an 8-inch diameter sieve if the container holds 16 ounces or less, and a 12 inch sieve if more than 16 ounces. With the screen tilted about 2½ inches and supported for drainage, distribute the contents of the package evenly over the screen in one sweeping motion. Drain for exactly two minutes, reversing the tilt of the screen after one minute.

2. Bulk Containers (principally fruits)

   After obtaining gross weights, allow the unopened containers to thaw at room temperature (approximately 70 ºF) until the product temperature in the center of the container is approximately 30 ºF.

Divide the thawed samples into four or more aliquots with each increment not to exceed 8 pounds and drain two minutes on a tilted 12 inch No. 8 mesh sieve, reversing the tilt of the screen after one minute. The combined weight of the four or more aliquots is the drained weight of the product.

Do not allow center temperatures to exceed 40°F prior to determining drained weights on retail or bulk containers.

3. In-line Control

a. Sampling

Subgroups of 3 may be taken every 30 minutes to provide a good in-line control on fill. The subgroups are drawn prior to freezing at a point where no further change in the net weight is likely to occur.

b. Tare

Tare weights should be determined as outlined in the AIM Inspection Series, General Procedures Manual.

c. Net Weights

Net weights should be determined as outlined in the AIM Inspection Series, General Procedures Manual. Immediately after the subgroup has been drawn, determine the net weight of each of the 3 sample units. They may be recorded on a $\bar{X}$ Data Sheet similar to the example on page 144.

d. Drained Weights

Drained weights are determined as follows and may be recorded on a $\bar{X}$ Data Sheet.

(1) Tare a No. 8 mesh sieve appropriately sized for the container.

(2) With the screen tilted about 2½ inches and supported for drainage, distribute the contents of the package evenly over the screen in one sweeping motion.

(3) Drain for exactly two minutes, reversing the tilt of the screen after one minute to release any water that may be on the flange.

(4) The weight of the sieve and product minus the weight of the dry sieve is the drained weight.

(5) The subgroup average of the net weights minus the subgroup average of the drained weights is the subgroup average of the weight of water.

e. Calculations

All calculations are to be made to the nearest 0.1 ounce. Calculate $\bar{X}$ (subgroup average) separately for the net weights and drained weights. These values may be recorded on the $\bar{X}$ Data Sheet opposite $\bar{X}$.

Determine $\bar{X}$ for the weight of water for each subgroup by subtracting the drained weight subgroup average from the net weight subgroup average. This value may also be recorded on the $\bar{X}$ Data Sheet opposite $\bar{X}$ (wt. of water).

At the end of each shift or production day run, calculate $\bar{X}$ for drained weights and $\bar{X}$ for weight of water by adding the approximate $\bar{X}$ values and dividing by the number of $\bar{X}$ values. If using the $\bar{X}$ Data Sheet, record these $\bar{X}$ values in the upper right-hand corner of the sheet.

f. Plotting

The $\bar{X}$ values (individual drained weight values) and the $\bar{X}$ values for drained weights representing each subgroup are plotted on the upper portion of a control chart. The $\bar{X}$ values for the weight of water are plotted on the lower portion of the control chart.

g. Limits

Warning limits and reject limits will vary with the product.

4. Limitations

These instructions <u>will not apply</u> to products for which special procedures have been developed. An example is the inspection of Strawberries under the State of California Marketing Order.

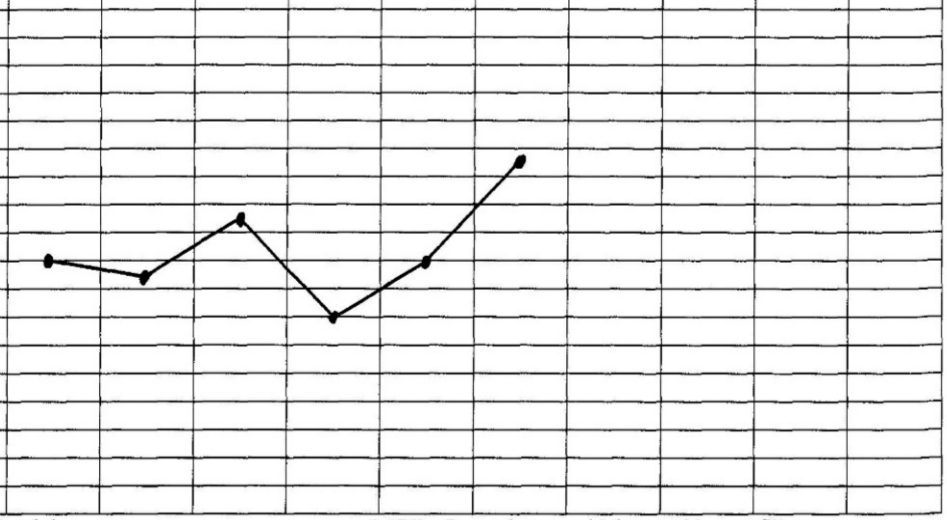
Example of a Statistical Weight Log:

MATTHEW'S CANNING COMPANY
STATISTICAL WEIGHT LOG

DATE: April 17, 2010 **PRODUCT:** FCOJ **CAN SIZE:** 24/12 oz **INSPECTORS:** A. Simmons A. Simmons

CODE	ABC 12A	→	→	→	ABC 12B	→				
BRAND	Jared's Juice	→	→	→	→	→				
TIME	0630	0712	0739	0801	0847	0910				
1	12.04	12.00	12.05	12.00	12.01	12.09				
2	12.00	12.00	12.04	11.98	12.00	12.07				
3	11.96	11.98	12.00	11.90	11.98	12.06				
	36.00	35.98	36.09	35.88	35.99	36.18				
$\overline{X}$	12.00	11.99	12.03	11.96	12.00	12.07				
	.00/1	-.01/2	.02/3	-.02/4	-.02/5	.05/5	Avg.=	12.01		
R	.08	.02	.05	.10	.03	.03				

SIZE		
32 oz	(12 oz)	6 oz
.21	.14	.07
.18	.12	.06
.15	.10	.05
.12	.08	.04
.09	.06	.03
.05	.04	.02
.03	.02	.01
.00	.00	.00
.97	.98	.99
.94	.96	.98
.91	.94	.97
.88	.92	.96
.85	.90	.95
.82	.88	.94
.79	.86	.93
.76	.84	.92
.73	.82	.91



1. Fill in heading, code, brand and time.
2. Record fills putting highest on line #1 and lowest on line #3
3. "T" = Total of all three fill weights
4. "X" = Average fill weight
5. Box with diagonal line (/)
   Top = running accumulative of avg. fill
   Bottom = Consecutive number of subgroup sample sets
6. "R" = Range between highest and lowest fill
7. Plot average fill on graph using appropriate can size column
8. Start new graph only when can size is changed and at start of new production date.
9. Average fill is determined by dividing the running accumulation by the number of subgroup samples

FILL OF CONTAINER

Despite label statements concerning the weight or volume of a product in a container, purchasers may be misled as to the amount of the commodity they are buying. The Food and Drug Administration (FDA) requires that food containers be filled as full as is practical without impairment of quality. Section 403 (d), of the Federal Food, Drug and Cosmetic Act (21 U.S.C. 343) (which may be found at the following internet address: https://www.ecfr.gov/cgi-bin/ECFR?page=browse) states that "a food shall be deemed to be misbranded if its container is made, formed or filled as to be misleading."

There is no single criterion that can be generally applied to all processed food products in determining proper fill. Factors which either singly or in combination may indicate improperly filled containers include:

1. Low net weight or contents.
2. Excessive headspace.
3. Low drained weight.
4. Insufficient packing medium.
5. Insufficient fruit or vegetable ingredient in relation to packing medium.
6. Container size considerably larger than actual contents of product therein.

Criteria for Determining "Fill of Container"

A. Consideration must be given to certain mandatory requirements by FDA, or fill recommendations included in U.S. Standards for Grades in certifying the "fill of container" for products as outlined below:

   1. FDA Mandatory Requirements

      Legal standards for "Fill of Container" have been published by the FDA for the following specific processed food products:

      Canned Applesauce
      Canned Apricots
      Canned Cherries
      Canned Cream-Style Corn
      Canned Crushed Pineapple
      Canned Fruit Cocktail
      Canned Grapefruit
      Canned Mushrooms
      Canned Peaches

Canned Pears
Canned Peas
Canned Pineapple Juice
Canned Tomatoes

Note that this list is not to be considered all inclusive, and other products may be added from time to time.

The criteria and method of determining compliance with these "fill of container" requirements vary for each product. Please review the following examples:

a. Containers filled as full as practicable without impairment of quality.

Examples: Canned Apricots, Canned Cherries, Canned Peaches, Canned Pears

b. Total weight of drained fruit (or vegetables) not less than a required percentage of the water capacity of the container.

Examples: Canned Fruit Cocktail, Canned Grapefruit, Canned Mushrooms, Canned Ripe Olives

c. When removed from the container and returned in a specified manner, the vegetable ingredient completely fills the container.

Example: Canned Peas

d. A fill of not less than 90 percent of the total capacity of the container.

Examples: Applesauce, Cream-Style Corn, Crushed Pineapple, Pineapple Juice, and Canned Tomatoes. 1/

e. **All products not specifically covered by a "standard of fill" must comply with the requirements of the Federal Food, Drug and Cosmetic Act (FD&C Act) with respect to deceptive fill**. In other words, the containers must be filled to the extent that the consumer is not deceived by the size of the primary container in relation to the actual amount of product.

1/ In glass with a capacity of 6½ fluid ounces or less, the fill is not less than 85 percent.

The following examples illustrate "deceptive fill."

(1) Actual contents considerably less than the capacity of the container.

Examples: Potato Flakes in which substantially less than 90 percent of the capacity of the container consists of product, or

Frozen Spinach in which the capacity of the carton is substantially greater than the volume of spinach in the carton.

(2) Noticeable deficiency of fruit and vegetable ingredient in relation to total contents of container (including packing medium).

Example: Canned Blackberries in which the drained weight of berries is extremely low (less than 50 percent of the water capacity of the can) even though the can is well filled with berries and packing medium.

2. Recommendations or Requirements of U.S. Standards for Grades

a. Canned Fruits and Vegetables

(1) FDA Standards of Fill for specific commodities becomes a requirement of the U.S. Standards for Grades.

Example: Those commodities listed in A.1. for which the FDA has published "Standards of Fill."

(2) In some cases, the U.S. Standards for Grades recommend:

(a) “Fill of not less than 90 percent of the capacity of container.”

Example: Canned Applesauce, Canned Beets.

(b) “As full as practical without impairment of quality.”

(3) If not specifically mentioned in the U.S. Standards for Grades, fill of container must meet the mandatory requirements of FDA with respect to deceptive fill.

b. Frozen Fruits and Vegetables and Miscellaneous Products (other than canned).

(1) Currently there are no FDA "Standards of Fill" for specific frozen fruits, vegetables, or for certain canned fruits and vegetables.

(2) The U.S. Standards for Grades do not include recommended fill of container for all commodities. However, Division policy requires that all products comply with the FD&C Act with respect to

deceptive fill.

(a) Recommendation in U.S. grade standard.

Example: Frozen Concentrated Sweetened Grape Juice - "as full as practical without impairment of quality."

(b) No recommendation in U.S. grade standard.

Examples: Frozen Spinach, Frozen Cauliflower, Frozen Berries, and most frozen products - proper fill implied by the mandatory requirements of the FD&C Act with respect to deceptive fill.

3. Guide for "Good Commercial Practice"

Because "fill of container" is so closely associated with other factors such as net weight, drained weight, and headspace, any administrative guides applicable to these factors must also be considered in dealing with fill of container. Inspectors should observe the following procedure to determine reasonable deviation within the limits of good commercial practice:

a. If the product is fluid or homogenous in nature (juice, puree, jams, and jellies) and headspace measurements are an index of properly filled containers, allow the same number of containers to exceed headspace requirements as are allowed for deviations in quality per sampling plans contained in the Regulations. No limit is being suggested as to what extent individual samples may exceed maximum headspace measurements, since extreme deviations will be reflected in net weight or content determinations.

b. Frozen Fruits and Vegetables. Sufficient data has not been accumulated to finalize a guide for good commercial practice. However, if the product does not occupy at least 50 percent of the capacity of the container, the certificate should reflect this.
The percent fill of a container is determined by the following calculation:

$$\left[\frac{\text{Volume of product in container}}{\text{Total capacity of container}}\right] \text{x } 100 = \text{Percent Fill}$$

Example: Frozen Spinach - capacity of carton 125 cu. in.
Volume of Spinach, by displacement, 60 cu. in.

$$\left[\frac{60}{125}\right] \text{x } 100 = 48 \text{ Percent Fill}$$

In this instance, the container is not well filled and the Grade Statement should be properly flagged to direct attention to the "Fill of Container" in the body of the certificate. (See the AIM Inspection Series Certification Manual.)

If the product occupies more than 50 percent but less than 75 percent of the container capacity, the fill would be questionable and should be reported in the body of the certificate, but the Grade Statement would not be flagged.

NET WEIGHT

Fresh Products

Refer to the Net Weight section of the General Market Manual for guidelines and procedures for determining net weight of fresh products.

Processed Products

Processed foods are commonly packed to meet a prescribed net weight or content and labeled accordingly. This net weight or content may be specified in a purchase specification or contract.

In the case of canned foods, if the containers are unlabeled and the required net weight or content is not stipulated in the purchase specification or contract, be guided by statements on labels customarily used for the commodity and container size.

Various guidelines have been developed for net weight and other measures of content. However, no specific reference is usually made to samples that contain an excessive quantity of product. Overfill may be undesirable for its effect upon vacuum, adequate sterilization of product under normal processing times and temperatures, or possible strain on container during retorting or processing. The Division is not in position to recommend maximum filling guides, but inspectors should review specifications with an eye for any specifications concerning over fill and under fill.

Net weights are not a factor of grade. However, compliance with the required net weight or volume is very important from an economic and regulatory viewpoint. The packer or other person responsible for shipping a product in interstate commerce is responsible for the accuracy and completeness of labels. Some buyers refuse to accept deliveries of processed products which contain more than a small percentage of short weight or short volume containers.

To avoid being considered mislabeled in accordance with the provisions of Section 403 of the Federal Food, Drug and Cosmetic Act, (which may be found at the following internet address: https://www.ecfr.gov/cgi-bin/ECFR?page=browse) a packaged food must meet the following criteria.

"It bears a label containing an accurate statement of the quantity of the contents in terms of weight, measure, or numerical count; provided that reasonable variations shall be permitted, and exemptions as to small packages shall be established, by regulations prescribed by the

Administrator."

The Act further provides that:

"The statement shall express the minimum quantity, or the average quantity, of the contents of the packages. If the statement is not so qualified as to show definitely that the quantity expressed is the minimum quantity, the statement shall be considered to express the average quantity."

Where the statement expresses "minimum quantity", no deviation below such declared minimum is permitted.

Where the statement expresses "average quantity":

- Variations are permitted when caused by unavoidable deviations in weighing or measuring which occur in good packing practices, except that such variations shall not be permitted to the extent that the average weight or measure of the packages in the shipment is below the quantity declared on the label and,

- No unreasonable shortage in any package is permitted, even though other packages in the same shipment compensate for such shortage.

Guide for "Good Commercial Practice"

A. A lot will be considered to comply with requirements of "good commercial practices" with respect to average net weight or other measure of contents under the following conditions:

1. The average of all containers meets the declared, required or recommended minimum; and

2. No container may be less than the tolerance specified in the following applicable groups:

a. Canned and Frozen Fruits and Vegetables

(1) Containers of 10 ounces or less: 10% or 0.5 ounce, whichever is less.

(2) Containers over 10 ounces up to 50 ounces: 5% or 1 ounce, whichever is less.

(3) Containers over 50 ounces: 2% or 2 ounces, whichever is less.

Example: 10 ounce Frozen Vegetable carton

(a) The sample average must be at least 10.0 ounces.

(b) No container in the sample may weigh less than 9.5 ounces.

The 0.5 ounce allowance is less than 10% of 10 ounces (1.0 ounce).

3. Canned and Frozen Concentrated Fruit or Vegetable Products

a. Containers of 8 ounces or less: 5% or 0.2 ounce, whichever is less.

b. Containers over 8 ounces up to 50 ounces: 2% or 0.5 ounces, whichever is less.

c. Containers over 50 ounces: 2% or 1.5 ounces, whichever is less.

Example: Tomato Paste in No. 10 cans, declared net weight 112 ounces

(1) The sample average must be at least 112 ounces.

(2) No container may weigh less than 110.5 ounces. The 1.5 ounces allowance is less than 2 percent of 112 ounces (2.24 ounces).

4. Miscellaneous Processed Products

Such as Jams and Jellies, Peanut Butter, Spices, Flavoring Extracts, and Similar Products

a. Containers of 8 ounces or less: 10% or 0.3 ounces, whichever is less.

b. Containers over 8 ounces up to 50 ounces: 5% or 0.8 ounces, whichever is less.

c. Containers over 50 ounces: 2% or 1.5 ounces, whichever is less.

Example: Fruit Jelly in 12 ounce jars

(1) The sample average must be at least 12.0 ounces.

(2) No container in the sample may weigh less than 11.4 ounces. 5% of 12 ounces (0.6 ounces) is less than the 0.8 ounce allowance.

In applying the guides, consider the allowance relative to sample size. Obviously, the tolerance of a "defective" or low net weight sample unit in a sample size of 6 is not the same as a "defective" in a sample size of 29. Consideration should be given to permitting an infrequent container to deviate beyond the range of good commercial practice. At the applicant’s request, you may check additional samples from the lot, and allow low net weights at a rate of 1 in 48.

VACUUM READINGS

The term "vacuum," as used in the canning industry represents the difference between atmospheric pressure and lower pressure existing in a closed container. Atmospheric pressure decreases with an increase in altitude at the rate of approximately 1 inch of mercury for each 1,000 feet. Consequently, a container having a reading of 7 inches of mercury at sea level would have only 2 inches of mercury in Denver (elevation 5,000 feet). Although pressure may be recorded using different units of measure, one of the most common units of measure for vacuum gauges is inches of mercury. This refers to the height of a column of mercury in a U-Shaped tube (manometer) that may be supported by that pressure.

Temperature also affects vacuum readings. There is a relationship between the temperature at which the container is closed and sealed, and the vacuum of the container after processing and cooling. There is also a relationship between the vacuum readings of sealed containers at various temperatures. Studies have shown that the vacuum decrease is approximately 1 inch of mercury for each 5 degrees Celsius © increase in temperature. Thus, a container having a vacuum of 5 inches of mercury at 20 degrees C would have zero (0) at 45 degrees C. Prolonged storage at higher temperatures of such merchandise could result in "flippers" or "swells."

Although there are several methods by which "vacuum" may be measured in canned food products, the conventional method of using a mechanical gauge calibrated against a mercury volume has been adopted by the Division. As discussed here, vacuum readings refer to those readings as determined by a conventional vacuum gauge, and are expressed in inches.

Cans should be at approximately room temperature before vacuums are taken. The correct technique for taking a vacuum reading is to force the tip of the vacuum gauge into the can at a high spot near the closing machine seam. This high spot is selected to minimize the chance of the gauge tip entering the product, plugging the gauge and obstructing a vacuum reading. Take care not to bang the gauge, which may dull the tip and damage the gauge. There may be some slight variation to the technique for specific products or can sizes; be guided by your supervisor.

Vacuum is not a factor of grade but may be a requirement of a purchase specification or contract. Inspectors must be alert for specific vacuum requirements in such orders.

The general requirement "packed in accordance with good commercial practice" which appears in most government specifications is interpreted as requiring vacuum on those products that are customarily packed so as to have a vacuum. The amount of vacuum in a can depends on many factors – product, container size, the particular process, temperature, and altitude. No attempt should be made to evaluate the readings except as directed in this instruction, or inspector's instructions for a specific commodity.

Guide for Good Commercial Practice

A. Consideration must be given to the type of product, type of container, special contractual requirements, and existing commercial practices.

1. Containers with screw cap closures or friction type lids may not be designed to maintain vacuums. Consequently zero vacuum reading in such containers may be considered acceptable under good commercial practices.

2. Zero vacuum readings are considered less serious in products of the acid group (pH of 4.5 or less) than for those in the non-acid group (pH in excess of 4.5).

Acid Group	Non-Acid Group
Apples	Asparagus
Apricots	Beets
Berries	Black-eyed and Field Peas
Cherries	Canned Dried Beans
Citrus Products	Carrots
Peaches	Corn
Pears	Green and Wax Beans
Pickles	Hominy
Plums	Lima Beans
Prunes	Okra
Sauerkraut	Peas
Tomatoes	Pimientos

Zero vacuum readings in containers which normally have a vacuum are recorded and certified according to the AIM Inspection Series, Certification Manual. If a contract or specification includes specific minimum acceptance levels for vacuum readings, these requirements must be taken into consideration when certifying the lot.

B. In the absence of a contractual or program requirement for zero vacuums, inspectors will be guided by the following for both commercial and government contracts.

1. Acid group

Allow 10 percent of the sample units to have zero vacuum readings before flagging the inspection certificate.

2. Non-acid group

Allow only those samples units to have zero vacuum readings as can be considered infrequent (1 in 48).

Vacuum Requirements

If a specification or contractual document does not specify or designate a vacuum in terms of a measurable determination, but simply states that the cans shall have a vacuum, any vacuum reading above zero is considered to meet these requirements. Unless the needle is influenced by a disturbance such as jarring, any movement of the vacuum gauge needle above zero is considered evidence of a vacuum and therefore complies with the requirements.

Where the specification or contractual document specifies a minimum vacuum, the permitted number of sample units that fail the requirement shall be as indicated in Contract Services Section instructions in the Inspections for Operational Rations Purchased by the Department of Defense Manual for DPSC deliveries, and in AIM Inspection Series, Sampling Manual for all other inspections.

When the vacuum indicates a vacuum of between 0 and 1 inch, record the vacuum as 1 inch on the score or tally sheet. Any other fractional vacuum reading above 1 inch will be rounded down and the vacuum recorded as a whole number. For example, a reading of 4 ½ inches on the vacuum gauge will be recorded as 4 inches.

MACROANALYTICAL PROCEDURES

"Macroscopic" analysis of a product refers to an evaluation of the substance through the use of a person’s unaided senses, primarily sight, smell, or taste. Probably every consumer in our society conducts some form of macroscopic examination to check for defects when purchasing or using foods and other consumer goods. The examination may range from a cursory or even unconscious visual check of the product to confirm that everything "looks right" to a much more detailed scrutiny to check for specific defects. A typical example of consumer macroscopic examination would be the shopper seen squeezing and sniffing the produce prior to purchasing.

In fulfilling responsibilities for protecting the public health and safety, regulatory authorities conduct more systematic examinations to detect both apparent and hidden defects. Over the years, standardized methods of macroscopic examination have evolved for determining filth, decomposition, and foreign matter in foods, drugs, and cosmetics and other products subject to the laws enforced by the U.S. Food and Drug Administration (FDA). These methods of analysis have evolved with the input of producers and consumers as well as regulatory authorities.

The FDA Macroanalytical Procedures Manual is available at the following website:
https://www.fda.gov/food/laboratory-methods-food/macroanalytical-procedures-manual-mpm

For inspectors without internet access, please contact your immediate supervisor as needed for a copy of this manual.

SALT DETERMINATION

This section in the Technical Manual is intended for use by inspectors and focuses on procedures for determining salt content in food products. Slight deviations in preparatory procedures are sometimes necessary for a particular commodity; be guided by the grading manuals for the product as needed.

SAFETY WARNING: Silver Nitrate ($AgNO_3$) solutions are used in titrations for salt determination. Dilute (0.1 N) $AgNO_3$ is not corrosive (although it will discolor the skin on contact), however, it may be necessary to work with concentrated or crystalline $AgNO_3$ to prepare the reagent. Both forms are extremely caustic and must be handled with great care. Wear protective clothing, eye wear and gloves so that it cannot contact your skin or eyes. Work only in an adequately ventilated room, or under a ventilated hood to avoid vapor inhalation. If you accidentally come in direct contact with either form of $AgNO_3$, immediately wash the area with running water for several minutes.

Be equally cautious when handling concentrated Nitric Acid. If it should contact your skin, quickly cover the area with large amounts of sodium bicarbonate or wash with running water.

See the AIM Inspection Series, Sanitation and Safety Manual for more information concerning the safe handling of corrosive chemicals. See also the Material Safety Data Sheets (MSDS) for these chemicals.

Glassware and Equipment

$AgNO_3$ solution will cause staining with a dark residue that is extremely difficult to remove from glassware. Wash flasks and beakers immediately after each titration or use. It is not practical to wash a burette after each test or between a series of titrations; however, a thorough washing at the end of each day will help to keep staining to a minimum.

Terminology

"Salt" as used in this instruction and in most food standards means "common salt" or sodium chloride (NaCl). It is also customarily referred to as "table salt" although table salt generally contains a few additives and is not chemically pure.

In this instruction, the total chloride content (i.e., that which occurs naturally, plus any added by the processor) is determined and results are expressed in terms of sodium chloride. These results frequently include several other chloride salts such as potassium chloride and calcium chloride. However, these other salts are usually present in extremely small quantities and are considered insignificant.

Methodology and Reagents

A. The most common methods for determining the salt content of food products involve titration, either with a visual indicator or by potentiometer. These methods include:

1. Visual Indicator Method

(a) Mohr method

(b) Volhard method

2. Potentiometer (pH Meter) Method

3. Conductivity (Salt Meter Method)

For methods 1 and 2, the reaction depends upon precipitation of all the chloride as AgC1, and detecting the end point either by a color change or observation of electromotive force (meter reading).

Whichever method is used, the preparation and standardization of reagents is very important. Most reagents can be purchased premixed and standardized in the concentrations needed for these reactions. **It is preferred that standardized solutions be purchased and used for these tests, when possible.** Note and adhere to "use by" or expiration dates for these solutions.

Mohr Method Reagents:

Silver Nitrate ($AgNO_3$): Because $AgNO_3$ is unstable in the presence of light, it should be kept in a dark brown glass container and stored in a cool, dark place. As with all reagents, once a portion of the $AgNO_3$ has been transferred to another container, unused quantities must not be returned to the master container because of the possibility of adulteration. $AgNO_3$ tends to weaken with time, so its normality should be checked against a known saline solution before use.

A. The $AgNO_3$ will need to be prepared and Standardized.

1. Preparation

Wear protective clothing and eye wear. Dissolve 16.99 grams of reagent grade $AgNO_3$ in distilled water and to make exactly 1 liter of solution. This should result in a solution that is very slightly stronger than 0.1 Normal. Any opalescence in the final solution is due to traces of a chloride or to unclean glassware.

2. Standardization

Measure out exactly 5.845 grams of reagent grade NaC1. Add enough distilled water to make exactly 1000 ml of solution in a volumetric flask. This will produce a salt solution of exactly 0.1 Normality.
Take a measured amount of the salt solution (25 to 40 ml), add potassium chromate indicator, and titrate to the end point.

The addition of calcium carbonate is not strictly necessary, but may make the end point easier to see. For those not familiar with the proper end point, a representative example can be helpful. Prepare by placing 40-50 ml of distilled water in a flask. Add 2 ml of potassium chromate indicator and 0.5 grams calcium carbonate. To this solution, add 1 drop of 0.1 N $AgNO_3$ solution. A slight yellow-orange color should develop, representing the proper silver-chromate end point.

Calculate normality of the $AgNO_3$ solution by the formula $V_1N_1 = V_2N_2$

V_1 = Volume of NaCl solution
N_1 = Normality of NaCl solution
V_2 = Volume of $AgNO_3$ solution used
N_2 = Normality of $AgNO_3$ solution

Example:

35.0 ml standard (exactly 0.1 N) NaC1 solution requires 34.2 ml $AgNO_3$ solution to reach the end point. Using the formula above:

$$(35.0)\ (0.10) = 34.2\ x$$
$$3.50 = 34.2\ x$$
$$0.1023 = x$$

The normality of the $AgNO_3$ reagent is 0.1023.

To convert to equivalent 0.1 strength $AgNO_3$, (exactly 0.1 N), multiply the actual titer by this factor; in the above example, the factor is 1.023.

Example:

40.21 ml 0.1023 N $AgNO_3$ is used in the titration

(40.21) (1.023) = 41.13 ml equivalent 0.1 $AgNO_3$.

Calcium Carbonate: ($CaCO_3$) Should be finely ground, reagent grade.

Potassium Chromate Indicator (K_2CrO_4): Dissolve 5 grams of K_2CrO_4 in a volumetric flask with distilled water, and make up to 100 m1.

Volhard Method Reagents:

Silver Nitrate ($AgNO_3$): (see previous pages for preparation and standardization).

Ammonium Thiocyanate (NH_4CNS): This reagent forms a pale reddish-brown color in the presence of ferric alum indicator when a slight excess is added to a standard $AgNO_3$ solution acidified with nitric acid.

A. The NH_4CNS solution will need to be prepared and standardized prior to use.

3. Preparation

Dissolve 7.6 grams of reagent grade Ammonium Thiocyanate in about 500 ml distilled water. Transfer to 1000 ml flask and make up to 1000 ml.

4. Standardization

To a 250 ml flask, add 40 ml 0.1 $AgNO_3$, 5 ml HNO_3 (1 + 1), and 2 ml ferric alum indicator. Titrate with the NH_4CNS solution (about 40 ml) to pale rose or tinge of brown end point. Calculate the normality of the thiocyanate solution by the formula $V_1N_1 = V_2N_2$ as in the example under $AgNO_3$. The exact normality of the $AgNO_3$ solution must be known.

Ammonium Thiocyanate (NH_4CNS): 0.10N – Adjust and standardize by titrating against 0.1 $AgNO_3$.

Nitric Acid (HNO_3) (1 + 1): Prepare by combining equal volumes of concentrated HNO_3 and distilled water. ***As with all acids, add the acid to the water, not the water to the acid***. For safety, add the acid slowly.

Nitric Acid (HNO_3) (2 percent): Prepare by combining concentrated HNO_3 and distilled water in the ratio of 3 ml HNO_3 per 197 ml water.

Ferric Ammonium Sulfate (Ferric Indicator): Saturated solution of $FeNH_4(SO_4)_2 \cdot 12\ H_2O$ (held in solution, ratio 1 $FeNH_4(SO_4)_2$ to 12 H_2O)

Filter Aid: Celite or diatomaceous earth.

Visual Indicator Methods

Two visual indicator methods are available for determination of salt in foods.

Mohr Method

A. This determination is generally simpler and faster than the Volhard method. It's the official AOAC method for determining the salt content of most foods. It is particularly suited for products that are not highly colored which will not interfere with the visual end point.

1. Equipment and Reagents:

Standard titration burette with stand

Erlenmeyer flask

Pipette, if results are to be expressed as grams per 100 ml

Analytical Balance, if results are to be expressed as percent by weight

Distilled Water

Silver Nitrate ($AgNO_3$), reagent grade of appropriate normality

(generally 0.1)

Calcium Carbonate ($CaCO_3$) for acid products

Potassium Chromate (K_2CrO_4) indicator

2. Procedure

a. Fill a clean burette with 0.1 N $AgNO_3$.

b. Put the prescribed amount of sample into the Erlenmeyer flask.

c. Dilute with about 25 ml distilled water to increase the volume of solution in the flask and allow for better agitation and easier end point detection.

d. Neutralize any naturally occurring acidity (such as in pickles and sauerkraut) by adding about 0.5 gram of powdered calcium carbonate ($CaCO_3$). This does not need to be weighed but can be estimated by using the tip of a spatula.

e. Add approximately 2 ml (4 to 5 drops) of Potassium Chromate indicator (K_2CrO_4).

f. Titrate with $AgNO_3$ to the characteristic yellow-orange end point of the chromate indicator.

3. Calculations

Determine, to the nearest one-tenth ml, the amount of $AgNO_3$ necessary to reach the end point. Calculate the salt content according to this formula:

$$S = \frac{(T)(N)(0.05845)(100)}{V}$$

S = Salt Content

T = ml $AgNO_3$ required to reach the end point

N = Normality of the $AgNO_3$

V = Sample size - either in ml or grams, depending upon the terms in which the results are expressed.

0.05845 = the factor necessary to convert the titration to NaC1 and represents the number of grams of NaC1 which will completely react with one ml of Normal $AgNO_3$.

100 = the factor necessary to convert the results into percent by weight or volume.

Example: 10 ml of pickle juice requires 41.7 ml of exactly 0.1 N $AgNO_3$ to reach the proper end point. The percent salt is calculated as follows:

$$S = \frac{(41.7)(0.10)(0.05845)(100)}{10} = 2.44$$

Therefore, the salt content is 2.44 grams per 100 ml pickle juice.

If the size of sample and the normality of $AgNO_3$ remain constant, a handy mathematical shortcut may be used when many samples are to be tested. Pre-calculate the following portion of the formula:

$$\frac{(N)(0.05845)(100)}{V}$$

Example: you have several samples of pickle juice to titrate for salt. You know from past experience that 0.1 N $AgNO_3$ used in conjunction with a sample size of 10 ml pickle juice provides a convenient working range with a 100 ml burette. You establish a constant as follows:

N = 0.1

V = 10 ml

$$\frac{(0.1)(0.05845)(100)}{10} = 0.05845 = \text{constant}$$

The constant factor is then multiplied by the amount of $AgNO_3$ used during each titration to obtain the amount of salt in each sample. Say the first sample required 28.1 ml 0.1 N $AgNO_3$. The calculation is (28.1) (0.05845), or 1.65 grams per 100 ml of product. All subsequent samples would be calculated in the same manner, substituting the actual amount of $AgNO_3$ used to titrate each sample.

Volhard Method

A. This method is more complicated and time consuming than the Mohr method. However, the end point is easier to discern, especially in intensely-colored products.

1. Equipment and Reagents

Filter paper, Buchner funnel and vacuum source

Erlenmeyer flask

250 ml beaker

Silver Nitrate ($AgNO_3$)

Nitric Acid HNO_3 (1 + 1)

Dilute Nitric Acid (HNO_3) (2%)

Filtering aid, such as Celite or diatomaceous earth

Ferric Ammonium Sulfate indicator ($FeNH_4 (SO_4)_2 \cdot 12 H_2O$)

Ammonium Thiocyanate (NH_4CNS) of same normality as $AgNO_3$ used, preferably 0.1 N

2. Procedure

   a. Measure sample and place in Erlenmeyer flask

   b. Add 5 ml HNO_3 (1 + 1)

   c. Add 50 ml distilled water and about 1/2 gram of filtering aid

   d. Add an excess of 0.1 N $AgNO_3$ (usually 30-40 ml)

   e. Stopper flask and shake vigorously

   f. Allow to stand for a few minutes

   g. Filter through rapid filter paper in Buchner funnel. Wash with dilute HNO_3 (2 %) and place filtrate in beaker

   h. Add 5 ml Ferric Alum indicator

   i Titrate filtrate to a permanent, faint brownish tinge using standard 0.1 N NH_4CNS.

3. Calculations

Subtract the amount of 0.1 N NH_4CNS used in step i above from the amount of 0.1 N $AgNO_3$ used in step d above. The remainder represents "T" in the mathematical formula described in the Mohr method. Use the same formula to calculate salt for the Volhard method of titration.

$$S = \frac{(T)(N)(0.05845)(100)}{V}$$

Example

To a 10.0 gram sample of product, 40.0 ml 0.1 $AgNO_3$ is added.
The filtrate requires 10.2 ml 0.1 N NH_4CNS to reach the end point.

0.1 N $AgNO_3$ in reaction = 40.0 - 10.2 = 29.8 = T

$$S = \frac{(29.8)(0.10)(0.05845)(100)}{10}$$

S = 1.74 Percent

Potentiometer (pH meter) Method

This method is superior to visual titration methods for products with characteristics that interfere with visually detecting the correct end point. For example, the intense red color of tomato products is likely to mask the yellow-orange end point of the potassium chromate.

A pH meter is primarily designed for measuring acidity or alkalinity, but it can be easily modified to determine salt content by using different types of electrodes. There are many makes and models in use. They may vary in the location of electrodes and controls, but the operating principle is the same. **Consult the instrument's manual for specific operating instructions**.

Equipment

Magnetic Stirrer

pH meter with scale divisions of 10 millivolts or less. Range not less than – 700 to + 700 MV. A direct-reading model is preferable.

Electrodes: Beckman Silver Billet Combination Electrode (Beckman Instruments Part No. 39187 or equivalent). Separate electrodes (Silver indicator electrode and Calomel reference electrode) for above meter are also satisfactory. The Combination Electrode is used without a silver chloride coating. Before using, clean electrode tip with scouring powder and rinse thoroughly with water to assure absence of a halide coating.

Electrode Attachment

If using two electrodes, connect the calomel electrode to the proper terminal on the meter using a jack adapter. Only one terminal will accept the jack adapter. Connect the silver electrode to the other terminal on the meter.

Reagents

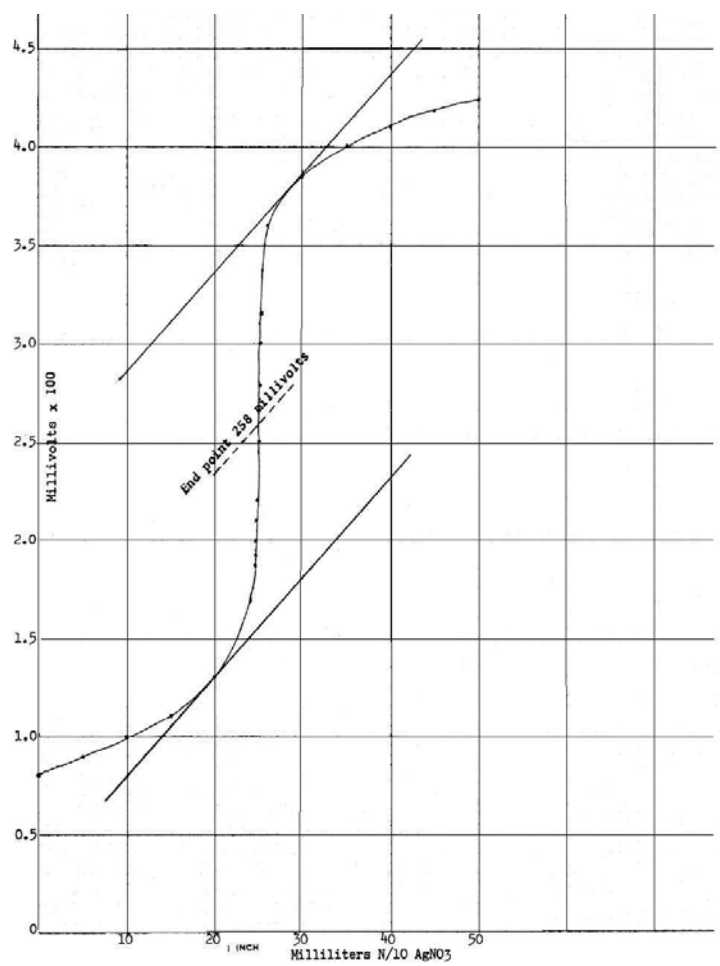
1. Sodium chloride standard solution, 0.0856 N.
2. Silver nitrate standard solution, approximately 0.0856 N.

Standardization

Pipette 25 ml aliquot of NaCl solution into a 250 ml beaker and dilute to approximately 100 ml with distilled water. Add 5.0 ml HNO_3 (1 + 4). Insert electrodes, start magnetic stirrer and continue stirring vigorously throughout the titration. Titrate with $AgNO_3$ standard, adding increments small enough that the voltage end point and corresponding ml $AgNO_3$ added can be determined accurately from a plot of MV readings versus ml $AgNO_3$. Use a total of 50.0 ml $AgNO_3$ to obtain complete titration curve.

The end point is the inflection point of curve. Determine by drawing two straight lines with a 45° slope to the axes, and tangent to titration curve at the two points of greatest curvature. The inflection point is at the intersection with titration curve with a line drawn parallel to and midway between the other two lines (see below). From the volume of $AgNO_3$ used, calculate normality and adjust to 0.0856 N. Re-standardize occasionally.

NaCl Potentiometric Titration Curve
Beckman Zeromatic pH Meter



Preparation of Sample

Either the solid portion or both the solid and liquid portions should be comminuted with a high-speed blender. If necessary, for the proper operation of the blender, add an equal weight of distilled water. Add 1 ml approximately 0.1 N $AgNO_3$ and 5 ml HNO_3 (1 + 4) to 100 ml water. This should produce not more than a slight turbidity.

Determination

The voltage end point obtained on pure NaCl solution may be used as specified in this method. When extreme accuracy is required, the titration curve must be determined for each sample. Using NaCl standard as before, recheck endpoint potential occasionally, and redetermine when either the individual electrode, combination electrode, or pH meter is replaced.

The surfaces of the electrode must be thoroughly rinsed with distilled water and wiped dry after each determination.

Samples containing <5.0% sodium chloride:

Weigh 5.00 ± 0.01 gram of prepared sample (10.00 ± 0.01 gram if equal weight of water is added in Step E. Preparation of Sample) in a 250 ml beaker. Dilute to approximately 100 ml with distilled water and add 5.00 ml HNO_3 (1 + 4). Stir to suspend all insoluble material and allow to stand at least 10 minutes for complete solution of chlorides. While stirring, titrate to endpoint established in "Standardization." If salt content is ≤1%, use a 10 ml burette to titrate.

$$\text{Percent NaCl} = \frac{\text{ml } 0.0856 \text{ N } AgNO_3}{10}$$

Samples containing > 5.0% sodium chloride:

Weigh 5.00 ± 0.01 gram of prepared sample (10.00 ± 0.01 gram if equal weight of water is added in Step E. Preparation of Sample). Transfer to a 100 ml volumetric flask and dilute to volume with distilled water. Mix and let stand at least 10 minutes. Mix the sample, allow settling, and transfer the aliquot containing 50-250 mg. NaCl to a 250 ml beaker. Dilute to approximately 100 ml with distilled water and add 5.00 ml HNO_3 (1 + 4). Stir to suspend all insoluble material and allow the sample to stand at least 10 minutes for complete solution of chlorides. While stirring, titrate to endpoint established in "Standardization."

$$F = \text{dilution factor} = 100/\text{ml aliquot titrated}$$

$$\text{Percent NaCl} = \frac{F \times \text{ml } 0.0856 \text{ N } AgNO_3}{10}$$

Conductivity (salt meter) Method

Another method of determining salt content is by use of a dedicated salt meter. A dedicated salt meter is an analytical device that can make a direct reading of the salt content of a product. Only instruments which have been approved by the Division shall be used.

The current instruments approved are the DiCromat II or DiCromat IIA manufactured by:

Noramar Co.
P.O. Box 771
Chagrin Falls, OH 44022

Phone: 440-338-5740
FAX: 440-247-3879
Web site: http://www.noramar.com

When using a salt meter, follow the manufacturer's instructions for instrument care, calibration, use, and sample preparation. Some products may require that the sample be diluted. Follow manufacturer's instructions for dilution of product prior to placing the sample into the salt meter. The salt meter should be calibrated for each product that will be routinely tested for salt content. A titration method suitable for the product that will be tested should be used to calibrate the salt meter. This shall be done on one sample per lot being graded, or daily if more than one lot is graded.

The first sample for analysis shall have the salt content determined by one of the titration methods. Once the salt content of the first sample has been determined, this product sample will be used to calibrate the salt meter in order to use the salt meter for the remaining samples from the lot, or lots graded daily.

REFERENCE LINKS	**Version Date** (Printed for distribution)

- ☐ **7 CFR 43.101, 102, 103, 104, 105, and 106:** https://www.ecfr.gov/cgi-bin/ECFR?page=browse. ____________
- ☐ **21 CFR 101.30, 102.33, 130.12:** https://www.ecfr.gov/cgi-bin/ECFR?page=browse. ____________
- ☐ **Certification Manual:** https://www.ams.usda.gov/publications/content/aim-certification-manual. ____________
- ☐ **FDA AMS MOU 225-96-2001:** http://www.fda.gov/AboutFDA/PartnershipsCollaborations/MemorandaofUnderstandingMOUs/DomesticMOUs/default.htm. ____________
- ☐ **FDA Macroanalytical Procedures Manual:** https://www.fda.gov/food/laboratory-methods-food/macroanalytical-procedures-manual-mpm. ____________
- ☐ **Form SC-637, Laboratory Sample Submittal Sheet:** https://usdagcc.sharepoint.com/sites/ams/AMSFormsCatalog/Forms/AllItems.aspx. ____________
- ☐ **General Market Manual:** https://www.ams.usda.gov/sites/default/files/media/GeneralMarketManual.pdf ____________
- ☐ **General Procedures Manual:** https://www.ams.usda.gov/publications/content/aim-general-procedures-manual. ____________
- ☐ **Sampling Manual:** https://www.ams.usda.gov/sites/default/files/media/SamplingManual.pdf. ____________
- ☐ **Sanitation and Safety Manual:** https://www.ams.usda.gov/publications/content/aim-inspection-series-sanitation-manual. ____________
- ☐ **Section 403 of the Federal Food, Drug and Cosmetic Act (21 U.S.C. 343):** https://www.ecfr.gov/cgi-bin/ECFR?page=browse ____________

Checked Materials have been printed from the links in this Manual and included for reference.

APPENDIX I-Thermometer Checks Log

Electronic version of Appendix I-Thermometer Checks Log

THERMOMETER CHECKS

ID # ______________________ **DATE LAST SERVICE_______________**

DATE	THERMOMETER NUMBER	READINGS °C/°F	USDA INITIALS	COMMENTS AND ADJUSTMENTS

APPENDIX II - Weekly Gram Scale Checks Log

Electronic version of Appendix II - Weekly Gram Scale Checks Log

WEEKLY GRAM SCALE CHECKS

Record to nearest 0.1 GRAM

ID # ______________________ **DATE LAST SERVICE**____________

DATE	VALUE READING WITH WEIGHT			USDA INITIALS	COMMENTS AND ADJUSTMENTS
	0 GRAMS	10 GRAMS	100 GRAMS		

APPENDIX III - Weekly Ounce Scale Checks Log

Electronic version of Appendix III - Weekly Ounce Scale Checks Log

WEEKLY OUNCE SCALE CHECKS

Record to nearest 0.1 ounce

ID # ______________________ **DATE LAST SERVICE______________**

DATE	VALUE READING WITH WEIGHT			USDA INITIALS	COMMENTS AND ADJUSTMENTS
	0 OUNCES	10 OUNCES	80 OUNCES		

APPENDIX IV - Refractometer Checks Log

Electronic version of Appendix IV - Refractometer Checks Log

WEEKLY *
DAILY **
RECORD BRIX OR ***
REF INDEX OF FLUID

REFRACTOMETER CHECKS

ID # ________________________ DATE LAST SERVICE_________________
_____degree PRISM USED

DATE	TEMP ** OF WATER	DEGREES/REF INDEX FOUND			USDA INITIAL	COMMENTS AND ADJUSTMENTS
		WATER **	PRISM nD *	CALIBRATION FLUID ***		

APPENDIX V - Daily pH Meter Checks Log

Electronic version of Appendix V - Daily pH Meter Checks Log

DAILY pH METER CHECKS

ID # ______________________ **DATE LAST SERVICE**_______________

DATE	TIME	ELECTRODES FREE OF CRYSTALS?	pH 7 pH 4	pH 10 pH 7	USDA INITIALS	COMMENTS AND ADJUSTMENTS SLOPE

APPENDIX VI - Analytical Glassware Checks Log

Electronic version of Appendix VI - Analytical Glassware Checks Log

ANALYTICAL GLASSWARE CHECKS

ID # ____________________ **DATE LAST SERVICED** ____________________

DATE	GLASSWARE ID # *	mL	WEIGHT	N VALUE OR OTHER	USDA INITIALS	COMMENTS AND ADJUSTMENTS

* 1. BURETTE
2. PIPETTE
3. COLOR TUBE
4. CENTRIFUGE TUBE
5. BEAKERS
6. GRADUATED CYLINDER

APPENDIX VII - Hydrometer Checks Log

Electronic version of Appendix VII - Hydrometer Checks Log

HYDROMETER CHECKS

ID # ______________________ **DATE LAST SERVICED**______________________

DATE	SERIAL NUMBER	READINGS ° BRIX		USDA INITIAL	COMMENTS AND ADJUSTMENTS
		Certified	Non-Certified		

APPENDIX VIII - Salometer Checks Log

Electronic version of Appendix VIII - Salometer Checks Log

SALOMETER CHECKS

☐ **Type I Brine for Pea Maturity (percent NaCl by weight)**
☐ **Type II Canned Ripe Olives (percent saturation, degrees salometer)**

Serial Number or ID_____________________ **Date Placed in Service**_______________________

Date	Visual inspection for damage Meets/Fails	Verification method indicate a, b, c, d, or e		Temp °F	Temp correction	Uncorr salometer reading	Final reading (grading salometer)	USDA Initials
		a. Distilled water c. 13 % brine solution d. Olive brine e. Other (State type) ___________________	b. Reference standard Salometer serial # ___________________ Final reading reference standard salometer					

APPENDIX IX - Colorimeter Calibration Checks Log - Hunter D45

Electronic version of Appendix IX - Colorimeter Calibration Checks Log - Hunter D45

COLORIMETER CALIBRATION CHECKS

HUNTER D45

ID # ______________________ **DATE LAST SERVICE**__________________

DATE	SCALES	(+) OR (-) READINGS	USDA INITIALS	COMMENTS AND ADJUSTMENTS
	X			
	Y			
	Z			
	X			
	Y			
	Z			
	X			
	Y			
	Z			
	X			
	Y			
	Z			
	X			
	Y			
	Z			
	X			
	Y			
	Z			
	X			
	Y			
	Z			
	X			
	Y			
	Z			
	X			
	Y			
	Z			

APPENDIX X - Colorimeter Calibration Checks Log - Hunter D45D5

Electronic version of Appendix X - Colorimeter Calibration Checks Log - Hunter D45D5

COLORIMETER CALIBRATION CHECKS

HUNTER D45D2

ID # ______________________ **DATE LAST SERVICE**_________________

DATE	SCALES	(+) OR (-) READINGS	USDA INITIALS	COMMENTS AND ADJUSTMENTS
	X			
	Y			
	Z			
	X			
	Y			
	Z			
	X			
	Y			
	Z			
	X			
	Y			
	Z			
	X			
	Y			
	Z			
	X			
	Y			
	Z			
	X			
	Y			
	Z			
	X			
	Y			
	Z			
	[illegible]			
	Y			
	Z			

APPENDIX XI - Colorimeter Calibration Checks Log - Macbeth Color-Eye 3000, 3100, and i5

Electronic version of Appendix XI - Colorimeter Calibration Checks Log - Macbeth Color-Eye 3000, 3100, and i5

COLORIMETER CALIBRATION CHECKS

MACBETH COLOR-EYE 3000, 3100 AND i5

ID # ______________________ **DATE LAST SERVICED**________________________

DATE	TIME	CALIBRATED WITH WHITE TILE? Y, N	USDA INITIALS	COMMENTS AND ADJUSTMENTS

APPENDIX XII - Example: Optional Worksheet for Fruit/Sugar Ratio.

Electronic version of Optional Worksheet for Fruit/Sugar Ratio

Fruit – Sugar (F/S) Ratio Worksheet

Plant:____**Code:**______________________

Instructions: Check Fruit – Sugar Ratio each time a sample unit is drawn as follows:

1. Tare scale for pail and lid.
2. Weigh **one** finished pail (net weight) and enter in **column 2.**
3. Weigh **one** pail with fruit only (with lid) and enter in **column 3**
4. Subtract the fruit (**column 3**) from the fruit and sugar (**column 2**) and enter in [illegible]**nn 4.**
5. Divide the fruit (**column 3**) by the sugar (**column 4**) and enter in **Column 5.**
6. Total all the ratios in **column 5** and divide by the number of r[illegible]s and enter this ave[illegible] **column 6.**

To meet the requirements of a 5 + 1 ratio, the lot average must be betwee[illegible]**d 5.2.**
Target weights are in parentheses.

1 Time	2 Net Weight (30 LBS)	3 Fruit (25 LBS)	4 #2 minus #3 Sugar (5 LBS)	Fruit Su[illegible] Ratio [illegible]5.0)	6 Running Average (4.8-5.2)	7 Remarks

EXAMPLE