INTERNATIONAL
RECOMMENDATION

OIML R 134-1

Edition 2006 (E)

Automatic instruments for weighing road vehicles in motion and measuring axle loads

Part 1: Metrological and technical requirements – Tests

Instruments à fonctionnement automatique pour le pesage des véhicules routiers en mouvement et le mesurage des charges à l'essieu

Partie 1: Exigences métrologiques et techniques - Essais

OIML R 134-1 Edition 2006 (E)

ORGANISATION INTERNATIONALE
DE MÉTROLOGIE LÉGALE

INTERNATIONAL ORGANIZATION
OF LEGAL METROLOGY

Contents

Foreword

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Terminology

The terminology used in this Recommendation conforms to the *International Vocabulary of Basic and General Terms in Metrology* (VIM) [1], the *International Vocabulary of Legal Metrology* (VIML) [2], the *OIML Certificate System for Measuring Instruments* [3], and to OIML D 11 *General requirements for electronic measuring instruments* [4]. In addition, for the purposes of this Recommendation, the following definitions apply.

T.1 GENERAL DEFINITIONS

T.1.1 Weighing instrument

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

Note: In this Recommendation "mass" (or "weight value") is preferably used in the sense of "conventional mass" or "conventional value of the result of weighing in air" according to OIML R 111 [5] and OIML D 28 [6], whereas "weight" is preferably used for an embodiment (= material measure) of mass that is regulated in regard to its physical and metrological characteristics.

The instrument may also be used to determine other mass-related quantities, magnitudes, parameters or characteristics (e.g. axle load and axle-group load of a vehicle).

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

T.1.2 Automatic weighing instrument

Instrument that weighs without the intervention of an operator and that follows a predetermined program of automatic processes characteristic of the instrument.

T.1.3 Automatic instrument for weighing road vehicles in motion

Automatic weighing instrument, having a load receptor (T.2.3) and aprons (T.2.2.1), that determines the vehicle mass (T.3.1.5), axle loads (T.3.1.8), and if applicable the axle-group loads (T.3.1.11) of a road vehicle while the vehicle is crossing over the load receptor of the weighing instrument.

T.1.4 Control instrument

Weighing instrument used to determine the static reference vehicle mass of the reference vehicles and the static single-axle loads of a two-axle rigid reference vehicle.

The control instruments used as a reference instrument during testing may be:

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

T.1.5 Conventional true value (of a quantity)

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

T.1.6 Metrological authority

Legal entity (i.e. the verification, and/or issuing authority) designated or formally accepted by the government to be responsible for ascertaining that the automatic weighing instrument satisfies all or some specific 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

Place specified for the operation of instruments for weighing road vehicles in motion, which are installed in conformity with the requirements given in Annex B.

T.2.2 Weigh zone

Zone of the road comprising the load receptor with aprons in advance of and beyond each end of the load receptor in the direction of travel of the vehicle being weighed.

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 and that provides a straight, approximately-level, smooth track in the direction of travel of the vehicle being weighed.

T.2.3 Load receptor

Part of the weigh zone which receives the wheel loads of a vehicle and which realizes a change in the balance of the instrument when a wheel load is placed upon it.

T.2.4 Electronic instrument

Instrument equipped with electronic devices.

T.2.4.1 Electronic device

Device comprised of electronic sub-assemblies and that performs 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

Part of an electronic device comprised of electronic components and that has a recognizable function of its own.

T.2.4.3 Electronic component

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, etc.

T.2.5.1 Indicating device

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

Means to produce hard copies of the weighing results.

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 R 60] [7].

T.2.6 Software

T.2.6.1 Legally relevant software

Program(s), data and type-specific parameters that belong to the measuring instrument or device, and that define or fulfill functions which are subject to legal control.

Examples of legally relevant software are:

- final results of the measurement including the decimal sign and the unit;
- identification of the weighing range and the load receptor (if several load receptors have been used).

The following types of legally relevant software can be distinguished:

- type-specific; and
- device-specific.

T.2.6.2 Legally relevant parameter

Parameter of a measuring instrument or a module subject to legal control. The following types of legally relevant parameters can be distinguished: type-specific parameters and device-specific parameters.

T.2.6.3 Type-specific parameter

Legally relevant parameter with a value that depends on the type of instrument only. They are fixed at type approval of the instrument.

Examples of type-specific parameters are:

- parameters used for weight value calculation;
- stability analysis or price calculation and rounding;
- software identification.

T.2.6.4 Device-specific parameter

Legally relevant parameter with a value that depends on the individual instrument. Such parameters comprise calibration parameters (e.g. span adjustments or corrections) and configuration parameters (e.g. maximum capacity, minimum capacity, units of measurement, etc.). They are adjustable or selectable only in a special operational mode of the instrument. They may be classified as those that should be secured (unalterable) and those that may be accessed (settable parameters) by an authorized person.

T.2.6.5 Software identification

Sequence of readable characters of software that is inextricably linked to the software (e.g. version number, checksum).

T.2.6.6 Data storage

Storage used for keeping data ready after completion of the measurement for later legally relevant purposes.

T.2.7 Communication interface

Electronic, optical, radio or other hardware or software interface that enables information to be automatically passed between instruments and modules.

T.2.8 User interface

Interface that enables information to be passed between a human user and the instrument or its hardware or software components, e.g. switch, keyboard, mouse, display, monitor, printer, touch screen, etc.

T.2.9 Protective interface

Interface that prevents the introduction of any data into the data processing device of the instrument which may:

- display data that are not clearly defined and that could be taken as being a measurement result;
- falsify displayed, processed or stored measurement results or primary indications;
- adjust the instrument or change any adjustment factor.

T.2.10 Ancillary devices

T.2.10.1 Zero-setting device

Device for setting the indication to zero when there is no load on the load receptor.

T.2.10.2 Non-automatic zero-setting device

Zero-setting device that must be operated manually.

T.2.10.3 Semi-automatic zero-setting device

Zero-setting device that operates automatically following a manual command.

T.2.10.4 Automatic zero-setting device

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

T.2.10.5 Zero-tracking device

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.

T.3.1.2 Partial weighing

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

T.3.1.3 Weighing-in-motion (WIM)

Process of determining the vehicle mass, the axle load, and if applicable, the axle-group load of a moving vehicle (i.e. a vehicle crossing over the load receptor of the weighing instrument) 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 Vehicle mass (VM)

Total mass of the vehicle combination including all connected components.

T.3.1.6 Axle

Axis comprising two or more wheel assemblies with centers 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.3.1.7 Axle-group

Two or more 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 regulations.

T.3.1.8 Axle load

Fraction of the vehicle mass that is supported via the axle on the load receptor at the time of weighing.

T.3.1.9 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.3.1.7), all recorded axle loads (6.9) shall be considered as single-axle loads.

T.3.1.10 Static reference single-axle load

Single-axle load of known conventional true value determined statically (T.6.1) for a two-axle rigid vehicle.

T.3.1.11 Axle-group load

Sum of all axle loads in a defined group of axles; a fraction of the vehicle mass imposed on the axle-group at the time of weighing.

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

T.3.1.12 Tyre load

Portion of the vehicle mass imposed upon the tyre at the time of weighing, expressed in the units of mass.

T.3.1.13 Dynamic vehicle tyre force

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.3.1.14 Wheel load

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.3.2 Capacity

T.3.2.1 Maximum capacity (Max)

Maximum weighing-in-motion capacity of the load receptor without totalizing.

T.3.2.2 Minimum capacity (Min)

Value of the load below which the weighing-in-motion results before totalizing may be subject to an excessive relative error.

T.3.2.3 Weighing range

Range between the minimum and maximum capacities.

T.3.3 Scale interval, *d*

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

Value, expressed in units of mass, for stationary weighing vehicles or test weights that is the difference between two consecutive indicated or printed values.

T.3.4 Speed

T.3.4.1 Operating speed, *v*

Average velocity of the vehicle being weighed as it moves over the load receptor.

T.3.4.2 Maximum operating speed, v_{max}

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.3.4.3 Minimum operating speed, v_{min}

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.3.4.4 Operating speed range

Set of values specified by the manufacturer between the minimum and maximum operating speeds at which a vehicle may be weighed-in-motion.

T.3.4.5 Maximum transit speed

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

Time between the moment at which 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 weight value

Weighing value that is achieved when an automatic operation is ended and the instrument is completely at rest.

Note: This definition is only applicable to static weighing and not to weighing-in-motion.

T.3.8 Stable equilibrium

Condition of the instrument such that the recorded weighing values show no more than two adjacent values of each weighing cycle; with one of them being the final weight value. This condition is only valid for each separate weighing cycle and not for a group of cycles.

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 Indications of an instrument

Value of a quantity provided by a measuring instrument.

Note: "Indication", "indicate" or "indicating" include both displaying and/or printing.

T.4.1.1 Primary indications

Indications, signals and symbols that are subject to requirements of this Recommendation.

T.4.1.2 Secondary indications

Indications, signals and symbols that are not primary indications.

T.4.2 Methods of indication

T.4.2.1 Digital indication

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.4.2.2 Analog indication

Indication enabling the evaluation of the equilibrium position to a fraction of the scale interval.

T.4.3 Reading

T.4.3.1 Reading by simple juxtaposition

Reading of the weighing result by simple juxtaposition of consecutive figures giving the weighing result, without the need for calculation.

T.4.3.2 Overall inaccuracy of reading

Overall inaccuracy of reading of an instrument with analog indication is equal to the standard deviation of the same indication, the reading of which is carried out under normal conditions of use by several observers.

T.4.2 Errors

T.4.2.1 Error (of indication)

Indication of an instrument minus the (conventional) true value. [VIM 5.20]

T.4.2.2 Intrinsic error

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

T.4.2.3 Initial intrinsic error

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

T.4.2.4 Maximum permissible error, 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

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

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, memorized 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

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

T.4.2.9 Rounding error

Difference between a digital measurement result (indicated or printed) and the value of that measurement result with an analog indication.

T.4.2.10 Repeatability error

Difference between the highest and lowest results of successive measurements of the same load carried out under the same conditions of measurement. [VIM 3.6]

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.

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

Quantity that is not the measurand but that affects the result of the measurement.

T.5.1.1 Influence factor

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

T.5.1.2 Disturbance

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

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

T.6.2 In-motion test

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

T.6.3 Simulation test

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

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

T.7 VEHICLES

T.7.1 Vehicle

Loaded or unloaded road vehicle that is recognized by the instrument as a vehicle to be weighed.

T.7.2 Rigid vehicle

Road vehicle with a single chassis that includes neither coupling nor trailer, and that has two or more axles located along the length of the chassis that are oriented perpendicularly to the normal direction of travel of the vehicle.

T.7.3 Reference vehicle

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

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

determined on a control instrument (T.1.8).

T.8 Abbreviations and symbols

Symbols	Meaning
I	Indication
I_n	nth indication
L	Load
ΔL	Additional load to next changeover point
P	$I + 1/2\ d - \Delta L$ = Indication prior to rounding (digital indication)
E	$I - L$ or $P - L$ = Error
E %	$(P - L) / L$ %
E_0	Error at zero load
d	Actual scale interval
p_i	Fraction of the MPE applicable to a module of the instrument which is examined separately
MPE	Maximum permissible error
EUT	Equipment under test
sf	Significant fault
Max	Maximum capacity of the weighing instrument
Min	Minimum capacity of the weighing instrument
U_{nom}	Nominal voltage value marked on the instrument
U_{max}	Highest value of a voltage range marked on the instrument
U_{min}	Lowest value of a voltage range marked on the instrument
v	Operating speed
v_{min}	Minimum operating speed
v_{max}	Maximum operating speed
v_{min}, v_{max}	Operating speed range
DC	Direct current
AC	Alternating current
VM	Vehicle mass
WIM	Weigh-in-motion

Automatic instruments for weighing road vehicles in motion and measuring axle loads

1 GENERAL

1.1 Scope

This International Recommendation specifies the requirements and test methods for automatic instruments for weighing[1] road vehicles in motion, hereinafter referred to as “WIM instruments” that are used to determine the vehicle mass[2], the axle loads[3], and if applicable the axle-group loads[4] of road vehicles when the vehicles are weighed in motion[5].

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

Note: It is advisable for national legislation to prescribe more extensive verification methods than those prescribed in this Recommendation when WIM instruments are to used in a fully automatic mode for enforcement purposes (without the presence of a police officer).

1.2 Application

This Recommendation applies to WIM instruments:

- which are installed in a controlled weighing area (T.2.1);
- which are used for determining and indicating the vehicle mass, the single-axle loads, and if applicable the axle-group loads of a road vehicle in motion; and
- which are installed where the vehicle speed is controlled.

This Recommendation does not apply to WIM instruments that:

- determine individual axle loads by multiplying a single wheel load of an axle by two; or
- are installed on-board vehicles to measure axle load.

1.3 Terminology

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

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1 In this Recommendation, the term, “weighing” is as defined in T.1.1.
2 Total mass of the vehicle combination including all connected components (see T.3.1.5).
3 Fraction of the vehicle mass that is supported via the axle on the load receptor at the time of weighing (see T.3.1.8).
4 In determining the single-axle load, and if required the axle-group load, the conditions in 2.5 and, if appropriate the requirements of national regulation should be taken into account.
5 “Weighed in motion” means that the mass of the vehicle was determined while the vehicle was crossing over the load receptor of the WIM instrument.

2 METROLOGICAL REQUIREMENTS

2.1 Accuracy classes

2.1.1 Vehicle mass

For determining the vehicle mass, 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 regulations.

2.1.2 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

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

Note 2: The limitation of accuracy classes to certain applications may be determined by national regulation.

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 vehicle mass are as specified in Table 1 below.

Table 1

Accuracy class single-axle load and axle-group load	Accuracy class for vehicle mass					
	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 Vehicle mass

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

a) the value calculated according to Table 2, rounded to the nearest scale interval;

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

Table 2

Accuracy class for vehicle mass	Percentage of conventional value of the vehicle mass (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 %

2.2.1.2 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 2.2.1.2.1.

b) For all other reference vehicle single-axle loads and axle-group loads, the applicable limits of error are as specified in 2.2.1.2.2.

2.2.1.2.1 Maximum permissible error for two-axle rigid reference vehicle

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 the greater:

a) The value from Table 3 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 3

Accuracy class for single-axle load	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 %

2.2.1.2.2 Maximum permissible deviation (MPD) for all reference vehicle types except the two-axle rigid reference vehicle

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 the greater:

a) The value from Table 4 rounded to the nearest scale interval;

b) 1 $d \times n$ in the case of initial verification,
2 $d \times n$ in the case of in-service inspection,
Where n is the number of axles in the group, with $n = 1$ for single axles.

Table 4

Accuracy class for single-axle load and axle-group load	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 %

2.2.2 Static weighing

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

Table 5

Accuracy class for vehicle mass	Load, *m*, expressed in scale intervals	Maximum permissible errors	
		Initial verification	In-service inspection
0.2 0.5 1	$0 \le m \le 500$	± 0.5 *d*	± 1.0 *d*
	$500 < m \le 2\,000$	± 1.0 *d*	± 2.0 *d*
	$2\,000 < m \le 5\,000$	± 1.5 *d*	± 3.0 *d*
2 5 10	$0 \le m \le 50$	± 0.5 *d*	± 1.0 *d*
	$50 < m \le 200$	± 1.0 *d*	± 2.0 *d*
	$200 < m \le 1\,000$	± 1.5 *d*	± 3.0 *d*

Note: See Table 1 for the relationship between the accuracy classes for vehicle mass 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 load indicating and printing devices on an instrument shall have the same scale interval.

The relationship among 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

Accuracy class for vehicle mass	*d* (kg)	Minimum number of scale intervals	Maximum number of scale intervals
0.2	≤ 5	500	5 000
0.5	≤ 10		
1	≤ 20		
2	≤ 50	50	1 000
5	≤ 100		
10	≤ 200		

Note: See Table 1 for the relationship between the accuracy classes for vehicle mass 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 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

Accuracy class for vehicle mass			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 vehicle mass 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, the installation and testing requirements specified in Annex B and Annex A respectively, shall be applicable. In particular, the following effects on the weighing results should be taken into account:

- Lateral forces due to interactions of the control instrument with the vehicle;
- Forces on part of the vehicle by different transient behavior and friction within the axle suspensions;

- Forces on part of the ramps if there are different levels between the control instrument and ramp that could lead to varying distribution of the axle load.

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.

However, depending on local environmental conditions, 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 supply varies from the nominal voltage, U_{nom} (if only one voltage is marked on the instrument), or from the upper and lower limits of the voltage range, $U_{min} - U_{max}$, marked on the instrument at:

- AC mains power:

  Lower limit is $0.85 \times U_{nom}$ or $0.85 \times U_{min}$, upper limit is $1.10 \times U_{nom}$ or $1.10 \times U_{max}$;
- DC mains power, including rechargeable battery voltage supply if the battery can be fully (re)charged during the operation of the instrument:

  Lower limit is the minimum operating voltage, upper limit is $1.20 \times U_{nom}$ or $1.20 \times U_{max}$ (for a rechargeable battery, U_{max} is the voltage of a new or fully charged battery of the type specified by the manufacturer);
- Battery power (DC), non-rechargeable batteries, and also including rechargeable batteries if (re)charging of batteries during the operation of the instrument is not possible:

  Lower limit is the minimum operating voltage, upper limit is U_{nom} or U_{max};
- 12 V or 24 V road vehicle battery power:

  Lower limit is 9 V (for a 12 V battery) or 16 V (for a 24 V battery), upper limit is 16 V (for a 12 V battery) or 32 V (for a 24 V battery).

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

Battery-operated and DC mains powered instruments shall either continue to function correctly or not indicate any mass or load values if the voltage is below the manufacturer's specified value, the latter being larger than or equal to the minimum operating voltage.

2.8 Units of measurement

The 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 loads is not equal to the scale interval, *d*, it shall not be readily accessible when the instrument is in use for weighing-in-motion. In addition, if the instrument is not verified for use as a non-automatic weighing instrument (5.1.3), the scale interval for stationary loads shall not be readily accessible and shall only be used for static testing.

2.10 Operating speed (3.5.9)

WIM instruments shall comply with the appropriate metrological and technical requirements at vehicle speeds within the operating speed range:

- given by the operating speed interlock; or
- determined during the weighing test.

Operating speed shall be indicated and/or printed only after the entire vehicle has been weighed in motion.

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

WIM instruments shall have no characteristics likely to facilitate their fraudulent use.

3.2.2 Accidental breakdown and maladjustment

An instrument shall be so constructed that an accidental breakdown or maladjustment of control elements likely to disturb its correct functioning cannot take place without its effect being evident.

3.2.3 Interlocks

Interlocks shall prevent or indicate the operation of the instrument outside the specified working conditions. Interlocks are called for:

- minimum operating voltage (2.7.2);
- vehicle recognition (3.5.7);
- wheel position on the load receptor (3.5.8);
- direction of travel (3.5.8);
- range of operating speeds (3.5.9).

3.2.4 Use as a non-automatic weighing instrument

In addition to complying with the requirements of OIML R 76-1 [8] for non-automatic instruments, an instrument that can operate in a non-automatic mode shall be equipped with the means for enabling non-automatic operation that prevents both automatic operation and in-motion weighing.

3.2.5 Automatic operation

WIM instruments shall be designed to provide a level of confidence that their accuracy and operation comply with the requirements of this Recommendation for a period of at least one year of normal use. Any malfunction shall be automatically and clearly indicated (e.g. by a fault indication or by automatic switch off). The documentation supplied with the instrument (A.1.1) shall include a description of how this requirement is met.

The level of confidence shall take account of uncertainties of measurement, significant faults and failure of the instrument.

3.3 Zero-setting devices

3.3.1 Accuracy of the zero-setting device

WIM instruments 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;
- the instrument is in stable equilibrium;
- 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 Use as an integral control instrument

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

- 3.4.1 to 3.4.4 inclusive; and
- 6.2.1.

3.4.1 Zero-setting

WIM instruments 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, printing and data storage devices

3.5.1 Quality of indication

Reading of the primary indications (see T.4.1.1) shall be reliable, easy and unambiguous under conditions of normal use:

- the overall inaccuracy of reading of an analog indicating device shall not exceed 0.2 *d*;
- the figures, units and designations forming the primary indications shall be of a size, shape and clarity for reading to be easy.

The indication shall be the self-indicating type and shall bear the name or symbol of the appropriate unit of mass. The scales, numbering and printing shall permit the figures which form the results to be read by simple juxtaposition (see T.4.3.1).

3.5.2 Indication and printout for normal operation

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

For normal operation the scale interval of indications or printouts for the vehicle mass, the single-axle load or the axle-group load shall be the scale interval, *d*, in accordance with 2.3.

The results shall bear the name or symbol of the appropriate unit of mass in accordance with 2.8.

For WIM instruments to be used in applications concerned only with determining the vehicle mass, the minimum printout shall be the vehicle mass, the date and the time, and the operating speed with an associated clear warning message, if applicable. The individual axle or axle-group loads shall not be printed without an associated clear 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 vehicle mass, the date and the time, and the operating speed with an associated clear warning message, if applicable. The criteria for defining axle-groups need not be specified for the instrument. The vehicle mass and the axle-group loads shall not be printed without an associated clear warning that these results are not verified.

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 vehicle mass, the date and the time, and the operating speed with an associated clear warning message, if applicable. The criteria for defining axle-groups shall be specified for the instrument. The vehicle mass shall not be printed without an associated clear warning that these results are not verified.

3.5.3 Limits of indication

WIM instruments shall not indicate or print the single-axle loads, axle-group loads or the vehicle mass when the 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 Printing device

Printing shall be clear and permanent for the intended use. Printed figures shall be at least 2 mm high.

If printing takes place, the name or the symbol of the unit of measurement shall be either to the right of the value or above a column of values, or placed in accordance with national regulations.

3.5.5 Data storage

Measurement data may be stored in a memory of the instrument (hard drive) or on external storage for subsequent indication, printing, data transfer, totalizing, etc. In this case, the stored data shall be adequately protected against intentional and unintentional changes during the transmission and/or storage process and shall contain all relevant information necessary to reconstruct an earlier measurement.

For securing stored data, the following apply:

c) The appropriate requirements for securing in 3.6 and in 3.8;

d) Software transmission and downloading process shall be secured in accordance with the requirements in 3.6;

e) External storage device identification and security attributes shall ensure integrity and authenticity;

f) Exchangeable storage media for storing measurement data need not be sealed provided that the stored data is secured by a specific checksum or key code;

g) When storage capacity is exhausted, new data may replace oldest data provided that the owner of the old data has given authority to overwrite the old data.

3.5.6 Totalizing device

WIM instruments may be provided with a totalizing device which operates:

- automatically, in which case the instrument shall be provided with a vehicle recognition device (3.5.7); or
- semi-automatically (i.e. it operates automatically following a manual command).

3.5.7 Vehicle recognition device

WIM instruments which are able to operate without the intervention of an operator shall be provided with a vehicle recognition device. The device shall detect the presence of a vehicle in the weigh zone (T.2.2) and shall detect when the whole vehicle has been weighed. WIM instruments shall not indicate or print the vehicle mass unless all of the wheels of the vehicle have been weighed.

3.5.8 Vehicle guide device

WIM instruments shall not indicate or print the vehicle mass, the single-axle load, or the axle-group load 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 all the wheels of the vehicle pass fully over the load receptor.

If only one direction of travel is specified for an instrument, an error message shall be given or the instrument shall not indicate or print the vehicle mass, the single-axle load, or the axle-group load if a vehicle travels in the wrong direction. Alternatively, barriers or other traffic control methods may be used to prevent vehicles traveling in the wrong direction.

3.5.9 Operating speed (6.13)

The WIM instrument shall not indicate or print the mass or axle load values for any vehicle that has traveled over the load receptor at a speed outside the specified range of operating speeds without an associated clear warning message that these results are not verified.

The operating speed shall be indicated and printed if applicable in km/h, rounded to the nearest 1 km/h, as part of every vehicle weighing record.

3.6 Software

The legally relevant software used in WIM instruments 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 signaled automatically by means of an identification code. National legislation may specify the securing that is required.

The software documentation on the instrument shall include:

a) A description of the legally relevant software;
b) A description of the accuracy of the measuring algorithms (e.g. programming modes);
c) A description of the user interface, menus and dialogues;
d) The unambiguous software identification;
e) A description of the embedded software;
f) An overview of the system hardware, e.g. topology block diagram, type of computer(s), source code for software functions, etc., if not described in the operating manual;
g) Means of securing software;
h) The operating manual.

3.6.1 Means of securing software

The following means of securing legally relevant software apply:

a) Access shall only be allowed to authorized 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 the interventions to be memorized and it shall be possible to access and display this information; the records shall include the date and a means of identifying the authorized person making the intervention (see a) above); the traceability of the interventions shall be assured for at least the period of time in between periodical verifications depending on national regulations. Records may not be overwritten, and if the storage capacities for records are exhausted, no further intervention shall be possible without breaking a physical seal;
c) Downloading of legally relevant software shall only be possible through an appropriate protective interface (T.2.9) connected to the instrument;
d) The software shall be assigned with appropriate software identification (T.2.6.4). This software identification shall be adapted in the case of every software change that may affect the functions and accuracy of the instrument;
e) Functions that are performed or initiated via a software interface shall meet the relevant requirements and conditions of 4.3.5.

3.7 Installation

3.7.1 General

WIM instruments shall be manufactured and installed so as to minimize any adverse effects of the installation environment. The space between the weighing instrument and the 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 for determining vehicle mass, axle loads, and if applicable axle-group loads shall comply with the installation requirements specified in Annex B.

3.7.2 Drainage

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

3.7.3 Heating

If the operation of the weighing mechanism is installed in low temperature climate environments, there shall be provision for heating to ensure that the devices operate within the operating conditions specified by the manufacturer.

3.8 Securing of components, interfaces and preset controls

3.8.1 General

Components, interfaces, software devices and preset controls that are not intended to be adjusted or removed by the user shall be fitted with a securing means or shall be enclosed. When enclosed, it shall be possible to seal the enclosure. National legislation may specify the securing that is required.

The seals should, in all cases, be easily accessible. Securing 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.

3.8.2 Means of securing

Securing shall be provided by hardware, passwords or similar software means provided that:

a) The requirements for securing software in 3.6 apply;
b) Transmission of legally relevant data via interfaces shall be secured against intentional, unintentional and accidental changes in accordance with the requirements of 4.3.5.2;
c) The securing possibilities available in an instrument shall be such that separate securing of the settings is possible;
d) Stored data shall be secured against intentional, unintentional and accidental changes in accordance with the requirements of 3.5.5.

3.9 Descriptive markings

WIM instruments shall bear the following basic markings, variable according to national regulations.

3.9.1 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
▪ power supply voltage	V
▪ power supply frequency	Hz
▪ temperature range (when not –10 °C to +40 °C)	°C
▪ software identification (if applicable)	

3.9.2 Markings shown in code

▪ accuracy class vehicle mass	0.2, 0.5, 1, 2, 5 or 10	
▪ accuracy class single-axle (where applicable)	A, B, C, D, E or F	
▪ accuracy class axle-group (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		

3.9.3 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, the designation of the liquid(s) which the instrument is designed to weigh (if applicable), or 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.

3.9.4 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.

Descriptive markings may be either in the national language or in the form of adequate, internationally agreed and published pictograms or signs.

Markings shall be grouped together in a clearly visible place on the instrument, either on a descriptive plate or sticker fixed permanently near the indicating device, or on a non-removable part of the instrument itself. In case of a plate or sticker which is not destroyed when removed, a means of securing shall be provided, e.g. a non removable control mark that can be applied.

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

As an alternative, all applicable markings above may be shown on a programmable display which is controlled by software provided that:

- at least Max, Min and *d* shall be displayed as long as the instrument is switched on;
- the other markings may be shown on manual command;
- this shall be described in the type approval certificate.

In this case, means shall be provided for any access to reprogramming of the markings to be automatically and non-erasably recorded and made evident by an audit trail, e.g. by traceable access software such as an event logger providing a record of the changes or an event counter providing a non-resettable counter of any changes.

These programmable display markings need not be repeated on the data plate, if they are shown on or indicated near the display of the weighing result, with the exception of the following markings which shall be shown on the data plate:

- type and class designation of the instrument;
- name or identification mark of the manufacturer;
- type approval number;
- voltage supply;
- voltage supply frequency;
- pneumatic/hydraulic pressure, (if applicable).

3.10 Verification marks

3.10.1 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.

3.10.2 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

Upon switch-on, a special procedure such as a display test facility which is automatically initiated at switch-on of indication (in the case of electronic instruments permanently connected to the mains at switch-on of indication) shall be performed that shows all relevant signs of the indicator in their active and non-active states sufficiently long to be checked by the operator. This is not applicable for nonsegmented displays, on which failures become evident, for example screen-displays, matrix-displays, etc.

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 communication interfaces (T.2.7) enabling the coupling of the instrument to external equipment and user interfaces (T.2.8) permitting the exchange of information between a human user and the instrument. When an interface is used, the instrument shall continue to function correctly and its metrological functions (including all metrologically relevant parameters and software) shall not be influenced.

4.3.5.1 Interface documentation

The documentation on the instrument interfaces shall include:

a) A list of all commands (e.g. menu items);
b) Description of the software interface;
c) A list of all commands together;
d) A brief description of their meaning and their effect on the functions and data of the instrument.

4.3.5.2 Securing of interfaces

Communication and user interfaces shall not allow the legally relevant software and functions of the instrument and its measurement data to be inadmissibly influenced by other interconnected instruments, or by disturbances acting on the interface.

An interface through which the functions mentioned above cannot be performed or initiated, need not be secured. Other interfaces shall be secured as follows:

a) Data shall be protected (e.g. with a protective interface as defined in T.2.9) against accidental or deliberate interference during the transfer;
b) All functions in the software interface shall be subject to the requirements for securing software in 3.8.2;
c) All functions in the hardware interface shall be subject to the requirements for securing hardware in 3.8;
d) It shall be easily possible to verify the authenticity and integrity of data transmitted to and from the WIM instrument;
e) Functions performed or initiated by other connected instruments through the interfaces shall meet the appropriate requirements of this Recommendation.

Other instruments required by national regulations to be connected to the interfaces of a WIM instrument shall be secured to automatically inhibit the operation of the WIM instrument for reasons of the non-presence or improper functioning of the required device.

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 [9] and D 20 [10] 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:

- metrological requirements in clause 2, particularly with reference to the appropriate limits of error when using the range of reference vehicles (6.5) and operating conditions specified by the manufacturer;
- technical requirements in clause 3;
- 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 used in non-automatic (static) operation in accordance with 2.2.2, meets the weighing performance test requirements of OIML R 76-1 [8].

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 Evaluation of errors and deviation for automatic weighing

5.1.3.2.1 Vehicle mass

For determination of the vehicle mass, the error for automatic weighing shall be the indicated reference vehicle mass observed and recorded (6.12) as appropriate, minus the conventional true value of the reference vehicle mass as defined in 6.7 as appropriate. The maximum permissible error shall be as specified in 2.1.1 for initial verification and as appropriate for the class of the instrument.

5.1.3.2.2 Single-axle load or axle-group load

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

5.1.3.2.2.1 Single-axle load

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

a) In-motion tests 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 maximum permissible errors shall be as specified in 2.2.1.2.1 for initial verification and as appropriate for the accuracy class of the instrument.
b) In-motion tests 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 maximum permissible deviation shall be as specified in 2.2.1.2.2 for initial verification and as appropriate for the accuracy class of the instrument.

5.1.3.2.2.2 Axle-group load

For axle-group load, the deviation for automatic weighing shall be determined as follows:

a) For WIM instruments which determine and indicate the loads independent of single-axles or axle-groups by summation of individual axle load errors in accordance with national regulations for axle-group load (see T.3.1.7).
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 maximum permissible deviation shall be as specified in 2.2.1.2.2 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.

5.1.3.3 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 clauses 2.7 and 4.

5.1.3.3.1 Apportioning of errors

Where modules of an instrument or system are tested separately 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, taking into account the following conditions:

- For purely digital devices, p_i may be equal to 0;
- For weighing modules, p_i may be equal to 1;
- For all other modules (including digital load cells), p_i shall not exceed 0.8 and shall not be less than 0.3, when more than one module contributes to the effect in question.

For mechanical structures including weighbridges evidently designed and manufactured according to sound engineering practice, an overall fraction $p_i = 0.5$ may be applied without any test, e.g. when levers are made of the same material and when the chain of levers has two planes of symmetry (longitudinal and transversal).

If the metrological characteristics of the load cell or other major component have been evaluated in accordance with the requirements of OIML R 60 [7] or any other applicable Recommendation, that evaluation shall be used to aid type evaluation if so requested by the applicant.

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 a control instrument. The instrument under test may be used as the control instrument provided that it complies with the requirements in 6.2.1.

5.1.5 Place of testing

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

- on a site at which all necessary tests can be conducted and agreed upon between the metrological authority and the applicant;
- at a laboratory considered appropriate by the metrological authority;
- at 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 (3.9);
- 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) that the instrument is intended to weigh. However, for instruments to be used in applications where the axle load is required, the test utilizing the two-axle rigid reference vehicle must be conducted.

5.2.1.2 In-motion test error evaluation

5.2.1.2.1 Vehicle mass

For all reference vehicle types, the error for automatic weighing shall be as specified in 5.1.3.2.1.

5.2.1.2.2 Single-axle load or axle-group load

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

5.2.1.2.2.1 Single-axle load

a) For in-motion tests with the two-axle rigid reference vehicle, the error for automatic weighing shall be as specified in 5.1.3.2.2.1 a).

b) For in-motion tests with all other reference vehicle types, the error for automatic weighing shall be as specified in 5.1.3.2.2.1 b).

5.2.1.2.2.2 Axle-group load

The error for automatic weighing shall be as specified in 5.1.3.2.2.2 for axle-group load.

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 a control instrument. The instrument under test may be used as the control instrument provided that it complies with the requirements in 6.2.1.

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 in 2.2 shall be applied.

6 TEST METHODS

6.1 Test procedures

6.1.1 Vehicle mass

For the vehicle mass a complete WIM instrument shall be tested for compliance with the requirements specified in 2.1.1 using the range of vehicles specified in 6.5, and if applicable also the integral control instrument (6.2.1) shall be tested.

6.1.2 Single-axle load and axle-group load

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:

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

6.2 Control instrument

A control instrument for determining the conventional true value of each reference vehicle mass shall be available for testing. The control instrument may either be separate or integral.

6.2.1 Integral control instrument

The WIM instrument under test may be used as the control instrument provided that it:

- has an appropriate scale interval or scale interval for stationary load (2.9); and
- complies with the requirements in 3.4.

6.2.2 Separate control instrument

6.2.2.1 Control instrument for full-draught vehicle weighing

A separate control instrument, capable of being used to determine the conventional true value of each reference vehicle mass by full-draught weighing when stationary, shall ensure the determination of the conventional true value of each reference vehicle's mass to an error not greater than one-third of whichever is the smaller of the appropriate MPE for in-motion tests in 2.1.1.

6.2.3 Control instrument for static reference single-axle load 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 one-third of whichever is the smaller of the appropriate MPE for in-motion tests in 2.2.1.2.1.
- be provided with approach and exit aprons in the same plane as the load receptor which shall extend to a length sufficient to fully support the two-axle rigid vehicle being weighed. The aprons shall have no longitudinal slope and not more than 1 % of transverse 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 or transversely-sloped plane passing through the load receptors during the weighing operations.

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:

a) minimum capacity;

b) maximum capacity;

c) at least two loads in between a) and b).

6.3.2 Distribution of test loads

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.

6.3.4 Repeatability tests

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

6.4 Verification standards

6.4.1 Weights

The standard weights or standard masses used for the type examination or verification of an instrument shall principally meet the metrological requirements of OIML R 111 [6]. 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

The test shall be carried out only during verification and at the place of use taking A.5.2.2.2 into account.

When testing instruments at the place of use (application), instead of standard weights any other constant load may be used, provided that standard weights of at least 50 % of Max are used. Instead of 50 % of Max, the portion of standard weights may be reduced to:

- 35 % of Max if the repeatability error is ≤ 0.3 *d*; or
- 20 % of Max if the repeatability error is ≤ 0.2 *d*.

The repeatability error (6.3.4) shall be checked at a load of about the value at which the substitution is made, by placing this load three times on the load receptor. The results of the repeatability test (A.5.2.5) may be used if the test loads have a comparable mass.

If the instrument is provided with an automatic zero-setting or zero-tracking device, it may be in operation during the tests, except for the temperature test. The error at zero point is then determined according to A.5.1.2.

6.5 Reference vehicles

The type and number of 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.

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

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

- one three/four-axle rigid;
- one four-or more axle articulated;
- one two/three-axle rigid 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 and as one of the reference vehicles for in-motion tests.

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

The reference vehicles shall be used for tests in the unloaded and loaded condition (A.9.3.1).

Vehicles carrying liquid loads or other products that that may be subjected to fluctuations in their center of gravity when the vehicle moves, shall be used as reference vehicles only if the WIM instrument will be applied subsequently for determining the mass, 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 may be subjected to fluctuations in their center of gravity by vehicle movement”.

If the WIM instrument is intended to be used for determining the vehicle mass, the single-axle loads or the axle-group loads of vehicles with conventional steel leaf spring suspension, tests shall be carried out on vehicles with at least one such single-axle and one such axle-group suspension type. If the WIM instrument is not intended for this use, it shall bear the marking “not to be used to weigh vehicles with conventional steel leaf spring suspension”.

6.6 Number of in-motion tests

Each reference vehicle (the two-axle rigid plus two or more others) shall undertake at least five test runs at each of three different speeds as detailed A.9.3.2 when unloaded and when loaded. Thus at least 90 reference vehicle runs are required for any testing session. If appropriate, a higher number of in-motion test runs may be conducted, in accordance with national regulations.

6.7 Conventional true value of the reference vehicle mass

The conventional true value of each reference vehicle mass, 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

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 load and, if required, the axle-group load 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 each single axle on the reference vehicle during an in-motion test, divided by the number of single-axle load values recorded for each respective single axle.

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 of the single-axle load and the axle-group load

The corrected mean of the axle loads 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.9.3.2.2.2 3) in relation to the systematic error of the instrument used for determining the recorded values.

6.12 Indicated mass of the vehicle

The vehicle mass following an automatic weighing operation shall be indicated and recorded. Where possible, the procedures in A.3.5 and A.3.6.2 shall be used to eliminate rounding errors included in any digital indication.

6.13 Indicated operating speed

The instrument shall indicate and record the operating speed following an in-motion test (3.5.2). Alternatively, the procedure given in A.9.3.2.4.2 shall be used to determine the operating speed and the error.

6.14 Examination and tests of electronic instruments

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.

6.14.1 Examination

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

6.14.2 Performance tests

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

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 setup that sufficiently represents the weighing instrument. The equipment shall continue to function correctly as specified in Annex A.

6.14.3 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.

Annex A
(Mandatory)

Test procedures for automatic instruments for weighing road vehicles in motion and measuring axle-loads

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 Compare 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 in OIML R 134-2.

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 in OIML R 134-2.

A.2 EXAMINATION FOR INITIAL VERIFICATION

A.2.1 Compare construction with documentation (5.2)

Examine the instrument for conformity with the requirements in 3.9 for the approved type.

A.2.2 Descriptive markings (3.9)

Check the descriptive markings according to the checklist in the test report format in OIML R 134-2.

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

Check the arrangement for verification marks and securing according to the checklist in the test report in OIML R 134-2.

A.3 GENERAL TEST CONDITIONS

A.3.1 Voltage 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 energized 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 occurred.

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 Recovery

After each test, allow the instrument to recover sufficiently before the following test.

A.3.5 Indication with a scale interval not greater than 0.2 *d*

If an instrument has a device for displaying the indication with a scale interval of 0.2 *d* or less, this device may be used to calculate the error. If such a device is used, it should be noted in the test report.

A.3.6 Control instruments and test standards

A.3.6.1 Control instrument (6.2)

Control instruments meeting the requirements of 6.2 shall be used for weighing the vehicles. Where necessary, standard test weights meeting the requirements of 6.4.1 may be used to assess the rounding error.

A.3.6.2 Use of standard weights to assess rounding error

A.3.6.2.1 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 1 000 kg and thereby indicates 1 000 kg. After adding successive weights of 1 kg, the indication changes from 1 000 kg to 1 010 kg at an additional load of 3 kg. Inserted in the above formula, these observations give:

$$P = (1\ 000 + 5 - 3)\ \text{kg} = 1\ 002\ \text{kg}$$

Thus the true indication prior to rounding is 1 002 kg, and the error is:

$$E = (1\ 002 - 1\ 000)\ \text{kg} = 2\ \text{kg}$$

A.3.6.2.2 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:

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

then 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.

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

The tests in 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)

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 A.5.2 shall also be applied.

The test in 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

The initial zero-setting range is the sum of the positive and negative portions of the initial zero-setting range. If the load receptor cannot readily be removed, only the positive part of the initial zero-setting range need be considered.

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 the load receptor (platform) from the instrument. 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 load receptor (platform) removed, add weights to any live part of the scale until the instrument indicates zero again.
3) Then remove the 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 the load receptor (platform) of the instrument, then before proceeding to step 3) above, apply a test load 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 adjust 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: The tests in this subclause are to be performed on the integral control instrument in-situ at the time of type approval or verification.

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 errors shall be the appropriate values from 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 on 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 shall be increased by one scale interval above the initial indication, $I + d$.

A.5.2.5 Repeatability test (3.4.4 and 6.3.4)

Two series of weighings shall be performed, one with a load of about 50 % and one with a load close to 100 % of Max. Each series shall consist of at least three weighings. Readings shall be taken when the instrument is loaded, and when the unloaded instrument has come to rest between weighings. In the case of a zero deviation between the weighings, the instrument shall be reset to zero, without determining the error at zero. The true zero position need not be determined between the weighings.

If the instrument is provided with automatic zero-setting or zero-tracking, it shall be in operation during the test.

For initial verification, one test with about 50 % of Max is sufficient with no more than three weighings.

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 stabilized 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 stabilized, 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:
    - the zero indication error, E_{0I}, is not greater than 0.25 *d* (3.3.1);
    - the 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:
    - the zero variation error ($E_0 - E_{0I}$) is not greater than $0.25\, d \times p_i$;
    - the 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.6.3 Operating speed (3.5.9)

Verify that the automatic indication and printing of the operating speed contain a clear warning message if the speed is outside the specified range.

A.7 INFLUENCE FACTOR AND DISTURBANCE TESTS

A.7.1 Test conditions

Further guidance on the metrological performance testing requirements for influence quantities and disturbances is provided in the appropriate reference standards as indicated for each test and in OIML D 11 [4].

A.7.1.1 General requirements

Instruments for determining the vehicle mass, the single-axle load and/or the axle-group load 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 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

If a simulator is used to test a module, the repeatability and stability of the simulator should make it possible to determine the performance of the module with at least the same accuracy as when a complete instrument is tested with weights, the mpe to be considered being those applicable to the module. If a simulator is used, this shall be noted in the Test Report Format and its traceability referenced.

A.7.1.2.2 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.7.1.2.3 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 shall be 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 voltage variations	MPE	A.7.2.4
DC mains voltage variations, including rechargeable battery if the battery can be fully (re)charged during the operation of the instrument	MPE	A.7.2.5
Battery voltage variations (DC), including non-rechargeable, and rechargeable battery if (re)charging of the battery during the operation of the instrument is not possible	MPE	A.7.2.6
Voltage variations in 12 V or 24 V road vehicle batteries	MPE	A.7.2.7

* 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 [11], IEC Publication 60068-2-2 [12] and 60068-3-1 [13], and according to Table 8.

Table 8

Environmental phenomena	Test specification	Test setup
Temperature	Reference of 20 °C	
	Specified high for 2 hours	IEC 60068-2-2
	Specified low for 2 hours	IEC 60068-2-1
	Temperature of 5 °C, if the specified low temperature is ≤ 0 °C	IEC 60068-2-1
	Reference of 20 °C	

Notes: Use IEC 60068-3-1 for background information

The static temperatures test is considered as one 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 dry heat (non-condensing) and cold. The test in A.7.2.2 may be conducted during this test.
Preconditioning:	16 hours
Condition of the EUT:	EUT is connected to the voltage supply and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Voltage supply 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.
Stabilization:	2 hours at each temperature under "free air" conditions. "Free air" conditions mean a minimum air circulation to keep the temperature at a stable level.
Temperature:	As specified in 2.7.1.1
Temperature sequence:	a) At the reference temperature of 20 °C; b) At the specified high temperature; c) At the specified low temperature; d) At a temperature of 5 °C, if the specified low temperature is below 10 °C; and e) At the reference temperature.
Barometric pressure:	Changes in barometric pressure shall be taken into account.
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 stabilization 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 shall 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 stabilization the error of the zero indication shall be determined.

The change in zero indication per 5 °C shall be calculated. The changes in 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 the EUT: EUT connected to the voltage supply and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Voltage supply 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 [14] and IEC Publication 60068-3-4 [15], and according to Table 9.

Table 9

Environmental phenomena	Test specification	Test setup
Damp heat, steady state	Upper limit temperature and relative humidity of 85 % for 48 hours	IEC 60068-2-78 IEC 60068-3-4

Note: Use IEC 60068-3-4 for guidance for damp heat tests.

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.

Preconditioning: None required.

Condition of the EUT: EUT is connected to the voltage supply and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. The zero-setting and zero-tracking facilities shall be enabled as for normal operation.

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

Stabilization: 3 hours at reference temperature and 50 % humidity.

2 days at the upper limit temperature as specified in 2.7.1.1.

Temperature: Reference temperature (20 °C or the mean value of the temperature range whenever 20 °C is outside this range) and at the upper limit as specified in 2.7.1.1.

Temperature-humidity 48 hour sequence:

a) Reference temperature of 20 °C at 50 % humidity;

b) Upper limit temperature at 85 % humidity;

c) Reference temperature of 20 °C at 50 % humidity.

Barometric pressure: Changes in barometric pressure shall be taken into account.

Number of test cycles: At least one cycle.

Test information: After stabilization 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) other 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 stabilization 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 variations (2.7.2)

AC mains voltage supply variation tests are carried out according to Basic Standard IEC Publication 61000-2-1 [16] and IEC Publication 61000-4-1 [17], and according to Table 10.

Table 10

Environmental phenomena	Test specification		Test setup
AC mains voltage variation	U_{nom}		IEC 61000-2-1 IEC 61000-4-1
	Upper limit:	1.10 × U_{nom} or 1.10 × U_{max}	
	Lower limit:	0.85 × U_{nom} or 0.85 × U_{min}	
	U_{nom}		

Note: Where an instrument is powered by a three phase supply, the voltage variations shall apply for each phase successively.

Supplementary information to the IEC test procedures:

Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions of AC mains voltage variations.
Preconditioning:	None required.
Condition of the EUT:	The EUT is connected to the AC mains supply 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 anytime during the test except to reset if a significant fault has been detected.
Number of test cycles:	At least one cycle.
Test information:	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. Stabilize the EUT at the nominal voltage and record the following data: a) date and time; b) temperature; c) relative humidity; d) AC voltage supply; e) test loads; f) indications (as applicable); g) errors; h) functional performance. Repeat the test for each of the voltages defined in IEC 61000-4-1 in section 5 (noting the need in certain cases for the test weighing to be repeated 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 voltage variations (2.7.2)

Instruments operating from DC mains voltage supply, including rechargeable battery if recharging of the battery during the operation of the instrument is possible, shall fulfill the tests in A.7.2, with the exception of A.7.2.4 which is to be replaced by the test according to Basic Standard IEC Publication 60654-2 [18] and according to Table 11.

Table 11

Environmental phenomena	Test specification		Test setup
DC mains voltage variations	U_{nom}		IEC 60654-2
	Upper limit:	$1.20 \times U_{nom}$ or $1.20 \times U_{max}$	
	Lower limit:	minimum operating voltage (see 2.7.2)	
	U_{nom}		

Note: If a voltage-range is marked, use the average value as nominal U_{nom}.

Supplementary information to the IEC test procedures:

Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions of DC mains voltage variations.
Pre-condition:	None
Condition of the EUT:	The EUT is connected to the DC mains voltage supply 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:	Stabilize the EUT at the nominal voltage and record the following data at no load and with one load or simulated load: a) date and time; b) temperature; c) relative humidity; d) DC voltage supply; 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 voltage supply (DC), not mains connected, including non-rechargeable battery voltage supply and also including rechargeable battery supply if (re)charging of battery voltage supply during the operation of the instrument is not possible (2.7.2)

Battery-powered instruments shall fulfill the tests in A.7.2, with the exception of A.7.2.4 and A.7.2.5 and A.7.2.6 which are to be replaced by the test in Table 12.

Table 12

Environmental phenomena	Test specification	Test setup
Battery voltage variations	U_{nom}	No reference to standards for this test.
	Minimum operating voltage (see 2.7.2)	
	U_{nom}	

Note: If a voltage range is marked, use the average value as nominal U_{nom}.

Supplementary test information:

Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions of voltage variations of a fully charged battery.
Pre-condition:	None
Condition of the EUT:	The EUT is connected to the battery voltage supply 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:	Stabilize the EUT at the nominal voltage and record the following data at no load and with one load or simulated load: a) date and time; b) temperature; c) relative humidity; d) battery voltage supply; e) test loads; f) indications (as applicable); g) errors; h) functional performance. Reduce the voltage supply 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 from 12 V or 24 V road vehicle batteries (2.7.2)

Road vehicle battery operated instruments shall fulfill the tests in A.7.2, with the exception of A.7.2.4 which is to be replaced by the following test conducted in accordance with ISO 16750-2 [25] and according to Table 13.

Table 13

Environmental phenomena	Test specification			Test setup
	U_{nom}	Upper limit	Lower limit	
12 V or 24 V road vehicle battery voltage variation	12 V	16 V	9 V	ISO 16750-2
	24 V	32 V	16 V	

Note: The nominal voltage, U_{nom}, of the electrical system in road vehicles is usually 12 V or 24 V, but the practical voltage at the battery connection points can vary considerably.

Supplementary information to the ISO test procedures:

Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions of road vehicle battery voltage variations.
Preconditioning:	None
Condition of the EUT:	The EUT is connected to the voltage supply 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 for each functional mode.
Test information:	Stabilize the EUT at the nominal voltage and record the following data at no load and with one load or simulated load: a) date and time; b) temperature; c) relative humidity; d) voltage supply; e) test loads; f) indications (as applicable); g) errors; h) functional performance. Reduce the voltage supply to the EUT until the instrument clearly ceases to function properly according to the specifications and metrological requirements, and record the indication.
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	§
AC mains voltage short time power reduction	sf*	A.7.3.1
Electrical fast transients/burst immunity on mains supply lines and on I/O circuits and communication lines	sf	A.7.3.2
Electrical surges on mains supply lines and on I/O circuits and communication lines	sf	A.7.3.3
Electrostatic discharge	sf	A.7.3.4
Immunity to electromagnetic fields	sf	A.7.3.5
Electrical transient conduction for instruments powered by 12 V or 24 V road vehicle batteries	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 [19] and according to Table 14.

Table 14

Environmental phenomena	Test specification			Test setup
Voltage dips and short interruptions	Test	Reduction of amplitude to	Duration / number of cycles	IEC 61000-4-11
	Test a	0 %	0.5	
	Test b	0 %	1	
	Test c	40 %	10	
	Test d	70 %	25/30*	
	Test e	80 %	250/300*	
	Short interruption	0 %	250	

* These values are for 50 Hz /60 Hz, respectively

Note: A test generator suitable to reduce for a defined period of time the amplitude of one or more half cycles (at zero crossings) of the AC mains voltage shall be used. The test generator shall be adjusted before connecting the EUT. The mains voltage reductions shall be repeated 10 times with an interval of at least 10 seconds.

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 while observing the weight indication of a single static load.

Preconditioning: None required.

Condition of the EUT: The EUT is connected to the voltage supply 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 and are not to be adjusted 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: The EUT shall be tested with one small static test load.

Stabilize all factors at nominal reference conditions. Apply one load or simulated load and record:

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

In accordance with the test specification in Table 14, interrupt the voltages to the corresponding durations / number of cycles 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.
Maximum allowable variations:	The difference between the indication due to the disturbance and the indication without the disturbance either shall not exceed 1 *d* (T.4.2.7), or the EUT shall detect and react to a significant fault.

A.7.3.2 Electrical fast transients/burst immunity on the mains supply lines and on the I/O circuits and communication lines

Electrical fast transients/burst immunity tests are carried out at the positive and the negative polarities for at least 1 minute at each polarity in accordance with the Basic Standard IEC Publication 61000-4-4 [20] and according to Tables 15 and 16.

Table 15

Environmental phenomena	Test specification	Test setup
Fast transient common mode	0.5 kV (peak) 5/50 ns T_l/T_h 5 kHz rep. frequency	IEC 61000-4-4

Note: Applicable only to ports or interfacing with cables whose total length may exceed 3 m according to the manufacturer's functional specification.

Table 16

Environmental phenomena	Test specification	Test setup standard
Fast transient common mode	1 kV (peak) 5/50 ns T_l/T_h 5 kHz rep. frequency	IEC 61000-4-4

Notes: DC supply lines, not applicable to battery-operated appliance that cannot be connected to the mains while in use.

A coupling/decoupling network shall be applied for testing AC supply 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 separately on the mains voltage, and on the I/O circuits and communication lines (if any), while observing the indications for one static test load.
Preconditioning:	None required.
Condition of the EUT:	The performance of the test generator shall be verified before connecting the EUT. The EUT is connected to the voltage supply 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 and are not to be adjusted 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: Both positive and negative polarity of the bursts shall be applied. The duration of the test shall not be less than one minute for each amplitude and polarity. The injection network on the mains shall contain blocking filters to prevent the burst energy being dissipated in the mains. For the coupling of the bursts into the input/output and communication lines, a capacitive coupling clamp as defined in the reference standard shall be used.

Before any test stabilize the EUT under constant environmental conditions. Apply one small static test load and record:

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

Maximum allowable variations: The difference between the indication due to the disturbance and the indication without the disturbance either shall not exceed 1 *d* (T.4.2.7), or the EUT shall detect and react to a significant fault.

A.7.3.3 Electrical surges on mains supply lines and on I/O circuits and communication (signal) lines

Electrical surge tests are carried out according to Basic Standard IEC Publication IEC 61000-4-5 [21] and according to Table 17.

Table 17

Environmental phenomena	Test specification	Test setup
Surges on mains supply lines and on I/O circuits and communication lines	0.5 kV (peak) line to line 1.0 kV line to earth a) 3 positive and 3 negative surges applied synchronously with AC supply voltage in angles 0°, 90°, 180° and 270°. b) 3 positive and 3 negative surges applied on DC supply lines and on I/O circuits and communication lines.	IEC 61000-4-5

Note: This test is only applicable in those cases where the risk of a significant influence of surges can be expected such as outdoor installations and/or indoor installations connected to long communication and signal lines (lines longer than 30 m or those lines partially or fully installed outside the buildings regardless of their length). It is also applicable to DC powered instruments if the voltage supply comes from a DC network.

Supplementary information to the IEC test procedures

Object of the test: To verify compliance with the provisions in 4.1.2 under conditions where electrical surges are applied separately to the mains supply lines, and to the I/O circuits and communication lines (if any), while

	observing the indications for one static test load.
Preconditioning:	None required.
Condition of the EUT:	The characteristics of the test generator shall be verified before connecting the EUT. The EUT is connected to the voltage supply 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 and are not to be adjusted 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:	The test consists of exposure to surges for which the rise time, pulse width, peak values of the output voltage/current on high/low impendence load and minimum time interval between two successive pulses are defined in IEC 61000-4-5. The injection network depends on the lines the surge is coupled to and is defined in IEC 61000-4-5. The EUT shall be tested with one small static test load. Before any test stabilize the EUT under constant environmental conditions. Apply one load or simulated load and record: a) date and time; b) temperature; c) relative humidity; d) voltage supply; e) test load; f) indications (as applicable); g) errors; h) functional performance.
Maximum allowable variations:	The difference between the indication due to the disturbance and the indication without the disturbance either shall not exceed 1 *d* (T.4.2.7), or the EUT shall detect and react to a significant fault.

A.7.3.4 Electrostatic discharge

Electrostatic discharge tests are carried out according to Basic Standard IEC Publication 61000-4-2 [22] and according to Table 18.

Table 18

Environmental phenomena	Test specification		Test setup
Electrostatic discharge	Test voltage	Levels(1)	IEC 61000-4-2
	contact discharge	6 kV	
	air discharge	8 kV	

Notes: Tests shall be performed at the specified lower levels, starting with 2 kV and proceeding with 2 kV steps up to and including the level specified above in accordance with IEC 61000-4-2.

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 weight indication for one small static test load.
Preconditioning:	None required.
Condition of the EUT:	The performance of the test generator shall be verified before connecting the EUT. The EUT is connected to the voltage supply 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 and are not to be adjusted 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:	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 the horizontal or vertical coupling planes as specified in the reference standard. Air discharges shall be used where contact discharges cannot be applied. Before any test stabilize the EUT under constant environmental conditions. Apply one small static test load and record: a) date and time; b) temperature; c) relative humidity; d) voltage supply; e) test load; f) indications (as applicable); g) errors; h) functional performance.
Maximum allowable variations:	The difference between the indication due to the disturbance and the indication without the disturbance either shall not exceed 1 *d* (T.4.2.7), or the EUT shall detect and react to a significant fault.

A.7.3.5 Immunity to electromagnetic fields

A.7.3.5.1 Immunity to radiated electromagnetic fields

Radiated, radio-frequency, electromagnetic (EM) field immunity tests (radio-frequency EM fields higher than 80 MHz) are carried out in accordance to Basic Standard IEC Publication 61000-4-3 [23] and according to Table 19.

Table 19

Environmental phenomena	Test specification		Test setup
Radiated electromagnetic field	Frequency ranges (MHz)	Field strength (V/m)	IEC 61000-4-3
	80 to 2 000(1)	10	
	26 to 80(2)		
Modulation	80 % AM, 1 kHz sine wave		

Notes: IEC 61000-4-3 only specifies test levels above 80 MHz. For frequencies in the lower range the test methods for conducted radio frequency disturbances according to A.7.3.4.2 are recommended.

For EUTs having no mains or other I/O ports available so that the test according to A.7.3.4.2 cannot be applied, the lower limit of the radiation test is 26 MHz.

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 radiated electromagnetic fields applied while observing the weight indication for one small static test load.

Preconditioning: None required.

Condition of the EUT: The performance of the test generator shall be verified before connecting the EUT.

The EUT is connected to the voltage supply 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 and are not to be adjusted 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: The EUT shall be exposed to EM field strength as specified in Table 19. The frequency ranges to be considered are swept with the modulated carrier. The performance of the EUT shall be verified.

Before any test stabilize the EUT under constant environmental conditions. Apply one small static test load and record:

a) date and time;

b) temperature;

c) relative humidity;

d) voltage supply;

e) test load;

f) indications (as applicable);

g) errors;

h) functional performance.

Maximum allowable variations: The difference between the indication due to the disturbance and the indication without the disturbance either shall not exceed 1 *d* (T.4.2.7), or the EUT shall detect and react to a significant fault.

A.7.3.5.2 Immunity to conducted electromagnetic field tests

Conducted, radio-frequency, electromagnetic field (EM) immunity tests (radio-frequency EM fields lower than 80 MHz) are carried out in accordance to Basic Standard IEC Publication 61000-4-6 [24] and according to Table 20.

Table 20

Environmental phenomena	Test specification		Test setup
Conducted electromagnetic field	Frequency range MHz	RF amplitude (50 ohms) V (e.m.f)	IEC 61000-4-6
	0.15 to 80	10 V	
Modulation	80 % AM, 1 kHz sine wave		

Note: This test is not applicable when the EUT has no mains or other input port.

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 electromagnetic fields applied while observing the weight indication for one small static test load.

Preconditioning: None required.

Condition of the EUT: The performance of the test generator shall be verified before connecting the EUT.

The EUT is connected to the voltage supply 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 and are not to be adjusted 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: Before any test stabilize the EUT under constant environmental conditions. Apply one small static test load and record:

a) date and time;

b) temperature;

c) relative humidity;

d) voltage supply;

e) test load;

f) indications (as applicable);

g) errors;

h) functional performance.

Maximum allowable variations: The difference between the indication due to the disturbance and the indication without the disturbance either shall not exceed 1 *d* (T.4.2.7), or the EUT shall detect and react to a significant fault.

A.7.3.6 Electrical transient conduction for instruments powered by a road vehicle battery

A.7.3.6.1 Electrical transient conduction along supply lines of 12 V or 24 V batteries

Transient immunity tests along supply lines of 12 V and 24 V vehicle batteries are carried out in accordance to ISO 7637-2 [26] and according to Table 21.

Table 21

Environmental phenomena	Test specification			Test setup
Conduction along 12 V or 24 V supply lines	Test pulse	Pulse voltage, U_s		ISO 7637-2
		U_{nom} = 12 V	U_{nom} = 24 V	
	2a	+50 V	+50 V	
	2b	+10 V	+20 V	
	3a	–150 V	–200 V	
	3b	+100 V	+200 V	
	4	–7 V	–16 V	

Note: Test pulse 2b is only applicable if the instrument is connected to the battery via the main (ignition) switch of the car, i.e. if the manufacturer has not specified that the instrument is to be connected directly (or by its own main switch) to the battery.

Supplementary information to the ISO test procedures

Applicable standards: ISO 7637-2
§ 5.6.2: Test pulse 2a + b,
§ 5.6.3: Test pulse 3a + 3b,
§ 5.6.4: Test pulse 4.

Object of the test: To verify compliance with the provisions in 4.1.2 under the following conditions while observing the weight indication for one small static test load:

- 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).

Preconditioning: None

Condition of the EUT: The EUT is connected to the voltage supply 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 and are not be adjusted at any time during the test except to reset if a significant fault has been indicated.

Stabilization: Before any test stabilize the EUT under constant environmental conditions.

Test information: The EUT is exposed to conducted disturbances (on the supply voltage by direct brief coupling on supply lines) of the strength and character as specified in Table 21. With the static load in place record:

a) date and time;
b) temperature;
c) relative humidity;
d) voltage supply;
e) test load;
f) indications (as applicable);
g) errors;
h) 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 1 *d* (T.4.2.7), or the EUT shall detect and react to a significant fault.

A.7.3.6.2 Transient conduction by capacitive and inductive coupling via lines other than supply lines

Transient immunity tests via lines other than supply lines for 12 V or 24 V road vehicle batteries are carried out in accordance with ISO 7637-3 [27] and according to Table 22.

Table 22

Environmental phenomena	Test specification			Test setup
Electrical transient conduction via lines other than supply lines	Test pulse	Pulse voltage, U_s		ISO 7637-3
		U_{nom} = 12 V	U_{nom} = 24 V	
	a	–60 V	–80 V	
	b	+40 V	+80 V	

Supplementary information to the ISO test procedures:

Applicable standards: ISO 7637-3, § 4.5: Test pulses a and b.

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), under the following conditions while observing the weight indication for one small static test load.

Preconditioning: None

Condition of the EUT:	The EUT is connected to the voltage supply 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 and are not to be adjusted at any time during the test except to reset if a significant fault has been indicated.
Stabilization:	Before any test stabilize the EUT under constant environmental conditions.
Weighing test:	The EUT is exposed to conducted disturbances (bursts of voltage spikes by capacitive and inductive coupling via lines other than supply lines) of the strength and character as specified in Table 22. With the static load in place record: a) date and time; b) temperature; c) relative humidity; d) voltage supply; e) test load; f) indications (as applicable); g) errors; h) 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 1 *d*, or the EUT shall detect and react to 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 the present time.
Test procedure 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):	$0.5 \le t \le 10$.
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 2.2.2 for initial verification for the test load applied on any of the *n* measurements.
Number of tests, *n*:	At least eight, 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:	The EUT is connected to the voltage supply and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. The EUT shall be stabilized 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: Stabilize 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) indications (as applicable);
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 vehicle mass (VM) and, if required, for axle load and axle-group load.

Ensure that the desired scale interval and the maximum capacity comply with 2.3. Check that the minimum capacity complies with 2.4.

For type approval, tests shall be carried out in accordance with the requirements of this Recommendation, and especially the requirements in 5.1 and A.1.

For initial verification, tests shall be carried out in accordance with the requirements of this Recommendation, and especially the requirements in 5.2 and A.2.

For subsequent and in-service verification, tests shall be carried out in accordance with the requirements of this Recommendation, and especially the requirements in 5.3.

In determining the single-axle load, and if required, the axle-group load, the conditions specified in 2.5 and, if appropriate the requirements of national regulations should be taken into account.

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 6.2.1 and be tested, using the static weighing test method 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 may 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 in A.9.3.1.1 shall be applied. When the instrument has been tested according to the test in 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 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

For testing instruments to be used for determining the vehicle mass (VM), select the required number of reference vehicles as specified in 6.5, and conduct the following tests:

a) The conventional true value (T.1.9) of the unloaded reference vehicle mass 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 loaded reference vehicle mass shall be determined by:
   - loading the unloaded reference vehicles in a) above with standard test loads; or
   - 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 using the following method:

a) 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 vehicle mass by the summation of the recorded values for the two axle loads and record the VM 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.

b) 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:

$$\overline{\text{Axle}_i} = \frac{\sum_1^{10} \text{Axle}_i}{10}$$

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) Add the two mean single-axle loads to determine the mean of the static vehicle mass:

$$\overline{\text{VM}} = \sum_{i-1}^{2} \text{Axle}_i$$

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

$$\overline{\text{VM}} = \frac{\sum_1^{10} \text{VM}}{10}$$

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

$$\overline{\text{CorrAxle}_i} = \overline{\text{Axle}_i} \times \frac{\text{VM}_{\text{ref}}}{\overline{\text{VM}}}$$

where: VM_{ref} is the conventional true value of each reference vehicle mass 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.3.1.10) 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 reference vehicle mass determined by full-draught weighing (6.7) on a suitable control instrument (6.2.1):

$$\text{VM}_{\text{ref}} = \sum_{i-1}^{2} \overline{\text{CorrAxle}_i}$$

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 be traveling at a steady speed before arriving at the apron.

Test runs shall be conducted using the two-axle rigid reference vehicle plus a minimum of two other reference vehicles (6.5) with each vehicle unloaded and loaded.

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

For each vehicle and loading condition at least five test runs shall be performed with three test runs made over the center of the load receptor, one test run made to the left side of the load receptor, and one test run made to the right side of the load receptor.

The five test runs shall be conducted at the following speeds that are within the range of speeds for which the instrument is to be evaluated:

a) near maximum operating speed, v_{max} (T.3.4.2);
b) near minimum operating speed, v_{min} (T.3.4.3);
c) near the center of the range of operating speeds (T.3.4.4).

A.9.3.2.1 Vehicle mass measurement

Record the vehicle masses as they are displayed or printed (6.12) by the instrument under test, and calculate the errors according to the vehicle reference weights determined in A.9.3.1.2.

No error shall exceed the applicable maximum permissible error for the specified accuracy class in 2.1.1.

A.9.3.2.2 Axle load measurement

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

A.9.3.2.2.1 In-motion test with the two-axle rigid vehicle (5.1.3.2.2.1 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. Calculate the difference (error) in each recorded single-axle load of the two-axle rigid vehicle and its respective static reference single-axle load (A.9.3.1.3).
2) The maximum difference (error) between any recorded single-axle load and the conventional true value of the static reference single-axle loads (A.9.3.1.3) shall not exceed the applicable maximum permissible errors in 2.2.1.2.1 for the specified accuracy class.

A.9.3.2.2.2 In-motion tests with all other reference vehicle types (5.1.3.2.2.1 b)

1) As specified in 6.6, 6.9 and A.9.3.2, conduct the 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 have been set by national regulations (T.3.1.7), all recorded axle loads shall be considered as single-axle loads (T.3.1.9). For each reference vehicle (except the two-axle rigid) and its loading condition, calculate the mean single-axle loads and, if required, the mean axle-group loads of the test runs specified in A.9.3.2 according to the following equations:

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

where: i is the single-axle rank
n is the number of test runs
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 test runs
Group_i is the recorded load for that axle-group

2) Use the values indicated or printed by the instrument under test according to A.9.3.2 c) and recorded as specified in 6.12 for the vehicle mass and calculate the mean of the reference vehicle mass according to the following:

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

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

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

where: q is the number of single axles on the vehicle
g is the number of axle-groups on the vehicle, which may be zero

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

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

where: VM_{ref} is the conventional true value of the reference vehicle mass 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 reference vehicle mass:

$$\text{VM}_{\text{ref}} = \sum_{i=1}^{q} \overline{\text{CorrAxle}}_i + \sum_{i=0}^{g} \overline{\text{CorrGroup}}_i$$

where: q is the number of single axles on the vehicle
g is the number of axle-groups on the vehicle, which 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 (if more than one axle-group) corrected mean axle-group load:

$$\text{DevAxle}_i = \text{Axle}_i - \overline{\text{CorrAxle}_i}$$

$$\text{DevGroup}_i = \text{Group}_i - \overline{\text{CorrGroup}_i}$$

6) No deviation shall exceed the appropriate maximum permissible deviation as specified in 2.2.1.2.2 for the applicable accuracy class.

7) For future reference only (to quantify any difference in the fraction of the vehicle mass carried on each of the two-axle rigid reference vehicle's single axles when determined by static (A.9.3.1.3 4)) and by in-motion (A.9.3.2.2 3)) weighing), also perform the calculations above (1-5) for all test runs of the two-axle rigid reference vehicle, unloaded and loaded. Include these results in the test report so that this data will not be lost. These results shall not be used in lieu of those from A.9.3.2.1 for evaluating the WIM instrument being tested.

A.9.3.2.4 Operating speed measurement (2.10)

A.9.3.2.4.1 Test of operating speed interlock (A.6.3)

To test the functioning of the operating speed interlock, test runs with one of the reference vehicles shall be made at speeds outside the range of operating speeds:

a) at a speed of at least 5 % in excess of the maximum operating speed, v_{max};
b) at a speed of at least 5 % below the minimum operating speed, v_{min} (if applicable).

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 (3.5.9).

A.9.3.2.4.2 Test of operating speed (3.5.9)

To determine and test the operating speed during an in-motion test, conduct six test runs of the unloaded two-axle rigid reference vehicle over the lateral center of the load receptor at constant speed. Three runs shall be near maximum operating speed, v_{max}, and three additional runs shall be just above minimum operating speed, v_{min}.

The reference value (conventional true value) for speed to be used in calculating the error in the indicated operating speed for each test run shall be the quotient of the measured axle spacing (to the nearest 10 mm) of the static two-axle rigid reference vehicle divided by the measured time interval (to the nearest millisecond) between arrival at a defined location (e.g. the leading edge) on the load receptor by the front and the rear axle of the moving two-axle rigid reference vehicle.

No error in the indicated operating speed shall exceed 1 km/h.

A.9.3.2.5 Test of vehicle recognition device interlock (3.5.7)

The correct function of the device shall be tested by the following test procedure if:

a) the WIM instrument automatically determine axle-group loads; or
b) a maximum number of axles per vehicle is given on the plate; or
c) the length of the weigh zone is given on the plate.

Connect two of the reference vehicles together with a suitable towing device (strap or chain) to form a combination vehicle that has an overall length greater than the minimum, or otherwise specified (B.4), apron length. Have the front vehicle tow the connected rear vehicle (with driver onboard) over the full length of the weigh zone at a speed near the maximum operating speed, v_{max}, with the instrument operating in automatic mode.

The instrument shall:

a) determine the correct axle-group loads or detect a failure;
b) detect the exceeding of the maximum number of axles;
c) detect the fact that all of the wheels of the vehicle being weighed were not within the weigh zone throughout the weighing operation and not indicate or print any mass or load values unless there is a clear warning message on the indication and/or the printout.

Annex B
(Mandatory)

Practical instructions for the installation of automatic instruments for weighing road vehicles in motion and measuring axle loads

B.1 Installation and operation

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

B.2 Weigh zone

The weigh zone (T.2.2) shall comprise a load receptor with an apron on both ends.

B.3 Apron construction

The aprons (T.2.2.1) in advance of and beyond the load receptor 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 approaches and passes over the load receptor.

Note: Annex C gives an example of an apron specification which may be used to construct aprons which have been shown to respect the conditions in this Annex. This example should be considered when specifying aprons.

B.4 Apron geometry

Each of these aprons shall have a minimum length of 16 m. However, prior to beginning any test, the Member State in which this Recommendation is being used may specify a different apron length (shorter or longer) which is deemed adequate to fully support simultaneously all wheels of the longest vehicle type that will be weighed by the instrument to be tested (see 3.5.7) as it approaches and passes over the load receptor. 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 a steady 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.

If no lateral guide system is used (3.5.8), the aprons shall have sufficient width throughout their length to extend transversely a minimum of 300 mm beyond each lateral edge of the load receptor and the width of the load receptor shall be clearly marked over the whole length of the aprons.

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

Annex C
(Informative)

General guidelines for the installation and operation of automatic instruments for weighing road vehicles in motion and measuring axle loads

C.1 Apron characteristics

To achieve the necessary levels of accuracy (with the exception of WIM instruments for full-draught weighing) the minimum requirements for the apron smoothness should include the following:

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

b) the surface of the apron outside the 8 m length of apron beyond the load receptor should be within a tolerance of ±6 mm from the level or transversely-sloped plane that includes the load receptor.

C.2 Apron compliance checks

Compliance with the apron geometry and characteristics specified above and in Annex B should be determined by a suitably qualified person at a specified period (e.g. if concrete is used, 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 should be taken at a suitable point within the apron minimum area (i.e. the "16 m area") and its position marked on the drawing in the test report format. Its position should be determined by taking elevations using a precise level and staff, and choosing the point which minimizes the extent of any remedial work having regard to the requirements specified above.

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

If concrete is used, a simple stability check should 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, should pass at a low speed along the approximate lateral center of the concrete aprons. Elevations should 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 in C.1.

C.3 Routine durability checks

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

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.

C.4 Spilt material and ice

Care should 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.5 Overhead structures

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

C.6 Tare weighing

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

C.7 Notice of speed restrictions

There should 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.

Bibliography

Below are references to Publications of the International Electrotechnical Commission (IEC), the International Organization for Standardization (ISO) and the OIML, where mention is made in this Recommendation.

Ref.	Standards and reference documents	Description
[1]	International Vocabulary of Basic and General Terms in Metrology (VIM) (1993)	Vocabulary, prepared by a joint working group consisting of experts appointed by BIPM, IEC, IFCC, ISO, IUPAC, IUPAP and OIML.
[2]	International Vocabulary of Terms in Legal Metrology, OIML, Paris (2000)	Vocabulary including only the concepts used in the field of legal metrology. These concepts concern the activities of the legal metrology service, the relevant documents as well as other problems linked with this activity. Also included in this Vocabulary are certain concepts of a general character which have been drawn from the VIM.
[3]	OIML B 3 (2003) OIML Certificate System for Measuring Instruments (formerly OIML P 1)	Provides rules for issuing, registering and using OIML Certificates of conformity.
[4]	OIML D 11 (2004) General requirements for electronic measuring instruments	Contains general requirements for electronic measuring instruments.
[5]	OIML R 111 (2004) Weights of classes E_1, E_2, F_1, F_2, M_1, M_{1-2}, M_2, M_{2-3} and M_3	Provides the principal physical characteristics and metrological requirements for weights used with and for the verification of weighing instruments and weights of a lower class.
[6]	OIML D 28 (2004) Conventional value of the result of weighing in air	Provides the definition of the quantity "conventional mass" (conventional value of the result of weighing in air) as it is used for the characterization of weights and its relation to the physical quantities mass and density and the evaluation of its uncertainty.
[7]	OIML R 60 (2000) Metrological regulation for load cells	Provides the principal static characteristics and static evaluation procedures for load cells used in the evaluation of mass.
[8]	OIML R 76-1 (2006) Non-automatic weighing instruments.	Provides the principal physical characteristics and metrological requirements for the verification of non-automatic weighing instruments.
[9]	OIML D 19 (1988) Pattern evaluation and pattern approval	Provides advice, procedures and influencing factors on pattern evaluation and pattern approval.
[10]	OIML D 20 (1988) Initial and subsequent verification of measuring instruments and processes	Provides advice, procedures and influencing factors on the choice between alternative approaches to verification and the procedures to be followed in the course of verification.
[11]	IEC 60068-2-1 (1990-05) with amendments 1 (1993-02) and 2 (1994-06) Environmental testing, Part 2: Tests, Test A: Cold	Concerns cold tests on both non heat dissipating and heat dissipating equipment under test (EUT).

Ref.	Standards and reference documents	Description
[12]	IEC 60068-2-2 (1974-01) with amendments 1 (1993-02) and 2 (1994-05) Environmental testing Part 2: Tests, Test B: Dry heat	Contains test Ba: dry heat for non heat dissipating specimen with sudden change of temperature; test Bb dry heat for non heat dissipating specimen with gradual change of temperature; tests Bc: dry heat for heat dissipating specimen with sudden change of temperature; test Bd dry heat for heat dissipating specimen with gradual change of temperature. The 1987 reprint includes IEC No. 62-2-2A.
[13]	IEC 60068-3-1 (1974-01) + Supplement A (1978-01): Environmental testing Part 3 Background information, Section 1: Cold and dry heat tests	Gives background information for Tests A: Cold (IEC 68-2-1), and Tests B: Dry heat (IEC 68-2-2). Includes appendices on the effect of: chamber size on the surface temperature of a specimen when no forced air circulation is used; airflow on chamber conditions and on surface temperatures of test specimens; wire termination dimensions and material on surface temperature of a component; measurements of temperature, air velocity and emission coefficient. Supplement A gives additional information for cases where temperature stability is not achieved during the test.
[14]	IEC 60068-2-78 (2001-08) Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state (IEC 60068-2-78 replaces the following withdrawn standards: IEC 60068-2-3, test Ca and IEC 60068-2-56, test Cb)	Provides a test method for determining the suitability of electro-technical products, components or equipment for transportation, storage and use under conditions of high humidity. The test is primarily intended to permit the observation of the effect of high humidity at constant temperature without condensation on the specimen over a prescribed period. This test provides a number of preferred severities of high temperature, high humidity and test duration. The test can be applied to both heat-dissipating and non-heat dissipating specimens. The test is applicable to small equipment or components as well as large equipment having complex interconnections with test equipment external to the chamber, requiring a setup time which prevents the use of preheating and the maintenance of specified conditions during the installation period.
[15]	IEC 60068-3-4 (2001-08) Environmental testing - Part 3-4: Supporting documentation and guidance - Damp heat tests	Provides the necessary information to assist in preparing relevant specifications, such as standards for components or equipment, in order to select appropriate tests and test severities for specific products and, in some cases, specific types of application. The object of damp heat tests is to determine the ability of products to withstand the stresses occurring in a high relative humidity environment, with or without condensation, and with special regard to variations of electrical and mechanical characteristics. Damp heat tests may also be utilized to check the resistance of a specimen to some forms of corrosion attack.

Ref.	Standards and reference documents	Description
[16]	IEC 61000-2-1 (1990-05) Electromagnetic compatibility (EMC) Part 2: Environment Section 1	Description of the environment - Electromagnetic environment for low-frequency conducted disturbances and signaling in public power supply systems.
[17]	IEC 61000-4-1 (2000-04) Basic EMC Publication Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques. Section 1: Overview of IEC 61000-4 series	Gives applicability assistance to the users and manufacturers of electrical and electronic equipment on EMC standards within the IEC 61000-4 series on testing and measurement techniques. Provides general recommendations concerning the choice of relevant tests.
[18]	IEC 60654-2 (1979-01), with amendment 1 (1992-09) Operating conditions for industrial-process measurement and control equipment - Part 2: Power	Gives the limiting values for power received by land-based and offshore industrial process measurement and control systems or parts of systems during operation.
[19]	IEC 61000-4-11 (2004-03) Electromagnetic compatibility (EMC) Part 4-11: Testing and measuring techniques - Voltage dips, short interruptions and voltage variations immunity tests	Defines the immunity test methods and range of preferred test levels for electrical and electronic equipment connected to low-voltage power supply networks for voltage dips, short interruptions, and voltage variations. This standard applies to electrical and electronic equipment having a rated input current not exceeding 16 A per phase, for connection to 50 Hz or 60 Hz AC networks. It does not apply to electrical and electronic equipment for connection to 400 Hz AC networks. Tests for these networks will be covered by future IEC standards. The object of this standard is to establish a common reference for evaluating the immunity of electrical and electronic equipment when subjected to voltage dips, short interruptions and voltage variations. It has the status of a Basic EMC Publication in accordance with IEC Guide 107.
[20]	IEC 61000-4-4 (2004-07) Electromagnetic compatibility (EMC) Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	Establishes a common and reproducible reference for evaluating the immunity of electrical and electronic equipment when subjected to electrical fast transient/burst on supply, signal, control and earth ports. The test method documented in this part of IEC 61000-4 describes a consistent method to assess the immunity of an equipment or system against a defined phenomenon. The standard defines: ▪ test voltage waveform; ▪ range of test levels; ▪ test equipment; ▪ verification procedures of test equipment; ▪ test setup; and ▪ test procedure. The standard gives specifications for laboratory and post-installation tests.

Ref.	Standards and reference documents	Description
[21]	IEC 61000-4-5 (2001-04) consolidated edition 1.1 (Including Amendment 1 and Correction 1) Electromagnetic compatibility (EMC)- Part 4-5: Testing and measurement techniques - Surge immunity test	Relates to the immunity requirements, test methods, and range of recommended test levels for equipment to unidirectional surges caused by over-voltages from switching and lightning transients. Several test levels are defined which relate to different environment and installation conditions. These requirements are developed for and are applicable to electrical and electronic equipment. Establishes a common reference for evaluating the performance of equipment when subjected to high-energy disturbances on the power and inter-connection lines.
[22]	IEC 61000-4-2 (1995-01) with amendment 1 (1998-01) and amendment 2 (2000-11) Consolidated Edition: IEC 61000-4-2 (2001-04) Ed. 1.2 Basic EMC Publication. Electromagnetic Compatibility (EMC) - Part 4: Testing and measurement techniques - Section 2: Electrostatic discharge immunity test. Basic EMC Publication	
[23]	IEC 61000-4-3 Consolidated Edition 2.1 (including amendment 1) (2002-09) Electromagnetic Compatibility (EMC) - Part 4: Testing and measurement techniques - Section 3: Radiated, radio-frequency, electromagnetic field immunity test	
[24]	IEC 61000-4-6 (2003-05) with amendment 1 (2004-10) Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques. Section 6: Immunity to conducted disturbances, induced by radio-frequency fields	Relates to the conducted immunity requirements of electrical and electronic equipment to electromagnetic disturbances coming from intended radio-frequency (RF) transmitters in the frequency range 9 kHz-80 MHz. Equipment not having at least one conducting cable (such as mains supply, signal line or earth connection), which can couple the equipment to the disturbing RF fields is excluded. This standard does not intend to specify the tests to be applied to particular apparatus or systems. Its main aim is to give a general basic reference to all concerned product committees of the IEC. The product committees (or users and manufacturers of equipment) remain responsible for the appropriate choice of the test and the severity level to be applied to their equipment.
[25]	ISO 16750-2 (2003) Road vehicles - Environmental conditions and testing for electrical and electronic equipment - Part 2: Electrical loads	

Ref.	Standards and reference documents	Description
[26]	ISO 7637-2 (2004) Road vehicles - Electrical disturbance by conduction and coupling - Part 2: Electrical transient conduction along supply lines only	
[27]	ISO 7637-3 (1995) with correction 1 (1995) Road vehicles - Electrical disturbance by conduction and coupling - Part 3: Passenger cars and light commercial vehicles with nominal 12 V supply voltage and commercial vehicles with 24 V supply voltage - electrical transient transmission by capacitive and inductive coupling via lines other than supply lines	