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| **INSTRUCTIONS**  For items designated **Voting** by NCWM:   * Express regional support as written * Express regional support with recommended modifications * Express regional opposition or concern and a recommendation to downgrade to Informational, Developing, or Withdrawn, **OR** * Take no regional position on the item.   For items designated **Informational**, **Assigned** or **Developing**:   * Provide comments and suggestions to improve the item and, if appropriate, recommend a status change, * Recommend the item be withdrawn with justification, **OR** * Indicate that the item was reviewed and there were no comments.   For **New Items** which have no assigned status:   * Forward the item to NCWM with comments and recommended status of Voting, Informational, Assigned, Developing, **OR** * Do not forward to NCWM and provide justification for this action. In this instance, you will recommend a Withdrawal of the item in case it was forwarded to NCWM by another region, **OR** * Select the final option of “No Recommendation”. This option is used when the region lacks insight on whether the proposal has merit. The proposal will not be forwarded to NCWM by your region. |

SWMA Specifications and Tolerances (S&T) Committee

2023 Annual Meeting Report Template

Mr. Mark Lovisa, Committee Chair

Louisiana

**INTRODUCTION**

The Specifications and Tolerances (S&T) Committee (hereinafter referred to as “Committee”) submits its Report to the Southern Weights and Measures Association (SWMA). The Report consists of the SWMA Agenda (NCWM Carryover and NEW items) and this Addendum. Page numbers in the tables below refer to pages in this Addendum. Suggested revisions to the handbook are shown in **bold face print** by **~~striking out~~** information to be deleted and **underlining** information to be added. Requirements that are proposed to be nonretroactive are printed in **bold-faced *italics.***

Presented below is a list of agenda items considered by the SWMA and its recommendations to the NCWM Specifications and Tolerances Committee.

|  |
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| Subject Series List |

Handbook 44 – General Code GEN Series

Scales SCL Series

Belt-Conveyor Scale Systems BCS Series

Automatic Bulk Weighing Systems ABW Series

Weights WTS Series

Automatic Weighing Systems AWS Series

Weigh-In-Motion Systems used for Vehicle Enforcement Screening WIM Series

Liquid-Measuring Devices LMD Series

Vehicle-Tank Meters VTM Series

Liquefied Petroleum Gas and Anhydrous Ammonia Liquid-Measuring Devices LPG Series

Hydrocarbon Gas Vapor-Measuring Devices HGV Series

Cryogenic Liquid-Measuring Devices CLM Series

Milk Meters MLK Series

Water Meters WTR Series

Mass Flow Meters MFM Series

Carbon Dioxide Liquid-Measuring Devices CDL Series

Hydrogen Gas-Metering Devices HGM Series

Electric Vehicle Refueling Systems EVF Series

Vehicle Tanks Used as Measures VTU Series

Liquid Measures LQM Series

Farm Milk Tanks FMT Series

Measure-Containers MRC Series

Graduates GDT Series

Dry Measures DRY Series

Berry Baskets and Boxes BBB Series

Fabric-Measuring Devices FAB Series

Wire-and Cordage-Measuring Devices WAC Series

Linear Measures LIN Series

Odometers ODO Series

Taximeters TXI Series

Timing Devices TIM Series

Grain Moisture Meters (a) GMA Series

Grain Moisture Meters (b) GMB Series

Near-Infrared Grain Analyzers NIR Series

Multiple Dimension Measuring Devices MDM Series

Electronic Livestock, Meat, and Poultry Evaluation Systems and/or Devices LVS Series

Transportation Network Measuring Systems TNS Series

Other Items OTH Series

|  |  |  |
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[SCL-24.2 Multiple Sections Regarding Tare 223](#_Toc143527694)

[SCL-22.3 D UR.3.3. Single-Draft Vehicle Weighing., and UR.3.4. Axle and Axle Group Weight Values. 224](#_Toc143527695)

[SCL-23.3 A Verification Scale Division e: Multiple Sections Including, T.N.1.3., Table 6., T.N.3., T.N.4., T.N.6., T.N.8., T.N.9., T.1., T.2., S.1.1.1., T.N.1.2., Table S.6.3.a., Table S.3.6.b., Appendix D, S.1.2.2., Table 3., S.5.4., UR.3., Table 8. 224](#_Toc143527696)

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[B1-MLK-24.1 *~~N.3.2. Field Standard Meter Test.~~*N.3.2. Transfer Standard Test. 235](#_Toc143527730)

[B1-MFM-24.1 *~~.~~*N.3.2. ~~Field Standard Meter~~Transfer Standard Test. 235](#_Toc143527731)

**Appendices**

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| Table B Glossary of Acronyms and Terms |

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| Acronym | Term | Acronym | Term |
| ABWS | Automatic Bulk Weighing System | NEWMA | Northeastern Weights and Measures Association |
| AAR | Association of American Railroads | NIST | National Institute of Standards and Technology |
| API | American Petroleum Institute | NTEP | National Type Evaluation Program |
| CNG | Compressed Natural Gas | OIML | International Organization of Legal Metrology |
| CWMA | Central Weights and Measures Association | OWM | Office of Weights and Measures |
| EPO | Examination Procedure Outline | RMFD | Retail Motor Fuel Dispenser |
| FHWA | Federal Highway Administration | S&T | Specifications and Tolerances |
| GMM | Grain Moisture Meter | SD | Secure Digital |
| GPS | Global Positioning System | SI | International System of Units |
| HB | Handbook | SMA | Scale Manufactures Association |
| LMD | Liquid Measuring Devices | SWMA | Southern Weights and Measures Association |
| LNG | Liquefied Natural Gas | TC | Technical Committee |
| LPG | Liquefied Petroleum Gas | USNWG | U.S. National Work Group |
| MMA | Meter Manufacturers Association | VTM | Vehicle Tank Meter |
| MDMD | Multiple Dimension Measuring Device | WIM | Weigh-in-Motion |
| NCWM | National Conference on Weights and Measures | WWMA | Western Weights and Measures Association |

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| Details of All Items *(In order by Reference Key)* |

# SCL – SCALES

SCL-24.1 S.1.7. Capacity Indication, Weight Ranges, and Unit Weights.

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| **GEN-23.1** |
| **Regional recommendation to NCWM on item status:**  Recommend as a Voting Item on the NCWM agenda  Recommend as an Information Item on the NCWM agenda  Recommend as an Assigned Item on the NCWM agenda  *(To be developed by an NCWM Task Group or Subcommittee)*  Recommend as a Developing Item on the NCWM agenda  *(To be developed by source of the proposal)*  Recommend Withdrawal of the Item from the NCWM agenda  *(In the case of new proposals, do not forward this item to NCWM)*  No recommendation from the region to NCWM  *(If this is a new proposal, it will not be forwarded to the national committee by this region)* |
| **Comments and justification for the regional recommendation to NCWM:** *(This will appear in NCWM reports)* |
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SCL-24.2 Multiple Sections Regarding Tare

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| **GEN-23.1** |
| **Regional recommendation to NCWM on item status:**  Recommend as a Voting Item on the NCWM agenda  Recommend as an Information Item on the NCWM agenda  Recommend as an Assigned Item on the NCWM agenda  *(To be developed by an NCWM Task Group or Subcommittee)*  Recommend as a Developing Item on the NCWM agenda  *(To be developed by source of the proposal)*  Recommend Withdrawal of the Item from the NCWM agenda  *(In the case of new proposals, do not forward this item to NCWM)*  No recommendation from the region to NCWM  *(If this is a new proposal, it will not be forwarded to the national committee by this region)* |
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SCL-22.3 D UR.3.3. Single-Draft Vehicle Weighing., and UR.3.4. Axle and Axle Group Weight Values.

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| **GEN-23.1** |
| **Regional recommendation to NCWM on item status:**  Recommend as a Voting Item on the NCWM agenda  Recommend as an Information Item on the NCWM agenda  Recommend as an Assigned Item on the NCWM agenda  *(To be developed by an NCWM Task Group or Subcommittee)*  Recommend as a Developing Item on the NCWM agenda  *(To be developed by source of the proposal)*  Recommend Withdrawal of the Item from the NCWM agenda  *(In the case of new proposals, do not forward this item to NCWM)*  No recommendation from the region to NCWM  *(If this is a new proposal, it will not be forwarded to the national committee by this region)* |
| **Comments and justification for the regional recommendation to NCWM:** *(This will appear in NCWM reports)* |
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SCL-23.3 A Verification Scale Division e: Multiple Sections Including, T.N.1.3., Table 6., T.N.3., T.N.4., T.N.6., T.N.8., T.N.9., T.1., T.2., S.1.1.1., T.N.1.2., Table S.6.3.a., Table S.3.6.b., Appendix D, S.1.2.2., Table 3., S.5.4., UR.3., Table 8.

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| **GEN-23.1** |
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| **Comments and justification for the regional recommendation to NCWM:** *(This will appear in NCWM reports)* |
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SCL-22.2 A UR.1. Selection Requirements, UR.1.X. Cannabis

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| **GEN-23.1** |
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| **Comments and justification for the regional recommendation to NCWM:** *(This will appear in NCWM reports)* |
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# AWS – automatic weighing systems code

AWS-24.1 N.1.5. Test Loads,

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| **GEN-23.1** |
| **Regional recommendation to NCWM on item status:**  Recommend as a Voting Item on the NCWM agenda  Recommend as an Information Item on the NCWM agenda  Recommend as an Assigned Item on the NCWM agenda  *(To be developed by an NCWM Task Group or Subcommittee)*  Recommend as a Developing Item on the NCWM agenda  *(To be developed by source of the proposal)*  Recommend Withdrawal of the Item from the NCWM agenda  *(In the case of new proposals, do not forward this item to NCWM)*  No recommendation from the region to NCWM  *(If this is a new proposal, it will not be forwarded to the national committee by this region)* |
| **Comments and justification for the regional recommendation to NCWM:** *(This will appear in NCWM reports)* |
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AWS-24.2 N.1.6. Influence Factor Testing.

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| **GEN-23.1** |
| **Regional recommendation to NCWM on item status:**  Recommend as a Voting Item on the NCWM agenda  Recommend as an Information Item on the NCWM agenda  Recommend as an Assigned Item on the NCWM agenda  *(To be developed by an NCWM Task Group or Subcommittee)*  Recommend as a Developing Item on the NCWM agenda  *(To be developed by source of the proposal)*  Recommend Withdrawal of the Item from the NCWM agenda  *(In the case of new proposals, do not forward this item to NCWM)*  No recommendation from the region to NCWM  *(If this is a new proposal, it will not be forwarded to the national committee by this region)* |
| **Comments and justification for the regional recommendation to NCWM:** *(This will appear in NCWM reports)* |
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AWS-24.3 N.22.3. Shift Test (Dynamic)

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| **GEN-23.1** |
| **Regional recommendation to NCWM on item status:**  Recommend as a Voting Item on the NCWM agenda  Recommend as an Information Item on the NCWM agenda  Recommend as an Assigned Item on the NCWM agenda  *(To be developed by an NCWM Task Group or Subcommittee)*  Recommend as a Developing Item on the NCWM agenda  *(To be developed by source of the proposal)*  Recommend Withdrawal of the Item from the NCWM agenda  *(In the case of new proposals, do not forward this item to NCWM)*  No recommendation from the region to NCWM  *(If this is a new proposal, it will not be forwarded to the national committee by this region)* |
| **Comments and justification for the regional recommendation to NCWM:** *(This will appear in NCWM reports)* |
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# WIM – WEIGH-IN-MOTION SYSTEMS – TENTATIVE CODE

WIM-23.1 I Remove Tentative Status and Amend Numerous Sections Throughout

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| **GEN-23.1** |
| **Regional recommendation to NCWM on item status:**  Recommend as a Voting Item on the NCWM agenda  Recommend as an Information Item on the NCWM agenda  Recommend as an Assigned Item on the NCWM agenda  *(To be developed by an NCWM Task Group or Subcommittee)*  Recommend as a Developing Item on the NCWM agenda  *(To be developed by source of the proposal)*  Recommend Withdrawal of the Item from the NCWM agenda  *(In the case of new proposals, do not forward this item to NCWM)*  No recommendation from the region to NCWM  *(If this is a new proposal, it will not be forwarded to the national committee by this region)* |
| **Comments and justification for the regional recommendation to NCWM:** *(This will appear in NCWM reports)* |
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# VTM – VEHICLE TANK METERS

VTM-20.2 A Table T.2. Tolerances for Vehicle Mounted Milk Meters.

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| **GEN-23.1** |
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# LPG – LIQUIFIED PETROLEUM GAS AND ANHYDROUS AMMONIA LIQUID-MEASURING DEVICES

LPG-23.1 I S.2.5. Zero-Set-Back Interlock

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| **GEN-23.1** |
| **Regional recommendation to NCWM on item status:**  Recommend as a Voting Item on the NCWM agenda  Recommend as an Information Item on the NCWM agenda  Recommend as an Assigned Item on the NCWM agenda  *(To be developed by an NCWM Task Group or Subcommittee)*  Recommend as a Developing Item on the NCWM agenda  *(To be developed by source of the proposal)*  Recommend Withdrawal of the Item from the NCWM agenda  *(In the case of new proposals, do not forward this item to NCWM)*  No recommendation from the region to NCWM  *(If this is a new proposal, it will not be forwarded to the national committee by this region)* |
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LPG-24.1 *S.1.5.7. ~~Retail Motor Fuel Dispenser~~Liquefied Petroleum Gas Retail Motor Fuel Device., S.2.6.1. Electronic Stationary (Other than Stationary ~~Retail Motor Fuel Dispensers~~Liquefied Petroleum Gas Retail Motor Fuel Device). S.6.2. Automatic Timeout Pay-at-Pump ~~Retail Motor Fuels Devices~~Liquefied Petroleum Gas Retail Motor Fuel Device.* and, *S.4.3. Location of Marking Information: ~~Retail Motor Fuel Dispensers~~Liquefied Petroleum Gas Retail Motor Fuel Device.*

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| **GEN-23.1** |
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LPG-24.2 *~~S.2.5. Zero-Set-Back Interlock.~~* S.2.5. Zero-Set-Back Interlock.

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| **GEN-23.1** |
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# MLK – MILK METERS

MLK-23.2 A Table T.1. Tolerances for Milk Meters

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| **GEN-23.1** |
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# HGM – HYDROGEN GAS-MEASURING DEVICES

HGM-23.1 D UR.3.8. Safety Requirement

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| **GEN-23.1** |
| **Regional recommendation to NCWM on item status:**  Recommend as a Voting Item on the NCWM agenda  Recommend as an Information Item on the NCWM agenda  Recommend as an Assigned Item on the NCWM agenda  *(To be developed by an NCWM Task Group or Subcommittee)*  Recommend as a Developing Item on the NCWM agenda  *(To be developed by source of the proposal)*  Recommend Withdrawal of the Item from the NCWM agenda  *(In the case of new proposals, do not forward this item to NCWM)*  No recommendation from the region to NCWM  *(If this is a new proposal, it will not be forwarded to the national committee by this region)* |
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# EVF – ELECTRIC VEHICLE FUELING SYSTEMS

EVF-24.1 S.1.3. Mobile Device as Indicating Element for AC Chargers.

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| **GEN-23.1** |
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EVF-24.2 S.2.7. Indication of Delivery, N.5.2. Accuracy Testing., and T.2.1. EVSE Load Test Differences.

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| **GEN-23.1** |
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EVF-23.4 D S.5.2. EVSE Identification and Marking Requirements, S.5.3. Abbreviations and Symbols, and N.5. Test of an EVSE System.

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| **GEN-23.1** |
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EVF-23.6 S.5.2. EVSE Identification and Marking Requirements., and T.2. Tolerances.

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| **GEN-23.1** |
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EVF-23.7 D ~~N.1. No Load Test, N.2. Startin Load Test.~~, N.5.2. Accuracy Testing, And Appendix D: maximum deliverable amperes.

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| **GEN-23.1** |
| **Regional recommendation to NCWM on item status:**  Recommend as a Voting Item on the NCWM agenda  Recommend as an Information Item on the NCWM agenda  Recommend as an Assigned Item on the NCWM agenda  *(To be developed by an NCWM Task Group or Subcommittee)*  Recommend as a Developing Item on the NCWM agenda  *(To be developed by source of the proposal)*  Recommend Withdrawal of the Item from the NCWM agenda  *(In the case of new proposals, do not forward this item to NCWM)*  No recommendation from the region to NCWM  *(If this is a new proposal, it will not be forwarded to the national committee by this region)* |
| **Comments and justification for the regional recommendation to NCWM:** *(This will appear in NCWM reports)* |
|  |

# GMA – GRAIN MOISTURE METERS 5.56 (A)

GMA-19.1 D Table T.2.1. Acceptance and Maintenance Tolerances Air Oven Method for All Grains and Oil Seeds.

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| **GEN-23.1** |
| **Regional recommendation to NCWM on item status:**  Recommend as a Voting Item on the NCWM agenda  Recommend as an Information Item on the NCWM agenda  Recommend as an Assigned Item on the NCWM agenda  *(To be developed by an NCWM Task Group or Subcommittee)*  Recommend as a Developing Item on the NCWM agenda  *(To be developed by source of the proposal)*  Recommend Withdrawal of the Item from the NCWM agenda  *(In the case of new proposals, do not forward this item to NCWM)*  No recommendation from the region to NCWM  *(If this is a new proposal, it will not be forwarded to the national committee by this region)* |
| **Comments and justification for the regional recommendation to NCWM:** *(This will appear in NCWM reports)* |
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# OTH – OTHER ITEMS

OTH-16.1 I Electric Watthour Meters Tentative Code

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| **GEN-23.1** |
| **Regional recommendation to NCWM on item status:**  Recommend as a Voting Item on the NCWM agenda  Recommend as an Information Item on the NCWM agenda  Recommend as an Assigned Item on the NCWM agenda  *(To be developed by an NCWM Task Group or Subcommittee)*  Recommend as a Developing Item on the NCWM agenda  *(To be developed by source of the proposal)*  Recommend Withdrawal of the Item from the NCWM agenda  *(In the case of new proposals, do not forward this item to NCWM)*  No recommendation from the region to NCWM  *(If this is a new proposal, it will not be forwarded to the national committee by this region)* |
| **Comments and justification for the regional recommendation to NCWM:** *(This will appear in NCWM reports)* |
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OTH-24.1 Appendix D, Definitions: liquefied petroleum gas retail motor-fuel device.

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| **GEN-23.1** |
| **Regional recommendation to NCWM on item status:**  Recommend as a Voting Item on the NCWM agenda  Recommend as an Information Item on the NCWM agenda  Recommend as an Assigned Item on the NCWM agenda  *(To be developed by an NCWM Task Group or Subcommittee)*  Recommend as a Developing Item on the NCWM agenda  *(To be developed by source of the proposal)*  Recommend Withdrawal of the Item from the NCWM agenda  *(In the case of new proposals, do not forward this item to NCWM)*  No recommendation from the region to NCWM  *(If this is a new proposal, it will not be forwarded to the national committee by this region)* |
| **Comments and justification for the regional recommendation to NCWM:** *(This will appear in NCWM reports)* |
|  |

OTH-24.2 Appendix D, Definitions: National Type Evaluation Program (NTEP) and Certificate of Conformance (CC)

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| **GEN-23.1** |
| **Regional recommendation to NCWM on item status:**  Recommend as a Voting Item on the NCWM agenda  Recommend as an Information Item on the NCWM agenda  Recommend as an Assigned Item on the NCWM agenda  *(To be developed by an NCWM Task Group or Subcommittee)*  Recommend as a Developing Item on the NCWM agenda  *(To be developed by source of the proposal)*  Recommend Withdrawal of the Item from the NCWM agenda  *(In the case of new proposals, do not forward this item to NCWM)*  No recommendation from the region to NCWM  *(If this is a new proposal, it will not be forwarded to the national committee by this region)* |
| **Comments and justification for the regional recommendation to NCWM:** *(This will appear in NCWM reports)* |
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# Item block 1 (b1) Transfer Standard

B1-LMD-24.1 *~~N.3.5.X.~~* *~~Field Standard Meter Test~~*N.3.5.X. Transfer Standard Test.

B1-VTM-24.1 *~~N.3.5.X.~~* *~~Field Standard Meter Test~~*N.3.5.X. Transfer Standard Test.

B1-LPG-24.3 N.3.2. ~~Field Standard Meter~~Transfer Standard Test.

B1-MLK-24.1 *~~N.3.2. Field Standard Meter Test.~~*N.3.2. Transfer Standard Test.

B1-MFM-24.1 *~~.~~*N.3.2. ~~Field Standard Meter~~Transfer Standard Test.

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| **GEN-23.1** |
| **Regional recommendation to NCWM on item status:**  Recommend as a Voting Item on the NCWM agenda  Recommend as an Information Item on the NCWM agenda  Recommend as an Assigned Item on the NCWM agenda  *(To be developed by an NCWM Task Group or Subcommittee)*  Recommend as a Developing Item on the NCWM agenda  *(To be developed by source of the proposal)*  Recommend Withdrawal of the Item from the NCWM agenda  *(In the case of new proposals, do not forward this item to NCWM)*  No recommendation from the region to NCWM  *(If this is a new proposal, it will not be forwarded to the national committee by this region)* |
| **Comments and justification for the regional recommendation to NCWM:** *(This will appear in NCWM reports)* |
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Mr. Mark Lovisa, Louisiana | Committee Chair

Mr. Timothy Morales, Texas | Member

Mr. Heath Higdon, Kentucky | Member

Mr. Greg Gholston, Mississippi | Member

Mr. Alan Walker, Florida | Member

**Specifications and Tolerances Committee**

## **APPENDIX A**

**Item SCL-23.3 – Final Report of the Verification Scale Division Task Group**

*Note: This appendix originally appeared for* ***Item Block 2 - Define True Value For Use In Error Calculations****, which was withdrawn and replaced by* ***SCL-23.3 - Verification Scale Division e: Multiple Sections Including, T.N.1.3., Table 6., T.N.3., T.N.4., T.N.6., T.N.8., T.N.9., T.1., T.2., S.1.1.1., T.N.1.2., Table S.6.3.a., Table S.3.6.b., Appendix D, S.1.2.2., Table 3., S.5.4., UR.3., Table 8.*** *The Committee decided to preserve the appendix, since it remains relevant to item SCL-23.3.*

**Participants:**

Doug Musick, Chair (KS)

Ross Andersen (NY, Retired and original submitter of the item)

John Barton (NIST OWM)

Luciano Burtini (Measurement Canada)

Anthony Bong Lee (Orange County, CA)

Steve Cook (CA, Retired)

Darrell Flocken (NTEP)

Eric Golden (Cardinal Scale)

Jan Konijnenburg (Rice Lake Weighing Systems)

Richard Suiter (Richard Suiter Consulting)

Steve Timar (NY)

Howard Tucker (FL)

The mission of the task group, as defined by the S&T Committee, is to review Handbook 44, Section 2.20. Scales and relevant portions of OIML R76, using the items included in S&T Agenda Items: Block 2 as a reference point, and recommend changes as necessary to:

1. Clarify how the error is determined in relation to the verification scale division (e) and the scale division (d)
2. Clarify which is the proper reference; the verification scale division (e) or the scale division (d) throughout this section
3. Ensure proper selection of a scale in reference to the verification scale division (e) and the scale division (d)
4. Clarify the relationship between the verification scale division (e) or the scale division (d)

This report is divided into three sections:

1. Clarify the relationship between e and d, i.e., ensure we understand the terms. (Mission items 4 and1)
2. Propose changes to the Scales Code, if necessary, to ensure the code correctly identifies e or d as appropriate to the code paragraph. (Mission items 2 and 3)
3. Address other issues that arose as potential problems that might require additional investigation beyond the scope of this workgroup.

**PART 1. Clarify the Relationship Between e and d.**

We begin by looking at current HB44 definitions. The verification scale division e is used to express tolerance values and it is used in classification. The designations of e and the accuracy class are made by the manufacturer. The scale division d is a function of the actual scale function and display. Note that for weight classifiers, the weighing instrument may never display quantity at the resolution of e, and for ungraduated devices there is no scale division d to permit comparison to e.

**verification scale division, value of (e).** – A value, expressed in units of weight (mass) and specified by the manufacturer of a device, by which the tolerance values and the accuracy class applicable to the device are determined. The verification scale division is applied to all scales, in particular to ungraduated devices since they have no graduations. The verification scale division (e) may be different from the displayed scale division (d) for certain other devices used for weight classifying or weighing in pre‑determined amounts, and certain other Class I and II scales.[2.20]

**scale division, value of (d).** – The value of the scale division, expressed in units of mass, is the smallest subdivision of the scale for analog indication or the difference between two consecutively indicated or printed values for digital indication or printing. (Also see “verification scale division.”) [2.20, 2.22]

**scale division, number of (n).** – Quotient of the capacity divided by the value of the verification scale division. [2.20]



The values of e and d must be understood as referring to different things. The verification scale refers to the scale of measurement for the reference (or true value), think of the reference standard. The instrument scale refers to the scale of measurement of the instrument under test. Consider this assortment of instruments in the table below. It should be clear that the divisions of the verification scale do not always equal those on the instrument scale and may not even be in the same units. In addition, when we employ an artifact, like a test weight or slicker plate measure, the divisions of the verification scale are not visible since the artifact represents a single point on the measurement scale of the reference.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Instrument Scale** | **Scale div d** | **Verification “True Value” Scale** | **Scale div e** | **Relation e to d** |
| Rule | 1/16 in | Standard Rule or Tape | 1/16 in | e = d |
| Taximeter | 1/10 mi | Road Course | 2 ft | e << d |
| LMD’s | 0.1 gal | Prover indication | 5 cu in | e > d |
| Mass Flow Meter | 1 lb | Reference Scale | 0.01 lb | e < d |
| Weighing Devices | 0.01 lb | Test Weight (artifact) | mfr choice | e < d, e = d, e > d |
| Test Measure | 1 cu in | Slicker Plate (artifact) | ? | e ? d |

For weighing instruments, it turns out that e and d have no fixed relationship. It is different for weight classifiers (e < d), for most instruments (e = d), and for high resolution instruments (e>d). The critical point is that the instrument scale and the verification scale are independent of each other. Once you have disconnected e (declared by the manufacturer) from d (displayed on the instrument), it may now become evident that much of our confusion arose because we thought of them as connected in some way.

In the graphics below both error and tolerance are always expressed in terms of the divisions (e) of the verification scale. The primary assumption is that the verification scale is constant, and it is the displayed scales of the instruments we test that move. The scales in black are depicted as in error by +1 e or –1 e.

A screenshot of a cell phone

Description automatically generated

Error of delivery =

verification scale – instrument scale

+ in excess

– in deficiency

A screenshot of a cell phone

Description automatically generated

Error of Indication =

instrument scale – verification scale

+ over registration

– underregistration

Much of our confusion arises because scales are tested using artifacts with no visible scale divisions. We could mirror this in the test of a fuel dispenser. Normally you stop the test at 5 gallons on the instrument scale and read the error as – 3 cu in from the test measure (verification) scale. Now change that procedure and stop the test at the zero mark on the test measure. How would you determine the error? Assume the instrument now reads 5.012 gal. The error is -0.012 gal (-3 cu in), and we calculate it as verification scale – instrument scale. We determined the error from the instrument scale. The verification scale division, however, did not switch from the test measure to the instrument simply because we changed the procedure. The verification scale division remains 1 cu in and is still on the test measure, the reference.

A picture containing clock

Description automatically generatedConsider the Class III scale at right where e = d. Technically you can’t see divisions on either scale since the artifact has no visible divisions and the instrument is digital. The correct instrument indication of 500 d is 1.2 e short of 500 e on the verification scale. You could mirror this by applying 498.8 e of test weights to get indication of 500 d. It is not in tolerance, but only if you apply error weights in your test.

A screenshot of a cell phone

Description automatically generatedConsider the Class II scale at right where e = 10 d. You can’t see divisions on either scale because the test weight is an artifact and the instrument are digital. The correct instrument indication of 50,000 d is short of the 5,000 e on the verification scale by 7 d. Thus, we say the error is +0.7 e. Error = instrument scale – verification scale. This instrument is clearly in tolerance. No error weights are necessary to see to finer than 1 e.

The principles of classification are found in the following HB44 paragraphs. In principle, the manufacturer tells the official what accuracy is to be applied to the instrument.

**T.N.1. Principles.**

**T.N.1.1. Design.** – The tolerance for a weighing device is a performance requirement independent of the design principle used.

**T.N.1.2. Accuracy Classes.** – Weighing devices are divided into accuracy classes according to the number of scale divisions (n) and the value of the scale division (d).

**T.N.1.3. Scale Division.** – The tolerance for a weighing device is related to the value of the scale division (d) or the value of the verification scale division (e) and is generally expressed in terms of d or e.

Yet, the T.N.1.2. and T.N.1.3. paragraphs conflict with the definitions. According to the definition of e, it is e “by which the tolerance values and the accuracy class applicable to the device are determined.” When the Scales Code was drafted prior to adoption in 1984, it appears some things were lost in translation from the OIML R76 on which it was based. What was lost can be expressed as those things not included in HB44 and those things incorrectly translated in HB44.

For example, R76 expresses the classification information in four required markings, and one auxiliary marking. R76 requires marking of Class, Max, e, and Min, and requires marking of d if different from e. Those markings describe the maximum and minimum loads and the relative accuracy. In contrast, HB44 requires marking of Class, capacity, and d, and requires marking of e if different from d. HB44 does not require marking of minimum load. While R76 considers minimum load part of the class structure, HB44 does not.

It is this switch of e and d that causes confusion because the translation of R76 to HB44 lost some of the meaning. Much of the second part of this report covers the changes required to rectify the situation. The workgroup is attempting to ensure the Code states e when the requirement applies to e and d when it applies to d. The workgroup is also proposing to add important material from R76 that is missing.

Some additional confusion comes from the stepped tolerance structure. For example, it is common to think that the instrument gets 1 division of error over the first tolerance step (maintenance). The correct interpretation of the code requires the instrument maintain a % accuracy based on the number of divisions of load at the break points. The space under the step riser is not supposed to be used by the instrument provided you eliminate the rounding error.

Between 1 division and 10,000 divisions for Class II in R76, this is 0.02%. At 10,000 e, 0.02% is 2 e. At 1,000 e, 0.02% is 0.2 e, and at minimum load of 50 e, 0.02% is 0.01 e. The principle is: the larger the number of verification scale divisions (n) the more accurate the instrument must be, i.e. relative error. Section 2.2 of R76 makes this clear by stating that e represents absolute accuracy and n represents relative accuracy. The Scales Code has no parallel section. It is the relative accuracy that should be our focus, but that’s not found in HB44.

**PART 2. Proposed changes to the Scales Code (related issues are grouped for convenience)**

**Group 1. Changes to clarify definitions relating to e.**

**verification scale division, value of (e).** **–** A value, expressed in units of weight (mass) and specified by the manufacturer of a device, by which the tolerance values and the accuracy class applicable to the device are determined. The verification scale division is applied to all scales, in particular to ungraduated devices since they have no graduations. ~~The verification scale division (e) may be different from the displayed scale division (d) for certain other devices used for weight classifying or weighing in pre‑determined amounts, and certain other Class I and II scales.~~[2.20]

(Amended 20XX)

The last sentence is explained fully in the technical requirements in the Code. The workgroup finds it unnecessary and believe it contributes to confusion.

**verification scale division, number of (n).** **–** Quotient of the capacity divided by the value of the verification scale division. [2.20]



(Amended 20XX)

**scale division, number of (n). –** See “verification scale division, number of (n)”

The addition of the word “verification” to the definition of n is essential since without it the section refers to the scale division d. The second definition for n was added as a cross reference since the revision will move from the s section to the v section.

**Group 2. Changes to ensure proper classification of instruments.**

**T.N.1.2. Accuracy Classes.** – Weighing devices are divided into accuracy classes according to the number of verification scale divisions (n) and the value of the verification scale division ~~(d)~~ (e).

(Amended 20XX)

**T.N.1.3. Verification Scale Division.** – The tolerance for a weighing device is ~~related to the value of the scale division (d) or the value of the~~ in the order of magnitude of the verification scale division (e) and is generally expressed in terms of ~~d or~~ e.

(Amended 20XX)

These changes bring the principles in the T.N. section in agreement with the definitions. Classification is exclusively based on e.

| **Table 3.**  ***Parameters for Accuracy Classes*** | | | |
| --- | --- | --- | --- |
| ***Class*** | ***Value of the Verification Scale Division***  ***(~~d or~~ e1)*** | ***Number of Verification Scale4 Divisions (n)*** | |
| ***Minimum*** | ***Maximum*** |
| ***SI Units*** | | | |
| *I* | *equal to or greater than 1 mg* | *50 000* | *‑‑* |
| *II* | *1 to 50 mg, inclusive* | *100* | *100 000* |
|  | *equal to or greater than 100 mg* | *5 000* | *100 000* |
| *III2,5* | *0.1 to 2 g, inclusive* | *100* | *10 000* |
|  | *equal to or greater than 5 g* | *500* | *10 000* |
| *III L3* | *equal to or greater than 2 kg* | *2 000* | *10 000* |
| *IIII* | *equal to or greater than 5 g* | *100* | *1 200* |

The middle section of the table was not included for brevity. Notes continue below:

|  |
| --- |
| *1 ~~For Class I and II devices equipped with auxiliary reading means (i.e., a rider, a vernier, or a least significant decimal differentiated by size, shape, or color), the value of the verification scale division “e” is the value of the scale division immediately preceding the auxiliary means.~~ The verification scale division e does not always equal the displayed scale division d. To ensure the correct value for e is used, refer to required markings on the device (see also notes 3 and 4 in Table S.6.3.b.).*  *2 A Class III scale marked “For prescription weighing only” may have a verification scale division (e) not less than 0.01 g*.  (Added 1986) (Amended 2003)  *3 The value of a verification scale division for crane and hopper (other than grain hopper) scales shall be not less than 0.2 kg (0.5 lb). The minimum number of verification scale divisions, n, shall be not less than 1000.*  *4 On a multiple range or multi-interval scale, the number of verification divisions, n, for each range independently shall not exceed the maximum specified for the accuracy class. The number of verification scale divisions, n, for each weighing range is determined by dividing the scale capacity for each range by the verification scale division, e, for each range. On a scale system with multiple load‑receiving elements and multiple indications, each element considered shall not independently exceed the maximum specified for the accuracy class. If the system has a summing indicator, the nmax for the summed indication shall not exceed the maximum specified for the accuracy class.*  (Added 1997)  *5 The minimum number of verification scale divisions, n, for a Class III Hopper Scale used for weighing grain shall be 2000.*) |
| [*Nonretroactive as of January 1, 1986*]  (Amended 1986, 1987, 1997, 1998, 1999, 2003, ~~and~~ 2004 and 20XX) |

The changes to the header of Table 3 ensure the classification is based on e consistent with the definitions and the principles in T.N.1. The scale division d is not involved in classification. This change should reduce confusion. The changes to the notes at the bottom of the table again ensure e is correctly referenced instead of d or the “scale division.” Referencing “n” in notes 3, 4, and 5 ensure that it is referring to e since n = capacity / e.

| **Table S.6.3.a.**  **Marking Requirements** | | | | | |
| --- | --- | --- | --- | --- | --- |
|  | **Weighing Equipment** | | | | |
| **To Be Marked With** | **Weighing, Load-Receiving, and Indicating Element in Same Housing or Covered on the Same CC1** | **Indicating Element not Permanently Attached to Weighing and Load-Receiving Element or Covered by a Separate CC** | **Weighing and Load-Receiving Element Not Permanently Attached to Indicating Element or Covered by a Separate CC** | **Load Cell with CC**  **(11)** | **Other Equipment or Device**  **(10)** |
| Manufacturer’s ID (1) | X | X | X | X | X |
| Model Designation and Prefix (1) | X | X | X | X | X |
| Serial Number and Prefix (2) | X | X | X | X | X (16) |
| Certificate of Conformance Number (CC) (23) | X | X | X | X | X (23) |
| Accuracy Class (17) | X | X (8) | X (19) | X |  |
| Nominal Capacity (3)(18)(20) | X | X | X |  |  |
| Value of Scale Division, “d” (~~3~~ 4) | X | X |  |  |  |
| Value of Verification Scale Division, “e” (~~4~~ 3) | X | X |  |  |  |
| Temperature Limits (5) | X | X | X | X |  |

*Note: The remainder of the table was not included for brevity.*

The changes to column 1 in the 7th and 8th rows simply reverse the references to the notes in Table S.6.3.b. They reflect the primacy of e in classification, which is addressed in parallel changes to notes 3 and 4 in Table S.6.3.b. (see changes to Table S.6.3.b. below).

| **Table S.6.3.b.**  **Notes for Table S.6.3.a. Marking Requirements** |
| --- |
| 1. Manufacturer's identification and model designation and *model designation prefix.\**   *[\*Nonretroactive as of January 1, 2003*]  (Also see G‑S.1. Identification.) *[Prefix lettering may be initial capitals, all capitals or all lower case]*  (Amended 2000)   1. *Serial number [Nonretroactive as of January 1, 1968] and prefix [Nonretroactive as of January 1, 1986].*  (Also see G‑S.1. Identification.) 2. The device shall be marked with the nominal capacity. *The nominal capacity shall be shown together with the value of the verification scale division, “e” (e.g., 15 × 0.005 kg, 30 × 0.01 lb, or capacity = 15 kg, ~~d~~ e = 0.005 kg) in a clear and conspicuous manner and be readily apparent when viewing the reading face of the scale indicator unless already apparent by the design of the device. Each verification scale division value ~~or weight unit~~ with its associated nominal capacity shall be marked on multiple range or multi‑interval scales. In the absence of a separate marking of the scale division “d” (see Note 4), the value of the scale division “d” shall be equal to the value of the verification scale division “e.”*   *[Nonretroactive as of January 1, 1983]*  (Amended 2005 and 20XX)   1. *Required only if different from ~~“d”~~ “e.” This does not apply to an ungraduated device (equal arm scale) where the graduations do not refer to a fixed weight value.*   *[Nonretroactive as of January 1, 1986]*  *(Amended 20XX)* |

The original Scales Code adopted 1984 made d the primary mandatory marking but this resulted in confusion. The changes make e the mandatory marking and now requires d only if different from e.

The changes regarding multiple range and multi-interval scales makes the note say what we have always been applying. The intent was for each range or subrange of the instrument to have marking of capacity and e. The “or weight unit” could refer to lb or kg, but that is clearly not the intent.

There is some concern if this might pose problems for existing equipment. If the marking is of the form “capacity 30 lb x 0.01 lb” the workgroup sees not conflict. However, markings in the form “capacity = 30 lb d = 0.01 lb” would cause a conflict as devices using that form would no longer conform with the proposed changes. The workgroup decided to refer this to the scale manufacturers to see if there are any devices in the marketplace that would be affected. We also learned that this might cause a conflict with Measurement Canada as they do see devices with markings of capacity= d=. Note this is not an issue when e ≠ d as both markings is already required by the combination of notes 3 and 4. If necessary, a note with qualification “devices manufactured before January 1, 20XX” could be added to accept existing scales marked with d = provided d = e.

**S.1.2.2. Verification Scale ~~Interval~~ Division**

The magnitude of the verification scale division e relative to the scale division d for different types of devices is given in Table S.1.2.2. Relative Magnitude of e to d.

|  |  |
| --- | --- |
| **Table S.1.2.2.**  **Relative Magnitude of e to d** | |
| Type of device (see Note) | Relative magnitude of e to d |
| Graduated, without an auxiliary indicating device | e = d |
| Graduated, with an auxiliary indicating device | e > d and e is chosen by the manufacturer according to Table 3. and S.1.2.2.1. |
| Graduated, and marked for use in special applications (weight classifier) | e ≤ d and e is chosen by the manufacturer according to Table 3. and S.1.2.2.4. |

*Note: Ungraduated devices, e.g. equal arm balances where the scale graduations do not represent a fixed weight quantity, are not included in this table since they have no scale divisions (d) to permit comparison with (e).*

**S.1.2.2.1. Class I and II Scales and Dynamic Monorail Scales. –** If e ≠ d, the verification scale ~~interval~~ division “e” shall be determined by the expression:

d < e < 10 d

If the displayed scale division (d) is less than the verification scale division (e), then the verification scale division shall be less than or equal to 10 times the displayed scale division.

The value of e must satisfy the relationship, e = 10k of the unit of measure, where k is a positive or negative whole number or zero. This requirement does not apply to a Class I device with d < 1 mg where e = 1 mg. If e ≠ d, the value of “d” shall be a decimal submultiple of “e,” and the ratio shall not be more than 10:1. If e ≠ d, and both “e” and “d” are continuously displayed during normal operation, then “d” shall be differentiated from “e” by size, shape, color, etc. throughout the range of weights displayed as “d.”

(Added 1999) (Amended 20XX)

***S.1.2.2.2. Class I and II Scales Used in Direct Sales.*** *­– When accuracy Class I and II scales are used in direct sale applications the value of the displayed division “d” shall be equal to the value of the verification scale interval “e.”*

*[Nonretroactive as of January 1, 2020; to become retroactive as of January 1, 2023]*

(Added 2017)

**S.1.2.2.3. Deactivation of a “d” Resolution.** – It shall not be possible to deactivate the “d” resolution on a Class I or II scale equipped with a value of “d” that differs from “e” if such action affects the scale’s ability to round digital values to the nearest minimum unit that can be indicated or recorded as required by paragraph G-S.5.2.2. Digital Indication and Representation.

(Added 2018)

**S.1.2.2.4. Class III and IIII Scales.** The value of “e” is specified by the manufacturer as marked on the device. Except for dynamic monorail scales, “e” must be less than or equal to “d.”

(Added 1999)

**~~S.5.3.~~ S.1.2.2.5. Multi-Interval and Multiple Range Scales~~, Division Value~~.** – On a multi-interval scale ~~and~~ or a multiple range scale, the value of “e” shall be equal to the value of “d.”

(Added 1986) (Amended 1995 and 20XX)

**S.1.2.2.6. Class IIIL Scales.** On Class IIIL scales the value of “e” shall equal the value of “d.”

(Added 20XX)

(Add new definition)

**auxiliary indicating device.** – a means to increase the display resolution of a weighing device, such as a rider or vernier on an analog device, or a differentiated least significant digit to the right of the decimal point on a digital device. [2.20]

(Added 20XX)

Section S.1.2.2. is a key part of understanding application of e and d. The first change was to make references uniform to verification scale “division” as used in all other parts of the code. This section currently uses the term verification scale “interval”. Several additions of the term “scale’ were also added to S.1.2.2.1. for clarity. Of note, R76 exempts Class I from the e not greater than 10 d requirement when e = 1 mg or less.

A major addition is the new text and table in T.1.2.2. This would create a parallel section in HB44 to R76 section 3.1.2 and Table 2. This section describes four types of instruments:

1. Graduated without an auxiliary indicating device – most instruments e = d
2. Graduated with an auxiliary indicating device – Class I and II with high resolution e > d
3. Graduated & marked for special applications – weight classifiers (round down instruments) e < d
4. Ungraduated – equal arm balances where graduations don’t refer to fixed weight quantities. No d

These four types also impact application of minimum load in Table 8.

The current S.5.3. was moved to this section as S.1.2.2.5. to keep these paragraphs dealing with the magnitude of e and d together. A new paragraph S.1.2.2.6. was added to address Class IIIL where e should always equal d. Now all classes (I, II, III, IIIL, and IIII) are covered in S.1.2.2. to clarify relative magnitude of e and d.

The addition of the definition rounds out the expansion of this section

***~~S.5.4.~~ S.5.3. Relationship of Minimum Load Cell Verification Interval Value to the Verification Scale Division.***– *The relationship of the value for the minimum load cell verification scale interval, vmin, to the verification scale division, ~~d~~ e, for a specific scale using National Type Evaluation Program (NTEP) certified load cells shall comply with the following formulae where N is the number of load cells in a single independent1 weighing/load-receiving element (such as hopper, railroad track, or vehicle scale weighing/load-receiving elements):*

1. *vmin ≤ ~~d\*~~ e for scales without lever systems; and  
    √N*
2. *vmin ≤ ~~d\*~~ e for scales with lever systems.  
    √N x (scale multiple)*

*~~[\*When the value of the scale division, d, is different from the verification scale division, e, for the scale, the value of e must be used in the formulae above.]~~*

*This requirement does not apply to complete weighing/load-receiving elements or scales, which satisfy all the following criteria:*

* *the complete weighing/load-receiving element or scale has been evaluated for compliance with T.N.8.1. Temperature under the NTEP;*
* *the complete weighing/load-receiving element or scale has received an NTEP Certificate of Conformance; and*
* *the complete weighing/load-receiving element or scale is equipped with an automatic zero‑tracking mechanism which cannot be made inoperative in the normal weighing mode. (A test mode which permits the disabling of the automatic zero-tracking mechanism is permissible, provided the scale cannot function normally while in this mode.*

*[Nonretroactive as of January 1, 1994]*

(Added 1993) (Amended 1996, ~~and~~ 2016, and 20XX)

The renumbering resulted from the move of S.5.3. to the S.1.2.2. section as S.1.2.2.5. The other changes correctly reference e instead of d in this section. Technically, *vmin* for load cells corresponds to verification scale division e for weighing instruments. They are accuracy ratings declared by the manufacturer. There is no significant change for the inspector in properly referring to e since for scales where e = d the issue is moot and when e ≠ d the section already directed the use of e. With the change the inspector will always use e.

**Group 3. Changes to clarify appropriate application of tolerances (Marked Scales)**

| **Table 6.**  **Maintenance Tolerances**  (All values in this table are in verification scale divisions “e”) | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Tolerance ~~in Scale Divisions~~** | | | | | | |
|  | **1** | **2** | | **3** | | **5** |
| **Class** | **Test Load** | | | | | |
| I | 0 - 50 000 | 50 001 ‑ | 200 000 | 200 001 + |  |  |
| II | 0 ‑   5 000 | 5 001 ‑ | 20 000 | 20 001 + |  |  |
| III | 0 ‑      500 | 501 ‑ | 2 000 | 2 001 ‑ | 4 000 | 4 001 + |
| IIII | 0 ‑        50 | 51 ‑ | 200 | 201 ‑ | 400 | 401 + |
| III L | 0 ‑      500 | 501 ‑ | 1 000 | (Add 1 ~~d~~ e for each additional  500 ~~d~~ e or fraction thereof) | | |

The proper reference in this section has always been e, and this is how it has always been interpreted. The current language says “scale divisions” which technically refers to d. This means we weren’t following the Code. The removal of “in Scale Divisions” after Tolerances in the second row was made to provide parallel construction with the header for Test Load. The parenthetical at the top should be sufficient to cover both sections of the table.

The change for Class IIIL was made since e should be used to specify tolerances and we added S.1.2.2.6. requiring that d = e for this class.

**T.N.3.4. Crane and Hopper (Other than Grain Hopper) Scales.** – The maintenance and acceptance tolerances shall be as specified in T.N.3.1. Maintenance Tolerance Values and T.N.3.2. Acceptance Tolerance Values for Class IIIL, except that the tolerance for crane and construction materials hopper scales shall not be less than 1 e ~~d~~ or 0.1 % of the scale capacity, whichever is less.

(Amended 1986 and 20XX)

**T.N.4.3. Single Indicating Element/Multiple Indications.** – In the case of an analog indicating element equipped with two or more indicating means within the same element, the difference in the weight indications for any load other than zero shall not be greater than one‑half the value of the verification scale division (e) ~~(d)~~ and be within tolerance limits.

(Amended 1986)

The reference to tolerances in T.N.3.4. and T.N.4.3. should follow the principle of expressing tolerances in e.

**Group 4. Changes to clarify appropriate application of tolerances (Unmarked Scales)**

**T.1. General.** – The tolerances applicable to devices not marked with an accuracy class shall have the tolerances applied as specified in Table T.1.1. Tolerances for Unmarked Scales.

Note: When Table T.1.1. refers to T.N. sections it shall be accepted that the scale division d on the unmarked scale always equals the verification scale division e.

(Amended 20XX)

Prior to 1984, tolerances were based on percentage of load for most scales. There was no concept of verification scale division e. In the T.N. section all tolerances are expressed in e. The note is added to clarify that d for the T. section is always equal to e from the T.N. section.

The workgroup noted that several specific paragraphs in the T. section for unmarked scales refer to tolerances in terms of d. Those sections are shown below. With the addition of the note to T.1. General, it was decided that it was not appropriate or necessary to change the d to e in these paragraphs.

**T.2.2. General.** – Except for scales specified in paragraphs T.2.3. Prescription Scales through T.2.8. Railway Track Scales: 2 d, 0.2 % of the scale capacity, or 40 lb, whichever is least.

**T.2.4.2. With More Than One‑Half Ounce Capacity.** – 1 d or 0.05 % of the scale capacity, whichever is less.

**T.2.7. Vehicle, Axle‑Load, Livestock, and Animal Scales.**

**T.2.7.1. Equipped With Balance Indicators.** – 1 d.

**T.2.7.2. Not Equipped With Balance Indicators.** – 2 d or 0.2 % of the scale capacity, whichever is less.

**T.2.8. Railway Track Scales.** – 3 d or 100 lb, whichever is less.

**Group 5. Changes to clarify appropriate scale selection (reference Table 8)**

|  |  |  |
| --- | --- | --- |
| **Table 8.**  **Recommended Minimum Load** | | |
| **Class** | **Value of Verification Scale Division “e”**  **~~(d or e\*)~~** | **Recommended Minimum Load in scale divisions “d” (See notes) ~~(d or e\*)~~** |
| I | equal to or greater than 0.001 g | 100 |
| II | 0.001 g to 0.05 g, inclusive | 20 |
|  | equal to or greater than 0.1 g | 50 |
| III | All~~\*\*~~ | 20 |
| III L | All | 50 |
| IIII | All | 10 |
| ~~\*For Class I and II devices equipped with auxiliary reading means (i.e., a rider, a vernier, or a least significant decimal differentiated by size, shape or color), the value of the verification scale division “e” is the value of the scale division immediately preceding the auxiliary means. For Class III and IIII devices the value of “e” is specified by the manufacturer as marked on the device; “e” must be less than or equal to “d.”~~  *The displayed scale division d is not always equal to the verification scale division e. To ensure the correct values are used, refer to required markings on the device (see also notes 3 and 4 in Table S.6.3.b.).*  *For an ungraduated device, the scale division d shall be replaced with the verification scale division e in the last column.*    ~~\*\*~~A minimum load of ~~10 d~~ 5 e is recommended for a weight classifier marked in accordance with a statement identifying its use for special applications. | | |

In the header, the change in column 2 references e and the change in column 3 references d and directs you to the notes. Currently, the Code references (d or e) in both columns which causes confusion. We’re never sure which one to use. The justification for d in the last column follows below.

It is vital to understand that Table 8. is tied closely to Table 3. You will find that header to the first two columns in both tables, with these changes, will be identical. The workgroup also revised the \* note to remove the \* and use parallel text to revised note 1 of Table 3. The notes section contains two special exceptions to the general values in column 3 the table. The first directs you to use e in the last column for ungraduated instruments, as these have no d values. The second directs you to use a minimum load of 5 e for weight classifiers. This aligns the value with R76. Note that the use of d for weight classifiers leads to unusual situations. Two weight classifiers with 100 lb capacity and e of 0.05 lb should have the same minimum load. However, they might have very different d values, say 1 lb and 0.2 lb. Declaring minimum load as 10 d for these result in very large differences of 10 lb minimum load for the first instrument and 2 lb for the second. Since e < d for weight classifiers, the minimum load is correctly expressed in e.

**Understanding Minimum Load**

In R76, minimum load “Min” is included in the principles of classification, see 2.2. below. There are 4 mandatory markings; Class, Max, Min and e. When R76 was translated into HB44 a conscious decision was made to remove Min from the classification and make it a user requirement. Thus, HB44 only has 3 mandatory markings; Class, Capacity, and d. We have already proposed to change the d to e above.



In R76, the issue of instrument accuracy is focused on Class, Max and e, parallel to HB44. Absolute accuracy in terms of e and relative accuracy in terms of n. When the load is very small, i.e. less than Min, it might appear that R76 is addressing the large relative errors resulting in 1 e tolerance for some small number of e in load. However, this is not the case. The distinction is that Min applies to use of the instrument and not to testing of the instrument.

In testing under R76 tolerances, rounding errors are eliminated (see 3.5.3.2.). In practice this usually means error weights are used to resolve the instrument errors to at least 0.2 e (NTEP generally uses 0.1 e). In addition, R76 expects that instrument divisions are relatively uniform throughout the series. In order to get a +1 e error at 1 e load and still meet the requirement that the zero division be +/- 0.5 division wide, would require the 1 e divisions be 0 e wide (i.e. be skipped). To visualize in analog, imagine an indicator that starts at zero and jumps immediately to the 2 graduation. A load of 1 e would indicate 2 e. Likewise a load of 2 e would indicate 3 e and this pattern would repeat until the tolerance breakpoint, a load of 500 e would indicate 501 e. Then the second graduation after the break point would be skipped, i.e. the 502 e graduation. A load of 501 e would indicate 503 e with a +2 e error. All the loads up to 20,000 e would now show a +2 e error. Instruments obviously should not, and DO NOT, operate that way.

If we assume instrument divisions are uniform, as R76 does, then the divisions should be accurate to about the relative % of the accuracy class. For Class II in the first step this is 0.02%. Thus at 20 e load the maximum expected error (after eliminating rounding) should be in the order of 0.004 e, and not the 1 e permitted in the tolerance structure. So, what relative error can R76 be addressing when dealing with Min?

When an instrument is used in commerce, it is the rounding of the indication to ½ scale division that results in large relative errors. Consider a cannabis sale of 1.05 g when the division size is 0.1 g. The instrument must round off to either 1.0 g or 1.1 g. Either one produces an error in the weighment of 0.05 g. That’s 4.8% relative error in the weighment (0.05 g / 1.05 g) with an instrument that’s supposed to be accurate to 0.02%. It is this rounding error “in use” that produces the large relative errors addressed in Min in R76 and the minimum load in HB44. This rounding error is a function of d, the displayed scale division, and not e. It is not a tolerance issue.

The confusion comes from the presentation of Min in terms of e in the last column of R76 Table 3. The table in R76 has an additional column for Min not found in HB44. In HB44 it has been relocated to Table 8. Looking closely at Table 8, you will find that the first two columns correspond to the first two columns in Table 3 in HB44. So why does R76 express this column in e instead of d? I suspect they did it because all other values in Table 3 are in e. For instruments where e = d, the issue is moot. Note however, that R76 reveals the ties to d for the Class I and II instruments with an auxiliary indicating device (differentiated least significant digit). In 3.4.3. R76 directs that d replace e in the Min column of Table 3 for instruments with an auxiliary indicating device.

On an instrument where e = 10 d, we can create the same scenario as before but now with a load of 1.005 g. The instrument must now round to either 1.00 g or 1.01 g. The rounding error is now 0.50% of the weighment (0.005 / 1.005). That is 10 times smaller at the same 20 e load.

Returning to the four types of instruments from revised S.1.2.2. and applying revised Table 8.:

1. Graduated without an auxiliary indicating device: minimum load in d
2. Graduated with an auxiliary indicating device: minimum load in d
3. Graduated and marked for special use (weight classifier): minimum load 5 e
4. Ungraduated (equal arm scales): minimum load in e

**Group 6. Changes to correctly reference to e or d as appropriate.**

**S.1.1.1. Digital Indicating Elements.**

(a) A digital zero indication shall represent a balance condition that is within ± ½ the value of the verification scale division.

*(b) A digital indicating device shall either automatically maintain a “center-of-zero” condition to ± ¼ verification scale division or less, or have an auxiliary or supplemental “center-of-zero” indicator that defines a zero‑balance condition to ± ¼ of a verification scale division or less.* *A “center-of-zero” indication may operate when zero is indicated for gross and/or net mode(s).*

*[Nonretroactive as of January 1, 1993]*

*(c) For electronic cash registers (ECRs) and point-of-sale systems (POS systems) the display of measurement units shall be a minimum of 9.5 mm (3/8 inch) in height.*

*[Nonretroactive as of January 1, 2021]*

*(Added 2019)*

(Amended 1992, 2008, ~~and~~ 2019, and 20XX)

The changes correctly reference e in this section as this is an issue of ensuring the zero indication is accurate to ¼ e. Hence it is a tolerance properly expressed in terms of e.

**T.N.9. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility.** – The difference between the weight indication due to the disturbance and the weight indication without the disturbance shall not exceed one verification scale division ~~(d)~~ (e); or the equipment shall:

(a) blank the indication; or

(b) provide an error message; or

(c) the indication shall be so completely unstable that it cannot be interpreted, or transmitted into memory or to a recording element, as a correct measurement value.

The tolerance in T.N.9. Radio Frequency Interference (RFI) and Other Electromagnetic Interference Susceptibility is to be applied independently of other tolerances. For example, if indications are at allowable basic tolerance error limits when the disturbance occurs, then it is acceptable for the indication to exceed the applicable basic tolerances during the disturbance.

(Amended 1997 and 20XX)

This is a tolerance for reaction to a disturbance and is properly expressed in e.

**Group 7. Identify appropriate application of code sections (in order of appearance)**

When the paragraph references d it is referring to the actual scale division and the concern is how the instrument operates. When the paragraph references e it is referring to the verification scale division and the concern is in classification of the instrument or in accuracy of the displayed values.

The sections in the table below currently correctly reference e or d as appropriate. The text of each section is not included for brevity. The justification may help explain the general rules above.

|  |  |  |
| --- | --- | --- |
| **Code Section** | **Applies to** | **Justification** |
| G-S.5.2.2.(c) | d | Rounding is a function of instrument operation not accuracy |
| G-S.5.2.2.(d) | d | Requires “d” to be an indicated zero and all digits to the left of “d” to be zero when d<1.  Requires “d” to be an indicated zero and all digits to the right of “d” to be zero when d>5. |
| S.1.2. | d | 1, 2, or 5 refers to d which is rounded. When e ≠ d refer to section S.1.2.2. for value of e. |
| S.1.2.1 | d | Refers to rounded values of d. |
| S.1.2.3. | e | This is a classification issue. It ensures accuracy of the piece counts. |
| S.1.7.(b) | e | This is a classification issue addressing maximum indication above capacity. |
| S.2.1.2. | d | They must be in terms of d since stability of zero setting applies to d. |
| S.2.1.3.(all) | d | These limit the window for action of AZT. They must be in terms of d since zero setting applies to d. |
| S.2.3. | d | Tare division must equal smallest increment displayed. |
| T.N.7. | d | Discrimination requires an instrument to discriminate to the displayed scale division (zone of uncertainty). This relates to the rounding of the smallest increment. |
| UR.3.7. | d | Minimum load is correctly expressed in d. (see Group 5 above) |
| UR.3.10. | e | As written, this is clearly e. (See issues for additional study) |

**PART 3. Issues Identified as Requiring Additional Study (outside the scope of this workgroup)**

**A.** The workgroup was in consensus that we should expand requirements in S.2.1.2. relating to semi-automatic zero to apply to all scales and not just scales used in direct sale. In first place, suitability is a User Requirement and not a specification. Second, correct operation to set zero should be applicable to all digital instruments as it is in R76.

**B.** The application of tolerances to net loads has always been assumed, even before the Scales Code adoption in 1984. Comparing T.2. for unmarked scales and T.N.2.1. for marked scales reveals important differences particularly regarding net loads. As written, T.N.2.1. exempts calculated net, but it appears to apply to both semi-automatic tare and preset tare. A comparison to R76 shows that OIML limits applicability of tolerances. Their MPE’s do not apply to calculated net values or when preset tare (keyboard or programmed tare) is in operation (section 2.2). It appears net loads have MPE’s applied only when the net zero is set in compliance with S.1.1.1.(b) which requires accuracy of zero to ¼ division.

This cannot be assured with preset tare or when net is based on two gross values. This has further ramifications to any case where all three (gross, tare and net) values are indicated/recorded for a transaction. OIML requires the gross and net weights be accurate but does not apparently require that the equation gross – tare = net be in mathematical agreement due to rounding issues. Note that in most transactions, the customer only gets one or two of the gross, tare or net values. Rounding issues do not arise for this reason. This may impact a current issue before NCWM dealing with printing tare on POS transaction receipts. Consider a POS transaction where the customer saw 1.02 lb on the weight display and sees 1.00 lb net and 0.03 lb tare. These are all accurate weights (and correct per R76) but the numbers don’t’ add up. The customer will claim they were overcharged by 0.01 lb since 1.02 lb – 0.03 lb = 0.99 lb.

**C.** The resolution of errors in testing scales was identified as an issue. The original proposal included a revision requiring resolution of error to at least 0.2 e. R76 specifically declares that errors be resolved to at least 0.2 e to eliminate rounding error. HB44 has no such provision and it might appear that rounding error is included in the tolerance. Instead of tolerance steps of 1, 2, etc., it could be argued that the tolerances are 1.5, 2.5, etc. as the result of direct reading. NTEP uses the R76 approach exclusively in testing, but it has no technical basis in the Code. There are obvious issues involved in using error weights in the field. The challenge is that you either eliminate rounding in determining tolerances or you don’t. We have two standards at play at present. In addition, it can be argued that Class IIIL instruments are already high resolution somewhat similar to Class I and II instrument with e >d. Class IIIL devices have enough resolution to read errors to 0.2 e or 0.1 e of the equivalent Class III instrument without using error weight.

**D.** The UR.3.10. requirement that transactions from dynamic monorail scales be based on e raises issues. It was discussed since it involves both e and d. The displayed scale divisions equal to e (i.e. 10 d) are not normally rounded. If e = 10 d then the rounding point is not 5 up/4 down, as it is for d, but rather 9.5 up/0.5 down. Does this requirement mean the scale design has to produce a properly rounded value for the transaction that may be different from the display, e.g. 943.7 lb to d of 0.1 lb now must be recorded for the transaction as 944 lb? In addition, in brief discussion, it seemed there were many ways this could be interpreted. The workgroup concluded it would be beneficial to open some discussions with USDA and the manufacturers to explores some of these questions. This also addresses similar issues to the proposal to delete S.1.2.2.2. where questions of using e or d are impacting high precision scales in cannabis and jeweler’s sales.