



**United States
Department of
Agriculture**

Marketing and
Regulatory
Programs

Grain Inspection,
Packers and
Stockyards
Administration

Federal Grain
Inspection
Service

Washington, DC

January 1999

Moisture Handbook

Program Handbook

January 1999

MOISTURE HANDBOOK

FOREWORD

This handbook sets forth the policies and procedures regarding the approval, alignment, calibration, operation, examination, and testing of moisture meters used in official inspection activities. The procedures contained in this handbook are applicable to all Grain Inspection, Packers and Stockyards (GIPSA) headquarters units, GIPSA field offices, sub-offices, and official agencies.

GIPSA's decision to approve and adopt the GAC 2100 as the new official moisture meter does not mean that the Agency endorses or recommends this instrument for unofficial purposes over other similar instruments that are not approved for the official system. The Agency's selection of this instrument was based on GIPSA's unique operational needs. Other instrument models may be as or more suitable for a commercial entity's needs.

For any given product, all official moisture measurements will be performed using the GAC 2100 exclusively on and after the transition date for that product; the Motomco Model 919 will be used until the transition date. Transition of all products to the new meter will not be completed until after 1999. Therefore, retain the previous version of this Handbook as a reference for use and testing of the Motomco Model 919.

David Orr, Director
Field Management Division

UNITED STATES DEPARTMENT OF AGRICULTURE
Grain Inspection, Packers and Stockyards Administration
1400 Independence Avenue, SW
Washington, D.C. 20250-3600

MOISTURE HANDBOOK

TABLE OF CONTENTS

CHAPTER 1	GENERAL INFORMATION
CHAPTER 2	MOISTURE METER CALIBRATION
CHAPTER 3	OPERATION AND TESTING OF THE GAC 2100 MOISTURE METER

CHAPTER 1

GENERAL INFORMATION

1.1	POLICY.....	Page 1-1
1.2	RESPONSIBILITIES.....	Page 1-2
1.3	RECORD KEEPING REQUIREMENTS.....	Page 1-4
1.4	EQUIPMENT IDENTIFICATION.....	Page 1-4
1.5	EQUIPMENT TESTING.....	Page 1-5
1.6	TESTING SCHEDULE.....	Page 1-6
1.7	REPAIRS.....	Page 1-6

1.1 POLICY

Dependable, well-maintained, precision equipment is essential to the accurate inspection of all commodities¹. Poorly designed or manufactured equipment and equipment that is excessively worn or misadjusted may cause incorrect factor determinations.

- a. Moisture. Moisture is the water content of grain or related commodities ascertained by the USDA air-oven method or by any method which gives equivalent results.
- b. Official Equipment. To ensure the accuracy and integrity of official inspections, moisture meters used for official purposes must be:
 - (1) A model and type² approved for use by GIPSA which gives results equivalent to the USDA air-oven method;
 - (2) Installed and operated according to the manufacturer's recommendations and the guidelines established by this handbook and the appropriate Occupational Safety and Health Administration (OSHA) Standards, 29 CFR 1910;
 - (3) Operated properly, utilizing officially approved calibration constants;
 - (4) Maintained in good repair;
 - (5) Tested at periodic intervals, in the prescribed manner, and found to be within tolerance; and
 - (6) Protected from unauthorized adjustments.

¹ The term "commodities," as used throughout the handbook, means grain, rice, beans, peas, lentils, oilseeds, and processed grain products.

² The mention of firm names or trade products does not imply that they are endorsed or recommended by the U.S. Department of Agriculture over other firms or similar products.

- c. Defective Equipment. Moisture meters which have serious operating deficiencies, do not operate within tolerance limitations, or have not been tested when required, shall be considered to be not approved for official use and shall be removed from service until a subsequent test establishes their accuracy.
- d. Elevator-Owned Equipment. Elevator-owned moisture meters may be used by official agencies for official purposes provided that the above criteria are met. The Field Office Manager should also consider the following guidelines before approving the use of elevator-owned moisture meters by official agencies:
 - (1) Review each situation, especially the methods that will be used to protect the meter from misuse or unauthorized adjustments.
 - (2) Seals and other appropriate security measures shall be used on moisture meters.
 - (3) If precautions are not adequate, do not approve the arrangement.
- e. Commercial Equipment. Commercial moisture meters are devices that are approved or allowed by local or State weights and measures jurisdictions as “legal for trade.” GIPSA official meters may meet stricter tolerances or design requirements than commercial meters; however, commercial meters may be considered for *Official Commercial Inspection Services*.
- f. Government-Owned Equipment Loans.
 - (1) Government-owned moisture meters may be loaned to official agencies during legitimate emergencies for short time periods. These temporary loan provisions must be documented.
 - (2) No open-ended loans are to be approved.

1.2 RESPONSIBILITIES

- a. GIPSA Headquarters:
 - (1) Field Management Division shall:
 - (a) Maintain a List of Approved Equipment;

- (b) Advise the GIPSA field offices on the selection and purchase of equipment; Assist in the purchase of inspection equipment;
 - (c) Assist APHIS Business Services (ABS) on joint purchase orders, blanket purchase arrangements, and purchases of new types of equipment;
 - (d) Assist ABS in the negotiation of maintenance contracts with applicable manufacturers; and
 - (e) Develop and publish policies and procedures pertaining to the maintenance, repair, use, and testing of moisture meters.
- (2) Technical Services Division (TSD) shall:
- (a) Evaluate new models and/or types of meters;
 - (b) Develop and maintain moisture meter calibrations;
 - (c) Maintain the Headquarters Standard meters in good repair;
 - (d) Test the Headquarters Standard meters;
 - (e) Provide samples for testing all GIPSA and official agency moisture meters;
 - (f) Evaluate test results, and approve or reject all GIPSA and official agency moisture meters;
 - (g) Maintain test records for all GIPSA and official agency moisture meters;
 - (h) Evaluate alternate testing methods;
 - (i) Develop policies, procedures, work forms, and schedules for the testing of equipment;

- (j) Administer the equipment testing program; and
 - (k) Train field personnel, in cooperation with the Audiovisual, Regulatory Management, and Training Staff.
- b. GIPSA Field Offices, Sub-Offices, and Official Agencies. Each office shall be responsible for all equipment that is used officially by their office. This includes moisture meters that are provided for official use by a facility.
 - (1) Maintain official meters in good repair and ensure compliance with OSHA Standards.
 - (2) Designate an equipment specialist who will serve as the primary contact responsible for moisture meter testing.
 - (3) Test their official moisture meters.
 - (4) Maintain test and audit trail records for all moisture meters that are used officially by their office.
 - (5) Field offices shall assist TSD in resolving moisture meter performance problems at official agencies.

1.3 RECORDKEEPING REQUIREMENTS

- a. GIPSA Headquarters. The office in charge of the moisture meter testing program shall maintain completed test forms for at least 5 years from the date of test for Headquarters Standard equipment and all other official moisture meters.
- b. GIPSA Field Offices, Sub-Offices, and Official Agencies. All offices shall maintain completed test forms for at least 5 years from the date of test for moisture meters that they use for official inspection.

1.4 EQUIPMENT IDENTIFICATION

- a. Serial Number. All moisture meters shall be identified by a serial number.
- b. Test Decal. The GIPSA test label (form FGIS-931, "Approved Label for Inspected

Machinery,") shall not be required.

1.5 EQUIPMENT TESTING

Unless there is a need to know, sample results or target values should be withheld from the test unit operator until after test completion (blind testing). All moisture meters should be tested 'as used' whenever possible. For example, a meter should be tested in its normal work environment.

- a. Initial Tests. New meters shall be tested prior to being put into service.
- b. Periodic Tests.
 - (1) Headquarters Standards shall be tested in accordance with Chapter 3 of this handbook. All other meters shall be tested periodically in accordance with the testing schedule below.
 - (2) All Moisture Meters.
 - (a) All moisture meters, other than those which are in storage or used only at seasonal points, shall be tested periodically in accordance with the testing schedule, whenever practical. An office manager may, with the concurrence of TSD, establish an alternate written schedule provided that the alternate schedule requires the testing of the meters at least once every 6 months.
 - (b) Meters held in storage are not required to be tested unless they are "back-up meters."
 - (c) "Back-up meters" must be tested on schedule. Untested equipment may not be placed into service under any circumstances.
 - (d) At seasonal inspection offices (those that are open less than 6 months a year), meters shall be tested once a year just prior to reactivation of the office.

- c. Supplemental Tests. Moisture meters shall be tested as soon as practicable whenever:
- (1) GIPSA Headquarters, a GIPSA field office, or an official agency has comparative inspection results or other information that shows the meter to be of questionable accuracy;
 - (2) It becomes apparent that the meter has not been tested in accordance with the established testing schedule;
 - (3) After any repairs or alterations (replacement of a minor part will not require the meter to be retested); or
 - (4) After movement or shipping. If a meter is hand-carried with care, the field office or official agency manager may elect to omit the grain moisture test and perform only the weighing test.

1.6 TESTING SCHEDULE

Moisture meters shall be tested each February and August. TSD may begin the periodic testing as early as January and July, depending on resources.

1.7 REPAIRS

- a. Repair of GIPSA-owned moisture meters shall be performed by factory-approved repair facilities only. Equipment Specialists are not authorized to repair meters, except as specified in the Maintenance section of this handbook.
- b. Safety. Before working on any equipment, read the instructions in the appropriate handbook section. Unplug equipment before beginning adjustments.
- c. Factory warranty of new meters (or repaired components) is one year.

CHAPTER 2

MOISTURE METER CALIBRATION

2.1	GENERAL REQUIREMENTS.....	Page 2-1
2.2	SCHEDULE.....	Page 2-1
2.3	EQUIPMENT REQUIREMENTS.....	Page 2-2
2.4	ANNUAL CALIBRATION STUDY.....	Page 2-2
2.5	REPORTS.....	Page 2-5
2.6	CRITERIA FOR CHANGES.....	Page 2-5
2.7	SAMPLE LIST.....	Page 2-7

2.1 GENERAL REQUIREMENTS

GIPSA is responsible for developing, implementing, and maintaining calibrations used with the official meter. ISE periodically verifies the accuracy of moisture meter calibrations used in the official system. The calibrations for the major grains inspected under the United States Grain Standards Act and the major classes of rough rice are checked annually. All other calibrations are checked on a nine-year cycle.

2.2 SCHEDULE

a. The commodities requiring annual calibration review are:

- (1) Barley (Two- and Six-rowed)
- (2) Corn
- (3) Oats
- (4) Rough Rice (Long Grain and Medium Grain)
- (5) Sorghum
- (6) Soybeans
- (7) Sunflower Seed (Oil Type)
- (8) Durum Wheat
- (9) Hard Red Spring Wheat
- (10) Hard White Wheat
- (11) Soft White Wheat
- (12) Hard Red Winter Wheat
- (13) Soft Red Winter Wheat

b. The commodities requiring nine-year cyclical review are:

- (1) Cycle years 1-3. Black beans, Great Northern beans, Pea (Navy) beans, Pinto beans, canola, flaxseed, rapeseed, Brewers Milled rice, Long Grain Brown rice, Long Grain Brown rice (Parboiled), Long Grain Milled rice, Long Grain Milled rice (Parboiled), Medium Grain Brown rice, Medium Grain Milled rice, and rye.

- (2) Cycle years 4-6. Black Eye beans, Dark Red Kidney beans, Light Red Kidney beans, Small Red beans, Lentils, Smooth Dry peas, Split peas, Wrinkled Dry peas, Brewers Milled rice (Parboiled), Medium Grain Milled rice (Parboiled), Second Head Milled rice (Long/Medium Grain), Short Grain Rough rice, safflower seed, and sunflower seed (Confectionery).
 - (3) Cycle years 7-9. Cranberry beans, Garbanzo beans, Baby Lima beans, Large Lima beans, Pink beans, Small White beans, Yelloweye beans, Austrian Winter peas, Brown mustard seed, Oriental mustard seed, Yellow mustard seed, Medium Grain Milled rice (Coated), Screenings Milled rice, Short Grain Brown rice, Short Grain Milled rice, Short Grain Second Head Milled rice, Second Head Milled rice (Parboiled), and triticale.
- c. The order of testing other commodities will be determined based on economic importance, market interest, sample availability, and program resources.

2.3 EQUIPMENT REQUIREMENTS

- a. The DICKEY-john Grain Analysis Computer GAC 2100 is the designated official moisture meter for work within the official system. Due to the amount of work involved in deriving official GAC 2100 calibrations for all grains, a transition period is required. For any given grain, the Motomco Model 919 will continue to be used until the official GAC 2100 calibration is implemented for that grain.
- b. All moisture meters, test weight apparatuses, and balances shall be approved, maintained, used, and tested in accordance with this handbook, the Grain Inspection Handbook, and the Equipment Handbook.
- c. GIPSA Headquarters shall maintain four Standard meters, three of which are kept in service as working Standard units. The remaining meter is a back-up unit, ready to be placed into service if one of the three Standard meters fails. All Headquarters Standard units must pass an initial test and, subsequently, the regularly scheduled maintenance tests. Procedures for these tests are outlined in Chapter 3.

2.4 ANNUAL CALIBRATION STUDY

- a. Sample Collection Notice. Sample collection assignments are communicated to GIPSA field offices in the spring of each year through a sample collection notice. TSD will submit the notice for the new crop year by April 15.

- (1) The notice states which calibrations are being evaluated, the offices responsible for submitting samples, the numbers and types of samples needed, and moisture range for each commodity under study. The number of samples requested from each office is based on production within the geographical area of responsibility.
 - (2) The moisture ranges and total numbers of samples requested for calibration review are given in Table 2.1.
- b. **Sample Collection Procedures.** The purpose of the sample collection effort is to obtain representative samples from the entire nation. It is understood that all requested moisture levels may not be available in all areas every year. Since a wide moisture range is important to the study, field offices should make all reasonable efforts to provide the requested samples. Submitted samples should be natural; that is, the moisture should not be adjusted by adding water or drying in the laboratory. Samples should weigh at least 1,200 grams; however, when only underweight samples are available, they may be used in the study. More specific instructions will be given in each current year's annual notice.
- c. **Sample Handling.** Upon receipt of a sample, TSD assigns an identification number and records the date received, source, grain type, moisture, and other pertinent information in the sample log. The integrity of the sample bag is checked and the sample is rebagged if needed. Polyethylene bags (six mil thickness) are used. Bags are heat sealed. Samples are stored at 35-45 EF unless tested within 24 hours of receipt.
- d. **Sample Testing.**
- (1) Samples are scheduled for testing in order of decreasing moisture content. Prior to testing, samples are removed from cold storage and equilibrated overnight to room temperature. (Samples over 18 percent moisture are equilibrated to room temperature on the day of testing.)
 - (2) Samples with objectionable amounts of foreign material are hand-sieved before testing. The condition of the sample (odor, appearance, damage, remaining foreign material, etc.) is recorded on a data sheet. TSD mixes the sample, determines the test weight, and records the result.

- (3) The sample is then divided into representative portions slightly in excess of the amounts needed for meter plus air oven analysis. An initial air oven portion is withdrawn and sealed in an airtight container.
- (4) TSD tests each sample on the official meter model at room temperature according to instructions in Book II, Chapter 1 of the Grain Inspection Handbook. A minimum of two measurements on each of two meters is collected; however, this number may be increased to accommodate special projects.
- (5) In addition to the official model, other NTEP-certified models may be included in the annual moisture calibration study under the NTEP Program.
- (6) Precautions are taken to control the effects of moisture loss during testing.
 - (a) Samples are kept sealed in moisture-proof containers except during actual meter testing. Air oven portions are withdrawn before and after meter testing and sealed in moisture-tight containers.
 - (b) Air oven moistures are determined on each portion, and the results are averaged.
 - (c) The total number of drops done on any meter portion is limited to twelve (except on a very few small samples which cannot be subdivided). When collecting data on multiple meter models (for instance, the NTEP certified models), data for the official model are collected midway.
 - (d) When testing samples above 18 percent moisture, half of the samples are randomly selected and tested in reverse order to prevent biasing the results of any model due to moisture loss. Special projects are supported by additional air oven testing.
- (7) Air oven portions are tested by the USDA air oven method for grain moisture determination. Duplicate analyses are run on both the initial and final portions (a total of four analyses per sample).
- (8) TSD reviews the data and investigates questionable results and instrument bias trends. When all tests for a particular commodity are completed, TSD submits the data for statistical processing.

2.5 REPORTS

- a. Statistical Output. A separate statistical report is generated for each commodity studied. Each report contains multi-year reviews (at least 3 years of data), including:
 - (1) Plots of meter bias vs. air oven moisture;
 - (2) Charts showing meter bias by 2 percent moisture intervals; and
 - (3) Data summary tables listing numbers of samples, instrument bias values, standard deviations of the bias values, 95 percent confidence intervals, tolerance violations (if applicable), and instrument repeatability.

- b. Moisture Reports. TSD prepares separate moisture reports for the official model on each calibration evaluated. Each report will be issued not later than 45 days prior to the normal start of harvest in the principal area(s) of production. The reports will include:
 - (1) A table listing the sources of samples and the number received from each location;
 - (2) A table reporting multi-year summary statistics;
 - (3) A multi-year review of meter bias versus air oven moisture and of yearly average and multi-year average bias patterns; and
 - (4) A summary of calibration accuracy, significant tolerance violations, and recommendations regarding the calibration.

2.6 CRITERIA FOR CHANGES

Moisture calibrations for the official model are evaluated for possible correction under the following rules:

- a. **General Rule.** A calibration should be revised if the three- or five-year data reviews show that any 2 percent moisture interval has an average bias that exceeds (at a confidence level of 95 percent) ± 0.30 percent moisture. (The bias tolerance is ± 0.50 percent moisture for corn above 15 percent moisture, sorghum above 21 percent moisture, and sunflower seed above 14.75 percent moisture.)

- b. **Rule for sustained biases not corrected by the General Rule.** A calibration is considered for bias correction when all of the following conditions are met:
 - (1) The three-year average calibration bias (the three-year average bias over the entire range) exceeds 0.15 percent moisture,

 - (2) The most recent three-year average calibration bias exceeds twice the standard deviation of past three-year average calibration biases.

- c. **Special Circumstances.** Unusual situations (such as abnormal crop years) that justify exceptions to the above rules are treated on a case-by-case basis.

2.7 SAMPLE LIST

Table 2.1, Moisture Ranges and Numbers of Samples Requested.

<u>Commodity</u>	<u>Assigned Moisture Range</u> (%)	<u>No. Samples Requested</u>
Barley	8 to 20	60
Corn	8 to 30	260
Flaxseed	5 to 15	40
Oats	8 to 20	80
Rye	8 to 20	60
Sorghum	8 to 25	60
Soybeans	8 to 20	210
Sunflower Seed	5 to 25	130
Wheat - Durum	7 to 20	70
- Hard Red Spring	7 to 20	70
- Hard White	7 to 20	60
- Soft White	8 to 20	60
- Hard Red Winter	8 to 20	70
- Soft Red Winter	7 to 20	60
Edible Beans	8 to 20	40 (per kind)
Lentils	7 to 20	50
Peas - Wrinkled Dry	7 to 20	50
- All Other Kinds	8 to 20	50 (per kind)
Canola and Rapeseed	4 to 15	50
Rough Rice	7 to 25	80 (per class)
Processed Rice (not parboiled)	10 to 16	60 (per class)
Processed Rice (parboiled)	10 to 20	60 (per class)
Safflower Seed	3 to 15	50

CHAPTER 3

OPERATION AND TESTING OF THE GAC 2100 MOISTURE METER

3.1	MAINTENANCE.....	Page 3-1
3.2	OPERATION.....	Page 3-4
3.3	HEADQUARTERS STANDARD METERS.....	Page 3-8
3.4	TESTING OFFICIAL MOISTURE METERS.....	Page 3-10
3.5	REPAIR OF GIPSA-OWNED MOISTURE METERS.....	Page 3-14
	Instructions for Completing Form FGIS-923, “Moisture Meter Test”.....	Page 3-17

3.1 MAINTENANCE

Meters must be maintained in good operating condition. Check them prior to initial use and periodically thereafter, as needed. Each maintenance check shall include the following:

- a. Environmental Conditions. Ensure that the moisture meter is placed in a room that is within the manufacturer's basic requirements of 10-40 EC (50-104 EF). To minimize the effects of instrument temperature in official inspection, it is recommended that the laboratory temperature for the GAC 2100 be maintained within the range of 15-30 EC (approx. 60-85 EF).
- b. Cell Cleaning.
 - (1) Display the DIAGNOSTICS MENU (Option 6 of the TESTS MENU). When the DIAGNOSTICS MENU displays, depress the LOAD key. The hopper doors open and will remain open until the UNLOAD key is depressed. Use the brush supplied in the accessory kit to clean the inside of the grain cell. Take care not to bump the sensing diodes.
 - (2) Slide the GAC 2100 to the front of the worktable and remove the grain drawer. Reach up inside and very carefully clean the strike-off arm spring. Clean excessive dust off of the window and other surfaces.
 - (3) Depress the UNLOAD key. The cell rotates 180 degrees to dump the residue from the cell cleaning procedure. The hopper doors close. Depressing PREVIOUS PAGE key twice returns the display to the MAIN MENU.
- c. Fuse Replacement. Replace the fuse only if necessary. Disconnect the power cord from the rear of the unit. Using a small screwdriver or similar tool, remove the cover and fuse block assembly. Replace the fuse with a 0.4 amp Slo-Blo type fuse. Replace the fuse block and cover.

- d. Electrical connections. Check the condition of the power cord and connections, and ensure that a grounded plug is used. Non-GIPSA personnel are cautioned that when using an adapter with a grounding wire, make sure the grounding wire is connected properly to a good earth ground, otherwise a shock hazard could be present. GIPSA personnel shall not use adapters. Also, failure to use a properly grounded outlet could cause moisture accuracy problems.
- e. Security. Security of the calibrations and other parameters affecting measurement accuracy must be ensured.
 - (1) Sealing. The access port on the rear (lower left side) of the unit shall be sealed to prevent access by unauthorized personnel. (All meters, regardless of their location.)
 - (2) Security Codes.
 - (a) Operator Level. No access code required.
 - (b) The Access Code Level is the basic security level. All modifications can be performed except those dealing with official calibrations, output options, and clearing of the audit memory. Actions are recorded in the audit trail.
 - (c) The User ID Code Level is the top security level. All modifications are allowed. Actions are recorded in the audit trail.
 - (3) Audit Trail Printing. Printing of the audit memory can be initiated by depressing the **(5)** key from the CALIBRATION MENU. A screen appears instructing you to press PRINT to begin. Depress the PRINT key. If only the header, current date, current time, and serial number print during this process, the audit memory is empty. Any entries under these headings indicate that changes have been made.
 - (4) Clearing Audit Trail. Authorized personnel only. Before clearing the audit trail, print and save the paper copy in the file with meter test records.
 - (5) Audit Trail Event Counter Display. The total number of changes to the audit memory can be displayed. From the MAIN MENU, select **(5)** TESTS MENU, and **(5)** DISPLAY. Four numbers appear at the bottom of the display. The third number (from left to right) is the total number of audit memory changes made to the instrument--the audit trail event count.

MOISTURE HANDBOOK
Chapter 3
Operation and Testing of the GAC 2100 Moisture Meter
01/08/99

- (6) Moisture Meter Record Log. A permanent log book shall be established and maintained for each GAC 2100. The book shall be kept with the meter at the official use site. The log will be used as an important historical record to indicate:
- (a) Serial Number.
 - (b) Meter test dates, results, and comments.
 - (c) Date and type of each repair.
 - (d) Date and location for each transfer to a new site.
 - (e) Date seal applied (number and initials).
 - (f) Date and initials for each entry or change of calibration constants (both official and unofficial).
 - (g) Date, time, and initials when recording the results of an audit trail event count.
 - (h) Date, time, and initials when checking seals, calibrations, etc., following return from cross utilization.
 - (i) Other historical information.

Figure 3.1,
Log Book Example

DATE	ACTION	NAME OF PERSON MAKING ENTRY
7-8-98	Rcv'd SN 4999 from Dickey John	JR
7-10-98	Checked calibrations for CORN, HIGH MOIST CORN, SOYBEANS, + SUNFLOWER SEED, per Directive 9180.61	PH
7-10-98	Applied seal FG 5321	JR
7-21-98	Tested & Approved by ISE	PH
7-22-98	Moved to XY7 ELEVATOR Beaumont, TX	PH

3.2 OPERATION

- a. Cross-utilized Equipment. When moisture meters are used by both official agency and unofficial (elevator) personnel, the elevator shall not make any changes to the meter set-up, unless approved and witnessed by the official agency. When a meter has been out of official agency control, the official agency shall check the operation of the meter before commencing daily operations. This should include a weighing test, security seal check, and printing of the audit trail. If problems are found, remove the unit from official service until corrected.
 - (1) As an alternative to printing the audit trail, the official agency may display and record the audit trail event count in order to verify that no changes have been made.
 - (2) Another alternative is to display the calibration constants and verify their correctness. An official list of calibration constants must be used.
 - (3) Whatever method of security check is performed, it must be recorded in the log book and the entry initialed.
- b. Current date and time shall be set.
- c. Test Weight per Bushel. This function is not approved for official use.
- d. Power-up and Grain Selection. When the power is turned on, the unit automatically begins a self-check to determine the status of the (1) load/strike-off mechanism; (2) unload function; (3) empty test cell weight; and (4) conductance/ capacitance measurement circuitry. The MAIN MENU (the “Home” screen through which all other screens are accessed) appears immediately after all start-up checks are successfully completed. Allow approximately 15 minutes of warm-up time before taking official moisture measurements. Press the (2) key to access the CALIBRATION MENU, then select the type of grain to be measured.
- e. Recording Results. The GAC 2100 does not require manual calculations or the reading of charts, therefore eliminating the use of a moisture log. Official personnel will maintain a work record on the pan ticket and certificate.
- f. Instrument Temperature. The built-in GAC 2100 instrument temperature range limit is 10-40 EC (50-104 EF). If the instrument temperature is determined to be outside the range of 10-40 EC, no moisture results will be displayed.

MOISTURE HANDBOOK
Chapter 3
Operation and Testing of the GAC 2100 Moisture Meter
01/08/99

To minimize the effects of instrument temperature in official inspection, it is recommended that the laboratory temperature for the GAC 2100 be maintained within the range of 15-30 EC (approximately 60-85 EF). (Same as for Model 919.)

- g. Sample Temperature. The built-in GAC 2100 sample temperature range limit is 0-40 EC (32-104 EF). If the instrument's measured sample temperature is outside the range of 0-40 EC, no moisture results will be displayed.

For optimum accuracy and consistency in official inspection, it is recommended that the sample temperature be brought within the range of 10-32 EC (50-90 EF) before performing moisture determinations.

- h. Sample-Instrument Temperature Difference. The built-in GAC 2100 sample-to-instrument temperature difference limit is 20 EC (36 EF). If the instrument finds the sample temperature to be different from the instrument temperature by more than 20 EC, it will not display moisture results.

For optimum accuracy and consistency in official inspection, it is recommended that the difference between the grain and instrument temperature not exceed 11 EC (20 EF). (Same as for model 919).

- i. Sample requirement. Pour the sample through the divider at least once (to mix the sample) before filling the hopper. The GAC 2100 does not require weighing a portion size.
- j. Handle all cold samples quickly to reduce the possibility of condensation in a warm room. Samples on which snow or ice has melted or which contain snow or ice, are unsuitable for moisture testing.
- k. Keep all samples in sealed moistureproof containers if they cannot be tested within approximately 15 minutes.
- l. Do not use paper bags, fiber cartons, or similar containers that allow moisture losses. Use metal cans, plastic containers, and plastic bags to preserve the sample integrity. Do not file samples with paper identification inserted in the grain. Paper absorbs moisture and lowers the moisture of the grain.

- m. When obtaining a portion for moisture testing, ensure that the sample has passed through the Boerner divider at least once (to mix the sample). If you obtain the moisture portion from the file or work sample by pouring or scooping, return the moisture portion to the file or work sample after testing to maintain the representativeness of the sample for other tests.
- n. Normal Warm-up. Samples should remain in the area where tests are to be made until the grain reaches a temperature within the established limits. Place the containers on a table in such a manner as to allow free access of air to all sides. Placing the containers on a wire grating or rack has the additional advantage of exposing the bottom as well as the sides of the containers to the air. Temperature equalization may be hastened by frequent shaking of the containers or by directing an electric fan at the cans.
- o. Quick Warm-up.
 - (1) Cut the sample down to the appropriate size for a moisture test (about 350 grams). Use of an excessively large sample will cause the warming process to be slower.
 - (2) Place the sample in a zipper-closure type 1-gallon storage bag (1.75 mil thick polyethylene). (Hefty OneZip® bags were found to be particularly convenient for this process.)
 - (3) Flatten the bag and squeeze out as much air as possible. Then close the bag.



- (4) Put the closed bag on a wire rack positioned at least 2 inches from any surface and directly in the air flow of a fan blowing room-temperature air. Air flow must be brisk on top and bottom sides of the bag. The fan should have a minimum blade diameter of 12 inches and should be run on medium to high

MOISTURE HANDBOOK
Chapter 3
Operation and Testing of the GAC 2100 Moisture Meter
01/08/99

speed. Flatten the bag and smooth out the grain sample so that it is essentially one kernel thick. Leave the flattened, closed bag on the rack for three (3) minutes. (The time may need to be adjusted, depending on grain and laboratory temperatures.)

- (5) This process should warm a 42 EF corn or soybean sample to about 60 EF in 3 minutes if the laboratory temperature is above 70 EF. For best accuracy, the grain should be warmed to above 50 EF. If the initial grain temperature is lower than 40 EF or the laboratory temperature is below 70 EF, the grain may need to remain on the rack for more than 3 minutes to reach a final temperature of 50 EF or greater. Also, as noted above, using a excessively large grain sample, failing to exclude air from the bag before closing, or failing to spread the grain out to a thin layer within the bag will slow the warming process.
- p. Pour the grain into the sample hopper. Fill the sample hopper located on top of the unit with enough grain to fill the measuring cell inside the instrument (heap grain slightly). The exact volume of grain is not important, except enough grain must be present to overflow the cell (approximately one pint). When the test begins, any excess grain spills over the cell and drops into the sample drawer. If the amount of grain is insufficient to overflow the test cell, depress UNLOAD to dump the sample and repeat the test with a sufficient sample size.
- q. Depress the LOAD key on the keyboard to start the test cycle.
- r. Wait briefly for the moisture test to finish.
- s. Observe the results of the test on the display.

- t. The GAC 2100 is equipped to report moisture outside the approved range for the calibration. An error indication will notify the operator if the calibration range is exceeded. When the moisture reading exceeds the approved calibration range, another determination shall be made from the work sample or file. If the second determination is not outside the approved calibration range, use the second moisture result. Otherwise, the final moisture shall be based on the average of the two determinations and rounded to the nearest 0.1 percent moisture.
- u. When finished with the measurement, depress the UNLOAD key.
- v. For additional instructions, refer to the GAC 2100 operator's manual.

3.3 HEADQUARTERS STANDARD METERS

- a. GIPSA Headquarters shall maintain four Standard meters, three of which are kept in service as working Standard units. The remaining meter is a back-up unit, ready to be placed into service if one of the three Standard meters fails. All Headquarters Standard units must pass the acceptance test and, subsequently, the regularly scheduled maintenance tests.
- b. Acceptance Test (for new/repared Standard units). Conduct duplicate direct comparison tests among two of the manufacturer's Standard meters and each new or repaired Headquarters Standard meter. Average the moisture results of the duplicate tests. Each new or repaired Headquarters Standard meter must meet the tolerances below. (To avoid unnecessarily transporting the manufacturer's Standard meters, a repaired meter may be tested in duplicate at the factory, transported by a technical specialist to TSD, and tested in duplicate against the remaining three Standard units.)

Conduct duplicate direct comparison tests among the three working Headquarters Standards and the new or repaired Standard meter. Average the moisture results of the duplicate tests. Each new or repaired Headquarters Standard meter must meet the tolerances below.

- c. Maintenance Tests. Once every two months, perform a direct comparison test among the Headquarters Standards. Each Headquarters Standard meter must meet the tolerances below.

Once a year, conduct a direct comparison test among two of the manufacturer's Standard meters and the Headquarters Standard meters. Each Standard meter must meet the tolerances below.

Test Tolerances for Headquarters Standard Meters		
<u>Diagnostic Self Test</u>	<u>Weight Test Deviation</u> (g)	<u>Maximum Moisture Test Deviation</u>
		<u>Direct Comparison</u> (%)
SCD1 = 379 ± 5	Average ± 0.5	Average ± 0.05
SCD2 = 2500 ± 5	Range # 0.5	Range # 0.25

Figure 3.2, Tolerances for Standards

If a Standard meter fails to meet one of the above specifications, the entire test may be repeated and the results of the two tests averaged to obtain the final result. Accuracy of test results is contingent on the manufacturer maintaining its Standards in a manner acceptable to TSD.

- d. Daily Continuity Check.
- (1) Obtain a sample of dockage-free HRW wheat in the range of 11.0-12.0 percent moisture. Store the sample in a moisture proof container at the instrument site. Once a day during data collection, obtain a moisture reading on each data collection meter using the designated sample. Record the results in an instrument log book. After two weeks, calculate the average of the daily readings for each portion. Compare subsequent daily check results against the average to determine if any meter is drifting.
 - (2) Some gradual drift is expected due to moisture loss over time. Recalculate the average every month to maintain a current baseline value. If a meter deviates more than 0.3 percent moisture from its current average, obtain a second reading to verify the drift. If drifting is evident, check the meter against the other Headquarters Standard meters according to the maintenance test, above. If the meter fails the test, remove it from service, until repaired.

3.4 TESTING OFFICIAL MOISTURE METERS

The instrument shall be warmed up for at least 30 minutes before performing parts a., b., and c., below. Before proceeding to part d., the instrument and sealed sample shall be allowed to equilibrate to the temperature of the room for at least four hours.

- a. Verify Calibration Constants.
 - (1) Record the location information on the data sheet.
 - (2) From the MAIN MENU, press **(3)** CALIBRATION MENU, **(1)** VIEW CALIBRATION, **(5)** HRW.
 - (3) Verify the issue date and values for K1 through K9. These values should agree with the official calibration constants list. Initial in the space provided.
 - (4) Press PAGE BACK to the SELECT GRAIN TO VIEW menu and repeat verification of K1 through K9 for all other grains having official calibrations.
 - (5) Press PAGE BACK to the MAIN MENU.

- b. Verify Diagnostic Test Values.
 - (1) Record the instrument serial number on the data sheet.
 - (2) From the MAIN MENU, press **(5)** TESTS MENU, **(6)** DIAGNOSTICS, **(5)** SCD1.
 - (3) Record values for SCD1 and SCD2.
 - (4) SCD1 should be within the range 379 ± 7 .
 - (5) SCD2 should be within the range 2500 ± 7 .
 - (6) Press PAGE BACK to the MAIN MENU.

- c. Verify accuracy of the weighing system. This test can be performed by the operator any time the instrument's accuracy is questioned. It must be performed immediately prior to conducting the moisture sample comparison test (part d., below).

MOISTURE HANDBOOK
Chapter 3
Operation and Testing of the GAC 2100 Moisture Meter
01/08/99

- (1) Clean out the sample drawer, striker arm, and cell area to remove any material that may be lodged in crevasses.
- (2) From the MAIN MENU, press **(5)** TESTS MENU, **(7)** TEST NETWORK MODE.
- (3) Pour 350-400 grams of a room temperature, medium moisture (approximately 10-12 percent), clean soybean sample into the sample hopper. The soybeans should have an official test weight of at least 55 pounds per bushel.
- (4) Press the LOAD key to start the measurement.
- (5) Wait until the measurement is completed. Do not unload the cell yet.
- (6) Record the D3 value. Divide by 10 to get the weight in grams and round to the nearest 0.1 gram. Record on the data sheet.
- (7) Empty all of the overflow grain from the sample drawer. Replace the sample drawer.
- (8) Press the UNLOAD key to dump the grain from the test cell into the sample drawer.
- (9) Carefully pour the grain from the sample drawer into a tared weighing pan (capture all grain that was in the test cell), weigh the grain using an approved and tested electronic grain test scale, and record the weight of the grain to the nearest 0.1 gram. This is a precise weight measurement. Be careful to minimize air currents around the grain test scale.
- (10) Calculate and record the difference between the GAC weight and the grain test scale weight.
- (11) Recombine the measured sample and the overflow portion and repeat steps 3 through 10 four more times, for a total of five determinations.
- (12) Average the differences. The average of the five differences should not exceed ± 1.0 gram.

- (13) The range of the five differences should not exceed 1.0 gram.
 - (14) Press PAGE BACK to the MAIN MENU.
- d. Verify performance with grain moisture sample.
- (1) From the MAIN MENU press **(5)** TESTS MENU, **(8)** PARAMETERS MENU, **(4)** VIEW CALIBRATION ADJUSTMENT CONSTANT.
 - (2) Record the instrument calibration adjustment constant (CAC) and sample I.D. number on the data sheet.
 - (3) Clean out the sample drawer, striker arm, and cell area to remove any material that may be lodged in crevasses.
 - (4) From the MAIN MENU press **(2)** SELECT GRAIN, **(5)** WHEAT HRW.
 - (5) Pour the entire check sample into the sample hopper. The weight of the sample is not critical, so it is allowable for a few kernels to remain in the can.
 - (6) Press the LOAD key to start the measurement.
 - (7) When the moisture measurement is displayed, record it on the data sheet.
 - (8) Press the NEXT PAGE key to see the D-values. Record the values for D1, D2, D3, and D4.
 - (9) Press the UNLOAD key to dump grain from the test cell into the sample drawer.
 - (10) Repeat steps 5 through 9 five more times, for a total of six determinations.
 - (11) Place the sample back into the original container and close it tightly. Retain the sample for possible retest until TSD validates the test.
 - (12) Record the name of the field meter operator and date of test on the data sheet.
 - (13) Fax the data sheet to TSD at (816) 891-8070.

Test Tolerances for Meters (Other than Headquarters Standards)			
<u>Diagnostic Self Test</u>	<u>Maximum Moisture Test Deviation</u>		
	<u>Weight Test Deviation</u> (g)	<u>Direct Comparison</u> (%)	<u>Sample Exchange</u> (%)
SCD1 = 379 ± 7	Average ± 1.0	N/A	Average ± 0.15
SCD2 = 2500 ± 7	Range # 1.0	N/A	Range N/A

Figure 3.3, Tolerances for Official Meters

- (14) TSD will enter the data into a spreadsheet and compare the results to the tolerance. The D-values are important because they provide the means to calculate moisture results to a greater precision and to determine possible causes for out-of-tolerance results.
- (15) The tolerance for moisture meters is ± 0.15 percent mean deviation from Standard meter, when testing by sample exchange using Hard Red Winter wheat in the range of 11.0 to 12.5 percent moisture.
- (16) TSD will fax the completed data sheet showing the test results to the official agency and field office. If results are out-of-tolerance, TSD will advise whether to retest the sample or seek instrument repair.
- (17) If the sample is to be retested, repeat steps 1 through 13. TSD will retest the sample after it is returned.
- (18) Return the moisture sample to:

TSD-ISE-Moisture
 USDA-GIPSA-FGIS Technical Center
 10383 N. Executive Hills Blvd.
 Kansas City, MO 64153-1394

3.5 REPAIR OF GIPSA-OWNED MOISTURE METERS

- a. General. All repairs to GIPSA-owned meters shall be made by the manufacturer. Field offices shall not attempt to make repairs or adjustments other than as outlined in this handbook or the GAC 2100 operator's manual.
- b. Moisture meter users should consult with TSD and the manufacturer (1-800-637-3302) to determine the need for maintenance and repair of malfunctioning meters. "Loaner" moisture meters are available from the manufacturer.
- c. To aid the manufacturer in determining the types of repairs needed, thoroughly describe the malfunction or operational difficulty, and provide any other pertinent information concerning the condition of the meter.
- d. Before packing the meter for shipment be sure to engage the shipping brace in the "transport position."
- e. Upon return, the meter shall be tested against a Headquarters Standard meter before authorization of payment (if necessary) and official use.

Reserved

Figure 3.4, Form FGIS-923, "Moisture Meter Test"

Part A
Part B
Part C
Part D

		U.S. DEPARTMENT OF AGRICULTURE Grain Inspection, Packers & Stockyards Administration Moisture Meter Test		FORM APPROVED OMB NO. 0580-0013 File Name: _____	
		Field Office _____ Agency _____ Location _____ Phone _____ Fax _____		<input type="checkbox"/> INITIAL <input type="checkbox"/> RETEST <input type="checkbox"/> REPAIR <input type="checkbox"/> 2ND SAMPLE	
PARTS A. AND B. CALIBRATION CONSTANTS & DIAGNOSTIC VALUES VERIFICATION					
VERIFIED K1 THRU K9 : Initials _____					
METER S/N		SCD1		SCD2	
PART C. WEIGHING ACCURACY TEST					
	DROP 1	DROP 2	DROP 3	DROP 4	DROP 5
D3 VALUE	1	5	→		
D3 / 10 ROUND TO 0.1	2				
SCALE WEIGHT (g)	3				
GAC WT - SCALE WEIGHT	4				
AVG OF DIFFERENCES		RANGE OF DIFFERENCES			
6		7			
PART D. GRAIN MOISTURE SAMPLE TEST					
METER CAC		SAMPLE I.D.			
	DROP 1	DROP 2	DROP 3	DROP 4	DROP 5
DISPLAY MOISTURE	3	5	→		
D1	4				
D2					
D3					
D4					
CALC. MOISTURE					
AVG MOISTURE					
STD. AVG. MOISTURE					
DEVIATION		OPERATOR (FIELD):		DATE TESTED:	
TOLERANCE 0.15		REVIEWER (HQ):		DATE REVIEWED:	
RECOMMENDED ACTION:		APPROVED <input type="checkbox"/>		RETEST <input type="checkbox"/>	
				REPAIR <input type="checkbox"/>	
COMMENTS _____ _____ _____					
Public reporting burden for this collection of information is estimated to average 0.083 hours per response and 0.001 hours of record keeping, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send Comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Agriculture, OIRM, AG Box 7630, Washington, D.C. 20250; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, D.C.					
Form FGIS 923 (9-98)					

Instructions for Completing
Form FGIS-923, "Moisture Meter Test"

Fill in any missing or incorrect information in the Identification Block.

Part A.

Verify all official calibration constants. Update all obsolete calibrations. Initial to indicate that all calibrations are correct.

Part B.

Enter meter serial number.

Enter SCD1 and SCD2 values.

Part C.

1. Enter the result of the first drop (the D3 value).
2. Divide the D3 reading by 10. Record the result to 0.1
3. Enter the weight reading from the lab scale.
4. Enter the difference (Item 2 minus Item 3).
5. Repeat Item 1 through Item 4 for a total of five drops.
6. Enter the average difference (average of five differences from Item 4).
7. Enter the range of differences (total spread of the differences).

Part D.

1. Enter the CAC from the meter display (not from records).
2. Enter the grain sample identification.
3. Enter the moisture display for the first drop.
4. Enter the values D1, D2, D3, and D4 for the first drop.
5. Repeat Items 3 and 4 for a total of six drops.

6. Enter the name of the field test meter operator.
7. Enter the date.

The United States Department of Agriculture (USDA) prohibits discrimination in its programs on the basis of race, color, national origin, sex, religion, age disability, political beliefs, and marital or familial status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (braille, large print, audiotape, etc.) should contact the USDA Office of Communications at (202) 720-5881 (voice) or (202) 720-7808 (TDD).

To file a complaint, write the Secretary of Agriculture, U.S. Department of Agriculture, Washington, D.C., 20250, or call (202) 720-7327 (voice) or (202) 720-1127 (TDD). USDA is an equal opportunity employer.