OIML TC9/SC2 - Automatic Weighing Instruments

Fifth Committee Draft Recommendation

Automatic instruments for weighing road vehicles in motion

July 2004

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ANNEX A (MANDATORY)

TEST PROCEDURES FOR AUTOMATIC INSTRUMENTS FOR WEIGHING ROAD VEHICLES IN MOTION

FOREWORD

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Bureau Internationale de Métrologie Légale
11, rue Turgot - 75009 Paris - France
Telephone: +33 1 48 78 12 82 and 42 85 27 11
Fax: +33 1 42 82 17 27
E-mail: biml@oiml.org
Internet: http://www.oiml.org

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This publication was developed by the OIML working group TC9/SC2 "Automatic Weighing instruments" - UK secretariat.

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TERMINOLOGY

The terminology used in this Recommendation conforms to the *International Vocabulary of Basic and General Terms in Metrology* (VIM - 1993 edition) and to the *International Vocabulary of Legal Metrology* (VIML - 2000 edition). In addition, for the purposes of this Recommendation, the following definitions apply.

T.1 GENERAL DEFINITIONS

T.1.1 Mass

A physical quantity the base unit of which is the kilogram.

T.1.2 Weight

The quantity representing the total vertical downward force that results from the effect of gravity acting on the mass of a vehicle; the product of the mass and the local acceleration due to gravity.

T.1.3 Load

The quantity representing a portion of the total mass of the vehicle due only to the vertically-downward force of gravity as exerted via a wheel, single axle or group of axles.

T.1.4 Weighing

The process of determining the mass of a vehicle or a portion thereof.

T.1.5 Weighing instrument

Measuring instrument used to determine the mass of a vehicle by using the action of gravity on this vehicle.

The weighing instrument may also be used to determine other mass-related quantities, magnitudes, parameters or characteristics.

According to its method of operation, a weighing instrument is classified as an automatic or non-automatic instrument.

T.1.6 Automatic weighing instrument

An instrument that determines the mass of an object without the intervention of an operator and follows a predetermined program of automatic processes characteristic of the instrument.

T.1.7 Automatic instrument for weighing road vehicles in motion

An automatic weighing instrument having a load receptor, inclusive of aprons, that determines the axle loads (T.3.1.9) and total mass of the vehicle (3.1.13) by weighing (T.1.4) the road vehicle in motion.

T.1.8 Control instrument

A weighing instrument used to determine the total mass of a reference vehicle or a static reference single-axle load.

Control instruments used as a reference during testing may be:

- separate from the instrument being tested or,
- integral, provides a static weighing mode when the instrument is being tested.

T.1.9 Conventional true value (of a quantity)

A value attributed to a particular quantity (e.g., axle load or total mass of a reference vehicle) and accepted, by convention, as having an uncertainty appropriate for a given purpose. [VIM 1.20]

T.1.10 Metrological authority

An authorised representative of the national service of legal metrology, a verification organisation or a manufacturer responsible for ascertaining and confirming that the instrument entirely satisfies the requirements of this Recommendation.

T.2 CONSTRUCTION

Note: In this Recommendation the term "device" is applied to any part which uses any means to perform one or more specific functions.

T.2.1 Controlled weighing area

A place specified for the operation of instruments for weighing road vehicles in motion which is in conformity with the installation requirements given in Annex B.

T.2.2 Weigh zone

Zone comprising the load receptor(s) with an apron on both ends.

T.2.2.1 Apron

Part of the weigh zone that is not the load receptor but which is located on either end of the load receptor.

T.2.3 Load receptor

The part of the weigh zone which receives the wheel load(s) of a vehicle and which realises a change in the balance of the instrument when a wheel load is placed upon it.

T.2.3.1 Single load receptor

A load receptor that can support all the wheels of a vehicle simultaneously for full-draught weighing or wheels on an axle or an axle-group sequentially for axle and axle-group partial weighing, or the wheel(s) on one end of an axle for axle partial weighing.

T.2.3.2 Multiple load receptors

An array of several load receptors mounted at specific spacings in the nominal direction of travel of the vehicle to receive the wheel loads on all axles of a vehicle simultaneously for full-draught weighing or sequentially for repeated partial weighing.

T.2.4 Electronic instrument

An instrument equipped with electronic devices.

T.2.4.1 Electronic device

A device comprised of electronic sub-assemblies and performing a specific function. An electronic device is usually manufactured as a separate unit and may be capable of being independently tested.

T.2.4.2 Electronic sub-assembly

A part of an electronic device comprised of electronic components and having a recognisable function of its own.

T.2.4.3 Electronic component

The smallest physical entity that uses electron or hole conduction in semiconductors, gases, or in a vacuum.

T.2.5 Module

Identifiable part of an instrument that performs a specific function or functions, and that can be separately evaluated according to the metrological and technical performance requirements in the relevant Recommendation. The modules of a weighing instrument are subject to specified partial error limits.

Note: Typical modules of a weighing instrument are: load cell, indicator, data processing device, weighing module.

T.2.5.1 Indicating device

The part of the instrument that displays the value of a weighing result in units of mass and other related values e.g., speed.

T.2.5.2 Printing device

The means to print the values determined by an automatic instrument for weighing road vehicles in motion.

T.2.5.3 Load cell

Force transducer which, after taking into account the effects of the acceleration of gravity and air buoyancy at the location of its use, measures mass by converting the measured quantity (mass) into another measured quantity (output) [OIML R60].

T.2.6 Ancillary devices

T.2.6.1 Zero-setting device

The means used to set to zero the weight indicating device when the load receptor is empty.

T.2.6.2 Non-automatic zero-setting device

A zero-setting device that must be operated manually.

T.2.6.3 Semi-automatic zero-setting device

A zero-setting device that operates automatically following a manual command.

T.2.6.4 Automatic zero-setting device

A zero-setting device that operates automatically and without the intervention of an operator.

T.2.6.5 Zero-tracking device

A device for maintaining the zero indication within certain limits automatically.

T.3 METROLOGICAL CHARACTERISTICS

T.3.1 Weighing

T.3.1.1 Full-draught weighing

Determining the mass of a vehicle that is entirely supported on the load receptor(s).

T.3.1.2 Partial weighing

Weighing a vehicle in two or more parts successively on the same load receptors.

T.3.1.3 Weighing-in-motion (WIM)

The process of determining the total mass or the axle loads of a moving vehicle by measurement and analysis of the dynamic vehicle tyre forces.

T.3.1.4 Static weighing

Weighing vehicles or test loads that are stationary.

T.3.1.5 Dynamic vehicle tyre force

The component of the time-varying force applied perpendicularly to the road surface by the tyre(s) on a wheel of a moving vehicle. In addition to the action of gravity, this force can also include dynamic effects of other influences on the moving vehicle.

T.3.1.6 Tyre load

The portion of the total mass of the vehicle imposed upon the static tyre at the time of weighing, expressed in the units of mass, due only to the vertically-downward force of gravity acting on the total mass of the static vehicle.

T.3.1.7 Axle

An axle comprises two or more wheel assemblies with centres of rotation lying approximately on a common axis extending the full width of the vehicle and oriented transversely to the nominal direction of travel of the vehicle.

T.3.1.8 Axle group

The number of axles included in a defined group and their respective interspaces (or axle spacing).

Note: The criteria for defining various axle-groups may be set by national prescriptions.

T.3.1.9 Wheel load

The sum of the tyre loads on all tyres included in the wheel assembly on one end of an axle; a wheel assembly may have a single tyre or dual tyres.

T.3.1.10 Axle load

The sum of the wheel loads on all wheels of an axle; a portion of the total mass of the vehicle imposed on the static axle from the effect of gravity at the time of weighing.

T.3.1.11 Single-axle load

Axle load which is not part of an axle-group load. For the purposes of this Recommendation, if no criteria for defining various axle-groups have been specified (T.3.1.12), all recorded axle loads (6.9) shall be considered as single-axle loads.

T.3.1.12 Static reference single-axle load

A single-axle load of known conventional true value determined statically (T.6.1) with a two-axle rigid vehicle.

T.3.1.13 Axle-group load

The sum of all axle loads in a defined group of adjacent axles; a portion of the total mass of the vehicle imposed on the static axle-group from the effect of gravity at the time of weighing.

Note: The criteria for defining various axle-groups may be set by national prescriptions.

T.3.1.14 Total mass of the vehicle

The total mass of the vehicle or the vehicle combination including all connected components.

T.3.2 Capacity

T.3.2.1 Maximum capacity (Max)

The largest load that an instrument is designed to weigh-in-motion without totalising.

T.3.2.2 Minimum capacity (Min)

The load below which a weighing-in-motion result before totalising may be subject to an excessive relative error.

T.3.2.3 Weighing range

The range between the minimum and maximum capacities.

T.3.3 Scale interval (*d*)

A value expressed in units of mass for weighing-in-motion that is the difference between two consecutive indicated or printed values.

T.3.3.1 Scale interval for stationary load

A value expressed in units of mass for weighing vehicles or test loads that are stationary that is the difference between two consecutive indicated or printed values.

T.3.4 Speed

T.3.4.1 Maximum operating speed (v_{max})

The greatest velocity of a vehicle that the instrument is designed to weigh-in-motion and above which the weighing results may be subject to an excessive relative error.

T.3.4.2 Minimum operating speed (v_{min})

The lowest velocity of a vehicle that the instrument is designed to weigh-in-motion and below which the weighing results may be subject to an excessive relative error.

T.3.4.3 Range of operating speeds

The set of values between the minimum and maximum operating speeds at which a vehicle may be weighed-in-motion.

T.3.4.4 Maximum transit speed

The maximum speed that a vehicle can travel on the weigh zone without producing a shift in the performance characteristics of a weighing instrument beyond those specified.

T.3.5 Warm-up time

The time between the moment that power is applied to an instrument and the moment at which the instrument is capable of complying with the requirements.

T.3.6 Durability

Ability of an instrument to maintain its performance characteristics over a period of use.

T.3.7 Final weighing value

Weighing value which is achieved if the instrument is completely in rest and balanced and there are no environmental influences or disturbances taking effect on the indication.

T.3.8 Stable equilibrium

The situation of the instrument in which the indication of the weighing result is sufficiently close to the final weighing value.

T.3.9 Discrimination

Ability of an instrument to react to small variations of load. The discrimination threshold, for a given load, is the value of the smallest additional load that, when gently deposited on or removed from the load receptor, causes a perceptible change in the indication.

T.4 INDICATIONS AND ERRORS

T.4.1 Digital indication

An indication in which the scale marks are a sequence of aligned figures that do not permit interpolation to a fraction of the scale interval.

T.4.2 Errors

T.4.2.1 Error (of indication)

The indication of an instrument minus the (conventional) true value of the mass. [VIM 5.20]

T.4.2.2 Intrinsic error

The error of an instrument determined under reference conditions. [VIM 5.24]

T.4.2.3 Initial intrinsic error

The intrinsic error of an instrument as determined prior to performance tests and durability evaluations.

T.4.2.4 Maximum permissible errors (MPE)

Extreme values of an error permitted by specifications or regulations between the indication of a weighing instrument and the corresponding true value, as determined by reference standard mass, at zero or no load, in the reference position. [VIM 5.21]

T.4.2.5 Maximum permissible deviation (MPD)

Maximum permissible deviation of any single-axle load, or if applicable, any axle-group load from the respective corrected mean of the single-axle load or the axle group load.

T.4.2.6 Fault

The difference between the error of indication and the intrinsic error of a weighing instrument.

Principally, a fault is the result of an undesired change of data contained in or flowing through an electronic instrument. In this Recommendation a "fault" is a numerical value.

T.4.2.7 Significant fault

A fault greater than 1 *d*.

The following are not considered to be significant faults:

- faults that result from simultaneous and mutually independent causes in the instrument or in its checking facility,
- faults that make it impossible to perform any measurement,
- transitory faults that are momentary variations in the indications which cannot be interpreted, memorised or transmitted as a measurement result,
- faults that are so serious that they will inevitably be noticed by those interested in the measurement.

T.4.2.8 Span stability

The capability of an instrument to maintain the difference between the indication of weight at maximum capacity and the indication at zero within specified limits over a period of use.

T.4.2.9 Rounding error

The difference between a digital measurement result (indicated or printed) and the value of that measurement result with an analogue indication.

T.4.2.10 Repeatability error (R)

The closeness of the agreement between the results of the difference between the highest and lowest successive measurements carried out under the same conditions of measurement.

Note: Repeatability conditions include:

- the same measurement procedure
- the same operator
- the same measuring instrument, used under the same conditions
- the same location
- repetition over a short period of time

Repeatability may be expressed quantitatively in terms of the dispersion characteristics of the results. [VIM 3.6]

T.4.2.11 Corrected result (mean axle and axle-group load)

Result of a measurement after algebraic correction for systematic error. [VIM 3.4]

T.5 INFLUENCES AND REFERENCE CONDITIONS

T.5.1 Influence quantity

A quantity that is not the measurand but that affects the result of the measurement.

T.5.1.1 Influence factor

An influence quantity having a value within the specified rated operating conditions of the instrument.

T.5.1.2 Disturbance

An influence quantity having a value that falls within the limits specified in this International Recommendation but that falls outside the rated operating conditions of the instrument.

T.5.2 Rated operating conditions

Conditions of use which give the ranges of the influence quantities for which the metrological characteristics are intended to lie within the specified maximum permissible errors.

T.5.3 Reference conditions

Conditions of use prescribed for testing the performance of a measuring instrument or for intercomparison of results of measurements.

Note: The reference conditions generally include reference values or reference ranges for influence quantities affecting the measuring instrument. [VIM 5.7]

T.6 TESTS

T.6.1 Static test

A test with standard weights or a load that remains stationary on the load receptor to determine an error.

T.6.2 In-motion test

A test with reference vehicles that are in motion on the load receptor to determine an error or deviation.

T.6.3 Simulation test

A test carried out on a complete instrument or part of an instrument in which any part of the weighing operation is simulated.

T.6.4 Performance test

A test to verify that the equipment under test (EUT) is capable of accomplishing its specified functions.

T.7 VEHICLES

T.7.1 Vehicle

A loaded or unloaded road vehicle that is recognised by the instrument as a vehicle to be weighed.

T.7.2 Rigid vehicle

A vehicle with two axles fixed firmly along the length of the vehicle and oriented perpendicularly to the normal direction of the vehicle.

T.7.3 Reference vehicle

Vehicles of known conventional true value (T.1.9) of:

- total mass and single-axle load of a two-axle rigid vehicle and
- total mass of other vehicles used for in-motion tests (6.5)

determined on a control instrument (T.1.8)

AUTOMATIC INSTRUMENTS FOR WEIGHING ROAD VEHICLES IN MOTION

1 GENERAL

1.1 Scope

This International Recommendation specifies the requirements and test methods for automatic instruments for weighing road vehicles in motion, hereinafter referred to as "WIM instruments", that are used to determine the axle loads and total mass of road vehicles when the vehicles are weighed in motion.

It provides standardised requirements and test procedures to evaluate the metrological and technical characteristics of such instruments in a uniform and traceable way.

1.2 Application

This Recommendation applies to WIM instruments:

- which are used for determining the total mass of a moving vehicle and
- which may be used for determining the loads of single axles or defined groups of axles and indicating such loads for specified accuracy classes.

In addition, this Recommendation applies only to instruments:

- which are installed in a controlled weighing area and
- for which the operating speed range has been specified by the manufacturer.

In this Recommendation, WIM instruments which, in normal use, could be operated in a non-automatic (static weighing) mode shall also comply with the relevant requirements of OIML R76 «Non-automatic weighing instruments».

This Recommendation does not apply to WIM instruments that:

- are installed directly into or onto a normal road surface,
- determine individual axle loads by multiplying a single wheel load of an axle by two
- are mounted on-board of vehicles to measure axle load.

1.3 Terminology

The terminology given in the terminology section shall be considered as part of this Recommendation.

2 METROLOGICAL REQUIREMENTS

2.1 Accuracy classes

2.1.1 Single-axle load and axle-group load

For determining single-axle load and, if required axle-group load, WIM instruments are divided into six accuracy classes as shown below:

A B C D E F

Notes:

(1) WIM instruments may have different accuracy classes for single-axle load and axle-group load.

(2) The limitation of accuracy classes to certain applications may be determined by national prescription.

2.1.2 Total mass of the vehicle

For determining the total mass of the vehicle, WIM instruments are divided into six accuracy classes as shown below:

0.2 0.5 1 2 5 10

Note: The limitation of accuracy classes to certain applications may be determined by national prescription.

2.1.3 Relationship between accuracy classes

The relationship between the accuracy classes for single-axle load and, if required, axle-group load and the accuracy classes for total mass of the vehicle are as specified in Table 1 below.

Table 1

Accuracy class for single-axle load and axle-group load	Accuracy class for total mass of the vehicle					
	0.2	0.5	1	2	5	10
A	✓	✓				
B	✓	✓	✓			
C		✓	✓	✓		
D			✓	✓	✓	
E				✓	✓	✓
F					✓	✓

2.2 Limits of error

2.2.1 Weighing-in-motion

2.2.1.1 Single-axle load and axle-group load

The limits of error applicable to single-axle loads and, if required, axle-group loads are as follows:

(a) For static reference single-axle loads of the two-axle rigid reference vehicle, the applicable limits of error are as specified in 2.2.1.1.1.

(b) For all other reference vehicle single-axle loads and axle-group loads, the applicable limits of error are as specified in 2.2.1.1.2.

2.2.1.1.1 Maximum permissible error

For the two-axle rigid reference vehicle, the maximum difference between the indicated single-axle load for in-motion tests and the conventional true value of the static reference single-axle load shall not exceed one of the following values, whichever is greater:

a) the value from Table 2 rounded to the nearest scale interval;
b) 1 *d* in the case of initial verification,
2 *d* in the case of in-service inspection.

Table 2

Static reference single-axle		
Accuracy Class	Percentage of conventional true value of the static reference single-axle load	
	Initial verification	In-service inspection
A	± 0.25 %	± 0.50 %
B	± 0.50 %	± 1.00 %
C	± 0.75 %	± 1.50 %
D	± 1.00 %	± 2.00 %
E	± 2.00 %	± 4.00 %
F	± 4.00 %	± 8.00 %

2.2.1.1.2 Maximum permissible deviation (MPD) from the corrected mean single-axle load or the corrected mean axle-group load

For all reference vehicle types except the two-axle rigid reference vehicle, the maximum difference between any indicated single-axle load or, if required, any axle-group load recorded during in-motion tests and the corrected mean single-axle load (6.10) or the corrected mean axle-group load (6.11), respectively, shall be one of the following values, whichever is greater:

a) the value from Table 3 rounded to the nearest scale interval;

b) 1 *d* x n in the case of initial verification,
2 *d* x n in the case of in-service inspection.

Where n is the number of axles in the group, with n = 1 for single axles.

Table 3

Reference single-axle or axle-group		
Accuracy Class	Percentage of the corrected mean single-axle load or corrected mean axle-group load	
	Initial verification	In-service inspection
A	± 0.50 %	± 1.00 %
B	± 1.00 %	± 2.00 %
C	± 1.50 %	± 3.00 %
D	± 2.00 %	± 4.00 %
E	± 4.00 %	± 8.00 %
F	± 8.00 %	± 16.00 %

2.2.1.2 Maximum permissible error (MPE) for total mass of the vehicle

The maximum permissible error for total mass of the vehicle determined by in-motion weighing, shall be one of the following values, whichever is greater:

a) the value calculated according to Table 4, rounded to the nearest scale interval;

b) 1 *d* x the number of axles in the totalisation in the case of initial verification,
2 *d* x the number of axles in the totalisation in the case of in-service inspection.

Table 4

Total mass of the vehicle		
Accuracy Class	Percentage of conventional value of total mass of the vehicle (6.7)	
	Initial verification	In-service inspection
0.2	± 0.10 %	± 0.20 %
0.5	± 0.25 %	± 0.50 %
1	± 0.50 %	± 1.00 %
2	± 1.00 %	± 2.00 %
5	± 2.50 %	± 5.00 %
10	± 5.00 %	± 10.00 %

2.2.2 Static weighing

The maximum permissible errors on static weighing for increasing or decreasing loads shall be the appropriate values in Table 5.

Table 5

Total mass of the vehicle			
Accuracy class	Load (m), expressed in scale intervals	Maximum permissible errors	
		Initial verification	In-service inspection
0.2 0.5 1	$0 \le m \le 500$	$\pm 0.5\ d$	$\pm 1.0\ d$
	$500 < m \le 2000$	$\pm 1.0\ d$	$\pm 2.0\ d$
	$2000 < m \le 5000$	$\pm 1.5\ d$	$\pm 3.0\ d$
2 5 10	$0 \le m \le 50$	$\pm 0.5\ d$	$\pm 1.0\ d$
	$50 < m \le 200$	$\pm 1.0\ d$	$\pm 2.0\ d$
	$200 < m \le 1000$	$\pm 1.5\ d$	$\pm 3.0\ d$

Note: See Table 1 for the relationship between the accuracy classes for total mass of the vehicle and the accuracy classes for single-axle load and, if required, axle-group load.

2.3 Scale interval (*d*)

For a particular method of weighing-in-motion and combination of load receptors, all weight indicating and printing devices on an instrument shall have the same scale interval.

The relationship between the accuracy class, the value of the scale interval and the number of scale intervals for the maximum capacity of the instrument shall be as specified in Table 6.

Table 6

Total mass of the vehicle			
Accuracy class	d (kg)	Minimum number of scale intervals	Maximum number of scale intervals
0.2	≤ 5	500	5000
0.5	≤ 10		

1	≤ 20		
2	≤ 50	50	1000
5	≤ 100		
10	≤ 200		

Note: See Table 1 for the relationship between the accuracy classes for total mass of the vehicle and the accuracy classes for single-axle load and, if required, axle-group load.

The scale intervals of the indicating or printing devices shall be in the form of 1×10^k, 2×10^k or 5×10^k, "k" being a positive or negative whole number or zero.

2.4 Minimum capacity

The minimum capacity shall not be less than the load, expressed in scale intervals, specified in Table 7.

Table 7

Total mass of vehicle	
Accuracy class	Minimum capacity in scale intervals
0.2 0.5 1	50
2 5 10	10

Note: See Table 1 for the relationship between the accuracy class for total mass of the vehicle and the accuracy classes for single-axle load and, if required, axle-group load.

2.5 Installation and testing of WIM instruments

For WIM instruments to be used in applications where the individual axle or axle-group loads are required (e.g. enforcement of axle overload), the installation and testing requirements specified in Annex B and A.9.3.2 respectively, shall be applicable. Further practical guidance on the installation and operation of these instruments is provided in Annex C.

2.6 Agreement between indicating and printing devices

For the same load, there shall be no difference between the weighing results provided by any two devices having the same scale interval.

2.7 Influence quantities

Refer to Annex A for test conditions.

2.7.1 Temperature

2.7.1.1 Temperature limits

WIM instruments shall comply with the appropriate metrological and technical requirements at temperatures from - 10 °C to + 40 °C.

For special applications, however, the limits of the temperature range may differ provided that this range shall not be less than 30 °C and shall be specified in the descriptive markings.

2.7.1.2 Temperature effect on no-load indication

The indication at zero or near zero shall not vary by more than one scale interval for a difference in ambient temperature of 5 °C.

2.7.2 Power supply

An electronic instrument shall comply with the appropriate metrological and technical requirements, if the voltage of the power supply varies at:

- AC mains power supply: - 15 % to + 10 % of the voltage marked on the instrument,
- DC mains power supply: minimum operating voltage to + 20 % of the voltage marked on the instrument (nominal voltage),
- battery operated instrument (DC): minimum operating voltage to + 20 % of the voltage marked on the instrument (nominal voltage)

Note: The minimum operating voltage is defined as the lowest possible operating voltage before the instrument is automatically switched off.

2.8 Units of measurement

Units of mass and load to be used on an instrument are the kilogram (kg) or the tonne (t).

2.9 Scale interval for stationary load

If the scale interval for stationary load is not equal to the scale interval (*d*), it shall be automatically put out of service when the instrument is in use for weighing-in-motion. In addition, if the instrument is not verified for use as a nonautomatic weighing instrument, the scale interval for stationary load shall not be readily accessible and shall only be used for static testing.

2.10 Operating speed

WIM instruments shall comply with the appropriate metrological and technical requirements at speed variations (acceleration/deceleration) of $\pm$ 5 % of the operating speed range marked on the instrument.

3 TECHNICAL REQUIREMENTS

3.1 Suitability for use

WIM instruments shall be designed to suit the vehicles, site and method of operation for which they are intended.

3.2 Security of operation

3.2.1 Fraudulent use

The WIM instrument shall have no characteristics likely to facilitate its fraudulent use.

3.2.2 Accidental maladjustment

WIM instruments shall be constructed so that maladjustments likely to disturb their metrological performance cannot take place without the effect being easily detected.

3.2.3 Interlocks

Interlocks shall prevent the use of any control device that may alter a weighing operation.

3.2.4 Use as a non-automatic weighing instrument

In addition to complying with the requirements of OIML R76 an instrument that can operate in a nonautomatic mode shall indicate the method and operational mode.

3.3 Zeroing devices

3.3.1 Zero-setting device

A WIM instrument shall be provided with a zero-setting device which may be automatic or semi-automatic.

A zero-setting device shall be capable of setting zero to within ± 0.25 *d* and shall have a range of adjustment not exceeding 4 % of the maximum capacity. The range of adjustment of the initial zero-setting device shall not exceed 20 % of the maximum capacity.

A semi-automatic zero-setting device shall not be operable during automatic operation.

An automatic and a semi-automatic zero-setting device shall function only when the instrument is in stable equilibrium.

3.3.2 Zero-tracking device

A zero-tracking device shall operate only when:

- the indication is at zero, and
- the instrument is in stable equilibrium, and
- the corrections are not more than 0.5 *d* per second, and
- within a range of 4 % of Max around the actual zero.

3.4 Integral control instrument

A WIM instrument to be used as a control instrument, for the purposes of determining the total mass of the vehicle or the static reference vehicle axle loads, shall meet the requirements of:

- 3.4.1 to 3.4.4 inclusive, and
- 6.2.3.

3.4.1 Zero-setting

The instrument shall be capable of setting zero to within ± 0.25 of the scale interval for a stationary load (2.9).

3.4.2 Eccentric loading

The indications for different positions of the load shall comply with the maximum permissible errors in 2.2.2 for initial verification for the given load.

3.4.3 Discrimination

An additional load that is equal to 1.4 times the scale interval for a stationary load, when gently placed on or withdrawn from each load receptor in turn when at equilibrium at any load shall change the initial indication.

3.4.4 Repeatability

The difference between the results of several weighings of the same load shall not be greater than the absolute value of the maximum permissible error of the instrument for that load.

3.5 Indicating and printing devices

3.5.1 Quality of indication

The indication shall be the self-indicating type. Indicating and printing devices shall allow reliable, simple and unambiguous reading of the results by simple juxtaposition and bear the name or symbol of the appropriate unit of mass.

3.5.2 Printing

The minimum printout resulting from each normal weighing operation shall be dependent upon the application of the instrument.

For WIM instruments to be used in applications concerned only with determining the total mass of the vehicle, the minimum printout shall be the total mass of the vehicle, the operating speed, the date and the time. The individual axle or axle-group loads shall not be printed without an associated warning that these results are not verified.

For WIM instruments to be used in applications where only individual axle loads are required, the minimum printout shall be the single-axle loads, the total mass of the vehicle, the operating speed, the date and the time. The criteria for defining axle-groups need not be specified for the instrument.

For WIM instruments to be used in applications where axle-group loads are required, the minimum printout shall be the single-axle loads (when appropriate), the axle-group loads, the total mass of the vehicle, the operating speed, the date and the time. In addition, the criteria for defining axle-groups must be specified for the instrument.

3.5.3 Weighing range

WIM instruments shall not indicate or print the single-axle loads, axle-group loads or the total mass of the vehicle when single-axle load (partial weighment) is less than Min or greater than Max + 9 *d* without giving a clear warning on the indication and/or the printout.

3.5.4 Totalising device

The WIM instrument shall be provided with a totalising device which totalises the individual axle loads to provide the total mass of the vehicle and, if required, axle-group loads. Operation of this device may be automatic, in which case the instrument shall be provided with a vehicle recognition device (3.5.5), or semi-automatic (operates automatically following a manual command).

3.5.5 Vehicle recognition device

The WIM instrument shall be provided with a vehicle recognition device when the total mass of the vehicle, single-axle loads and/or axle-group loads are indicated or printed automatically following a weighing operation. The device shall detect the presence of a vehicle and shall detect when the whole vehicle has been weighed.

3.5.6 Vehicle guide device

The WIM instrument shall not indicate or print the single-axle loads, axle-group loads or the total mass of the vehicle if any of the wheels of that vehicle did not pass fully over the load receptor. Alternatively, a lateral guide system may be used to ensure that the vehicle passes fully over the load receptor.

If only one direction of travel is specified for an instrument, an error message shall be given if a vehicle travels in the wrong direction. Alternatively, barriers or other traffic control methods may be used to prevent vehicles travelling in the wrong direction.

3.5.7 Operating speed

The WIM instrument shall not indicate or print the mass or load values of any vehicle that has travelled over the load receptors:

- at a speed outside the specified range of operating speeds, and/or
- with a speed variation (acceleration/deceleration) that would produce a weighing result that may be subject to an excessive relative error

unless there is a clear warning message on the indication and/or the printout.

3.5.8 Software

The metrologically relevant software used in a WIM instrument must be present in such a form in the instrument that alteration of the software is not possible without breaking a seal, or any change in the software can be signalled automatically by means of an identification code.

The software shall be assigned with a fixed version number. This version number shall be adapted in the case of every software change that may affect the functions and accuracy of the WIM instrument.

3.6 Installation

3.6.1 General

WIM instruments shall be manufactured and installed so as to minimise any adverse effects of the installation environment. The space between the weighing instrument and ground shall allow all covered parts of the load receptor to be kept free from all debris or other matter that could affect the accuracy of the WIM. Where particular details of installation have an effect on the weighing operation (e.g. site levels, length of aprons), these details shall be recorded in the test report.

WIM instruments shall comply with the installation requirements specified in Annex B.

3.6.2 Drainage

If the weighing mechanism is contained in a pit, there shall be a provision for drainage to ensure that no portion of the instrument becomes submerged or partially submerged in water or any other liquid.

3.6.3 Heating

If the weighing mechanism is installed in climate that has temperature below - 10 °C, there shall be provision for heating (i.e. heater cable) to ensure that no load cells becomes frozen.

3.7 Sealing devices

3.7.1 General

Components that are not intended to be adjusted or removed by the user shall be fitted with a sealing device or shall be enclosed. When enclosed, it shall be possible to seal the enclosure. However, other types of sealing are permitted which provide sufficient integrity, e.g. electronic seals.

The seals should, in all cases, be easily accessible. Sealing should be provided on all parts of the measuring system which cannot be materially protected in any other way against operations liable to affect the measurement accuracy.

Any device for changing the parameters of measurement results, particularly for correction and calibration, shall be sealed.

3.7.2 Electronic sealing devices

When access to parameters that participate in the determination of results of measurement is not protected by mechanical sealing devices, the protection shall fulfil the following provisions:

a) access shall only be allowed to authorised people, e.g. by means of a code (key-word) or of a special device (hard key, etc); the code must be changeable;

b) it shall be possible for at least the last intervention to be memorised; the record shall include the date and a means of identifying the authorised person making the intervention (see (a) above); the traceability of the last intervention shall be assured for at least two years, if it is not over-written on the occasion of a further intervention; if it is possible to memorise more than one intervention, and if deletion of a previous intervention must occur to permit a new record, the oldest record shall be deleted.

3.8 Descriptive markings

WIM instruments shall bear the following basic markings at each location having a mass or load indicating device or printing device.

3.8.1 Markings shown in full

- identification mark of the manufacturer
- identification mark of the importer (if applicable)
- type designation of the instrument

- serial number of the instrument (on each load receptor, if applicable)
- not to be used to weigh liquid products (if applicable)
- maximum transit speed km/h
- direction of weighing (if applicable)
- scale interval for stationary load (if applicable) kg or t
- electric power supply voltage V
- electric power supply frequency Hz
- temperature range (when not -10°C to 40°C) °C

3.8.2 Markings shown in code

- accuracy class total mass of the vehicle 0.2, 0.5, 1, 2, 5 or 10
- accuracy class single-axle load (where applicable) A, B, C, D, E or F
- accuracy class axle-group load (where applicable) A, B, C, D, E or F
- maximum capacity Max = kg or t
- minimum capacity Min = kg or t
- scale interval d = kg or t
- maximum operating speed v_{max} = km/h
- minimum operating speed v_{min} = km/h
- maximum number of axles per vehicle (where applicable) A_{max}
- type approval sign in accordance with national requirements

3.8.3 Supplementary markings

Depending upon the particular use of the instrument, one or more supplementary markings may be required on type approval by the metrological authority issuing the type approval certificate. For example, where a particular instrument is verified using a limited range of vehicles (e.g. air suspension systems only, three/four axle rigid vehicles only), then this should be marked on the instrument.

3.8.4 Presentation of descriptive markings

Descriptive markings shall be indelible and of a size, shape and clarity that permit legibility under normal conditions of use of the instrument.

Markings shall be grouped together in a clearly visible place on the instrument, either on a descriptive plate fixed near the indicating device or on the indicating device itself.

It shall be possible to seal the plate bearing the markings, unless it cannot be removed without being destroyed.

3.9 Verification Marks

3.9.1 Position

A place shall be provided for the application of verification marks. This place shall:

- be such that the part on which the marks are located cannot be removed from the instrument without damaging the marks,
- permit the easy application of the marks without changing the metrological qualities of the instrument,
- be visible when the instrument is in service.

3.9.2 Mounting

WIM instruments required to bear verification marks shall have a verification mark support located as specified above, which shall ensure the conservation of the marks as follows:

- when the mark is made with a stamp, the support may consist of a strip of lead or any other material with similar qualities inserted into a plate fixed to the instrument or a cavity bored into the instrument,
- when the mark consists of an adhesive transfer, a space shall be provided for this purpose.

4 REQUIREMENTS FOR ELECTRONIC INSTRUMENTS

Electronic instruments shall comply with the following requirements, in addition to the applicable requirements of all other clauses.

4.1 General requirements

4.1.1 Rated operating conditions

Electronic weighing instruments shall be designed and manufactured so that they do not exceed the maximum permissible errors under rated operating conditions.

4.1.2 Disturbances

Electronic weighing instruments shall be designed and manufactured so that when they are exposed to disturbances either:

a) significant faults do not occur; or
b) significant faults are detected and acted upon as specified in 4.3.1.

Note: A fault equal to or less than 1 *d* is allowed irrespective of the value of the error of indication.

4.1.3 Durability

The requirements in 4.1.1 and 4.1.2 shall be met durably in accordance with the intended use of the instrument.

4.1.4 Evaluation for compliance

A type of an electronic weighing instrument is presumed to comply with the requirements in 4.1.1, 4.1.2 and 4.1.3 if it passes the examination and tests specified in Annex A.

4.2 Application

The requirements in 4.1.2 may be applied separately to:

a) each individual cause of significant fault, and/or
b) each part of the electronic instrument.

The choice of whether 4.1.2 (a) or (b) is applied is left to the manufacturer.

4.3 Functional requirements

4.3.1 Acting upon a significant fault

When a significant fault has been detected, the instrument shall either be made in-operative automatically, or a visual or audible indication shall be provided and shall continue until the user takes action or the fault disappears

4.3.2 Switch-on procedure

If the failure of an indicator display element can cause a false weight indication then the instrument shall have a display test facility which is automatically initiated at switch-on (in the case of electronic instruments permanently connected to the mains at switch-on of indication), e.g. indication of all the relevant signs of the indicator in their active and non-active states for a sufficient time to be easily observed by the operator.

4.3.3 Influence factors

An electronic weighing instrument shall comply with the requirements of 2.7, and in addition it shall maintain its metrological and technical characteristics at a relative humidity of 85 % at the upper limit of the temperature range of the instrument.

4.3.4 Warm-up time

During the warm-up time of an electronic weighing instrument, there shall be no indication or transmission of the weighing result and automatic operation shall be inhibited.

4.3.5 Interface

An instrument may be equipped with an interface permitting the coupling of the instrument to external equipment. When an interface is used, the instrument shall continue to function correctly and its metrological functions shall not be influenced.

4.3.6 Battery power supply (DC)

An instrument that operates from a battery power supply shall, whenever the voltage drops below the minimum operating voltage (2.7.2), either continue to function correctly or automatically be put out of service.

4.3.7 DC mains power supply

Instruments with DC mains power supply shall either continue to function correctly or is automatically put out of service if the voltage is below the minimum operating voltage (2.7.2).

4.4 Examination and tests

The examination and testing of an electronic weighing instrument is intended to verify compliance with the applicable requirements of this Recommendation and especially the requirements for electronic instruments in Clause 4.

4.4.1 Examination

An electronic weighing instrument shall be examined to obtain a general appraisal of the design and construction.

4.4.2 Performance tests

An electronic weighing instrument or electronic device, as appropriate, shall be tested as specified in Annex A to determine their correct functioning.

Tests are to be conducted on the whole instrument except when the size and/or configuration of the instrument does not lend itself to testing as a unit. In such cases, the separate electronic devices shall be subjected to testing. It is not intended that electronic devices be further dismantled for separate testing of components. In addition, an examination shall be carried out on the fully operational weighing instrument or, if necessary, on the electronic devices in a simulated set-up that sufficiently represents the weighing instrument. The equipment shall continue to function correctly as specified in Annex A.

4.4.3 Span stability tests

The instrument shall be subjected to span stability tests at various intervals before, during and after being subjected to performance tests.

When an instrument is subjected to the span stability test specified in A.8:

- the maximum allowable variation in the errors of indication shall not exceed half the absolute value of the maximum permissible error in 2.2.2 for initial verification for the test load applied on any of the n measurements.
- where the differences of the results indicate a trend more than half the allowable variation specified above, the test shall be continued until the trend comes to rest or reverses itself, or until the error exceeds the maximum allowable variation.

5 METROLOGICAL CONTROLS

The metrological controls of WIM instruments shall, in agreement with national legislation, consist of the following:

- type approval;
- initial verification;
- subsequent verification;
- in-service inspection.

Tests should be applied uniformly by the metrological authority and should form a uniform program. Guidance for the conduct of type evaluation and initial verification is provided in OIML International Documents D 19 and D 20 respectively.

5.1 Type approval

5.1.1 Documentation

The application for type evaluation shall include documentation which provides the following information:

- metrological characteristics of the instrument;
- a standard set of specifications for the instrument;
- a functional description of the components and devices;

- drawings, diagrams and general software information (if applicable), explaining the construction and operation;
- any document or other evidence demonstrating that the design and construction of the instrument complies with the requirements of this Recommendation.

5.1.2 General requirements

Type evaluation shall be carried out on at least one, and normally not more than three, WIM instruments that represent the definitive type. At least one of the instruments shall be completely installed at a typical site and at least one of the instruments or the major component of an instrument shall be submitted in a form suitable for simulation testing in a laboratory. The evaluation shall consist of the tests specified in 5.1.3.

5.1.3 Type evaluation

The submitted documents shall be examined and tests carried out to verify that the WIM instruments comply with the:

a) metrological requirements in Clause 2, particularly with reference to the appropriate limits of error when using the range of vehicles (6.5) and operating conditions specified by the manufacturer,

b) technical requirements in Clause 3.

c) requirements for electronic instruments in Clause 4.

The appropriate metrological authority shall:

- conduct the tests in a manner which prevents unnecessary commitment of resources;
- permit the results of these tests to be assessed for initial verification when the same instrument is involved;
- ensure that an instrument that can be operated as a nonautomatic weighing instrument meets the relevant requirements of OIML R 76-1 for Class III or Class IIII instruments.

Note: The appropriate metrological authority is advised to accept, with the consent of the applicant, test data obtained from other metrological authorities without repeating the tests.

5.1.3.1 In-motion tests

A complete WIM instrument shall be tested:

- in accordance with the test methods in Clause 6, using the range of reference vehicles specified in 6.5.
- under the rated operating conditions in accordance with the type specification.

5.1.3.2 In-motion test error and deviation evaluation

5.1.3.2.1 Single-axle load or axle-group load

The requirements in this sub-clause are only applicable to instruments to be used in applications where the single-axle load or axle-group load is required.

5.1.3.2.1.1 Single-axle load

The single-axle load errors and deviations for automatic weighing of reference vehicles shall be determined as follows:

a) In-motion test with the two-axle rigid reference vehicle. The error for automatic weighing shall be the indicated single-axle load observed and recorded (6.9) as appropriate, minus the conventional true value of the static reference single-axle load (6.8) as appropriate. The MPE shall be as specified in 2.2.1.1.1 for initial verification and as appropriate for the accuracy class of the instrument.

b) In-motion test with all other reference vehicle axle types. The deviation for automatic weighing shall be the indicated single-axle load observed and recorded (6.9) as appropriate, minus the corrected mean single-axle load (6.11) as appropriate. The MPD shall be as specified in 2.2.1.1.2 for initial verification and as appropriate for the accuracy class of the instrument.

5.1.3.2.1.2 Axle-group load

For axle-group load, the deviation for automatic weighing shall be calculated:

a) For WIM instruments which determine and indicate the axle loads independent of single-axles or axle-groups:

   - by summation of individual axle load errors in accordance with national prescription for axle-group load (T.3.1.13).

b) For WIM instruments which automatically determine and indicate single-axle loads and axle-group loads separately:

   - by the indicated axle-group load observed and recorded (6.9) as appropriate, minus the corrected mean axle-group load (6.11) as appropriate.

The MPD shall be as specified in 2.2.1.1.2 for initial verification and as appropriate for the class of the instrument, if required, with different accuracy classes for single-axle loads and axle-group loads.

5.1.3.2.2 Total mass of the vehicle

For total mass of the vehicle, the error for automatic weighing shall be the indicated total mass of the reference vehicles observed and recorded (6.12) as appropriate, minus the conventional true value of the mass of the reference vehicle as defined in 6.7 as appropriate. The MPE shall be as specified in 2.2.1.2 for initial verification and as appropriate for the class of the instrument.

5.1.3.3 Simulation tests

Influence factors shall be applied during simulation tests in a manner that will reveal an alteration of the weighing result for any weighing process to which the WIM instrument could be applied, in accordance with Clause 2.7 and Clause 4.

5.1.3.3.1 Apportioning of errors

Where it is necessary to separately test modules of an instrument or system the following requirements apply.

The error limits applicable to a module which is examined separately are equal to a fraction p_i of the maximum permissible errors or the allowed variations of the indication of the complete

instrument. The fractions for any module have to be taken for the same accuracy class as for the complete instrument incorporating the part.

The fractions p_i shall satisfy the following equation:

$$p_1^2 + p_2^2 + p_3^2 + ... \leq 1$$

The fraction p_i shall be chosen by the manufacturer of the module and shall be verified by an appropriate test. However, the fraction shall not exceed 0.8 and shall not be less than 0.3, when more than one module contributes to the effect in question.

If the metrological characteristics of the load cell or other major component have been evaluated in accordance with the requirements of OIML International Recommendation R 60 or any other applicable Recommendation, that evaluation shall be used to aid type evaluation if so requested by the applicant.

Note: Since the requirements of this clause apply only to the instrument submitted for type evaluation and not to those subsequently submitted for verification, the means used to determine if the appropriate maximum permissible error or maximum allowable deviation has been exceeded will be decided and mutually agreed upon between the metrological authority and the applicant. Following are examples of these means:

- an adaptation of an indicating device or printer to give greater resolution than that of the scale interval;
- the use of the scale interval for stationary load;
- the use of weights of 1/10 *d* to determine the changeover point;
- any other means mutually agreed upon.

5.1.4 Provision of means for testing

For the purposes of testing, the applicant may be required to furnish the metrological authority with the test vehicles, material, qualified personnel and the control instruments. The instrument under test may be used as the control instrument provided it complies with the requirements in 6.2.3.

5.1.5 Place of testing

WIM instruments submitted for type approval may be tested at the following places:

- a site at which all necessary tests can be conducted and agreed upon between the metrological authority and the applicant;
- a laboratory considered appropriate by the metrological authority;
- any other suitable place mutually agreed upon between the metrological authority and the applicant.

5.2 Initial verification

5.2.1 Tests

WIM instruments shall be tested to verify that they comply with the requirements in Clauses 2 (except 2.7) and 3 for any vehicle(s) and product(s) loaded on a vehicle for which they are intended and when operated under normal conditions of use.

Tests shall be carried out by the appropriate metrological authority, in-situ, in a normal installation. The WIM instrument shall be installed so that an automatic weighing operation will be the same for testing as it is for a normal operation.

The appropriate metrological authority shall conduct the tests in a manner that prevents an unnecessary commitment of resources. In appropriate situations and to avoid duplicating tests previously performed on the instrument for type evaluation under 5.1.3, the authority may use the results of observed tests for initial verification.

5.2.1.1 In-motion tests

In-motion tests shall be conducted:

- in accordance with the descriptive markings (3.8),
- under the rated conditions for which the instrument is intended,
- in accordance with the test methods in Clause 6, with the exception that the reference vehicles shall be the types of vehicle(s) and product(s) for which the instrument is intended to weigh. However, for instruments to be used in applications where the axle load is required, the test utilising the two-axle rigid reference vehicle must be conducted.

5.2.1.2 In-motion test error evaluation

5.2.1.2.1 Single-axle load or axle-group load

The requirements in this sub-clause are only applicable to instruments to be used in applications where the single-axle load or the axle-group load is required.

5.2.1.2.1.1 Single-axle load

a) For in-motion test with the two-axle rigid reference vehicle, the error for automatic weighing shall be as specified in 5.1.3.2.1.1 (a).

b) For in-motion test with all other reference vehicle types, the error for automatic weighing shall be as specified in 5.1.3.2.1.1 (b).

5.2.1.2.1.2 Axle-group load

The error shall be as specified in 5.1.3.2.1.2 for axle-group load.

5.2.1.2.2 Total mass of the vehicle

For all reference vehicle types, the error shall be as specified in 5.1.3.2.2.

5.2.2 Provision of means for testing

For the purposes of testing, the applicant may be required to furnish the metrological authority with the test vehicles, material, qualified personnel and the control instruments. The instrument under test may be used as control instrument provided it complies with the requirements of 6.2.3.

5.2 .3 Place of testing

Initial verification tests shall be conducted entirely at the place of installation, and during testing the instrument shall include all parts which form the assembly as intended for normal use.

5.3 Subsequent metrological control

5.3.1 Subsequent verification

Subsequent verification shall be carried out in accordance with the same provisions as in 5.2 for initial verification.

5.3.2 In-service inspection

In-service inspection shall be carried out in accordance with the same provisions as in 5.2 for initial verification, with the exception that the in-service limits of error shall be applied.

6 TEST METHODS

6.1 Single-axle loads, axle-group loads and total mass of the vehicle

For single-axle loads and, if required, for axle-group loads a complete WIM system shall be tested for compliance with the metrological requirements in:

- 2.2.1.1 (a) using a two-axle rigid vehicle for the static reference axle load specified in A.9.3.1.3, and
- 2.2.1.1 (b) using the range of reference vehicles specified in 6.5

For the total mass of the vehicle a complete WIM instrument shall be tested for compliance with the requirements specified in 2.2.1.2 using the range of vehicles specified in 6.5.

6.2 Control instrument

6.2.1 Control instrument for full-draught vehicle weighing

A separate control instrument, capable of being used to determine the conventional true value (T.1.9) of the total mass of each reference vehicle by full-draught weighing when stationary, shall be available for weighing reference vehicles. The control instrument used for testing shall ensure the determination of the conventional true value of the total mass of each reference vehicles to an error not greater than:

(a) one-third of the appropriate in-service inspection MPE for in-motion tests in 2.2.1.2 if the control instrument is verified immediately prior to the tests,

(b) one-third of the appropriate in-service inspection MPE for in-motion tests in 2.2.1.2 if the control instrument is verified at any other time.

6.2.2 Control instrument for static reference single-axle loads of the two-axle rigid vehicle

As appropriate, a separate or integral control instrument, capable of being used to determine the conventional true value of the static reference single-axle loads by individual axle measurement when stationary, shall be used for tests with the two-axle rigid reference vehicle.

The control instrument used for determining the static reference axle loads shall:

- be able to support the entire contact area of all the tyres on the individual axle being weighed;

- ensure the determination of the conventional true value of the static reference axle loads of the two-axle rigid reference vehicle to an error not greater than:

    (a) one-third of the appropriate in-service inspection MPE for in-motion tests in 2.2.1.1.1 if the control instrument is verified immediately prior to the tests,

    (b) one-third of the appropriate in-service inspection MPE for in-motion tests in 2.2.1.1.1 if the control instrument is verified at any other time.

- be provided with approach and exit aprons in the same plane which shall extend to a length sufficient to fully support the vehicle being weighed. The aprons shall be in the same plane with the load receptor(s) and have no longitudinal slope. Where this specification cannot be achieved, alternative means may be provided to ensure that all of the wheels of the reference vehicle are within ± 3 mm of a horizontal plane passing through the load receptors during the measurement operations.

6.2.3 Integral control instrument

The WIM instrument under test may be used as the control instrument.

Integral control instruments shall:

- have an appropriate scale interval or scale interval for stationary load (2.9), and
- comply with the requirements of 3.4 and 6.2.2.

6.3 Static weighing test for integral control instruments

This test is applicable if the WIM instrument being verified is to be used as the control instrument for measuring the static reference axle loads of the two-axle rigid vehicle.

6.3.1 Test loads

Errors shall be determined for test loads of:

- zero;
- minimum capacity;
- maximum capacity;
- at or near a load where the maximum permissible error changes.

6.3.2 Distribution of test load

Except for eccentricity tests, standard weights or masses shall be evenly distributed on the load receptor.

6.3.3 Eccentricity tests

Tests shall be carried out without excessive stacking or overlapping of the load on the load receptor provided that the conditions are practical and safe.

6.4 Verification standards

6.4.1 Weights

The error of the standard weights or masses used shall not be greater than one-third of the maximum permissible error for the load, as specified in Table 5 for initial verification.

6.4.2 Substitution of standard weights

When testing instruments with Max > 1 *t*, instead of standard weights any other constant load may be used, provided that standard weights of at least 1 *t* or 50 % of Max, whichever is greater, are used. Instead of 50 % of Max, the portion of standard weights may be reduced to:

- 35% of Max if repeatability error is $\leq 0.3\ d$,
- 20% of Max if repeatability error is $\leq 0.2\ d$.

The repeatability error (R) has to be determined with a load of about 50 % of Max which is placed 3 times on the load receptor.

6.5 Reference vehicles

The reference vehicles to be used for testing shall represent the range of vehicles available in the appropriate Member State and for which the instrument is intended. Vehicle classification according to axle arrangement shall be accomplished using the available WIM-system axle-count and axle spacing information. In addition to a two-axle rigid vehicle, there shall be a minimum of two other different reference vehicles. Different axle configurations, tractor/trailer configurations, tractor/trailer linkage systems and suspension systems shall be used, as appropriate.

Where a particular instrument is tested using a limited range of vehicle types (e.g. air suspension systems only), then this should be noted in the type approval certificate.

A minimum of two other vehicles shall be selected from the three listed below:

- one three/four-axle rigid
- one five/six-axle articulated having a three-axle trailer
- one two/three-axle vehicle and a two/three-axle draw-bar trailer

The two-axle rigid vehicle shall be used as the reference vehicle for determining the conventional true value of static reference single-axle loads.

The other reference vehicles shall be selected to cover, as far as practicable, the weighing range for which the instrument is approved.

Vehicles carrying liquid or other products that shifts when the vehicle moves shall be used as reference vehicles only if the WIM instrument is used for determining the total mass and/or the loads of single-axles and/or axle-group of such vehicles.

If the WIM instrument is not intended for this use, it shall bear the marking “not to be used to weigh vehicles carrying liquids or other products that shifts”

6.6 Number of in-motion tests

Each reference vehicle shall undertake at least ten test runs at each speed category as detailed A.9.3.2.

6.7 Conventional true value of the total mass of the reference vehicles

The conventional true value of the total mass of each reference vehicle, unloaded and loaded, shall be determined using full-draught weighing, as detailed in A.9.3.1. 2.

6.8 Conventional true value of the static reference single-axle load values

The conventional true value of the static reference single-axle loads for the two-axle rigid reference vehicle, unloaded and loaded, shall be determined using the method detailed in A.9.3.1.3

6.9 Indicated single-axle load and axle-group load

The indication or printout of the single-axle loads and, if required, the axle-group loads following an automatic weighing operation shall be observed and recorded.

6.10 Mean single-axle load and mean axle-group load

The mean single-axle load shall be the sum of the indicated or printed axle loads obtained for single axle on the reference vehicle during an in-motion test, divided by the number of single-axle load values.

The mean axle-group load shall be the sum of the indicated or printed axle-group loads recorded for each defined axle-group on the reference vehicle during an in-motion test, divided by the number of load values recorded for each respective axle -group.

6.11 Corrected mean single-axle load and axle-group load

The corrected mean single-axle load and axle-group load for each single-axle or axle-group on a reference vehicle shall be the mean (6.10) of the recorded values (6.9) for the respective single-axles and axle-groups on the reference vehicle during an in-motion test, corrected proportionally (A.9.3.2.2 (3)) in relation to the systematic error of the WIM instrument used for determining the recorded values.

6.12 Indicated total mass of the vehicle

The total mass of the vehicle indicated or printed following an automatic weighing operation shall be observed and recorded. The total mass of the vehicle shall be the summation of all the indicated single-axle loads and, if applicable, axle-group loads of the vehicle.

ANNEX A (MANDATORY)

TEST PROCEDURES FOR AUTOMATIC INSTRUMENTS FOR WEIGHING ROAD VEHICLES IN MOTION

Meaning of Symbols

I	=	Indication
L	=	Load
ΔL	=	Additional load to next changeover point
P	=	$I + ½d - \Delta L$ = indication prior to rounding
d	=	Scale interval
E	=	$P - L$ = error
E%	=	$(P - L)/L$ %
MPE	=	Maximum permissible error
MPD	=	Maximum permissible deviation
EUT	=	Equipment Under Test
Max	=	Maximum capacity
Min	=	Minimum capacity
p_i	=	A fraction of the maximum permissible errors applicable to a part of the complete instrument which is examined separately.

A.1 EXAMINATION FOR TYPE APPROVAL

A.1.1 Documentation (5.1.1)

Review the documentation that is submitted, including necessary photographs, drawings, diagrams, general software information, relevant technical and functional description of main components, devices, etc. to determine if it is adequate and correct. Consider the operational manual.

A.1.2 Comparing construction with documentation (5.1.1)

Examine the various devices of the WIM instrument to ensure compliance with the documentation.

A.1.3 Technical requirements (3)

Examine the instrument for conformity with the technical requirements according to the checklist in the test report format (see OIML R xxx-2).

A.1.4 Functional requirements (4.3 and 4.4)

Examine the instrument for conformity with the functional requirements according to the checklist given in the test report format.

A.2 EXAMINATION FOR INITIAL VERIFICATION

A.2.1 Compare construction with documentation (5.2)

Examine the instrument for conformity with the approved type.

A.2.2 Descriptive markings (3.8)

Check the descriptive markings according to the checklist in the test report format.

A.2.3 Verification marks (3.9) and sealing devices (3.7)

Check the arrangement for verification marks and sealing according to the checklist given in the test report.

A.3 GENERAL TEST REQUIREMENTS

A.3.1 Power supply

Power-up the equipment under test (EUT) for a time period equal to or greater than the warm-up time specified by the manufacturer and maintain the EUT energised for the duration of each test.

A.3.2 Zero-setting

Adjust the EUT as closely as practicable to zero prior to each test, and do not readjust it at any time during the test, except to reset it if a significant fault has been indicated.

Certain tests require the automatic zero-setting and zero-tracking devices to be in operation (or not in operation). Where there is no specific requirement to this effect, the automatic zero-setting and zero-tracking devices shall be switched-off. When this is done it shall be mentioned in the test report.

A.3.3 Temperature

The tests shall be performed at a steady ambient temperature, usually normal room temperature unless otherwise specified. The temperature is deemed to be steady when the difference between the extreme temperatures noted during the test does not exceed one-fifth of the temperature range of the instrument without being greater than 5 °C and the rate of change does not exceed 5 °C per hour. Note that this requirement does not apply to in-motion tests.

The handling of the instrument shall be such that no condensation of water occurs on the instrument.

A.3.4 Indication with a scale interval smaller than *d*

If an instrument has a device for displaying the indication with a smaller scale interval than d (e.g. $\leq$ 0.2 d), this device may be used to calculate the error. If such a device is used, it should be noted in the test report.

A.3.5 Control instruments and test standards

A.3.5.1 Control instruments (6.2)

Control instruments meeting the requirements of clause 6.2 shall be used for weighing the vehicles. Where necessary, standard weights may be used to assess the rounding error.

A.3.5.2 Use of standard weights to assess rounding error

A.3.5.2.1 General method to assess error prior to rounding

For instruments with digital indication having a scale interval *d*, changeover points may be used to interpolate between scale intervals, i.e. to determine the indication of the instrument, prior to rounding, as follows:

At a certain load, *L*, the indicated value, *I*, is noted. Additional weights of say 0.1 *d* are successively added until the indication of the instrument is increased unambiguously by one scale interval (I + *d*). The additional load ΔL added to the load receptor gives the indication, *P*, prior to rounding by using the following formula:

$$P = I + 0.5\ d - \Delta L$$

The error prior to rounding is:

$$E = P - L = I + 0.5\ d - \Delta L - L$$

Example: an instrument with a scale interval, d, of 10 kg is loaded with 1000 kg and thereby indicates 1000 kg. After adding successive weights of 1 kg, the indication changes from 1000 kg to 1010 kg at an additional load of 3 kg. Inserted in the above formula these observations give:

$$P = (1000 + 5 - 3)\ \text{kg} = 1002\ \text{kg}$$

Thus the true indication prior to rounding is 1002 kg, and the error is:

$$E = (1002 - 1000)\ \text{kg} = 2\ \text{kg}$$

A.3.5.2.2 Correction for error at zero

Evaluate the error at zero load, (E_0) by the method of A.3.5.2.1.

Evaluate the error at load *L*, (*E*) by the method of A.3.5.2.1.

The corrected error prior to rounding, (E_c) is:

$$E_c = E - E_0$$

Example: if, for the example in A.3.5.2.1, the error calculated at zero load was:

$$E_0 = + 1\ \text{kg},$$

The corrected error is:

$$E_c = + 2 - (+ 1) = + 1\ \text{kg}$$

A.4 TEST PROGRAM

A.4.1 Type approval (5.1)

Clauses A.1, and A.5 to A.9 shall normally be applied for type approval.

Sub-clause A.5.2 may be omitted if the WIM instrument under test is not an integral control instrument.

The tests for clauses A.6 to A.8 may be performed with static load, with a vehicle movement simulator (switches) used if necessary for the calculation of the weighing results.

A.4.2 Initial verification (5.2)

Clauses A.2 and A.9 shall be applied for initial verification tests.

If the WIM instrument under test is to be used as an integral control instrument the tests in sub-clause A.5.2 shall also be applied.

The test in clause A.9 shall include all dynamic in-motion effects corresponding to normal operation of the instrument.

A.5 PERFORMANCE TESTS DURING TYPE EVALUATION

A.5.1 Zero-setting (3.3.1)

A.5.1.1 Range of zero-setting

A.5.1.1.1 Initial zero-setting

(a) Positive range

With the load receptor empty, set the instrument to zero. Place a test load on the load receptor and switch the instrument off and then back on. Continue this process until, after placing a load on the load receptor and switching the instrument off and on, it does not reset to zero. The maximum load that can be re-zeroed is the positive portion of the initial zero-setting range.

(b) Negative range

(1) Remove any load from the load receptor and set the instrument to zero. Then, if possible, remove any non-essential components of the load receptor. If, at this point, the instrument can be reset to zero by switching it off and back on, the mass of the non essential components is used as the negative portion of the initial zero-setting range.

(2) If the instrument cannot be reset to zero with the non-essential components removed, add weights to any live part of the scale until the instrument indicates zero again.

(3) Then remove weights and, after each weight is removed, switch the instrument off and back on. The maximum load that can be removed while the instrument can still be reset to zero by switching it off and on is the negative portion of the initial zero-setting range.

(4) The initial zero-setting range is the sum of the positive and negative portions.

(5) Alternatively, if it is not possible to test the negative range of initial zero setting by removing parts of the instrument, the instrument may be temporarily re-adjusted with a test load applied before proceeding to step (3) above. (The test load applied for the temporary re-calibration should be greater than the permissible negative portion of the initial zero setting range which can be calculated from the result of the positive range test).

(6) If it is not possible to test the negative portion of the initial zero-setting range by these methods then only the positive part of the initial zero-setting range need be considered.

(7) Reassemble or recalibrate the instrument for normal use after the above tests

A.5.1.1.2 Semi-automatic zero-setting

This test shall not be carried out during the span stability test.

This test is performed in the same manner as described in A.5.1.1.1, except that the zero-setting device is used rather than switching the instrument on and off.

A.5.1.1.3 Automatic zero-setting

This test shall not be carried out during the span stability test.

Remove the non-essential parts of the load receptor or re-adjust the instrument as described in A.5.1.1.1 and place weights on the live part of the scale until it indicates zero.

Remove weights in small amounts and after each weight is removed allow the instrument to operate through the appropriate part of the automatic cycle so as to see if the instrument is reset to zero automatically.

The maximum load that can be removed so the instrument can still be reset to zero is the zero-setting range.

A.5.1.2 Accuracy of zero-setting

A.5.1.2.1 Semi-automatic zero-setting

The accuracy of the zero-setting device is tested by setting the instrument to zero and then determining the additional load at which the indication changes from zero to one scale interval above zero. The error at zero is calculated according to the description in A.3.5.2.1.

A.5.1.2.2 Automatic zero-setting or zero-tracking

The indication is brought outside of the automatic range. Then the additional load at which the indication changes from one scale interval to the next above is determined and the error is calculated according to the description in A.3.5.2.1. It is assumed that the error at zero load would be equal to the error at the load in question.

A.5.2 Non-automatic tests of the integral control instrument (3.4)

Note: This sub-clause is only applicable to WIM instruments which are to be used as a control instrument.

A.5.2.1 Zero-setting

A.5.2.1.1 Accuracy of zero-setting (3.4.1)

Determination of the accuracy of zero setting is carried out as described in A.5.1.2.1 or A.5.1.2.2, as appropriate.

A.5.2.2 Determination of weighing performance

A.5.2.2.1 Preloading

Before the first weighing test, the WIM instrument shall be preloaded once to near Max.

A.5.2.2.2 Static weighing test (6.3)

Apply loads from zero up to and including Max, and then remove the loads back to zero. When determining the initial intrinsic error, at least ten different load values are selected, and for other weighing tests at least five are selected. The values of the loads selected shall include Max and Min, and values at or near those at which the maximum permissible error (MPE) changes.

It should be noted that when loading or unloading weights the load must be respectively increased or decreased in a uniform progression.

The maximum permissible error shall be the appropriate values from clause 2.2.2 for initial verification.

A.5.2.3 Eccentricity test (3.4.2 and 6.3.3)

Apply a load equal to 1/3 Max in each half of the load receptor. On an instrument with a load receptor having n points of support with n > 4 the fraction 1/(n-1) of Max shall applied to each point of support.

The errors shall not exceed the appropriate maximum permissible errors from 2.2.2 for initial verification.

A.5.2.4 Discrimination test (3.4.3)

The following tests are performed with three different loads, e.g. Min, 0.5 Max and Max.

A load plus sufficient substitution material (e.g. 10 times 0.1 *d*) is placed on the load receptor. The additional material is then successively removed until the indication, I, is decreased unambiguously by one scale interval, I – *d*. Replace substitution material equivalent to 0.1 *d* and then a load equal to 1.4 *d* shall be gently placed on the load receptor and the result will be increased by one scale interval above the initial indication, I + *d*.

A.5.2.5 Repeatability test (3.4.4)

The repeatability error (R) is determined as specified in 6.4.2.

A.6 ADDITIONAL FUNCTIONALITY

A.6.1 Warm-up time test (4.3.4)

This test is to verify that metrological performance is maintained in the period immediately after switch on. The method is to check that automatic operation is inhibited until a stable indication is obtained and to verify that zero and span errors comply with the requirements during the first 30 minutes of operation.

Other test methods which verify that metrological performance is maintained during the first 30 minutes of operation may be used.

(1) Disconnect the instrument from the power supply for a period of at least 8 hours prior to the test.

(2) Reconnect the instrument and switch on while observing the indicating device.

(3) Verify that it is not possible to initiate automatic weighing or printout until the indication has stabilised or until completion of the warm-up time if it is specified by the manufacturer (4.3.4).

(4) As soon as the indication of the indicating device has stabilised, set the instrument to zero if this is not done automatically

(5) Determine the error of zero-setting by the method of A.3.5.2.1.and record this error as E_{0i} (error of initial zero-setting) at first and as E_0 when repeating this step.

(6) Apply a load close to Max. Determine the error by the method of A.3.5.2.1 and A.3.5.2.2.

(7) Verify that:
- zero indication error (E_{0i}) is not greater than 0.25 *d* (3.3.1)
- span error is not greater than the maximum permissible error specified in 2.2.2 for initial verification.

(8) Repeat stages (5) and (6) after 5, 15 and 30 minutes.

(9) After each time interval verify that:
- zero variation error (E_0 - E_{0i}) is not greater than 0.25 $d * p_i$,
- span error is not greater than the maximum permissible error specified in 2.2.2 for initial verification.

A.6.2 Agreement between indicating and printing devices (2.6)

If the instrument has more than one indicating device, the indications of the various devices (both indicating and printing) are compared during the test.

A.7 INFLUENCE FACTOR AND DISTURBANCE TESTS

A.7.1 Test conditions

A.7.1.1 General requirements

WIM instruments for total mass of the vehicle, single-axle loads and, if required, axle-group loads shall comply with the influence factor and disturbance tests conditions and requirements specified in this Annex.

Influence factor and disturbance tests are intended to verify that electronic instruments can perform and function as intended in the environment and under the conditions specified. Each test indicates, where appropriate, the reference condition under which the intrinsic error is determined.

It is not possible to apply these tests to an instrument that is performing an automatic operation. The instrument shall therefore be subjected to the influence factors or disturbances under static conditions or simulated operation as defined herein. The permissible effects of the influence factors or disturbances, under these conditions, are specified for each case.

When the effect of one influence factor is being evaluated, all other factors are to be held relatively constant, at a value close to normal. After each test the instrument shall be allowed to recover sufficiently before the following test.

Where parts of the instrument are examined separately, errors shall be apportioned in accordance with 5.1.3.3.1.

The operational status of the instrument or simulator shall be recorded for each test.

When an instrument is connected in other than a normal configuration, the procedure shall be mutually agreed on by the approving authority and the applicant.

A.7.1.2 Simulator requirements

A.7.1.2.1 General

The simulator for influence factor and disturbance tests should include all electronic devices of the weighing system.

A.7.1.2.2 Weight simulator

For practical reasons, the weight simulator may take various forms. For example, it may be a weigh pan or platform scale of approximately 1/1000th of the weight range of a site installation, or a load cell simulator. Whichever method is adopted, it must be independently calibrated and readable to at least 0.1 *d*.

A.7.1.2.3 Interfaces (4.3.5)

Susceptibility that would result from the use of electronic interfaces to other equipment shall be simulated in the tests. For this purpose it is sufficient to connect 3 m of interface cable terminated to simulate the interface impedance of the other equipment.

A.7.1.2.4 Documentation

Simulators shall be defined in terms of hardware and functionality by reference to the instrument under test, and by any other documentation necessary to ensure reproducible test conditions. This information shall be attached to, or traceable from, the test report.

A.7.2 Influence factor tests (2.7)

Summary of tests

Test	Conditions applied	§
Static temperatures	MPE(*)	A.7.2.1
Temperature effect on no load indication	MPE	A.7.2.2
Damp heat, steady state	MPE	A.7.2.3
AC mains power voltage variation	MPE	A.7.2.4
DC mains power voltage variation	MPE	A.7.2.5
Battery-powered instruments (DC)	MPE	A.7.2.6

(*)maximum permissible error

A.7.2.1 Static temperatures (2.7.1.1)

Static temperature tests are carried out according to basic standard IEC Publication 60068-2-1 (1990)* and IEC Publication 60068-2-2 (1974)*, as detailed in the Bibliography [1] and according to Table 8.

* Or the most recent issue of the publication valid at the time of testing the instrument.

Table 8

Environmental phenomena	Test specification	Test set-up standard(s)
Temperature	Reference of 20 °C	
	Specified high for 2 hours	IEC 60068-2-2
	Specified low for 2 hours	IEC 60068-2-1
	5 °C	IEC 60068-2-1
	Reference of 20 °C	
Use IEC 60068-3-1 (1974) for background information and refer to Bibliography [1] for specific parts of the IEC test.		

Supplementary information to the IEC test procedures

Object of the test: To verify compliance with the provisions in 2.7.1.1 under conditions of dry heat (non-condensing) and cold. The test in A.7.2.2 may be conducted during this test.

Test procedures in brief:

Precondition: 16 hours.

Condition of the EUT: Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Power is to be "on" for the duration of the test. The zero-setting and zero-tracking facilities shall be enabled as for normal operation. If the test is performed together with A.7.2.2 automatic zero-setting and zero tracking shall not be in operation.

Stabilisation: 2 hours at each temperature under "free air" conditions.

Temperature: As specified in 2.7.1.1.

Temperature sequence: Reference temperature of 20 °C;
Specified high temperature;
Specified low temperature;
A temperature of 5 °C;
Reference temperature of 20 °C.

Number of test cycles: At least one cycle.

Test information: Adjust the EUT as close to zero indication as practicable prior to the test (if an automatic zero-tracking device is connected, adjust it to a value near zero). The EUT shall not be readjusted at any time during the test.

After stabilisation at the reference temperature and again at each specified temperature, apply at least five different test loads or simulated loads and record:

a) date and time;
b) temperature;
c) relative humidity;
d) test load;

e) indications (as applicable);
f) errors;
g) functional performance.

Maximum allowable variations: All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 2.2.2 for initial verification.

A.7.2.2 Temperature effect on the no-load indication (2.7.1.2)

Currently, there are no applicable standards. This test should be conducted as described below.

The instrument shall be set to zero and then changed to the prescribed highest and lowest temperatures as well as to 5 °C if applicable. After stabilisation the error of the zero indication shall be determined. The change in zero indication per 5 °C shall be calculated. The changes of these errors per 5 °C are calculated for any two consecutive temperatures of this test.

This test may be performed together with the temperature test in A.7.2.1. The errors at zero shall then be additionally determined immediately before changing to the next temperature and after the 2 hour period after the instrument has reached stability at this temperature.

Note: Preloading is not allowed before these measurements.

If the instrument is provided with automatic zero-setting or zero-tracking, it shall not be in operation.

Condition of EUT: Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Power is to be "on" for the duration of the test.

A.7.2.3 Damp heat, steady state (4.3.3)

Damp heat, steady state tests are carried out according to basic standard IEC Publication 60068-2-78 (2001)* and IEC Publication 60068-3-4 (2001)*, as detailed in the Bibliography [2] and according to Table 9.

Table 9

Environmental phenomena	Test specification	Test set-up standard(s)
Damp heat, Steady state.	Upper limit temperature and relative humidity of 85% for 48 hours.	IEC 60068-2-78
Use IEC 60068-3-4 for guidance for damp heat tests and refer to Bibliography [2] for specific parts of the IEC test.		

Supplementary information to the IEC test procedures:

Object of the test: To verify compliance with the provisions in 4.1.1 under conditions of high humidity and constant temperature.

*Or the most recent issue of the publication valid at the time of testing the instrument.

Precondition:	None required.
Condition of the EUT:	Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Power is to be "on" for the duration of the test. Adjust the EUT as close to zero indication as is practicable prior to the test (if an automatic zero-tracking device is connected, adjust it to a value near zero). The EUT shall not be readjusted at any time during the test. The handling of the EUT shall be such that no condensation of water occurs on the EUT.
Stabilisation:	3 hours at reference temperature and 50% humidity. 48 hours at the upper limit temperature as specified in 2.7.1.1.
Temperature:	Reference temperature of 20 °C and at the upper limit as specified in 2.7.1.1.
Relative humidity:	50 % at reference temperature, 85 % at upper limit temperature.
Temperature-humidity sequence:	Reference temperature of 20 °C at 50 % humidity, The upper limit temperature at 85 % humidity, Reference temperature of 20 °C at 50 % humidity.
Number of test cycles:	At least one cycle.
Test information:	After stabilisation of the EUT at reference temperature and 50 % humidity, apply at least five different test loads or simulated loads and record: a) date and time; b) temperature; c) relative humidity; d) test load; e) indications (as applicable); f) errors; g) functional performance. Increase the temperature in the chamber to the upper limit and increase the relative humidity to 85 %. Maintain the EUT at no load for a period of 48 hours. Following the 48 hours, apply the same test loads or simulated loads and record the data as indicated above. Decrease the relative humidity to 50 % and decrease the temperature in the chamber to the reference temperature. After stabilisation of the EUT, apply the same test loads or simulated loads and record the data as indicated above.

Allow full recovery of the EUT before any other tests are performed.

Maximum allowable variations: All errors shall be within the maximum permissible errors specified in 2.2.2 for initial verification.

A.7.2.4 AC mains voltage variation (2.7.2)

AC mains voltage variation tests are carried out according to basic standard IEC Publication 61000-4-11(2001)*, as detailed in Bibliography [3] and according to Table 10.

Table 10

Environmental phenomena	Test specification	Test set-up standard
Voltage variation	Reference voltage	IEC 61000-4-11
	Reference V +10%	
	Reference V –15%	
	Reference voltage	
Reference voltage shall be as defined at IEC 61000-4-11 section 5, refer to Bibliography [3] for specific parts of the IEC test.		

Supplementary information to the IEC test procedures:

Object of the test: To verify compliance with the provisions in 2.7.2 under conditions of voltage variations.

Test procedures in brief:

Pre-condition: None required.

Condition of the EUT: Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer.

Adjust the EUT as close to zero indication as practicable prior to the test. If it has an automatic zero-setting function then the instrument should be set to zero after applying each level of voltage.

Number of test cycles: At least one cycle.

Test load: The EUT shall be tested with a test or simulated load at or near Min and with one test load or simulated load between 50 % and the maximum capacity of the EUT.

Test information: Stabilise the power supply at the reference voltage within the defined limits and record:

a) date and time;
b) temperature;
c) relative humidity;
d) power supply voltage;

*Or the most recent issue of the publication valid at the time of testing the instrument.

e) test loads;
f) indications (as applicable);
g) errors;
h) functional performance.

Repeat the test for each of the voltages defined in IEC 61000-4-11 section 5 (noting the need in certain cases to repeat the test at both ends of the voltage range) and record the indications.

Maximum allowable variations: All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 2.2.2 for initial verification.

A.7.2.5 DC mains power voltage variation (2.7.2)

Electronic instruments with DC mains power supply shall fulfil the tests in A.6.2, with the exception of A.6.2.4 which is to be replaced by the test according to basic standard IEC Publication 60654-2 (2001)*, as detailed in Bibliography [4] and according to Table 11.

Table 11

Environmental phenomena	Test specification	Test set-up standard
DC mains voltage variations	Reference voltage V	IEC 60654-2
	Maximum operating voltage V	
	Minimum operating voltage V (2.7.2)	
Where V is the value marked on the instrument; if a range of voltages (V_{min}, V_{max}) is marked then the test shall be performed at V_{max} + 20 % and V_{min} + 20 %.		

Supplementary information to the IEC test procedures:

Object of the test: To verify compliance with the provisions in 2.7.2 under conditions of variations in DC mains power supply

Test procedure in brief: The test consists of exposure to the specified power supply condition for a period sufficient for achieving temperature stability and for performing the required measurements.

Pre-condition: None

Condition of the EUT Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test and do not readjust at any time during the test except to reset if a significant fault has been indicated.

Number of test cycles: At least one cycle.

Test information: Stabilise the power supply at the reference voltage within the defined limits and record:

*Or the most recent issue of the publication valid at the time of testing the instrument.

a) date and time;
b) temperature;
c) relative humidity;
d) power supply voltage;
e) test loads;
f) indications (as applicable);
g) errors;
h) functional performance.

Repeat the test for each of the voltages defined in IEC 60654-2 and record the indications.

Maximum allowable variations: All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 2.2.2 for initial verification.

A.7.2.6 Battery power supply (DC) (2.7.2)

Battery-powered instruments shall fulfil the tests in A.7.2, with the exception of A.7.2.4 and A.7.2.5 which are to be replaced by the test in Table 12.

Table 12

Environmental phenomena	Test specification	Test set-up standard
Battery power voltage variations	Reference voltage V	None
	Maximum operating voltage V	
	Minimum operating voltage V (2.7.2)	
Where V is the value marked on the instrument; if a range of voltages (V_{min}, V_{max}) is marked then the test shall be performed at V_{max} + 20 % and V_{min} + 20 %.		

Supplementary information to the IEC test procedures:

Object of the test: To verify compliance with the provisions in 2.7.2 under conditions of variations in battery power supply

Test procedure in brief: The test consists of exposure to the specified condition of the battery for a period sufficient for achieving temperature stability and for performing the required measurements.

Pre-condition: None

Condition of the EUT: Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test and do not readjust at any time during the test except to reset if a significant fault has been indicated.

Number of test cycles: At least one cycle.

Test information: Stabilise the power supply at the reference voltage within the defined limits and apply the measurement. Record:

a) date and time;
b) temperature;
c) relative humidity;
d) power supply voltage;
e) test loads;
f) indications (as applicable);
g) errors;
h) functional performance.

Reduce the power voltage to the EUT until the instrument ceases to function properly according to the specifications and metrological requirements, and record the indications

Maximum allowable variations: All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 2.2.2 for initial verification.

A.7.2.7 Voltage variations of a road vehicle battery

The upper limits specified for this test are in accordance with ISO/DIS 7637-2.3 (2003), Bibliography [5]. For specifications of the power supply used during the test to simulate the battery, refer to ISO 7637-2 (1996)* as detailed in Bibliography [6] and according to Table 13.

Table 13

Environmental phenomena	Test specification		Test set-up standard(s)
	Voltage	Severity	
Voltage variations of a road vehicle battery	Reference	Sufficient to achieve stability	ISO/DIS 7637-2.3, § 4.2 and 5 ISO 7637-2, § 4.4
	U_n = 12 V	14.5 V	
	U_n = 24 V	29.0 V	
	All batteries	Minimum operating voltage (2.7.2)	

Supplementary test information:

Object of the test: To verify compliance with the provisions in 2.7.2 under conditions of road vehicle battery voltage variations.

Test procedure in brief: The test consists of exposure to the specified power supply condition for a period sufficient for achieving temperature stability and for performing the required measurements.

* Or the most recent issue of the publication valid at the time of testing the instrument.

Preconditioning:	None
Condition of the EUT	Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test. If it has an automatic zero-setting function then the instrument should be set to zero after applying each level of voltage.
Number of test cycles:	At least one cycle for each functional mode.
Test load:	The EUT shall be tested with a test or simulated load at or near Min and with one test load between 50% and Max of the EUT.
Test information:	Stabilize the power supply at a voltage within the defined limits in Table 13 and record the following: a) date and time; b) temperature; c) relative humidity; d) power supply voltage; e) test loads; f) indications (as applicable); g) errors; h) functional performance. Repeat the weighing test for each of the defined voltages and record the indications.
Maximum allowable variations:	All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 2.2.2 for initial verification.

A.7.3 Disturbance tests (4.1.2)

Summary of tests		
Test	Condition applied	§
Short time power reduction	sf (*)	A.7.3.1
Bursts	sf	A.7.3.2
Electrostatic discharge	sf	A.7.3.3
Electromagnetic susceptibility	sf	A.7.3.4
Transient immunity test	sf	A.7.3.6

(*) value of the significant fault (see T.4.2.7)

A.7.3.1 Short time power reduction

AC mains short time power reduction (voltage dips and short interruptions) tests are carried out according to basic standard IEC Publication 61000-4-11(2001)* as detailed in Bibliography [7] and according to Table 14.

*Or the most recent issue of the publication valid at the time of testing the instrument.

Table 14

Environmental phenomena	Test specification	Test set-up standard
Voltage dips and short interruptions.	Interruption from reference voltage to zero voltage for one half cycle Interruption from reference voltage to 50 % of reference voltage for two half cycles. These mains voltage interruptions shall be repeated ten times with a time interval of at least 10 seconds.	IEC 61000-4-11
The reference voltage (rated voltage) shall be as defined at IEC 61000-4-11 section 5, refer to bibliography [7] for specific parts of the IEC test.		

Supplementary information to the IEC test procedures:

Object of the test: To verify compliance with the provisions in 4.1.2 under conditions of short time mains voltage interruptions and reductions.

Test procedures in brief:

Precondition: None required.

Condition of the EUT: Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer.

Adjust the EUT as close to zero indication as practicable prior to the test. Zero-setting functions shall not be in operation. The EUT shall not be readjusted at any time during the test except to reset if a significant fault has been indicated.

Number of test cycles: At least one cycle.

Test load: The EUT shall be tested with one small test load.

Test information: Stabilise all factors at nominal reference conditions. Apply the test load and record:

a) date and time;
b) temperature;
c) power supply voltage;
d) test load;
e) indications;
f) errors;
g) functional performance.

Interrupt the power supply to zero voltage for a period equal to one half cycle and conduct the test as detailed in IEC 61000-4-11 section 8.2.1. During interruption observe the effect on the EUT and record as appropriate.

Reduce the power supply to 50 % of nominal voltage for a period equal to two half cycles and conduct the test as detailed in IEC 61000-4-11 section 8.2.1. During reductions observe the effect on the EUT and record as appropriate.

Maximum allowable variations: The difference between the indication due to the disturbance and the indication without the disturbance either shall not exceed the value given in T.4.2.7, or the EUT shall detect and act upon a significant fault.

A.7.3.2 Electrical fast transients/burst immunity

Electrical fast transients/burst immunity tests are carried out according to basic standard IEC 61000-4-4 (2001)*, as detailed in Bibliography [8], for 2 minutes with a positive polarity and for 2 minutes with a negative polarity according to Tables 15.1, 15.2 and 15.3.

Table 15.1: Ports for signal lines and control lines

Environmental phenomena	Test specification	Test set-up standard
Fast transient common mode	0.5 kV (peak) 5/50 ns T_1/T_h 5 kHz rep. Frequency	IEC 61000-4-4
Note: Applicable only to ports or interfacing with cables whose total length may exceed 3m according to the manufacturer's functional specification.		

Table 15.2: Input and output DC power ports

Environmental phenomena	Test specification	Test set-up standard
Fast transient common mode	1 kV (peak) 5/50 ns T_1/T_h 5 kHz rep. Frequency	IEC 61000-4-4
Note: Not applicable to battery operated appliances that cannot be connected to the mains while in use.		

Table 15.3: Input and output AC power ports

Environmental phenomena	Test specification	Test set-up standard
Fast transient common mode	1 kV (peak) 5/50 ns T_1/T_h 5 kHz rep. Frequency	IEC 61000-4-4

A coupling/decoupling network shall be applied for testing AC power ports.

Supplementary information to the IEC test procedures

Object of the test: To verify compliance with the provisions in 4.1.2 under conditions where fast transients are superimposed on the mains voltage while observing the indication for one small test load.

Test procedures in brief:

* Or the most recent issue of the publication valid at the time of testing the instrument.

Precondition:	None required.
Condition of the EUT:	Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Reset the EUT if a significant fault has been indicated.
Stabilisation:	Before any test stabilise the EUT under constant environmental conditions.
Test information:	With the single static load in place record the following with and without the transients: a) date and time, b) temperature, c) test load, d) indications (as applicable).
Maximum allowable variations:	The difference between the indication due to the disturbance and the indication without the disturbance either shall not exceed the value given in T.4.2.7 or the instrument shall detect and act upon a significant fault.

A.7.3.3 Electrostatic discharge

Electrostatic discharge tests are carried out according to basic standard IEC 61000-4-2 (2001)*, as detailed in Bibliography [9], with test signals and conditions as given in Table 16.

Table 16

Environmental phenomena	Test specification	Test set-up standard
Electrostatic discharge	8 kV air discharge 6 kV contact discharge	IEC 61000-4-2
Note: The 6 kV contact discharge shall be applied to conductive accessible parts. Metallic contacts, e.g. in battery compartments or in socket outlets are excluded from this requirement.		

Supplementary information to the IEC test procedures:

Object of the test:	To verify compliance with the provisions in 4.1.2 under conditions where electrostatic discharges are applied while observing the indication for one small static test load.
Test procedures in brief:	Contact discharge is the preferred test method. 20 discharges (10 with positive and 10 with negative polarity) shall be applied on each accessible metal part of the enclosure. The time interval between successive discharges shall be at least 10 seconds. In the case of a non conductive enclosure, discharges shall be applied on

*Or the most recent issue of the publication valid at the time of testing the instrument.

	the horizontal or vertical coupling planes as specified in IEC 61000-4-2 (2001). Air discharges shall be used where contact discharges cannot be applied. Tests with other (lower) voltages than those given in Table 16 are not required. The performance of the EUT shall be verified.
Precondition:	None required.
Condition of the EUT:	Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Reset the EUT if a significant fault has been indicated.
Stabilisation:	Before any test stabilise the EUT under constant environmental conditions.
Test information:	With the single static load in place record the following with and without electrostatic discharge: a) date and time, b) temperature, c) test load, d) indications (as applicable).
Maximum allowable variations:	The difference between the indication due to the disturbance and the indication without the disturbance either shall not exceed the value given in T.4.2.7 or the instrument shall detect and act upon a significant fault.

A.7.3.4 Electromagnetic susceptibility

A.7.3.4.1 Radiated

Radiated, radio-frequency, electromagnetic (EM) field immunity tests (radio-frequency EM fields higher than 80 MHz) are carried out in accordance to IEC 61000-4-3 (2002)* as detailed in Bibliography [10] and according to Table 17.

Table 17: Enclosure port

Environmental phenomena	Test specification		
	Frequency ranges	Test field strength (RMS)	Test set-up standard
Radio-frequency EM field of general origin	80 MHz to 800 MHz	10 V/m	IEC 61000-4-3
	960 MHz to 1400 MHz		
Radio-frequency EM	800 MHz to 960 MHz	10 V/m	IEC 61000-4-3

*Or the most recent issue of the publication valid at the time of testing the instrument.

field caused by digital radio telephones	1.4 GHz to 2 GHz		
Modulation	80 % AM, 1 kHz sine wave		

Supplementary information to the IEC test procedures

Object of the test:	To verify compliance with the provisions in 4.1.2 under conditions of specified EM fields applied while observing the weight indication for one small static test load.
Test procedures in brief:	The EUT shall be exposed to EM field strength as specified in Table 17. The frequency ranges to be considered are swept with the modulated carrier. The performance of the EUT shall be verified.
Preconditioning:	None required.
Condition of the EUT:	Normal power supplied and «on» for a time period equal to or greater than the warm-up time specified by the manufacturer. Reset the EUT if a significant fault has been indicated.
Stabilization:	Before any test stabilize the EUT under constant environmental conditions.
Test information:	With the single static load in place record the following with and without electromagnetic fields: a) date and time, b) temperature c) test load d) indications (as applicable)
Maximum allowable variations:	The difference between the indication due to the disturbance and the indication without the disturbance either shall not exceed the value given in T.4.2.7 or the instrument shall detect and act upon a significant fault.

A.7.3.4.2 Conducted

Conducted, radio-frequency, electromagnetic field (EM) immunity tests (radio-frequency EM fields lower than 80 MHz) are carried out in accordance to IEC 61000-4-6 (2001)* as detailed in Bibliography [11] and according to Table 18.

Table 18

Environmental phenomena	Test specification

*Or the most recent issue of the publication valid at the time of testing the instrument.

	Frequency range	Test field strength (e.m.f.)	Test set-up standard
Radio-frequency EM field	150 kHz to 80 MHz	10 V	IEC 61000-4-6
Modulation	80 % AM, 1 kHz sine wave		

Supplementary information to the IEC test procedures:

Object of the test: To verify compliance with the provisions in 4.1.2 under conditions of specified conducted EM fields while observing the weight indication for one small static test load.

Test procedures in brief: Radio frequency EM current, simulating the influence of EM fields shall be coupled or injected into the power ports and input ports of the EUT using coupling and decoupling devices. The performance of the EUT shall be verified.

Precondition: None required.

Condition of the EUT: Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Reset the EUT if a significant fault has been indicated.

Stabilisation: Before any test stabilise the EUT under constant environmental conditions.

Test information: With the single static load in place record the following with and without electromagnetic fields:

a) date and time,
b) temperature,
c) test load,
d) indications (as applicable).

Maximum allowable variations: The difference between the indication due to the disturbance and the indication without the disturbance either shall not exceed the value given in T.4.2.7 or the instrument shall detect and act upon a significant fault.

A.7.3.5 Transient immunity test

A.7.3.5.1 Electrical transient conduction along supply lines of 12 V and 24 V vehicle batteries

Transient immunity tests along supply lines of 12 V and 24 V vehicle batteries are carried out in accordance to ISO/DIS 7637-2.3 (2003) as detailed in Bibliography [5] and according to Table 19.

Table 19

Environmental phenomena	Test specification					
	Test pulse	Voltage		Test severity		Test set-up standard
Transient immunity tests	pulse 1:	U_n = 12 V		U_s	-100 V	ISO/DIS 7637-2.3 § 4.6.1: Test pulse 1 § 4.6.2: Test pulse 2a + 2b § 4.6.3: Test pulse 3a + 3b § 4.6.4: Test pulse 4
		U_n = 24 V		U_s	-600 V	
	pulse 2:	U_n = 12 V	pulse 2a	U_s	+50 V	
			pulse 2b	U_s	+10 V	
		U_n = 24 V	pulse 2a	U_s	+50 V	
			pulse 2b	U_s	+20 V	
	pulse 3:	U_n = 12 V	pulse 3a	U_s	-150 V	
			pulse 3b	U_s	+100 V	
		U_n = 24 V	pulse 3a	U_s	-200 V	
			pulse 3b	U_s	+200 V	
	pulse 4:	U_n = 12 V		U_s	-7 V	
		U_n = 24 V		U_s	-16 V	

Supplementary test information:

Object of the test

To verify compliance with the provisions in 4.1.2 under the following conditions:

- Transients on the supply lines due to supply disconnection from inductive loads (pulse 1);
- transients due to a sudden interruption of currents in a device connected in parallel with the device under test due to the inductance of the wiring harness (pulse 2a);
- transients from DC motors acting as generators after the ignition is switched off (pulse 2b);
- transients on the supply lines, which occur as a result of the switching processes (pulses 3a and 3b);
- voltage reductions caused by energizing the starter-motor circuits of internal combustion engines (pulse 4).

Test procedure in brief:

The test consists of exposure of the EUT to disturbances on the power voltage by direct brief coupling on supply lines while observing the weight indications for a small static load.

Stabilisation:

Before any test stabilise the EUT under constant environmental conditions.

Preconditioning:

None

Condition of the EUT:

Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable prior to the test. Reset the EUT if a significant fault has been indicated.

Test sequence: Apply the test pulses and record the following:

a) date and time
b) temperature
c) test pulses
d) test loads
e) indications (as applicable)
f) functional performance at defined voltages

Repeat the test for the defined voltages and record the indications.

Maximum allowable variations: The difference between the indication due to the disturbance and the indication without the disturbance either shall not exceed the value given in T.4.2.7 or the instrument shall detect and act upon a significant fault.

A.7.3.5.2 Electrical transient conduction via lines other than supply lines for 12 V and 24 V vehicle batteries.

Transient immunity tests via lines other than supply lines for 12 V and 24 V vehicle batteries are carried out in accordance to ISO 7637-3 (2003) as detailed in Bibliography [12] and according to Table 20.

Table 20

Environmental phenomena	Test specification			
	Nominal voltage	Test severity		Test set-up standard(s)
Transient immunity tests	U_n = 12 V	U_s	-60 V	ISO 7637-3 § 4.5: Test pulses a and b
		U_s	+40 V	
	U_n = 24 V	U_s	-80 V	
		U_s	+80 V	

Supplementary test information:

Object of the test: To verify compliance with the provisions in 4.1.2 under conditions of transients which occur on other lines as a result of the switching processes (pulses a and b).

Test procedure in brief: The test consists of exposure of the EUT to bursts of voltage spikes by capacitive and inductive coupling via lines other than supply lines while observing the indication.

Preconditioning: None

Condition of the EUT: Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Reset the EUT if a significant fault has been indicated.

Stabilisation: Before any test stabilise the EUT under constant environmental conditions

Weighing and test sequence: Apply the test pulses and record the following:

a) date and time
b) temperature
c) test pulses
d) test loads
e) indications (as applicable)
f) functional performance

Repeat the test weighing for the defined voltages and record the indications.

Maximum allowable variations: The difference between the indication due to the disturbance and the indication without the disturbance either shall not exceed the value given in T.4.2.7 or the instrument shall detect and act upon a significant fault.

A.8 Span stability test (4.4.3)

Summary of test		
Test	Condition applied	§
Span stability	½ absolute MPE(*)	A.8

(*)maximum permissible error on initial verification given in 2.2.2.

Note: the maximum permissible error for the zero point shall also be taken into consideration.

Test method: Span stability.

Object of the test: To verify compliance with the provisions in 4.4.3 after the EUT has been subjected to the performance tests.

Reference to standard: No reference to international standards can be given at present time.

Test procedures in brief: The test consists of observing the variations of the error of the EUT or simulator under sufficiently constant ambient conditions (reasonably constant conditions in a normal laboratory environment) at various intervals: before, during and after the EUT has been subjected to performance tests.

The performance tests shall include the temperature test and, if applicable, the damp heat test. Other performance tests listed in this Annex may be performed.

	The EUT shall be disconnected twice from the mains power supply (or battery supply where fitted) for at least 8 hours during the period of the test. The number of disconnections may be increased if so specified by the manufacturer or at the discretion of the approval authority in the absence of any specification. In the conduct of this test, the operating instructions for the instrument as supplied by the manufacturer shall be considered.
Test severity:	Test duration: 28 days or the time period necessary to conduct the performance tests, whichever is less. Time (t) between tests (days): $0.5 \leq t \leq 10$. Test load: near maximum capacity (Max); the same test weights shall be used throughout the test.
Maximum allowable variations:	The variation in the errors of indication shall not exceed half the absolute value of the maximum permissible error in clause 2.2.2 for initial verification for the test load applied on any of the n measurements.
Number of tests (n):	At least 8 except where the differences of the results indicate a trend more than half the allowable variation specified, the measurements shall be continued until the trend comes to rest or reverses itself, or until the error exceeds the maximum allowable variation.
Precondition:	None required.
Test equipment:	Verified mass standards or simulated loads.
Condition of the EUT:	Normal power supplied and “on” for a time period equal to or greater than the warm-up time specified by the manufacturer. The EUT shall be stabilised at sufficiently constant ambient conditions after switch-on for at least five hours, and at least 16 hours after the temperature and damp heat tests have been performed.
Test sequence:	Stabilise all factors at sufficiently constant ambient conditions. Adjust the EUT as close to zero as possible. Automatic zero-tracking shall be made inoperative and any automatic built-in span adjustment device shall be made inoperative. Apply the test load (or simulated load) and determine the error. After the first measurement immediately repeat zeroing and loading four times to determine the average value

of the error. For the subsequent measurements perform only one, unless either the result is outside the specified tolerance or the range of the five readings of the initial measurement is more than 0.1 *d*.

Record the following data:

a) date and time;
b) temperature;
c) relative humidity;
d) test load;
e) indication;
f) errors;
g) changes in test location,

and apply all necessary corrections resulting from variations in temperature, etc. between the various measurements.

Allow full recovery of the EUT before any other tests are performed.

A.9 PROCEDURE FOR IN-MOTION TESTS

A.9.1 General

Note the accuracy classes required for the total mass of the vehicle and, if required, for axle load and axle-group load.

Ensure that the desired scale interval and the maximum capacity comply with Table 6. Check that the minimum capacity complies with 2.4.

For type approval, tests shall be carried out in accordance with national regulations and corresponding to the approval requirement of the applicant.

For initial verification, tests shall be carried out corresponding to the normal site operation of the instrument.

A.9.2 Control instrument

Establish whether or not the WIM instrument is to be used as an integral control instrument. If it is an integral control instrument then it shall comply with 6.2.3 and be tested, using the test methods in 6.3, in accordance with A.5.2.

If vehicles have to be moved over some distance from a separate control instrument to the EUT, the conditions must be closely controlled. Differences in weather conditions will cause errors which will not be determinable and so this should be avoided where possible. Consideration shall also be given to the amount of fuel used and any possible effects that this could have on the reference values.

A.9.3 Weighing

A.9.3.1 Static weighing

If the WIM instrument is provided with a static weighing mode, the static weighing test detailed at A.9.3.1.1 shall be applied. Where the instrument has been tested according to the test at A.9.2 then those results may be used.

A.9.3.1.1 Static weighing test

Apply test loads from zero up to and including Max, then remove the test loads back to zero. Where the size of the load receptor prevents loading to Max the reduced load should be noted. However, where a reduced load is used, it shall be at least 50 % of Max. At least ten different load values shall be selected. The values of the loads selected shall include Max and Min, and values at or near those at which the maximum permissible error (MPE) changes.

It should be noted that when loading or unloading weights the load must be respectively increased or decreased in a uniform progression.

Ensure that the error is recorded at each change in load and calculate the errors according to A.3.5.2. Record the errors and compare them to the limits in 2.2.2 as appropriate for initial verification or in-service inspection.

A.9.3.1.2 Full-draught weighing of reference vehicles

Select the required number of reference vehicles as specified in 6.5.

a) The conventional true value (T.1.9) of the total mass of the unloaded reference vehicle shall be determined:

- by full-draught weighing of the unloaded reference vehicles on the control instrument.

b) The conventional true value (T.1.9) of the total mass of the loaded reference vehicle shall be determined:

- by loading the unloaded reference vehicles in a) above with standard test loads, or
- by full-draught weighing of the loaded reference vehicles on the control instrument.

A.9.3.1.3 Determining static reference single-axle loads for the two-axle rigid reference vehicle

For testing instruments to be used in applications where the single-axle loads are required, the conventional true value of the static reference single-axle loads shall be determined for the two-axle rigid reference vehicle by including a minimum of two different axle loads (see last paragraph of this section) using the following method.

Weigh each axle of the static two-axle rigid reference vehicle in-turn on the control instrument specified in 6.2.2 and record the indicated single-axle load. After both axles have been weighed, calculate the total mass of the vehicle (TMV) by the summation of the recorded values for the two axle loads and record the TMV value. This operation shall be conducted five times with the vehicle facing in the same direction, and a further five times with the vehicle facing in the opposite direction.

For each of the above weighing operations, ensure that the vehicle is stationary, with the wheels on the axle being weighed fully supported by the load receptor, the engine switched

off, the gear in neutral and the brakes released. Use wheel chocks, if necessary, to prevent vehicle motion.

(1) Calculate the mean static reference single-axle load for each axle on the two-axle rigid vehicle according to the following:

$$\overline{Axle_i} = \frac{\sum_1^{10} Axle_i}{10}$$

where

i is the single-axle rank
10 is the number of weighments of each static axle,
$Axle_i$ is the recorded load for that axle

(2) Summate the two mean single-axle loads to determine the mean of the total mass of the static vehicle:

$$\overline{\mathrm{TMV}} = \sum_{i=1}^{2} \overline{\mathrm{Axle}_i}$$

Alternatively, use the recorded values for the total mass of the vehicle (TMV) calculated after each vehicle weighment as described above and calculate the mean of the total mass of the static two-axle reference vehicle according to the following:

$$\mathrm{TMV} = \frac{\sum_1^{10} \mathrm{TMV}}{10}$$

(3) Calculate the corrected mean single-axle loads as follows:

$$\overline{\mathrm{CorrAxle_i}} = \overline{\mathrm{Axle_i}} \times \frac{\mathrm{TMV_{ref}}}{\overline{\mathrm{TMV}}}$$

where

TMV_{ref} is the conventional true value of the total mass of the reference vehicle determined by full-draught weighing in 6.7.

(4) For the purposes of this Recommendation, the conventional true value of the static reference single-axle loads (see T.3.1.9) for the two-axle rigid reference vehicle shall be the respective corrected mean single-axle load as calculated in (3) above.

(5) Traceability of the conventional true value of the single-axle loads on the static reference two-axle rigid vehicle is provided by the fact that the sum of the two corrected mean static reference single-axle loads equals the conventional true value of the total mass of the reference vehicle determined by single-draught weighing (6.7) on a suitable control instrument (6.2.2):

$$\overline{\mathrm{TMV_{ref}}} = \sum_{i=1}^{2} \overline{\mathrm{CorrAxle_i}}$$

The static reference single-axle loads shall be determined with the vehicle unloaded and loaded appropriately such that the axle loads cover, as far as practicable, the weighing range of the instrument. A minimum of two different axle loads, e.g. one near Min and one near Max (respectively at the maximum permissible axle load of the two-axle rigid reference vehicle) shall be tested.

A.9.3.2 In-motion tests

Prior to any test adjust the instrument under test in-situ and in accordance with the manufacturer's specifications.

All weighing operations shall be started with the reference vehicle positioned in advance of the approach apron at a distance sufficient for the vehicle to reach the approximate test speed before arriving at the apron.

The speed of each vehicle shall be kept as constant as feasible during each in-motion test.

At least ten test runs shall be carried out over the range of speeds that the instrument is required to be approved for:

- six test runs shall be made over the centre of the load receptor,
- two test runs shall be made to the left side of the load receptor,
- two test runs shall be made to the right side of the load receptor.

The test runs shall be conducted at each of three speeds as specified below using each reference vehicle loaded and unloaded:

(i) ten test runs at the typical site operation speed for the determination of the corrected mean single-axle loads and, if required, the corrected mean axle-group loads, and

(ii) ten runs distributed equally among speeds near v_{max} and v_{min} so that each reference vehicle is tested at least with two different speeds.

A.9.3.2.1 In-motion test with the two-axle rigid vehicle (5.1.3.2.1.1 a)

(1) In accordance with 6.6 and 6.9 record the two single-axle loads of the two-axle rigid vehicle as they are indicated or printed by the instrument under test.

(2) The maximum difference (error) between any recorded single-axle load and the appropriate static reference single-axle load (A.9.3.1.3) shall not exceed the applicable maximum permissible errors in 2.2.1.1.1 for the specified accuracy class.

A.9.3.2.2 In-motion tests with all other reference vehicle types (5.1.3.2.1.1 b)

(1) As specified in 6.6 and 6.9 conduct the specified number ($n \geq 20$) of tests, record the single-axle loads and, if required, the axle-group loads of the vehicle as they are indicated or printed by the instrument under test. If no criteria for defining various axle-groups are have been set by national prescription (T.3.1.8), all recorded axle loads (6.9) shall be considered as single-axle loads (T.3.1.11). Calculate the mean single-axle loads and, if required, the mean axle-group loads according to the following:

$$\overline{\text{Axle}_i} = \frac{\sum_1^n \text{Axle}_i}{n}$$

where

i is the single-axle rank
n is the number of in-motion tests, at least 20
Axle_i is the recorded load for that axle

and

$$\overline{\text{Group}_i} = \frac{\sum_1^n \text{Group}_i}{n}$$

where

i is the group rank; may be zero
n is the number of in-motion tests, at least 20
Group_i is the recorded load for that axle-group

(2) Use the values indicated or printed by the instrument under test and recorded as specified in 6.12 for the total mass of the vehicle (TMV) and calculate the mean of the total mass of the reference vehicle according to the following:

$$\overline{\text{TMV}} = \frac{\sum_1^n \text{TMV}}{n}$$

Alternatively, summate the mean single-axle loads and axle-group loads to determine the mean of the total mass of the vehicle:

$$\overline{\text{TMV}} = \sum_{i=1}^{q} \overline{\text{Axle}_i} \; + \; \sum_{i=0}^{g} \overline{\text{Group}_i}$$

where

q is the number of single axles on the vehicle
g is the number of axle-groups on the vehicle; may be zero

(3) Calculate the corrected mean single-axle loads and, if required, the corrected mean axle-group load(s) as follows:

$$\overline{\text{CorrAxle}_i} = \overline{\text{Axle}_i} \times \frac{\text{TMV}_{\text{ref}}}{\overline{\text{TMV}}} \qquad \overline{\text{CorrGroup}_i} = \overline{\text{Group}_i} \times \frac{\text{TMV}_{\text{ref}}}{\overline{\text{TMV}}}$$

where

TMV_{ref} is the conventional true value of the total mass of the reference vehicle determined by full-draught weighing in 6.7.

(4) To provide traceability, the sum of the corrected mean single-axle loads and axle-group loads for the reference vehicle should be equal to the conventional true value of the total mass of the reference vehicle:

$$\mathrm{TMV_{ref}} = \sum_{i=1}^{q} \overline{CorrAxle_i} + \sum_{i=0}^{g} \overline{\mathrm{CorrGroup_i}}$$

where

q is the number of axles
g is the number of axle-groups on the vehicle; may be zero

(5) Calculate the deviation of each single-axle load from the respective corrected mean single-axle load and, if required, the deviation of each axle-group load from the respective corrected mean axle-group load:

$$\mathrm{DevAxle_i} = \mathrm{Axle_i} - \overline{\mathrm{CorrAxle_i}}$$

$$\mathrm{DevGroup_i} = \mathrm{Group_i} - \overline{\mathrm{CorrGroup_i}}$$

(6) No deviation shall exceed the appropriate maximum permissible deviation as specified in 2.2.1.1.2 for the applicable accuracy class.

A.9.3.2.3 Total mass of the vehicle error evaluation

As specified in 5.1.3.2.2 the error for the total mass of the vehicle is:

$$E_{tmv} = TMV - TMV_{ref}$$

No error shall exceed the applicable maximum permissible error for the specified accuracy class in 2.2.1.2.

A.9.3.2.4 Test of operating speed interlock

Test runs with the two-axle reference vehicle shall be made at three different speeds:

- at a speed of 5 % in excess of the maximum operating speed (v_{max})
- at a speed of 5 % below the minimum operating speed (v_{min}) (if applicable).
- with a speed variation in excess of the maximum operating speed variation:

$$[(v_{max}-v_{min})/v_{min}]$$

The instrument shall detect the above conditions and not indicate or print any mass or load values unless there is a clear warning message on the indication and/or the printout. (3.5.7).

ANNEX B (MANDATORY)

PRACTICAL INSTRUCTIONS FOR THE INSTALLATION OF AUTOMATIC INSTRUMENTS FOR WEIGHING ROAD VEHICLES IN MOTION.

B.1 Installation of WIM instruments

The mandatory installation requirements are subject to change in recognition of future technical developments.

B.1.1 Weigh zone

The weigh zone shall comprise a load receptor with an apron on both ends.

B.1.2 Apron construction

The aprons in advance of and beyond the load receptors shall consist of a stable, load bearing structure made of concrete or an equally durable material resting on a suitable foundation to provide a straight, smooth, approximately-level plane surface to support all tyres of a vehicle simultaneously as the vehicle passes over the load receptors.

B.1.3 Apron geometry

Each of these aprons shall have a minimum length to fully support simultaneously all wheels of the longest vehicle type that will be weighed by the instrument. A reasonably smooth and level road surface shall be provided in advance of the approach apron of sufficient length and width for the test vehicle to reach the approximate test speed before arriving at the apron.

The aprons shall be permitted to have a transverse slope, not exceeding 1 %, for drainage purposes. To minimize load transfer between axles of the vehicle, the aprons shall have no longitudinal slope. The load receptor shall be mounted in the same plane as the aprons.

The apron shall have sufficient width throughout its length to extend transversely a minimum of 300 mm beyond each lateral edge of the load receptor.

The apron (and load receptor) shall have sufficient width to fully support the widest vehicle that will be weighed by the instrument.

B.1.4 Apron characteristics

To achieve the necessary levels of accuracy with the exception of WIM instruments for full-draught weighing, the aprons shall satisfy the following requirements for smoothness:

a) for 8 metres in advance of and beyond the load receptor, the apron surface must be within a tolerance of ± 3 mm from the level or transversely-sloped plane; and

b) areas of the apron outside the 8-metre distance must be within a tolerance of ± 6 mm from the level or transversely-sloped plane.

ANNEX C (INFORMATIVE)

GENERAL INSTRUCTIONS FOR THE INSTALLATION AND OPERATION OF AUTOMATIC INSTRUMENTS FOR WEIGHING ROAD VEHICLES IN MOTION

C.1 Spilt material and ice

Care shall be taken in the design and operation of the installation to ensure that, as far as possible, a build-up of spilt material and ice on the weigh zone of the instrument either does not occur, or is removed regularly.

C.2 Overhead structures

Load receptors shall not be installed beneath a loading or conveying mechanism from which loose material might fall.

C.3 Tare weighing

The time between tare weighing and gross weighing operations associated with a particular load shall be minimal.

C.4 Notice of speed restrictions

There shall be means to ensure that all drivers of vehicles that cross the load receptor are aware of the minimum and maximum operating speeds at which they can proceed.

C.5 Compliance checks

Compliance with the apron geometry and characteristics specified above shall be determined by a suitably qualified person not less than 30 days after apron construction is complete (to allow for the adverse effects of shrinkage in the concrete during curing) and before the site is first used.

A level datum shall be taken at a suitable point within the ”16 metre area” and its position marked on the drawing in the test report format. Its position shall be determined by taking elevations using a precise level and staff, and choosing the point which minimises the extent of any remedial work having regard to the requirements specified above.

A 400 mm x 400 mm (nominal) grid of level control points shall be marked out on the aprons for 8 metres either side of the load receptor(s). A 1 metre x 1 metre (nominal) grid of level control points shall be marked out on the remainder of the aprons. Setting out lines for the control points shall be shown on the drawing in the test report format. Elevations shall be taken on all those points using the precise level and staff.

A simple stability check shall be undertaken to monitor any changes in apron elevation under an axle load. A loaded two-axle vehicle, with a rear axle loading as near to the maximum capacity of the WIM instrument as feasible, shall pass at a low speed over the approximate longitudinal centre of the concrete aprons. Elevations shall be taken at the corners of each slab making up the apron at each transverse joint to ensure that as the vehicle crosses the joint, no movement in elevation is outside the tolerances specified B.2.1.4.

C.6 Routine durability checks

Surface level compliance checks should be repeated using the same level control points at time intervals specified by national prescription.

Note: There are a number of factors (e.g. level of usage, construction of aprons, etc.) which should be taken into consideration when specifying the time interval between compliance checks.

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