

NIST, Office of Weights and Measures
Study Guide
for
Grain Moisture Meters (GMMs) and
Near Infrared (NIR) Measuring Devices

NIST OWM Study Guides are designed for use by weights and measures officials and service personnel to enhance and strengthen their knowledge of specific areas of legal metrology inspection and testing. These study guides are not intended to be a comprehensive summary of *all* training and development opportunities recommended for inspectors working in a specific topic area. Rather, they are intended to help individuals in their professional development by targeting the use of information and resources available on the NIST OWM website. Study guides are particularly ideal for use by individuals who are working remotely and are striving to enhance and strengthen their technical knowledge.

Included in this study guide are:

- An overview of resources available on the NIST OWM website, including self-study course material; videos; and newsletter articles and guidance documents on legal metrology issues.
- Suggestions for how each of these resources might be used for either independent, individual study or by groups of inspectors/service personnel led by an instructor or supervisor.
- Information on other training opportunities, including both on-line training and in-person instructor-led training and other resources for professional development.

We hope you find this guide useful in your continued development as a legal metrology professional. Please contact NIST OWM at owm@nist.gov if you have questions about this guide or suggestions for its improvement.

I. Course Materials – Self-Study Course on NIST Handbook 44

Estimated Study Time: 8-16 hours (self-study time; see below for details)

Below is a NIST OWM website link to a NIST Handbook 44 course designed for use as a self-study activity. OWM recommends completing this course before proceeding to other resources.

This self-study course describes the history, organization, and intended use of NIST Handbook 44. It also provides instruction on NIST Handbook 44 terminology; how to locate specific paragraphs; use of the National Conference on Weights and Measures Final reports to understand the application of specific sections; and use of requirements in conjunction with the NIST Examination Procedure Outlines.

<https://www.nist.gov/pml/weights-and-measures/legal-metrology-devices/training-materials>

While this course is particularly relevant for newer inspectors, it is also valuable for more experienced inspectors to enhance their understanding and use of the NIST Handbook 44. This course can also provide opportunities for discussion amongst field staff during in-person meetings or using web conferencing tools, if available.

This course has been designed as a self-study course. That means it is designed to enable you to work on your own, without an instructor. The only materials you will need are the course manual and a copy of the most recent edition of NIST Handbook 44; both the course manual and NIST Handbook 44 are available for download from the NIST OWM website at no charge. You should use a calculator for the exercises that involve computations.

The course is divided into five chapters. Chapter 2 is relatively short and introductory in nature, and you can easily complete it in a couple of hours. The other chapters are considerably longer and the subject matter is more difficult. You should allow yourself at least several hours to complete each of these.

You can set your own pace, but avoid rushing yourself: this material is important and should be studied carefully. At the same time, you should, if possible, work on this course steadily until you complete it. If you stretch it out too much, you may find that you need to spend more time reviewing material you've already covered before proceeding to a new subject.

Note Chapters 2 to 5 of this course each include a quiz (along with answers) on the learning concepts covered in the chapter.

<https://www.nist.gov/pml/weights-and-measures/legal-metrology-devices/training-materials>

Below is an outline of topics included in this course. Learning objectives for each chapter are included in the course material.

- **Chapter 1** – Introduction to the Course
- **Chapter 2** - Background
- **Chapter 3** – Organization and Format of NIST Handbook 44
- **Chapter 4** - How to Use NIST Handbook 44
- **Chapter 5** - Basic Principles Underlying NIST Handbook 44

II. Reference Documents

The following provides links on the NIST OWM website to the current editions of NIST Handbooks and/or other documents specifically relevant to the inspection and testing of commercial weighing and measuring devices and systems. These documents are available for viewing or downloading at no charge. Some documents are available for download either in entirety or in individual sections. Note that your state may adopt earlier editions of the NIST Handbooks.

1. NIST Handbook 44, *Specifications, Tolerances, and Other Technical Requirements for Commercial Weighing and Measuring Devices*

Current Edition:

<https://www.nist.gov/pml/weights-and-measures/publications/nist-handbooks/other-nist-handbooks/other-nist-handbooks-2-3>

Earlier Editions from 2000 to Current:

<https://www.nist.gov/pml/weights-and-measures/publications/nist-handbooks/other-nist-handbooks/other-nist-handbooks-2>

2. NIST Handbook 159, *Examination of Grain Moisture Meters Using Air-Oven Reference Method Transfer Standards*, 2017 Edition

<https://nvlpubs.nist.gov/nistpubs/hb/2017/NIST.HB.159-2017.pdf>

This Handbook is divided into two parts:

- *Part 1: Laboratory Grain Sample Preparation and Testing* provides guidance on developing grains samples used as standards to test moisture meters.
- *Part 2: Field Inspection and Evaluation* provides guidance and requirements for testing grain moisture meters

III. Newsletter Articles – NIST OWM

NIST OWM staff have developed newsletter articles on a variety of technical topics over the years; many of these articles are available for review and/or download from the NIST OWM web site. The following articles, listed alphabetically by topic along with the NIST OWM web site link, are relevant to the inspection and testing of grain moisture meters (GMMs) and Near-Infrared (NIR) Grain Analyzers. Each article takes approximately 10-20 minutes to read.

1. Accuracy of Measurement

Measure for Measure – Does Accuracy Matter to You? – July 2016

<https://www.nist.gov/system/files/documents/pml/wmd/pubs/2016/06/30/WConnections-Vol7-Issue4-July2016.pdf>

2. Audit Trails – Inspecting Equipment with Audit Trails

Inspecting Equipment with Audit Trails – December 2003 (Article J-007)

<https://www.nist.gov/system/files/documents/2017/05/09/J-007.pdf>

3. GMM Series – Part 1 - Overview

*Grain Moisture Meter (GMM) Series Part 1 – Overview of GMM Series Topics- November 2006
(Article C-005)*

https://www.nist.gov/system/files/documents/2017/05/09/C_005.pdf

4. GMM Series – Part 2 – Economic Impact

The Economic Impact of Errors in Moisture Measurements Part 2, Grain Moisture Meter Series – March 2007 – (Article C-006)

<https://www.nist.gov/system/files/documents/2017/05/09/C-006.pdf>

5. GMM Series – Part 3 – Near Infrared Technology

Grain Moisture Meter (GMM) Series Part 3 - Grain Moisture Meter Measurement Technology - Near Infrared – September 2007 – (Article C-007)

<https://www.nist.gov/system/files/documents/2017/05/09/C-007.pdf>

6. GMM Series – Part 4 – Grain Preparation, Storage, and Meter Testing

Grain Preparation, Maintenance and Storage of Grain Transfer Standards, Equipment and Apparatus, and Field Test Procedures – September 2008 – (Article C-008)

<https://www.nist.gov/system/files/documents/2017/03/14/c-008.pdf>

7. Operation and Calibration of GMMs

What do Grain Moisture Meters Measure and How are They Calibrated? – September 2006 – (Article C-004)

<https://www.nist.gov/system/files/documents/2017/05/09/C-004.pdf>

8. Standards – Thermometers

Get the Lead Out! – March 2006 (Article H-013)

<https://www.nist.gov/system/files/documents/2017/05/09/H-013.pdf>

9. Standards – Thermometers

NIST Launches New Website to Educate Industry About Alternatives to Mercury Thermometers – March 2013, Issue 1

<https://www.nist.gov/system/files/documents/2017/05/09/WMConnections-Vol4-Issue1-Feb-25-2013.pdf>

10. Suitability – Device Suitability and Application of NTEP CC

Suitability of Installation and Variations of Weighing and Measuring Devices Covered by an NTEP CC (Article J-014)

<https://www.nist.gov/system/files/documents/2017/05/09/J-014.pdf>

11. Technology – New Generation of Grain Moisture Meters

A New Generation of Grain Moisture Meters – February 2012 – (Article C-010)

<https://www.nist.gov/system/files/documents/2017/03/14/c-010.pdf>

12. Test Procedures and Tolerances – Grain Moisture Meters

Grain Moisture Meter Test Methods and Tolerances – May 2011 – (Article C-009)

<https://www.nist.gov/system/files/documents/2017/03/14/c-009.pdf>

13. Test Procedures - Grain Moisture Meters

Testing Grain Moisture Meters (GMMs) – May 2004 – (Article C-003)

<https://www.nist.gov/system/files/documents/2017/05/09/C-003.pdf>

14. Test Procedures - Moisture Basis – NIR Inspection

Near Infrared (NIR) Device Inspection and Moisture Basis – November 2002 – (Article C-001)

<https://www.nist.gov/system/files/documents/2017/05/09/C-001.pdf>

15. Test Procedures - Reference Methods - Air-Oven

Grain Moisture Air-Oven Reference Methods in the United States – November 2012 – (Article C-011)

<https://www.nist.gov/system/files/documents/2017/03/14/c-011.pdf>

16. Test Procedures - Reference Methods - Test Weight per Bushel

Determining Reference Test Weight per Bushel Value of Grains – September 2013 – (Article C-012)

<https://www.nist.gov/system/files/documents/2017/03/14/c-012.pdf>

17. Test Weight Feature on Grain Moisture Meters

New Requirements for Grain Moisture Meters Capable of Measuring Test Weight – February 2004 (Article C-002)

<https://www.nist.gov/system/files/documents/2017/05/09/C-002.pdf>

NIST OWM is continually developing new articles, so be sure to consult our website for any articles that may have been added since the issuance of this study guide. Articles organized by topic area such as “weighing” or “packaging and labeling” or “metrology” or other technical areas can be found at the following address:

<https://www.nist.gov/pml/weights-and-measures/weights-and-measures-newsletter-archives>

Complete newsletters published from 2010 to present can be found at the following address:

<https://www.nist.gov/pml/weights-and-measures/weights-and-measures-connection-newsletter-archive>

IV. Instructor-Led Training Opportunities

1. Webinars

NIST OWM periodically offers webinars and on-line presentations on a variety of topics related to legal metrology, including the inspection activity covered in this guide. OWM is currently working to increase its offerings of webinars related to the inspection and testing of commercial weighing and measuring devices. Be sure to consult our calendar of events to determine if there are any upcoming offerings related to the inspection activity covered in this study guide.

<https://www.nist.gov/pml/weights-and-measures/about-owm/calendar-events>

2. In-Person Training Events

NIST OWM periodically offers classroom-based training classes at various places around the U.S. Typically hosted by a weights and measures agency, this training ranges in duration from several days to a full week. Be sure to consult our calendar of events at the link referenced above for upcoming training events.

V. Technical Guidance and Interpretations

1. NIST OWM Technical Staff

As always, NIST OWM staff are available to provide guidance and interpretations on technical issues related to legal metrology. All our technical staff are working remotely and remain available via email and phone. If you are holding a virtual meeting to discuss specific technical issues, for example, and would like our input on a particular point, we may be able to connect with you remotely. All International Legal Metrology work (OIML and other) is being maintained. For reference, our technical staff contact list is available on our web site at:

<https://www.nist.gov/pml/weights-and-measures/about-owm/staff-and-technical-experts-directory>

2. NCWM Final Reports

Changes to NIST Handbooks 44, 130, and 133 are developed through the National Conference on Weights and Measures and voted on by state and local weights and measures officials. During the development of these changes, weights and measures officials, industry, NIST, and other stakeholders present and consider background

information and key technical points regarding those changes and their anticipated impact. This information is documented in the final reports of the National Conference on Weights and Measures (NCWM) Specifications and Tolerances Committee (for NIST Handbook 44) and the NCWM Laws and Regulations Committee (for NIST Handbooks 130 and 133). The reports also include Committee recommendations; input from the NIST technical advisors; and the intended application of specific requirements in Handbooks 44, 130, and 133. The information in the NCWM reports can be helpful in gaining a deeper understanding of many of the specific Handbook requirements, including their intended application and associated changes over the years.

Reports issued from 2008 to present are posted on the NIST OWM website at the following link:

<https://www.nist.gov/pml/weights-and-measures/publications/ncwm-annual-reports>

Copies of previous reports are available upon request from NIST OWM. A flash drive including all NCWM reports from 1905-2017 along with keyword search capability is also available upon request when NIST returns to normal operating status.