NTEP Test Description
In-motion pallet dimensioner

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Figures and Tables

1. Introduction

In-motion pallet dimensioner measures freight while it is being transported by forklifts without interruption. This document has been prepared for the NTEP Certificate of Conformance (CC).

1.1 Purpose

The purpose of this document is to describe the laboratory evaluation and test procedures for in-motion multiple dimension measuring devices (MDMD).

1.2 Concept of Operation

Provides accurate freight dimensions as forklifts are transporting the freight during normal operation. The forklift does not need to stop or deposit the Handling Unit (HU) for the measurement.

1.3 Hardware Configuration

Consists of the following hardware modules:

- Dimensioning Head Assemblies
- Acquisition Computer Assemblies
- Power Supply Assembly
- Tower Light
- Axis Camera
- Operating system

DUT	Device Under Test
Handling Unit	Carton, pallet, skid, or other bundled or unitized cargo that is individually identified and independently distributed or transported.
Hexahedron	A geometric solid or box consisting of six flat, rectangular sides.
Longitudinal	The orientation in which the longest axis of the test object is aligned in the horizontal plane and parallel to the direction of travel.
MDMD	Multiple Dimension Measuring Device
Minimum Spacing	The distance required between objects to ensure accurate measurement.
Multi-interval	A multi-interval device has a single measuring range divided into partial measuring ranges with different scale intervals, and the measuring range is determined automatically according to the dimension being measured.
Mixed Interval	A mixed interval device has different interval sizes for each axis. Devices having a multi-interval configuration are not included in this definition.

Non-Singulated	More than one object being measured at a time.
NTEP	National Type Evaluation Program
SI	International System of Units
Transverse	The orientation in which the longest axis of the test object is aligned in the horizontal plane and perpendicular to the direction of travel.
Vertical	The orientation in which the longest axis of the test object is aligned perpendicular to the horizontal plane.

1.4 Reference Documents

National Institute of Standards and Technology Handbook 44, 20xx Edition

National Conference on Weights and Measures Publication 14, 20xx Edition

NTEP Pub.14, 20xx Edition

1.5 General Information

The testing outlined in this document is complementary to the accompanying NTEP Testing workbook to record the results of each required NTEP Pub 14 test and procedure. The whole numbered sheets (1.23) represent the test requirements outlined in Pub 14. Some requirements on these sheets identify a summary requirement. The details of the summary requirement are documented on the decimal numbered sheets.

1.6 Test Standards

A set of test standards should be developed to support the NTEP Testing activities. The test boxes can be assembled into different configurations to enable testing the system's maximum pallet sizes. The boxes are light enough for 1-2 people to manipulate.

Each test standard is constructed to be rigid and dimensionally stable to ±2mm. The pallet surfaces have been selected to be opaque to 850 nm laser light.

The test standards identified for this testing are shown in Table 1

Table 1 - Test Standards examples

	Inches		
Standard	L	H	W
Cube	48	46	48
SB90%	11	11	11
SB100%	12	12	12
SB110%	13	13	13
90%L	87	36	18.1
100%L	96	36	18
110%L	105.4	36.4	18.1
P1	12	1	1
P2	12	2	2
P3	12	3	3
Med1	20	20	20
Med2	36	36	36
Med3	60	20	20
SM1	24	12	12
Tall	96.1	12	12
Cyl	47.7	13	12.5
Prism	36	21	18.1
Hex	36	27.4	23.7
Large1	75.2	75.2	36.5
Large2	96.2	96.1	36.2

2. Checklist and Procedure Review

2.1 Marking – Complete Devices

2.1.1 Application

This test is to verify that the measuring equipment is clearly and permanently labeled with the manufacturer's name or trademark, model designation, and serial number.

2.1.2 Purpose

The purpose of the test is to ensure that the markings will withstand wear and cleaning and that the badge is permanently attached to the device. Permanence of the badge must be obvious that the badge or plate containing the information has been removed.

2.1.3 Test Procedure

2.1.3.1 Permanence of Lettering Test Procedure

A. Rub over one letter of the marking at least 20 times using an ink eraser in the same manner and force as one would normally exert while erasing an inscription written in ball point pen.
    a. Use a Papermate Black Perl or Papermate Union #110 eraser.
B. Compare the letter to the grading chart found on sheet 1.1 (NTEP workbook) and record the result in reference 1.1 (NTEP workbook, sheet 1.1).
C. Clean the marking or badge with Formula 409® Multi-Surface Cleaner and a damp cloth.

D. Compare the letter to the grading chart found on sheet 1.1 (NTEP workbook) and record the result in reference 1.2.a (NTEP workbook, Sheet.1.1).
E. Clean the marking or badge with Bon AMI® powder cleanser and a damp cloth.
F. Compare the letter to the grading chart found on sheet 1.1 (NTEP workbook) and record the result in reference 1.2.b (NTEP workbook, Sheet.1.1).
G. Clean the marking or badge with Windex® Original glass cleaner and a damp cloth.
H. Compare the letter to the grading chart found on sheet 1.1 (NTEP workbook) and record the result in reference 1.2.c (NTEP workbook, Sheet.1.1).

2.1.3.2 Plate, Decal – Permanence of Installation / Durability Test Procedure

A. With the device powered on in the environmental chamber, stabilize the device at the nominal (approximately 20°C) test temperature for at least 2 hours.
B. Attempt to remove the badge and record the temperature, method of attachment and the indication of tampering fields for the Nominal temperature on sheet 1.1 (NTEP workbook).
C. Repeat Steps A and B after the device has stabilized at the low test temperature (-10°C) for at least 2 hours.
D. Repeat Steps A and B after the device has stabilized at the high test temperature (40°C) for at least 2 hours.

2.2 Sealing

2.2.1 Application

These tests verify that access to calibration and configuration parameters for a device is limited and that the integrity of the device is maintained by maintaining an audit trail of the changes.

2.2.2 Purpose

That this list of parameters has limited access and that changes to these parameters are recorded and can be reviewed.

2.2.3 Test Procedure

2.2.4 Sealed Parameter Test Procedure

2.3 Indicating and Recording Elements – General

2.3.1 Application

These tests facilitate the reading and interpretation of displayed values. Other tests address the proper operation and indicating and recording elements.

2.3.2 Purpose

The purpose of this test is to verify that the device indicates a ready (zero) state or non-ready state properly, that the device division “d” is presented correctly.

2.3.3 Test Procedure

The test procedures will be performed as described in Section 3 of Pub 14. Capture the test results for this section.

2.4 Values Defined

2.4.1 Application

These tests ensure that the use SI units or the conversion between SI units and Imperial units is performed with no loss of accuracy or resolution.

2.4.2 Purpose

This test is to verify that conversion factors and accuracy are maintained when measurements change from one system of measurements to another.

2.4.3 Test Procedure

2.5 Tare

2.5.1 Application

This test is to ensure that the tare feature only operates in a backward direction.

2.5.2 Purpose

The purpose of this test is to validate the NTEP S.2.2 (Handbook 14) requirement.

2.5.3 Test Procedure

2.6 Tare Operation – Facilitation of Fraud

2.6.1 Application

The purpose of this test is to ensure that the tare feature of the device does not facilitate fraud.

2.6.2 Purpose

2.6.3 Test Procedure

2.7 Recorded Representations

2.7.1 Application

This test ensures that all recorded values match the displayed values; they match units of measure and conform to the NIST Handbook 44 Appendix C units of measure.

2.7.2 Purpose

This test is to verify the accuracy and reliability of communication among all means of indication and registration of a device.

2.7.3 Test Procedure

All applicable items shall be tested as written (NTEP).

2.7.3.1 Agreement of Registrations Test Procedure

For item 7.3 (NTEP workbook, sheet 7) the following test procedure is performed for devices equipped with multiple indicating elements or are able to produce printed registrations of the measurements.

The following test must be performed for each unit of measurement that the device can display.

A. Indicating the ready state.

B. Verify the agreement between indications and registrations at zero

C. Present at least 4 objects to the device for measurement

D. Verify the agreement of all indications and registrations, including the printouts for each object.

E. Repeat A-E for all other units of measurement the device is capable of displaying.

Record the results for each object.

2.8 Design of Zero and Tare

2.8.1 Application

This test ensures that the zero or ready feature can be adjusted and that this feature is interlocked with and disabled during measurement operations.

2.8.2 Purpose

The purpose of this test is to verify that the zero / ready state of the system cannot be adjusted during measurement operations.

2.8.3 Test Procedure

2.8.3.1 Zero Maintenance Interlock Test Procedure

A. Ensure that the device is at zero or ready condition.
B. Place a standard on the forklift. Record the standard
C. Pass the standard through the DUT using the forklift. Observe and record the results.
D. Pass the standard through the DUT using the forklift. As the forklift passes through the DUT attempt to activate the calibration feature.
E. Observe and record the results
F. Pass the standard through the DUT using the forklift. Observe and record the results.

2.9 Systems with Two or More Measuring Elements

2.9.1 Application

This test ensures that devices coupled to two or more measuring elements with independent measuring systems prohibits the activation of measuring elements when not in use.

2.9.2 Purpose

The purpose of this test is to verify that the measuring elements in use are clearly identified and that measuring elements not in use cannot be activated inadvertently.

2.9.3 Test Procedure

2.10 Verification of Usage (Field Testing Only)

2.10.1 Application

This test ensures that a device provides the minimum set of information stated in table UR.5 (Handbook 44)

2.10.2 Purpose

The purpose of this test is to ensure that the customer receive consistent transaction information.

2.10.3 Test Procedure

2.11 Operating Temperature Verification of Warm-up Time (Accuracy after Cold Start)

2.11.1 Application

This test ensures that when a device is turned on it will not display or record any usable values until the operating temperature necessary for accurate measurement has been attained.

2.11.2 Purpose

The purpose of this test is to verify that the system does not display or record any usable values until the system is in the ready state.

2.11.3 Test Procedure

2.11.3.1 Accuracy after Cold Start Test Procedure

A. Ensure that the DUT is powered off.
B. Select a standard or test object.
C. Power on the machine and immediately pass the test standard through the DUT.
D. Observe and record all of the registrations produced as a result of the measurement.
E. Record if the system displayed or recorded useable data.
F. Wait for the ready condition of the DUT.
G. Record how the system indicated the ready state.
H. Record if the system displayed or recorded useable data.

I. Pass the test standard through the DUT three (3) more times.

J. Compare the results of the test measurements.

2.12 Performance Tests

Seven (7) performance tests have been identified to characterize and test the performance. The tests are described below along with the test procedure.

2.12.1 Repeatability Test

2.12.1.1 Application

This test ensures that the device is capable of accurately measuring an object within tolerance at different speeds.

2.12.1.2 Purpose

The purpose of this test is to verify that the device can accurately measure a test standard when the test standard is presented to the device multiple times and at different speeds.

2.12.1.3 Test Procedure

A. Ensure that the Device is at zero or ready condition.
B. Select a small standard and place it on the forks of the forklift with the forks between ? – ? inches above the floor.
C. Pass the forklift through the DUT at or near the minimum speed of the device. Observe and record the results .
D. Repeat step C nine (9) more times.
E. Repeat steps C and D at or near the middle speed of the device.
F. Repeat steps C and D at or near the maximum speed of the device.
G. Select a medium standard and place it on the forks of the forklift with the forks between ? – ? inches above the floor.
H. Perform steps C to F.
I. Select a large standard and place it on the forks of the forklift with the forks between ? – ? inches above the floor.
J. Perform steps C to F.

2.12.2 Return to Zero Test

2.12.2.1 Application

This test ensures that the measuring device returns to a zero or ready condition after an object is measured.

2.12.2.2 Purpose

The purpose of this test is to verify that the device returns automatically to a zero or ready condition after an object is measured.

2.12.2.3 Test Procedure

A. Ensure that the DUT has a stable zero or ready condition before beginning this test.
B. When a zero or ready condition is attained, pass a standard on a forklift through the measuring area.
C. Observe and record the measurement registrations for the standard in the table on sheet.
D. Ensure that the system returns to a zero or ready condition. Record the information that is displayed.
E. Repeat steps B to D two (2) more times.

2.12.3 Sensor / Emitter Obstruction Test

2.12.3.1 Application

This test ensures that devices that utilize emitting and sensing components to determine the dimensions of an object respond correctly when the sensing components are interfered with.

2.12.3.2 Purpose

The purpose of this test is to verify that appropriate feedback when a sensor is obstructed.

2.12.3.3 Test Procedure

A. Ensure that the DUT has a stable zero or ready condition.
B. Select a standard and place it on the forks of the forklift with the forks between ? – ? inches above the floor..
C. Pass the standard through the DUT and record the measurement.
D. Ensure that the DUT has a stable zero or ready condition.
E. Obscure ½ of the sensing area of one of the sensors.
F. Pass the standard through the DUT and record the registrations and note any observations.
G. Repeat steps D to F for the remaining sensors
H. Repeat steps D to F with the sensor completely covered

Interpretation of Results

The DUT is deemed to have met the requirements if, during this test:

a) All of the measurements registrations are within the limit of error, or
b) The display blanks and the transmission of any measurement information is prevented, or
c) The display shows an error message and the transmission of any measurement information is prevented, or
d) The measurements registration is so unstable that it cannot be interpreted and the transmission of any measurement information is prevented until the measurement has stabilized to within the limit of error of the standard being measured.

2.12.4 Forklift Sensor Missing Test

2.12.4.1 Application

This test ensures that if the markings on the forklifts are missing or damaged that the device responds correctly.

2.12.4.2 Purpose

The purpose of this test is to verify that the provides appropriate feedback when a forklift is obstructed or damaged.

2.12.4.3 Test Procedure

A. Ensure that the DUT has a stable zero or ready condition.
B. Select a standard and place it on the forks of the forklift with the forks between ? – ? inches above the floor.
C. Pass the standard through the DUT and record the measurement without any forklift obstructed.
D. Ensure that the DUT has a stable zero or ready condition.
E. Obscure one of the forklift sensor by covering it.
F. Pass the standard through the DUT and record the registrations and not any observations.
G. Repeat steps D to F for the remaining forklift sensor.

2.12.5 Static Object in the Field of View

2.12.5.1 Application

This test ensures that devices utilizing emitting and sensing components to determine the dimensions of an object respond correctly when static objects are placed in the field of view.

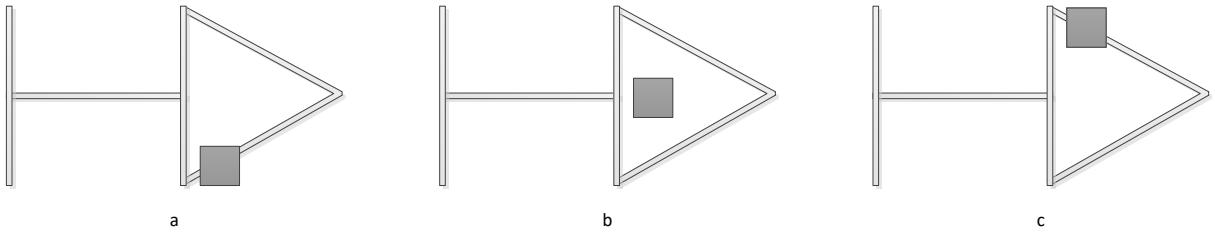
2.12.5.2 Purpose

The purpose of this test is to verify the behavior of the DUT when a static object is placed in the field of view.

2.12.5.3 Test Procedure

A. Ensure that the DUT has a stable zero or ready condition.
B. Select a standard and place it on the forks of the forklift with the forks between ? – ?? inches above the floor.
C. Pass a standard through the DUT and record the measurement
D. Ensure that the DUT has a stable zero or ready condition.
E. Place a medium sized object in the field of view markings of the system as shown in Figure 1.a.

Figure 1 - Static Object Placement



F. Pass the standard through the DUT and record the registrations and note any observations
G. Repeat step F three (3) more times
H. Repeat steps E to G with the obstruction as shown in Figure 1.b
I. Repeat steps E to G with the obstruction as shown in Figure 1.c

Interpretation of Results

The DUT is deemed to have met the requirements if, during this test:

e) All of the measurements registrations are within the limit of error, or
f) The display blanks and the transmission of any measurement information is prevented, or
g) The display shows an error message and the transmission of any measurement information is prevented, or
h) The measurements registration is so unstable that it cannot be interpreted and the transmission of any measurement information is prevented until the measurement has stabilized to within the limit of error of the standard being measured.

2.12.6 Moving Secondary Object

2.12.6.1 Application

This test ensures that if a secondary object is moving through the field of view that the device responds correctly.

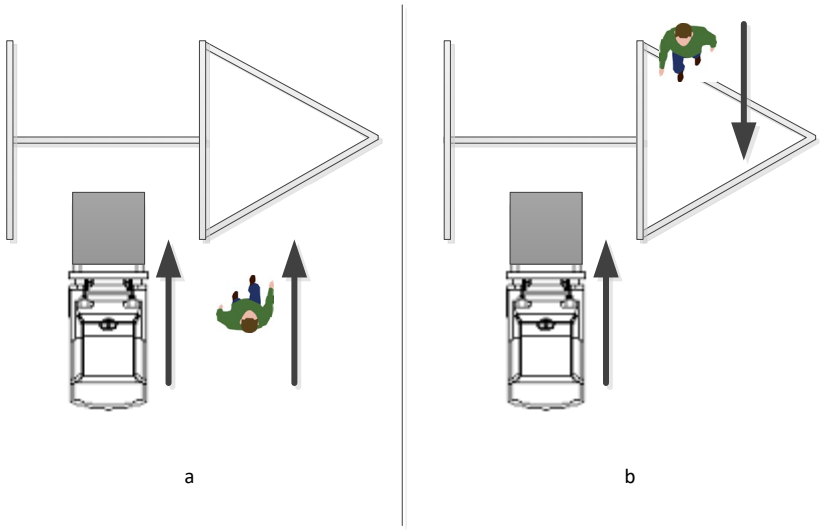
2.12.6.2 Purpose

The purpose of this test is to verify that appropriate feedback when a forklift and another moving object move through the field of view at the same time.

2.12.6.3 Test Procedure

A. Ensure that the DUT has a stable ready condition.
B. Select a medium sized standard and place it on the forks of the forklift with the forks between ? – ?? inches above the floor.
C. Pass the standard through the DUT and record the measurements.
D. Ensure that the DUT has a stable ready condition.
E. Pass the standard through DUT while a person safely passes through the DUT at the same time as shown in Figure 2.a.

Figure 2 - Moving Secondary Object Test



F. Record the registrations and note any observations on sheet 12.7.
G. Repeat Steps D to F with a person walking in the opposite direction as the forklift as shown in Figure 2.b

Interpretation of Results
The DUT is deemed to have met the requirements if, during this test:

a) All of the measurements registrations are within the limit of error, or
b) The display blanks and the transmission of any measurement information is prevented, or
c) The display shows an error message and the transmission of any measurement information is prevented, or
d) The measurements registration is so unstable that it cannot be interpreted and the transmission of any measurement information is prevented until the measurement has stabilized to within the limit of error of the standard being measured.

2.12.7 Forklift Orientation Test

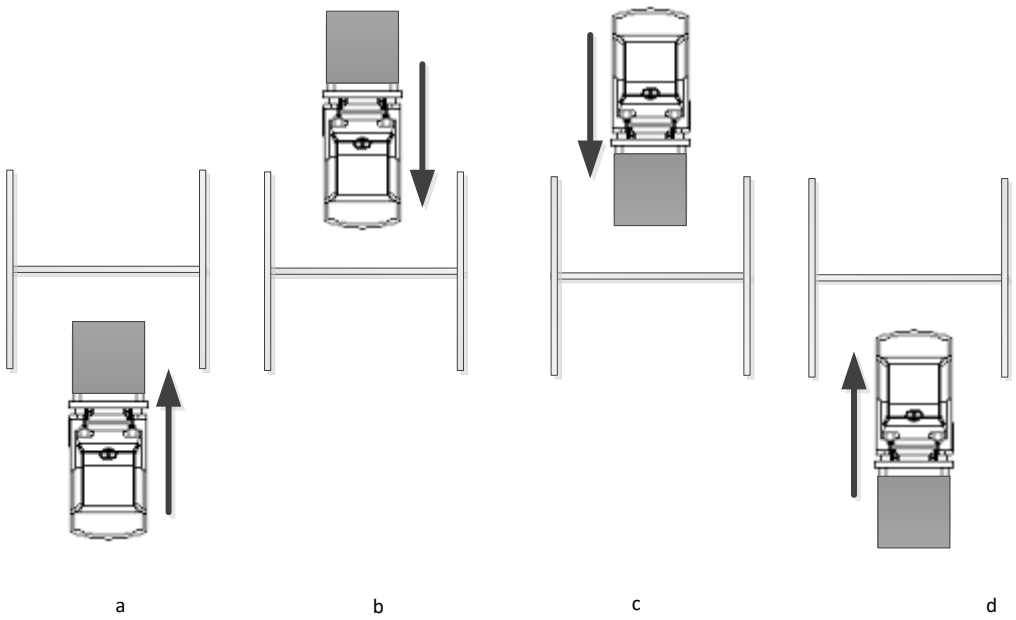
2.12.7.1 Application
This test ensures that a forklift can travel through the system in either direction and in the forward or backward orientation. This ensures that the system can correctly measure the pallet no matter which way the forklift moves through the system.

2.12.7.2 Purpose
The purpose of this test is to verify that the system measures an object independent of the forklift orientation.

2.12.7.3 Test Procedure
A. Ensure that the DUT has a stable ready condition.
B. Select a medium sized standard and place it on the forks of the forklift with the forks between ? – ?? inches above the floor.

C. Face the forklift towards the DUT and pass through the system as shown in figure Figure 3.a. Record the measurements
D. Ensure that the DUT has a stable ready condition.
E. Without turning the forklift pass back through the DUT in reverse as shown in Figure 3.b. Record the measurements

Figure 3 – Forklift Orientation Test



F. Turn the forklift so that it is facing the forklift on the opposite side of the DUT from the first pass as shown in Figure 3.c. Record the registrations
G. Without turning the forklift pass back through the DUT in reverse as shown in Figure 3.d. Record the measurements

Interpretation of Results

The DUT is deemed to have met the requirements if, during this test:

e) All of the measurements registrations are within the limit of error, or
f) The display blanks and the transmission of any measurement information is prevented, or
g) The display shows an error message and the transmission of any measurement information is prevented, or
h) The measurements registration is so unstable that it cannot be interpreted and the transmission of any measurement information is prevented until the measurement has stabilized to within the limit of error of the standard being measured.

2.13 Position Test

2.13.1 Application

This test ensures that measurements are made using different positions of the test object and consistent with the manufacturers specified use for the device.

2.13.2 Purpose

The purpose of this test is to verify that the device measures accurately when a test object is presented at different locations in the measurement area.

2.13.3 Test Procedure

Objects pass beneath will dimension the object if it passes through a 10'(?) x 10'(?) area marked on the floor directly below the center of the device. The Eccentricity test procedure defined below describes the five (5) basic patterns that a forklift will follow through the device.

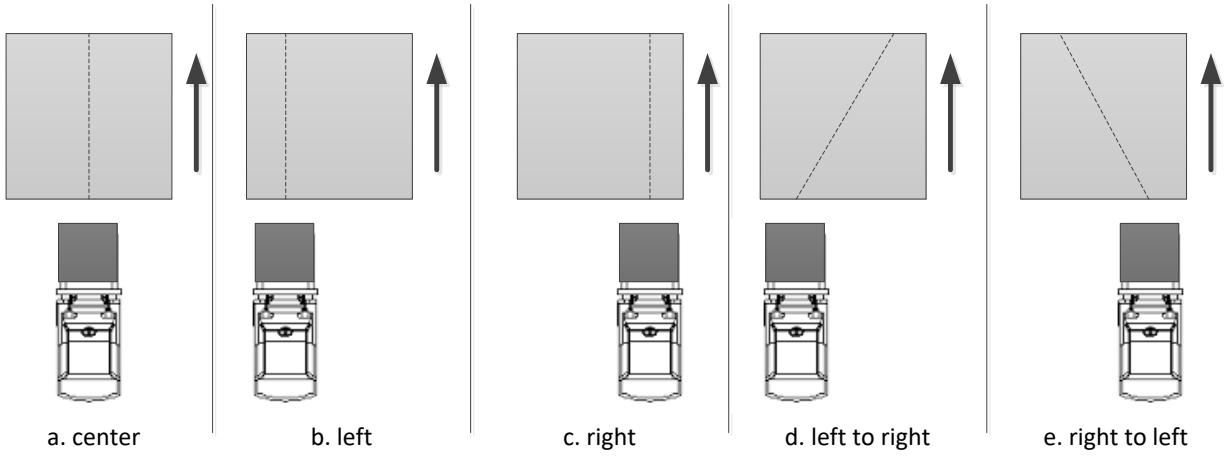
The system does not have any structural elements in the dimensioning area to interfere with the movement and measurement of objects as they pass beneath the system. The system does have a 10' x 10' area on the floor directly below the center of the device called the travel lane. If an object goes outside the travel lane the dimensioner will perform a measurement but also provide an error that the object was not in the travel lane during the measurement. The Out of Bounds test procedure defined below describes the steps for validating this behavior.

2.13.3.1 Eccentricity Test Procedure

The system measures objects as they pass through the marked area on the floor. To satisfy this test requirement objects will make five (5) passes through the unit using different patterns. Figure 4 describes the patterns the forklift will travel.

A. Ensure that the device is at zero or in the ready condition.
B. Pass four (4) standards in increasing sizes from the smallest to the largest in the transverse orientation through the DUT, near the center of the device. Refer to Figure 4.a. Record the measurements

Figure 4 - Eccentricity Testing Patterns



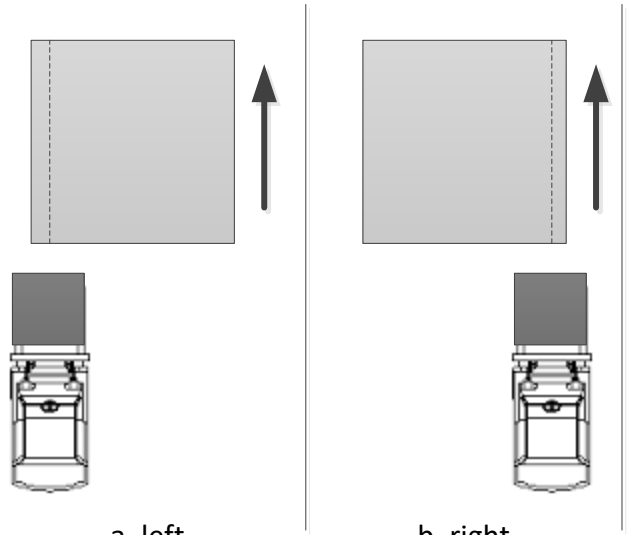
C. Repeat steps A and B for the three (3) remaining standards.
D. Repeats steps A to C but shifted to the left of the measurement area, Refer to Figure 4.b.
E. Repeats steps A to C but shifted to the right of the measurement area, Refer to Figure 4.c.
F. Repeats steps A to C but move from the left of the measurement area to the right, Refer to Figure 4.d.
G. Repeats steps A to C but move from the right of the measurement area to the left, Refer to Figure 4.e.
H. Perform steps A to G at the lowest, a middle speed, and the highest speed of the device.

2.13.3.2 Out of Bounds Test

The system measures objects as they pass through the marked area on the floor directly below the center of the unit. If an object passes outside of the marked area the system will perform the measurement and generate an error indicating that the object passed outside the marked area and the confidence parameter of the measurement record will be low. This test procedure verifies that the system will indicate an out of bounds error when an object travels outside the floor markings.

A. Ensure that the device is at zero or in the ready condition.
B. Pass four (4) standards in increasing sizes from the smallest to the largest in the transverse orientation through the DUT, outside the left boundary of the marked travel lane. Refer to Figure 5.a. Record the measurements

Figure 5 - Out of Bounds Travel Patterns



C. Repeat steps A and B for the three (3) remaining standards.
D. Repeat steps A to C but shifted to the right of the measurement area. Refer to Figure 5.b.

2.14 Variable Orientation Test

2.14.1 Application

This test ensures that the device is capable of measuring the same results when presented repeatedly with the same object but in different orientations.

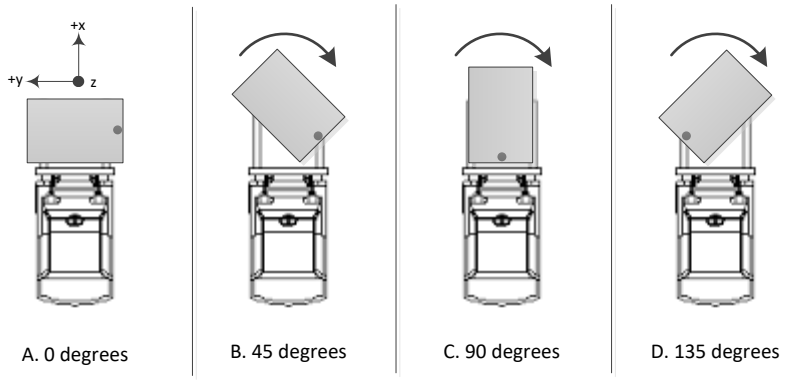
2.14.2 Purpose

The purpose of this test is to verify that the device provides the same measurements for an object when presented repeatedly with the object in different orientations.

2.14.3 Test Procedure

A. Ensure that the device is at zero or in the ready condition.
B. Select a standard where length ≠ width ≠ height and place it on the forklift in the longitudinal position (0°) with the "x" axis in the direction of travel. Refer to Figure 6.a. Drive the forklift through the DUT.

Figure 6 - Variable Orientation Test Positions



C. Observe and record the results
D. Repeat steps A to C for the same standard but rotated to the right with each of the following variations from the "x" axis; 45°, 90°, and 135°. Refer to Figure 6.b, c and d respectively. Observe the indications and record the measurements.
E. Turn the standard onto its side so that the "x" axis shown in Figure 6.a is now facing up in the "z" axis.
F. Repeat steps A to D and record results.
G. Replace the Cuboidal standard with an irregular standard and repeat steps A to F.

2.15 Measurement Speed Test

2.15.1 Application

This test ensures that the device will maintain the required levels of accuracy when an object passes through the device different speeds.

2.15.2 Purpose

The purpose of this test is to verify that the device report measurements within the stated accuracy when test objects are passed through the system at different speeds.

2.15.3 Test Procedure

2.15.3.1 Measurement Speed Test Procedure

Objects are measured when they pass through the system on a forklift moving at speeds between ? and ? mph. This test is performed near the minimum speed of the system, at medium speed and at high speed through the system. A forklift will carry standards of different sizes and shapes through the system.

A. Ensure that the device is at zero or ready condition.
B. Place a test standard on the forklift and pass the forklift through the DUT near the center of the measurement area with the forklift moving at the *highest speed* of the DUT.
C. Observe and record the results
D. Pass a standard or test object with a length equal to the **maximum length** capacity of the DUT through the measurement area and observe, and record the results.
E. Pass a standard or test object with a length equal to the **maximum width** capacity of the DUT through the measurement area and observe, and record the results.
F. Pass a standard or test object with a length equal to the **maximum height** capacity of the DUT through the measurement area and observe, and record the results.
G. Pass a standard or test object with a length equal to the **minimum length** capacity of the DUT through the measurement area and observe, and record the results.
H. Place a standard or test object with a length equal to the **minimum width** capacity of the DUT in the measurement area and observe, and record the results
I. Pass a standard or test object with a length equal to the **minimum height** capacity of the DUT through the measurement area and observe, and record the results.
J. Repeat steps B through I two (2) more times.
K. Repeat steps A through J with the forklift moving at *medium speed* through the DUT.
L. Repeat steps A through J with the forklift moving at the *slowest speed* through the DUT.

2.16 Minimum Spacing Test

2.16.1 Application

The test ensures that the device responds correctly when two or more forklifts follow each other through the device within the stated minimum spacing distance.

2.16.2 Purpose

The purpose of this test is to verify that the device reports measurements within the stated accuracy when test objects are passed through the system with two forklifts in quick succession.

2.16.3 Test Procedure

The minimum stated distance between forklifts is ?? feet.

A. Ensure that the device is at zero or ready condition.
B. Ensure that the test area is safe for two forklifts to travel through the system and stop safely.
C. Place a standard on each forlklift with the forks between ?-?? inches from the floor. Record the standards on each forklift on sheet
D. Pass the first forklift through the system followed by the second forklift through the measurement area with a spacing greater than the minimum forklift spacing distance and at a speed near the DUT's minimum speed.
E. Observe and record the measurements
F. Repeat steps C through E with the forklifts at the minimum spacing.
G. Repeat steps C through E with the forklifts at the minimum spacing with each driving along opposite sides of the measurement area.
H. Repeat steps B through G a the middle speed of the DUT.

2.17 Irregularly Shaped Objects Test

The system is capable of measuring non-cuboidal object. The following test procedures cylindrical, triangular and irregular objects.
At some speeds and certain orientations, test objects may become unstable. Portions of the test for which the standards are unstable should be skipped.

2.17.1 Variable Shape – Cylindrical Standards Test Procedure

2.17.1.1 Application

This test ensures that the system can measure cylindrical objects passing through the system on the forklift.

2.17.1.2 Purpose

The purpose of this test is to verify that cylindrical objects passing through the system at various speeds and different travel lane patterns (center, left and right).

2.17.1.3 Test Procedure

A. Ensure that the device is in the ready condition.
B. Select a cylindrical standard and place it on the forks of the forklift with the forks between ? – ?? inches above the floor. Record the standard's dimensions
C. Pass the standard through the DUT three (3) times at the system's high speed down the center of the travel lane. Record the measurements
D. Repeat steps B to C on the left side of the travel lane.
E. Repeat steps B to C on the right side of the travel lane.
F. Repeat steps C to E at the system's low speed and record the measurements
G. Repeat steps A to F for a second cylindrical standard.

2.17.2 Variable Shape - Triangular Prism Standards Test Procedure

2.17.2.1 Application

This test ensures that the system can measure an irregular prism shaped object passing through the system on the forklift.

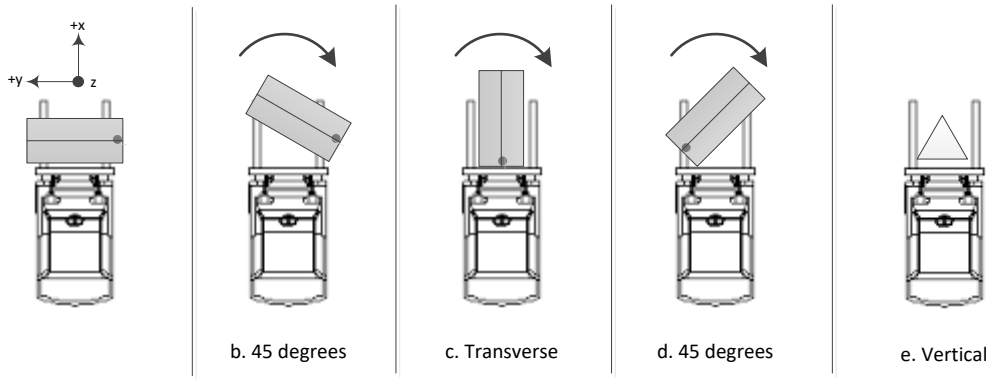
2.17.2.2 Purpose

The purpose of this test is to verify that triangular prism shaped objects passing through the system at various orientations and speeds are measured correctly by the system.

2.17.2.3 Test Procedure

A. Ensure the device is in a ready condition.
B. Place the triangular test object in the longitudinal orientation, as shown in Figure 7.a, on the forks of the forklift with the forks between ? – ?? inches above the floor and pass the forklift through the center of the DUT at the system's high speed.

Figure 7 - Triangular Test Object Placement



C. Observe the responses of the DUT and record the results
D. Rotate the test object 45° from the longitudinal orientation, as shown in Figure 7.b, and pass the forklift through the center of the DUT at the system's high speed.
E. Observe the responses of the DUT and record the results.
F. Measure the test object again with the test object in the transverse orientation, as shown in Figure 7.c. Observe the responses of the DUT and record the results.
G. Measure the test object once more with the test object positioned a further 45 degrees, as shown in Figure 7.d. Observe the responses of the DUT and record the results.
H. Put the test object in the vertical orientation and pass it through the center of the DUT, as shown in Figure 7.e. Observe the responses of the DUT and record the results
I. Repeat steps A through H for a second triangular standard.
J. Repeat Steps A through I at low speed and record results.

2.17.3 Variable Shape – Irregular Test Standards Test Procedure

2.17.3.1 Application

This test ensures that the system can measure an irregular irregularly shaped object passing through the system on the forklift.

2.17.3.2 Purpose

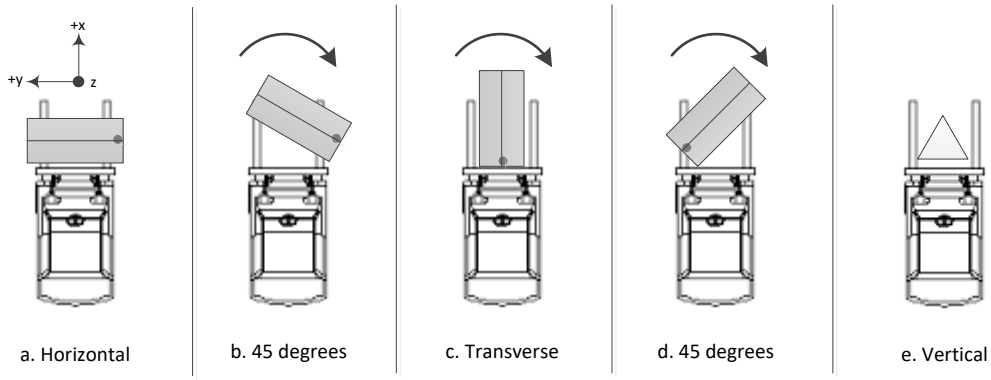
The purpose of this test is to verify that irregularly shaped objects passing through the system at various orientations and speeds are measured correctly by the system.

2.17.3.3 Test Procedure

K. Ensure the device is in a ready condition.

L. Place the irregularly shaped test object in the longitudinal orientation, as shown in Figure 7.a, on the forks of the forklift with the forks between ? – ?? inches above the floor and pass the forklift through the center of the DUT at the system's high speed.

Figure 8 - Irregular Test Object Placement



M. Observe the responses of the DUT and record the results.

N. Rotate the test object 45° from the longitudinal orientation, as shown in Figure 7.b, and pass the forklift through the center of the DUT at the system's high speed.

O. Observe the responses of the DUT and record the results.

P. Measure the test object again with the test object in the transverse orientation, as shown in Figure 7.c. Observe the responses of the DUT and record the results

Q. Measure the test object once more with the test object positioned a further 45 degrees, as shown in Figure 7.d. Observe the responses of the DUT and record the results

R. Put the test object in the vertical orientation and pass it through the center of the DUT, as shown in Figure 7.e. Observe the responses of the DUT and record the results.

S. Repeat steps A through H for a second triangular standard.

T. Repeat Steps A through I at low speed and record results on sheet 19.7

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2.18 Minimum and Maximum Measurement Capabilities

2.18.1 Application

This test ensures that when objects are smaller than the devices smallest measurable dimension or more than maximum measurable dimension plus 9d the system will properly identify the object.

2.18.2 Purpose

The purpose of this test is to verify that the device complies with object smaller than the smallest measurable object or larger than the largest measurable object plus 9d by either:

1) Not displaying or recording any usable values for that axis, or
2) Identify the display or recorded representation with and error indication for that axis.

2.18.3 Test Procedure

2.18.3.1 Minimum and Maximum Measurement Test Procedure

A. Ensure that the device is at zero or ready condition.
B. Place a standard on the forklift where the length measurement is equal to the DUT's maximum length plus nine (9) times the measuring division d for the length axis.
C. Pass the standard through the DUT. Observe and record the results
D. Repeat steps B and C for the width and height dimensions.
E. Repeat steps A to D with a standard where the dimension length is smaller than DUT's minimum dimension minus one (1) measuring division d for each axis.
F. Observe and record the results

2.19 Power Voltage

2.19.1 Application

This test ensures that the device is adequately protected against voltage variations.

2.19.2 Purpose

The purpose of this test is to validate that the device generates an error indication or measures objects within tolerance when the supply voltage fluctuates -15% to +10% of the nominal voltage.

2.19.3 Test Procedure

The power rating for the system is ??? volts AC at ?? amps. The DC testing test procedure will not be performed.

2.19.3.1 AC Voltage Variation Test Procedure

A. Stabilize the device at constant environmental conditions and record the following data:
    - Time
    - Temperature
    - Relative Humidity

- Power Supply Voltage
- Test Load
- Device Indications
- Device Errors

B. Ensure that the device is at zero or in the ready condition.
C. Select a standard or test object of the size dimensions equal to ½ to ¾ of the maximum capacity for each axis and place it on the forklift.
D. Reduce the power supply voltage for the DUT to 85% of nominal line voltage at 60Hz.
E. Record the device indication with and without the test object passing through the DUT.
F. Increase the power supply voltage for the DUT to 110% of nominal line voltage at 60Hz.
G. Record the device indication with and without the test object passing through the DUT.
H. Remove the load and reapply the nominal power supply voltage ((to within ± 2% of nominal line voltage) at 60 Hz to the DUT.
I. Record the device indication with and without the test object passing through the DUT.

Interpretation of Results
If all measurements are within tolerances or provide an error indication this test passes.

2.20 Influence Factor

2.20.1 Application
This test ensures that the device is capable of accurately measuring an object within tolerance when the device is subjected to temperature fluctuations.

2.20.2 Purpose
The purpose of this test is to verify that the device performs accurate measurements over the temperature range of the device by testing the device at a nominal temperature (approximately 20°C) and at the extreme ranges of the device (-10°C and 40°C).

2.20.3 Test Procedure

2.20.3.1 Influence Factor Test Procedure

Test Preparation
Test objects shall not be soaked with device. Leave the test objects outside of the chamber while not performing tests.
Do not exceed a temperature change rate of 1 °C/min. Take readings after each temperature variation.
Test Procedure

A. With the device powered on in the environmental chamber, stabilize the device at the nominal (approximately 20°C) test temperature for at least 2 hours.
B. Ensure that the DUT is at zero or in the ready condition.

C. Prior to the application of test objects, record:
    a. Time and Date
    b. Temperature
    c. Relative Humidity

D. Select a test standard with dimensions within the range of each axis listed on the device and place it on the forklift
E. Drive the forklift with the standard through the DUT. Record dimensions of test objects and any error indication.
F. Repeat step E three (3) more times
G. Repeat steps D through F three (3) more times with different test standards within the range of each axis listed on the device.
H. Repeat Steps A through G after the device has stabilized at the low test temperature (-10°C) for at least 2 hours.
I. Repeat Steps A through G after the device has stabilized at the high test temperature (40°C) for at least 2 hours.
J. Repeat Steps A through G after the device has stabilized at the nominal test temperature (approximately 20°C) for at least 2 hours.

Interpretation of Results
If all measurements are within applicable tolerance.