AFRICAN STANDARD

DARS 1373

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Vehicle Load Management - Equipment Verification - Static Scale Verification

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Introduction

The main goal of a Weigh Station is effective and efficient vehicle load management by way of accurate weighing results.

Accurate weighing results of both domestic road transport and international cross border road transport call for the verification of the Static Scale to be performed in a consistent manner to ensure reliable weigh results irrespective of the weigh station at which the Static Scale is installed.

This standard specifies the verification process to ensure the continuous effective and efficient overload control that conforms to legal requirements.

Vehicle Load Management - Equipment Verification - Static Scale Verification

1 Scope and application

1.1 Scope

This document:

- Gives specifications for the verification of a Static Scale installed at a Weigh Station, hereafter referred to as Static Scale.
- Specifies the verification masses to be used throughout this process.

1.2 Application

This document applies to Static Scales used at Weigh Stations.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ARS 1372-1: Vehicle Load Management – Accreditation – Part 1: Weigh Station Layout and Design

ARS 1372-2: Vehicle Load Management – Accreditation – Part 2: Vehicle Load Management Information System

OIML R 76-1: Non-automatic weighing instruments – Part 1 – Metrological and technical requirements - Tests

SANS 1697-2007: Verification standards for the verification of mass-measuring instruments, including commercial standard masspieces

3 Terms and definitions

For the purpose of this standard the following definitions and abbreviations apply.

3.1 Definitions

3.1.1
accuracy of a measurement
The degree to which a measured value can be equated to the true value or a value accepted as reference.

3.1.2
accuracy of a measurement instrument
The degree to which measurements from a specific measurement instrument can be equated to the true value or a value accepted as reference.

3.1.3
Accuracy
δ
Value used as a percentage to quantify the maximum allowed relative error.

3.1.4
accuracy range
The range of measurements acceptable for a specific Reference Value based on the Accuracy. [Reference Value – [(δ/100)*Reference Value), Reference Value + ((δ/100)*Reference Value)]

3.1.5
adjustment
An operation or change made to a measuring instrument to reduce the error of measurement.

3.1.6
axle
In relation to a vehicle, means a device or set of devices, whether continuous across the width of the vehicle or not, about which the wheels of the vehicle rotate and which is so placed that, when the vehicle is travelling straight ahead, the vertical centre lines of such wheels would be in one vertical plane at right angles to the longitudinal centre-line of such vehicle.

3.1.7
axle distance
The distance between the centres of two axles, parallel to the nominal direction of travel of the vehicle.

3.1.8
axle unit
In relation to a vehicle, means a set of two or more parallel axles of such vehicle which are so interconnected as to form a unit.

3.1.9
axle unit load
The sum of the wheel mass of all wheels on any axle unit.

3.1.10
axle load
The sum of the wheel mass of all wheels on any axle.

3.1.11
axle spacing
See axle distance.

3.1.12
Calibration
The process of comparing a measuring instrument against a traceable standard or another accepted reference and adjust the measuring instrument to reduce the error of measurements.

3.1.13
Change-over Point
CoP
The point (in kg) in the interval of a static scale where the scale changes from measuring the lower interval value to measuring the next, higher interval value. The Change-over point must be a value for which:

$$0.25 * e \leq CoP \leq 0.75 * e$$

where *e* is the scale interval.

3.1.14
confidence level
The chance that, in reality, the measurement errors of the system under test lie within the Accuracy Range [-δ,+δ]. The confidence level is used to qualify the reliability of the outcome of a test procedure.

3.1.15
error of measurement
The difference between the measured value and the true value or an accepted reference value for an individual measurement.

3.1.16
Gross Combination Mass
GCM
Maximum design mass of a combination of vehicles and their load as specified by the manufacturer of the drawing vehicle on the vehicle plate.

3.1.17
Gross Vehicle Mass
GVM
Maximum design mass of a vehicle and its load as specified by the manufacturer of the vehicle on the vehicle plate.

3.1.18
load sensor
A sensor installed in or under the road pavement measuring the dynamic force exerted by a vehicle on the road.

3.1.19
measurement error
Difference between the measured value and the accepted reference value.

3.1.20
operating ranges
Range between the minimum and maximum value of influence quantities where the system performs according to its specifications.

3.1.21
performance test
A test to determine whether a measurement instrument is capable of performing according to its specified functions.

3.1.22
precision
The variation in the measurement results when doing same measurement over and over again.

3.1.23
rated operating conditions
Conditions of use which give the ranges of the influence quantities for which the performance of the system lies within the specifications.

3.1.24
reference conditions
Conditions of use prescribed for testing the performance of a measuring instrument or for inter-comparison of measurements.

3.1.25
relative measurement error
Error of measurement divided by the accepted reference value.

3.1.26
resolution
Smallest value of the Scale Interval that a measuring instrument is capable of discriminating.

3.1.27
scale interval
e
The difference between two consecutive values indicated by a measurement instrument.

3.1.28
sensor
Part of a measuring instrument that is directly affected by the parameter to be measured and produces a related signal.

3.1.29
standard deviation
σ
The measure of the distribution of data about a mean value. It describes the dispersion (spread) of data on either side of a mean value.

3.1.30
scale deck
An indivisible surface of the Static Scale to which force is applied and measured by Load Cells.

3.1.31
static scale
A weighing instrument which measures the mass of a stationary vehicle by measuring the force applied to the scale deck or scale decks by the tyres of the vehicle.

3.1.32
static weighing
Weighing of a vehicle while that vehicle is stationary relative to the scale.

3.1.33
total vehicle mass
The total mass of a vehicle or combination of vehicles in kg, measured as the sum of the loads on all the wheels of the vehicle that are in contact with the road surface.

3.1.34
validity of measurement
An indication of confidence in the quality of a measurement determined by a WIM-system itself intended to filter measurement that were disturbed by external factors such as driver behaviour.

3.1.35
vehicle class
Group of vehicles with the same characteristics like number of axles, number of axle units, vehicle length, etc.

3.1.36
vehicle length
See Wheel Base.

3.1.37
Vehicle Load Management Information System
VLMIS
The computerised information system contemplated in ARS 1372-2: Vehicle Load Management – Accreditation – Part 2: Vehicle Load Management Information System.

3.1.38
verification
The process of comparing a measuring instrument against a traceable standard or another accepted reference.

3.1.39
weighing range
Range between the minimum and maximum value of the measured variable where the system performance according to its specifications.

3.1.40
wheel base
The distance between the centres of the first and last axle of a vehicle.

3.1.41
wheel load
The portion of the gross mass imposed upon a weighing instrument by the tyre(s) of a stationary wheel at the time of weighing, due only to the vertical downward force of gravity acting on the mass of the vehicle.

3.2 Abbreviations

HSWIM	high speed weigh in motion
kg	kilogram
m	metre
N	newton

4 Verification Procedure

4.1 Introduction

The procedure for Static Scale verification as described below shall be conducted by a verification agent with cooperation of the vendor, or by their authorised representatives. It requires different pre-weighed masspieces to be placed on the scale as indicated with each test.

4.2 Frequency of verification

The verification procedure shall be applied immediately after the initial installation of a Static Scale system. It shall be applied again when a system is reinstalled or whenever site conditions or Static Scale system components (including software and settings) have changed significantly. If site conditions or system components do not change significantly, Verification shall be performed so that 12 calendar months do not pass without verification being applied.

Where large inaccuracies are observed when the Static Scale is calibrated after the initial installation or reinstallation, likely due to high traffic volumes or other environmental factors, the next verification may be scheduled sooner than 6 months.

4.3 Verification Masspieces

Standard masspieces used for the performance of the prescribed tests shall be calibrated in compliance with and be covered by a certificate indicating traceability to SANS 1697-2007 or a corresponding National Standard for Standard Masspieces [1]. The maximum permissible tolerance, positive or negative, including uncertainty of measurement of masspieces shall not exceed 0.01% of their nominal value.

[1] A National Standard for Standard Masspieces similar to SANS 1697-2007 may alternatively be complied with.

4.4 Procedure

Before starting with the verification of the static scale, clarify and prepare the following:

1. Determine the technical characteristics of the static scale (max mass, scale interval) and the accuracy requirement (max error allowed and uncertainty)
2. Typically, the whole measurement range is verified and the verification is performed in the location where the instrument is being used. Make sure you have enough masspieces available for the verification procedure.
3. The Static Scale should be switched on at least 30 minutes before the verification. The temperature of the masspieces should be stabilized to the same temperature where the verification is to be done.

In case the Static Scale fails in verification and it needs to be adjusted, make an “as found” Static Scale Verification Field Sheet in conformance with Annex B. An informative completed example is included in 0.

A Verification Certificate in conformance with Annex A shall be issued upon confirmation that the Static Scale passed all the required tests.

In the application of this procedure for purposes of calibration prior to verification, the system must be re-adjusted by the authorised calibration agent and all tests shall be performed after the adjustment. The calibration testing shall continue until the Static Scale passes all tests.

The verification of a Static Scale will be divided into 6 different tests, each to be completed as specified.

4.4.1 Test 1: True Zero Verification

The initial verification test shall be performed without any masspieces in order to verify the true zero value.

1. Empty the Static Scale; and
2. Confirm the value to zero.

4.4.2 Test 2: Change-over Point Test

The change-over point test is done to insure that the change-over point for the Static Scale is within the defined limits:

$$0.25 * e \ \leq CoP \ \leq 0.75 * e$$

1. Ensure the scale is zeroed and ready for use;
2. Place 40kg on a Scale Deck;
3. Add 2kg to that deck and read the scale measurement;
4. Repeat step 3 until the scale measurement reads 60kg;
5. Record the mass added in addition to the 40kg as the change-over point for that deck;
6. Repeat steps 1 to 5 for all Scale Decks;
7. Ensure every recorded Change-over point is within the limits defined for a change-over point.

In the application of this procedure for purposes of calibration prior to verification and any change-over point is not within the limits, adjustments must be made by the authorised calibration agent and the test repeated until all change-over points are within the defined limits.

4.4.3 Test 3: Load cell Eccentricity (Corner) Measurement

Load cells in a Static Scale may produce unequal outputs, which leads to a corner error and possible error for the load. For the load cell eccentricity test, the load placed on the Deck Surface shall be calculated as follows:

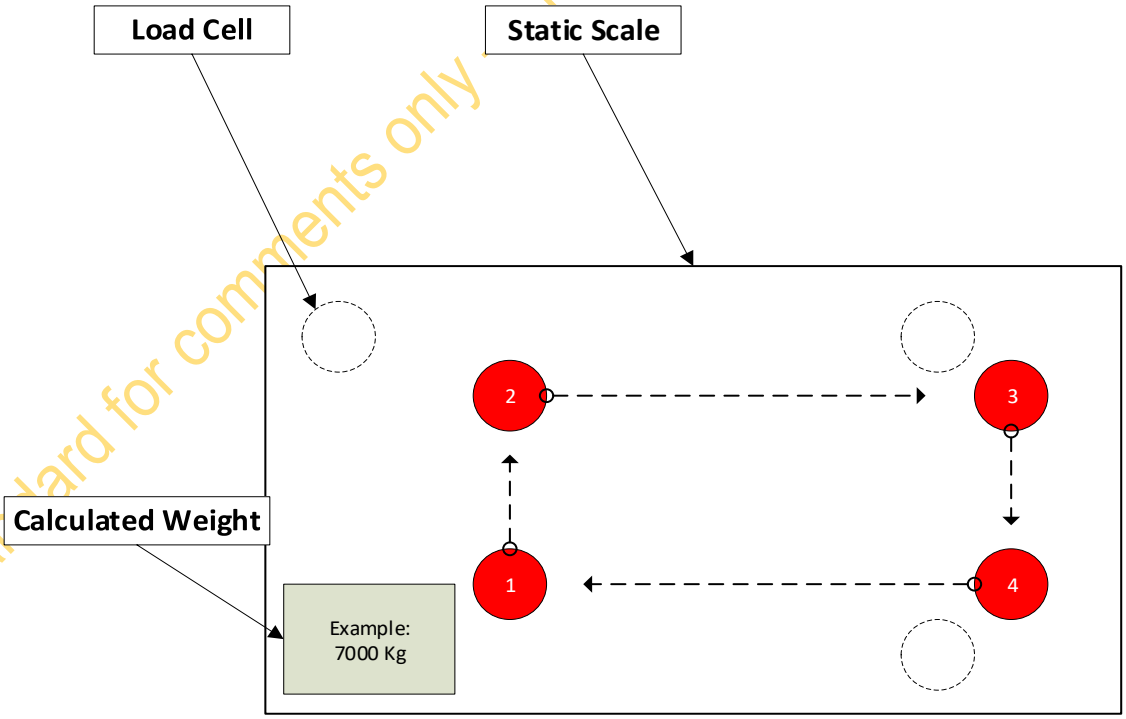
$$Load\ Cell\ Weight = \left[\frac{Scale\ Deck\ Load\ Capacity}{Number\ of\ Load\ Cells - 1}\right]$$

$$Surface\ Area = \left[\frac{Scale\ Deck\ Surface\ Area}{Number\ of\ Load\ Cells}\right]$$

1. Verify that the Static Scale is zeroed;
2. Place the masspieces on the first load cell corner;
3. Verify that the Static Scale mass matches the mass added to that corner;
4. Repeat for all the load cells;
5. Every corner should be verified ensuring that all measurements fall within the Accuracy Range.

In the application of this procedure for purposes of calibration prior to verification, adjustments must be made by the authorised calibration agent and every corner must be verified again before concluding the test.

Example for a deck with a load capacity of 28 tons and 4 load cells:



4.4.4 Test 4: Range Test

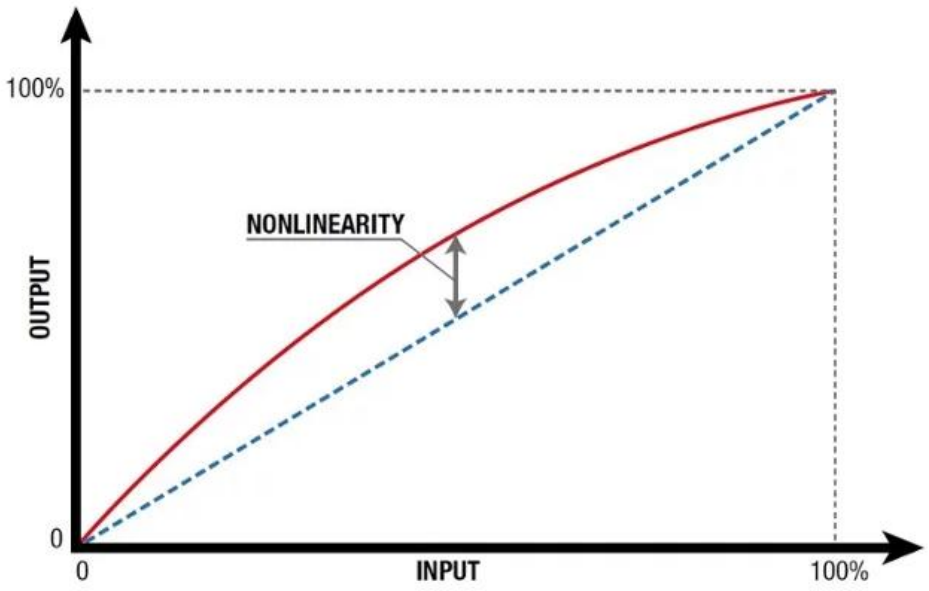
The range test consists of Static Scale verification with the maximum known/ verified mass. For verification, use at least 90% of the Total capacity of a Scale Deck of the Static Scale. Make up mass can be used for testing to higher ranges.

1. Ensure each Scale Deck is zeroed and ready for use;
2. Place the masspieces in the middle of the Scale Deck to be verified;
3. Repeat this process for all the Scale Decks of the Static Scale, ensuring all measurements are within the Accuracy Range.

4.4.5 Test 5: Linearity Test

In a linearity test, using multiple points through the entire measurement range of the Static Scale helps to reveal any inconsistency in measurements. Linearity anomalies imply that the Static Scale does not measure equally accurate throughout the range. Even if the zero and full span are correct, there may be errors in the middle of the range, which is referred as linearity errors, or non-linearity.

The below picture is a general illustration of non-linearity. The Static Scale zero and full range is adjusted correctly, however there is an error in the midrange due to non-linearity of the Static Scale:



1. Select 5 test loads, each at 20%, 40%, 60%, 80%, and 100% of the Scale Deck capacity;
2. Verify that the Static Scale is zeroed;
3. Add a test load to a Scale Deck of the Static Scale;
4. Record the readings;
5. Repeat steps 3 and 4 until all masspieces are on the Scale Deck and the readings are recorded;
6. Identify non-linear measurements;
7. Repeat steps 1 to 6 for every Scale Deck of the Static Scale.

In the application of this procedure for purposes of calibration prior to verification, adjustments are made to the Scale Deck by the authorised calibration agent and the process is repeated until all measurements are linear and in the Accuracy Range.

4.4.6 Test 6: Repeatability Test

The repeatability test is performed to ensure the repeatability of the Static Scale by ensuring that the same mass is displayed at all times when applying a given verified load in any direction.

1. Verify that the Static Scale is zeroed;
2. Place the mass pieces (not less than half of the capacity of the Scale Deck) on each Scale Deck of the Static Scale, record the readings, and remove the mass pieces;
3. Drive a vehicle with a tare of at least 5 tons and loaded with a non-shifting mass to at least 90% of its respective registered GVM over the Scale Deck from left to right, and then from right to left;
4. Repeat steps 1 to 3 an additional 4 (four) times;
5. Repeat steps 1 to 4 for every Scale Deck of the Static Scale.

Annex A
(normative)

Format for Verification Certificate

Verification Certificate

Verification performed in compliance with ARS 1373
Vehicle Static Scale for use by Weigh Station Road Traffic Authorities

Certificate Number:			
Verification Agent:			
Address:			
Owner of Static Scale:			
Location of Static Scale:			
Details of Static Scale			
Manufacturer:		Model:	
Serial Number:		Scale Decks:	
Maximum Capacity (kg):		Measurement Interval:	
Traceability of Standard Masspieces			
Certificate Number(s):		Date(s) of Calibration:	
Identification of Masspieces Used:			

I hereby certify that the above Static Scale conforms to the verification requirements as set out in ARS 1373, all tests as shown on the Verification Field Sheet attached.

Date:		Time:	
Name of Verification Officer:			
Signature of Verification Officer:			
Verification Seal Identification Number:			

Annex B
(normative)

Static Scale Verification Field Sheet

Static Scale Verification Field Sheet

Verification performed in compliance with ARS 1373

Test Conditions and Variables

Static Scale			
Scale Interval		Accuracy	

Test 1: True Zero Verification

As Left Measurement			
Static Scale clear (Yes/No)		Scale measurement	

Test 2: Change-over Point

As Left Measurement			
Deck 1 Change-over Point		Deck 3 Change-over Point	
Deck 2 Change-over Point		Deck 4 Change-over Point	

Test 3: Load Cell Eccentricity Test

Mass			
Load Cell Mass		Mass Used	

As Left Measurements			
Scale Deck 1			
Corner 1 Measurement		Corner 3 Measurement	
Corner 2 Measurement		Corner 4 Measurement	
Scale Deck 2			
Corner 1 Measurement		Corner 3 Measurement	
Corner 2 Measurement		Corner 4 Measurement	
Scale Deck 3			
Corner 1 Measurement		Corner 3 Measurement	
Corner 2 Measurement		Corner 4 Measurement	
Scale Deck 4			
Corner 1 Measurement		Corner 3 Measurement	
Corner 2 Measurement		Corner 4 Measurement	

Test 4: Range Test

Mass			
90% of Static Scale Capacity		Mass Used	

As Left Measurements			
Scale Deck 1 Measurement		Scale Deck 3 Measurement	
Scale Deck 2 Measurement		Scale Deck 4 Measurement	

Test 5: Linearity Test

Mass			
Test Mass 1		Test Mass 4	
Test Mass 2		Test Mass 5	
Test Mass 3			

Scale Deck 1			
As Left Measurements			
Test 1		Test 4	
Test 2		Test 5	
Test 3			

Scale Deck 2			
As Left Measurements			
Test 1		Test 4	
Test 2		Test 5	
Test 3			

Scale Deck 3			
As Left Measurements			
Test 1		Test 4	
Test 2		Test 5	
Test 3			

Scale Deck 4			
As Left Measurements			
Test 1		Test 4	
Test 2		Test 5	
Test 3			

Test 6: Repeatability Test

Mass	
Mass Used	

Scale Deck 1			
As Left Measurements			
Test 1		Test 4	
Test 2		Test 5	
Test 3			

Scale Deck 2			
As Left Measurements			
Test 1		Test 4	
Test 2		Test 5	
Test 3			

Scale Deck 3			
As Left Measurements			
Test 1		Test 4	
Test 2		Test 5	
Test 3			

Scale Deck 4			
As Left Measurements			
Test 1		Test 4	
Test 2		Test 5	
Test 3			

Annex C
(informative)

Example of a Completed Static Scale Verification Field Sheet

Static Scale Verification Field Sheet

Verification performed in compliance with ARS 1373

Test Conditions and Variables

Static Scale			
Scale Interval	20 kg	Accuracy	1

Test 1: True Zero Verification

As Left Measurement			
Static Scale clear (Yes/No)	Yes	Scale measurement	0 kg

Test 2: Change-over Point

As Left Measurement			
Deck 1 Change-over Point	6 kg	Deck 3 Change-over Point	8 kg
Deck 2 Change-over Point	8 kg	Deck 4 Change-over Point	10 kg

Test 3: Load Cell Eccentricity Test

Mass			
Load Cell Mass	10 000 kg	Mass Used	10 000 kg [a]

As Left Measurements			
Scale Deck 1			
Corner 1 Measurement	10 020 kg	Corner 3 Measurement	10 080 kg
Corner 2 Measurement	9 980 kg	Corner 4 Measurement	9 960 kg
Scale Deck 2			
Corner 1 Measurement	9 980 kg	Corner 3 Measurement	9 920 kg
Corner 2 Measurement	10 060 kg	Corner 4 Measurement	10 060 kg
Scale Deck 3			
Corner 1 Measurement	9 980 kg	Corner 3 Measurement	10 040 kg
Corner 2 Measurement	10 000 kg	Corner 4 Measurement	9 960 kg
Scale Deck 4			
Corner 1 Measurement	10 040 kg	Corner 3 Measurement	9 980 kg
Corner 2 Measurement	10 020 kg	Corner 4 Measurement	10 020 kg

[a] Accuracy Range: [10 000 kg - (10 000 kg*1%), 10 000 kg + (10 000 kg*1%)] = [9 900 kg, 10 100 kg]

Test 4: Range Test

Mass			
90% of Static Scale Capacity	36 000 kg	Mass Used	38 000 kg

As Left Measurements			
Scale Deck 1 Measurement	37 720 kg	Scale Deck 3 Measurement	38 020 kg
Scale Deck 2 Measurement	38 040 kg	Scale Deck 4 Measurement	37 940 kg

Test 5: Linearity Test

Mass			
Test Mass 1	8 000 kg	Test Mass 4	32 000 kg
Test Mass 2	16 000 kg	Test Mass 5	40 000 kg
Test Mass 3	24 000 kg		

Scale Deck 1			
As Left Measurements			
Test 1	7 980 kg	Test 4	31 960 kg
Test 2	16 020 kg	Test 5	39 940 kg
Test 3	24 040 kg		

Scale Deck 2			
As Left Measurements			
Test 1	8 020 kg	Test 4	31 980 kg
Test 2	16 080 kg	Test 5	40 040 kg
Test 3	24 020 kg		

Scale Deck 3			
As Left Measurements			
Test 1	8 040 kg	Test 4	32 060 kg
Test 2	15 980 kg	Test 5	40 120 kg
Test 3	24 060 kg		

Scale Deck 4			
As Left Measurements			
Test 1	8 020 kg	Test 4	31 920 kg
Test 2	16 040 kg	Test 5	39 900 kg
Test 3	24 040 kg		

Test 6: Repeatability Test

Mass	
Mass Used	20 000 kg

Scale Deck 1			
As Left Measurements			
Test 1	20 020 kg	Test 4	20 020 kg
Test 2	20 020 kg	Test 5	20 000 kg
Test 3	20 040 kg		

Scale Deck 2			
As Left Measurements			
Test 1	19 980 kg	Test 4	20 020 kg
Test 2	20 000 kg	Test 5	19 980 kg
Test 3	19 960 kg		

Scale Deck 3			
As Left Measurements			
Test 1	20 020 kg	Test 4	19 980 kg
Test 2	20 020 kg	Test 5	20 000 kg
Test 3	20 000 kg		

Scale Deck 4			
As Left Measurements			
Test 1	20 040 kg	Test 4	20 020 kg
Test 2	20 020 kg	Test 5	20 040 kg
Test 3	19 960 kg		

Bibliography

TRS-007, Standard Design Specification and Technical Requirements of a Weigh Station, *Version 002 or later*, www.tttfp.org

URS-007, Standard Specification for a Vehicle Load Management Information System, *Version 004 or later*, www.tttfp.org