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## Tests for Multi-interval and Multiple Range Weighing Instruments

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NIST often receives questions about the differences between multi-interval and multiple range scales. A *multiple range scale* (weighing instrument) is defined as a weighing instrument having two or more weighing ranges with different maximum capacities and different scale intervals for the same load receptor, each range extending from zero to its maximum capacity. The selection of the weighing range may be determined manually through a pushbutton or switch or may automatically change to the higher capacity range once the load exceeds the capacity of the lower range. A *multi-interval scale* (weighing instrument) is defined as a weighing instrument having one weighing range that is divided into partial weighing ranges (segments). Each weighing range (segment) is defined by its interval size, its minimum capacity, and its maximum capacity. The selection of the appropriate weighing segment is determined automatically according to the load applied, both on increasing and decreasing loads.

NIST Handbook 112, *Examination Procedure Outline (EPO) for Commercial Weighing and Measuring Devices*, addresses recommended test procedures for single range scales (weighing instruments). Weights and measures inspectors are taught to treat each range on multi-interval and multiple range instruments as separate scales for the determination of tolerances in NIST training courses. However, the EPO and the training courses do not address performance testing of multi-interval and multiple range instruments or even how to tell the difference between the two types of devices. It has also been reported that these instruments are not uniformly tested throughout the country. Should multiple range and multi-interval instruments be tested the same or differently than single interval/range instrument? Should shift test loads be determined based upon one-half capacity of each weighing range, or should the shift test load be determined based on the maximum capacity of the scale with the tolerance being based upon the weighing range of the test load? The following discussion will help inspectors to distinguish the differences between the two types of instruments and to identify technically correct test procedures for these devices.

Multiple range and multi-interval weighing are metrologically significant features or options of weighing instruments and separable indicating elements. NTEP will evaluate weighing instruments with these features and list them on the NCWM Certificate of Conformance. Another way to tell the difference between an automatic multi-interval and multiple range instrument is that the multiple range instrument does not automatically change the minimum interval from the higher value to the lower value when the load decreases from the higher to the lower capacity range.

In principle, a *multi-interval instrument* should be tested as a single instrument. Increasing/decreasing load tests for a multi-interval instrument can be conducted the

same as a single interval/range instrument. Shift tests shall be conducted at one-half the capacity of the instrument, not the partial weighing range or segment. When available test loads are less than one-half capacity, corner tests permitted in Scales Code paragraph N.1.3.8. (a) shall be performed at one-quarter of the instrument capacity. Each range on a **multiple range instrument** should be tested as a separate instrument, including shift and/or corner tests. Increasing/decreasing-load tests for a multiple range instruments that automatically changes to the next higher range can be conducted the same as a single interval/range instrument.

The following requirements must also be verified for both multi-interval and multiple range instruments:

- The motion detection and discrimination requirements must be satisfied for each interval size.
- The interval size for the first weighing segment applies to the tests to determine the width of zero and the amount of the automatic zero setting mechanism.
- The net weight must be in mathematical agreement with the gross and tare weights that are indicated and recorded (i.e., net = gross - tare). Even when gross and tare weights fall in different weighing segments, the scale intervals for the gross and tare weights differ.
- The manual entry of keyboard, thumb-wheel, and digital tare values must be entered to the displayed scale interval.
- The scale interval must change when the load in a lower weighing range reaches its maximum value so that rounding occurs properly and the number of displayed decimal places does not change within the same weight indication for instruments that automatically changes to the next higher range.

For example, a multiple range/multi-interval instrument that is marked with a capacity of 0-10 x 0.005 for the first range and 10-30 x 0.01 for the second range must display 10.00 not 10.000 once the scale has exceeded an internal weight indication of 9.9975. If not, the instrument would display 10.000 with a load of 9.998 or 10.00 with a load 10.004.

These requirements and procedures are consistent with test procedures in NCWM Publication 14, *Weighing Devices* and *OIML R 76-1 for Non-automatic Weighing Instruments* and will be included in the next publication of NIST Handbook 112 and future NIST training courses.

The application of tolerances for multiple range, multi-interval, and weight classifying weighing instruments will be the subject of a future newsletter article.