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WELMEC

European cooperation in legal metrology

Guide for the Testing of Automatic Catchweighing Instruments



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WELMEC

European cooperation in legal metrology

WELMEC is a co-operation between the legal metrology services of the Member States of the European Union and EFTA. This document is the introduction to WELMEC.

WELMEC is publishing a number of Guides to provide guidance to manufacturers of measuring instruments and to notified bodies responsible for conformity assessment of their products. The Guides are purely advisory and do not themselves impose any restrictions or additional technical requirements beyond those contained in relevant EC Directives. Alternative approaches may be acceptable, but the guidance provided in these documents are representing the considered view of WELMEC as to the best practice to be followed.

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1 Introduction

Scope

The guide describes the procedures suitable to be used when testing automatic catchweighing instruments for type-examination according to the Measuring Instruments Directive (2004/22/EC) [MID]. The document is based on using OIML Recommendation R51:2006 Automatic catchweighing instruments as “Normative document”. [Throughout this guide OIML R51 or R51 refers to OIML Recommendation R51-1 Edition 2006, and OIML R76 refers to OIML Recommendation R76-1 Edition 2006.]

This guide gives additions to, or interpretations of, OIML R51 accepted by WELMEC members. This guide refers also to other WELMEC guides and especially those developed for non-automatic weighing instruments [NAWIs].

This guide is applicable to instruments incorporating a transport system (e.g. checkweighers and weigh-price labellers) and front-end loaders. Additional considerations for instruments using hydraulic pressure sensors are also described in this guide. Other (Category Y) instruments may be added at a later stage.

The intention of the guide:

- It describes the terms and aspects that are important when automatic catchweighing instruments are tested for type approval;
- It describes test procedures that are clear and acceptable by national approval bodies;
- It functions as a reference in the description of the tests that have been carried out and of which the outcome is laid down in a certificate.

2 Terminology

The definitions of OIML R51 apply. For the purpose of this guide the following additional definitions apply:

Family

The range of versions of a weighing instrument based on the same type of indicator or weighing module. The concept of family mentioned here is for testing purposes only.

Front-end loader

A vehicle incorporated catchweigher that determines the quantity of loose material held in the bucket (load receptor).

Class X(x)

Throughout this guide class X(x) refer to class XI(x), XII(x), XIII(x) or XIII(x).

3 Written declaration

The manufacturer shall give to the testing authorities a written declaration including:

- Manufacturers name and address and also the authorised representative if applicable;
- That OIML Recommendation R51 has been used as “Normative document” to demonstrate conformity to the applicable essential requirements of MID;
- Which class applies to the instrument, class X(x) or class Y(y) or both;
- That the automatic catchweighing instrument can not be disturbed or fraudulently manipulated via the protective interfaces (Article 4.2.4 of R51).
- Electromagnetic environment class (E1, E2, E3)
- Utilisation in a specified permanent continuous electromagnetic field.
- Ambient humidity of the climatic operating environment (non-condensing, condensing).
- Special conditions (e.g. outdoors, long signal lines [relevant for surge test])

4 Equipment under Test (EUT)

To reduce the number of instruments to be tested, the range of instruments of a manufacturer can be grouped into families.

For the purpose of type evaluation/approval, a family shall consist of automatic catchweighing instruments, which have the same modules, i.e.:

- Type of indicator;
- Load cell;
- Weighing module;
- Hydraulic pressure sensors.

For indicators we can mention:

- If the type of the indicator is changed in one or more of its legally relevant parts and new influence factor and disturbance tests are necessary, it is a new family.
- If only new disturbance tests are necessary, i.e. for another version of the cabinet of the indicator, it belongs to the same family.

4.1 Determining the mode of operating for influence factor tests

To determine if an instrument can be tested with static loads in non-automatic operation, see chapter 6.4.5 Influence factor tests of the OIML R51.

If an instrument can be tested with static loads in non-automatic operation, chapter 4.2 applies (category 1). If not, chapter 4.3 applies (category 2).

4.2 Instrument tested in non-automatic mode

4.2.1 Considerations for determining the EUT

When determining the EUT, the same criteria apply as mentioned in OIML R76 for non-automatic weighing instruments.

To determine the EUT, the following criterion applies:

Every family has to be tested as a complete instrument according to R51 or using the modular approach as mentioned in chapter 4.2.2.

For Front-end loaders, if the modular approach is not applied and as laboratory tests on the complete instrument are not normally possible, a simulation test unit is necessary comprising the following components:

- transducer(s),
- indicator including the weight acceptance control,
- simulation device for automatic operation using where necessary the sensors for the weighing position or the weighing zone,
- correction devices (if any) which makes a correction of the measured value depending e.g. on lift angle or vehicle level,
- where necessary interlock-sensors which set limits of the function of the instrument, e.g. bucket position.

4.2.2 Test considerations

For the purpose of type evaluation the same procedures can be used to combine tests for different versions as applied to non-automatic weighing instruments (modular approach as mentioned in R76). However R51 needs to be considered, e.g. warm-up relating to automatic zero-setting.

For testing and certifying the modules, the following WELMEC guidelines can be used where applicable:

- WELMEC 2, Common Application;
- WELMEC 2.1, Guide for Testing Indicators;
- WELMEC 2.4, Guide for Testing of Load Cells;
- WELMEC 2.5, Guide for modular approach and testing of PCs and other digital peripheral devices;
- WELMEC 7.2, Software Guide.

Example 1: Where load cells having the same capacities belong to different versions, approval of the load cell with the best characteristics implies approval of the load cell with lesser characteristics. [For further elaboration on load cells, see WELMEC guide for testing of load cells]

Example 2: If the indicator has two different cabinets, both versions may need to be tested for EMC behaviour.

Error fraction p_i for Front-end loader weighing instruments:

Because important components of the load transmission device of the weighing instrument (levers, joints, force transmission) are not "non-critical" types of weighing instruments according to WELMEC 2.4 the following error fractions p_i are given as an acceptable solution:

Performance criteria	Transducer	Indicator *
warm-up time test	0,7	0,4
influence factor tests	0,7	0,4
power supply variation	-	1
span stability test	-	1

Performance criteria	Simulation test unit **
warm-up time test	0,8
influence factor tests	0,8
power supply variation	1
span stability test	1

* correction devices included if applicable

** in accordance as described in 4.2.1

4.3 Instrument tested in automatic mode

4.3.1 Considerations for determining the EUT

When determining the EUT, the following should be considered:

- During type-approval tests the manufacturer shall specify the transport system. If the automatic catchweighing instrument passes the type-approval tests, other similar transport systems are covered as well.
- The manufacturer can choose the optimum weigh table in combination with the optimum tests loads.
- The highest speed of operation needs to be tested.
- The highest accuracy class needs to be tested.

- for class X(x) instruments the smallest value of x and e.
- for class Y(y) instruments the highest class of y and the smallest value of e.
- The highest number of verification scale intervals needs to be tested and the lowest value of $\mu\text{V}/e$. Remark: if the available resolution on the test unit allows to calculate if other combinations are within the MPE, then this is allowed.
- The highest temperature range.
- If it is not possible to combine the above mentioned parameters into one automatic catchweighing instrument version, then more than one sample needs to be tested, the principle being that the selected sample of instruments to be tested shall take into account all the parameters identified in this chapter. For example: If the manufacturer specifies for the different types of automatic catchweighing instruments, different speeds of operation and different classes, the tests will be performed on the instrument with the highest speed of operation with the corresponding lowest value of x / highest class of y. The tests need to be repeated for another type of automatic catchweighing instrument with a lower value of the x (higher accuracy) /higher class of y with the corresponding highest speed of operation.
- If the automatic catchweighing instrument has different functions, all legally relevant functions need to be tested for compliance with the technical requirements of Chapter 3 of OIML R51. For example, if the automatic catchweighing instrument has two different versions,
 - version A with a dynamic setting device but without price calculations, and
 - version B with price calculation but without a dynamic setting device,
 then, for both versions, compliance with the technical requirements of Chapter 3 and the requirements for electronic instruments of Chapter 4 of OIML R51 need to be examined. For test purposes, both versions can be combined in one EUT.

4.3.2 Test considerations

The representative version(s) of a family of instruments may be tested as a complete instrument or may be tested using the modular approach.

The modular approach that is applied to NAWIs should also be applied to automatic catchweighing instruments as far as possible. For automatic catchweighing instruments that weigh dynamically, at least one sample has to be tested dynamically; dynamic tests cannot be completely abandoned or be replaced by simulation tests.

For testing and certifying the modules, the following WELMEC guidelines can be used where applicable:

- WELMEC 2, Common Application;
- WELMEC 2.1, Guide for Testing Indicators;

- WELMEC 2.4, Guide for Testing of Load Cells (**for load cells for dynamic weighing applications refer to the Note below**);
- WELMEC 2.5, Guide for modular approach and testing of PCs and other digital peripheral devices;
- WELMEC 7.2, Software Guide.

Note: Load cells for dynamic weighing applications are neither covered by WELMEC 2.4 nor by OIML Recommendation (R60). In this case, when using the modular approach, it is therefore necessary to test at least one load cell dynamically. To conduct these tests a load transport system and the load transmission device have to be included in the test. An acceptable solution for the error fractions p_i for instruments incorporating the typical modules is given in the following table:

Performance criteria	Load cell (dynamically)	Indicator
combined effect	0.8	0.5
temperature effect on no-load indication	0.8	0.5
power supply variation	-	1
damp heat	0.8	0.5

If an instrument is tested dynamically, any other load cell may be used provided the following conditions are met:

- There is a respective OIML Certificate of Conformity (R60) or a test certificate (EN45501) issued for the load cell by a Notified Body responsible for type examination under Directive 90/384/EEC.
- The certificate contains the load cell types and the necessary load cell data required for the manufacturer's declaration of compatibility of modules (WELMEC 2, Issue 4, 2004, Section 11), and any particular installation requirements. A load cell marked NH is allowed only if humidity testing to EN45501 has been conducted on this load cell.
- It is not a load cell with digital output.
- The characteristics of the replacement load cell such as n_{lc} , Y, Z are the same or better than the load cell that is tested dynamically.
- The design of the load cells and the material are the same.
- No oil damper is used.

Load cells with different characteristics can only be used if additional dynamic testing has been performed.

It is allowed to change from one transport system to another transport system during type approval test and combine the test results of the different transport systems to a best case specification under the condition that after the change of transport system:

- The number of scale intervals has not changed;
- The value of $\mu\text{V}/\text{e}$ has not changed.

For example: if during the temperature tests, different transport systems are used for the different loads, the test results of those different combinations of test loads and transport systems may be combined to determine the lowest possible value of $x /$ highest class of y . If a Notified Body combines tests then this should be clearly stated in the Test Report and the test data of the different tests should be included in the test report.

4.3.3 Considerations for Front-end loading weighing instruments

For instruments that weigh dynamically in normal operation it may be possible to fully duplicate this dynamic operation in the laboratory. Only in this instance there will be no requirement to perform additional dynamic tests on a complete instrument. It should be noted that it will be exceptional to fully duplicate the dynamic operation in the laboratory and full details shall be included in the test report.

5 Test plan

It is important that the automatic catchweighing instrument is tested under normal conditions of use. To limit the number of tests, the automatic catchweighing instrument should, as far as possible, be tested under conditions that cover the maximum range of applications.

Where possible, tests should be performed on a complete instrument. Simulation tests should be the exception and not a way to avoid dynamic testing.

5.1 Test plan for instruments tested in non-automatic mode

For these instruments, all tests as defined in OIML R51 have to be performed. If the manufacturer has an OIML R76 test report, or the modules have a Test Certificate issued by a Notified Body under the NAWI Directive 90/384/EEC, those test results should be utilised to be supportive of determining compliance with the requirements and with agreement of the owner of the TC.

A complete instrument should be tested under the normal conditions of use for which the instrument is intended (R51-1, 5.2.2).

Note: The tests include a check to see if the automatic catchweighing instrument complies with the technical requirements as stated in OIML R51-1. If the test results or test certificates do not indicate that compliance with the technical requirements has been evaluated, then the Notified Body should perform this test on the automatic catchweighing instrument.

5.2 Test plan for instruments tested in automatic mode

For these instruments, the use of OIML R76 test report or the use of test certificates will not cover all the tests.

Apart from the tests already performed on the modules, the following tests have to be performed on the complete instrument if applicable:

1. Range of dynamic setting;
2. Accuracy of zero-setting;
3. Stability of zero and frequency of automatic zero-setting;
4. Accuracy of tare setting;
5. Zero and span errors immediately after appearance of a stable indication;
6. Eccentric loading;
7. Alternative speed of operation;
8. Temperature test;
9. Temperature effect on no load indication, if applicable;
10. Power variation test;
11. Tilting test;
12. In the case that the test certificate of the indicator does not state that the indicator can be used for an automatic catchweighing instrument, also the checklist has to be performed.

5.3 Test plan for weighing modules

For a weighing module (tested with transport system):

- which includes all mechanical parts with exception of the transport system, and
- which performs all relevant functions of an automatic catchweighing instrument,

the fractional error p_i is assumed to be equal to 0.8. The transport system may then have $p_i = 0.5$.

The weighing module can have a test certificate. In this case, if another manufacturer (with agreement of the owner of the TC) uses this weighing module in his automatic catchweighing instrument, the notified body may decide that no additional dynamic tests need to be performed if the dynamic tests have been performed on the weighing module.

5.4 Considerations for front-end loaders

The considerations in this section are additional to the test plan.

Combined into the test procedures required by R51, the following shall be tested. If possible it shall be done during the tests in the test plan according to 5.1 or 5.2, or else in addition to the test plan according to 5.1 or 5.2 if applicable:

- the correct function of the interlock sensors,
- the accuracy and function of any correction devices eg tilt sensor,
- the weight acceptance control (which includes the vehicle vibration and lifting system acceleration correction) during the in-situ test of the complete instrument.

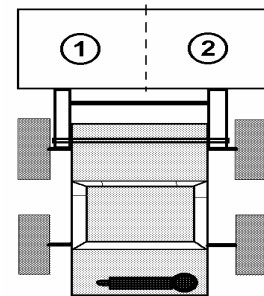
Testing should ensure that weighing results produced, under rated operating conditions of speed, lift angle, level etc, remain accurate.

Safety Note: Before carrying out tests ensure the manufacturers specifications will not be exceeded. Ensure testing is carried out in a safe way, for example, personnel should not be near the vehicle during tilt tests.

Front-end loaders should be tested under the normal conditions of use with standard weights or, alternatively, with loose material. The loose material should be weighed on a control instrument. If a container is used to receive the load on the control instrument its weight shall be taken into account (e.g. by taring). Care should be taken to ensure that none of the load is lost when transferring the material to and from the control instrument.

Eccentricity:

Test at, or near, 1/3 of Max and distribute the standard mass over about half the surface of the load carrier on the left hand side (position 1 in the picture), at right angles to the driving direction (direction of lifting). Repeat this test on the right hand side (position 2 in the picture) of the load carrier.



On site testing is to be considered the norm for front-end loaders in addition to laboratory testing.

For instruments that weigh dynamically in normal operation it may be possible to fully duplicate this dynamic operation in the laboratory. Only in this instance there will be no requirement to perform additional dynamic tests on a complete instrument. It should be noted that it will be exceptional to fully duplicate the dynamic operation in the laboratory and full details shall be included in the test report.

5.5 Considerations for front-end loaders with hydraulic pressure sensors

The considerations in this section are additional to the considerations in section 5.4. This section aims at identifying the differences in testing between front-end loaders with load cells and front-end loaders with hydraulic pressure sensors.

Where more than one type of pressure sensor can be used, each type shall be tested in the laboratory. As pressure transducers are not as well known as load cells, no reduction of the test programme is envisaged for a family of pressure transducers.

Two ways of applying loads in the laboratory are:

- Directly to the pressure transducer using a suitable pressure generator (e.g. a calibrated dead weight pressure tester).
- Using standard weights hung from the lever mechanism or loaded into an appropriate load receiver fitted to the end of the lever.

Transducer range of use:(to be discussed / confirmed):

- Where more than one type of pressure sensor can be used, each type shall be tested in the laboratory, and where necessary the dynamic behaviour shall be tested.
- The manufacturer shall specify the minimum and maximum pressure range(s) in relation to the weighing range.
- When using the modular approach the philosophy of R60 should be followed.
- If the modular approach is not applied, the tests should be conducted with the simulation test unit using the minimum utilised range of the transducer together with the minimum scale interval (in accordance with R76 philosophy).

The working temperature of the hydraulic fluid may be critical to the accurate measurement of weight therefore it has to be taken into account during testing. The manufacturer shall specify the measures taken to account for the effects of the fluid temperature under normal operating conditions. These measures shall be tested accordingly.

Testing procedures should ensure that the manufacturer's specified operating conditions are not exceeded. For example: Repeated weighings on a stationary front-end loader may result in high fluid temperature or even seal failure because of the lack of air cooling.

Note : the use of test certificates for pressure sensors was not defined at the time this issue of the guide was published ; this matter is still under discussion.

5.6 Peripheral equipment

With respect to peripheral equipment that can be connected to the automatic catchweighing instrument, the following requirements should be taken into account:

- In the case of protective interfaces (in the sense of R76-1 article 5.3.6.1):
 - Cables shall be connected to all input/output and communication lines;
 - Cable types and lengths shall be as specified in the manufacturer's authorised manual or as specified in the test certificate. If cable lengths longer than 3 metres are specified, testing with lengths of 3 metres is regarded as sufficient.
- In the case of non-protective interfaces:
 - Peripheral equipment shall be connected to these interfaces to demonstrate correct functioning of the system or sub-system and the non-corruption of weighing results.

Exception: If the non-protective interface is intended for a reject mechanism, only the presence of a signal on the interface needs to be checked. If it functions correctly, the manufacturer can use any reject mechanism.

6 Interpretations of OIML R51

General	For items that are not mentioned in OIML R51, we refer to OIML R76.
A.6.3.2 of R51	For D11: The values of tables 16.1 and 16.2 should be multiplied by 2 for class E2 (i.e, 1kV and 2kV). OK for class E1.
A.6.3.2 of R51	For D11: The values of table 17 should be multiplied by 2 for classes E1 and E2 (i.e, 1kV and 2kV).
A.6.3.6.1 of R51	For class E3 , to fulfill the essential requirement of MID-Annex 1-n°1.3.3, a) , class E3, 2nd hyphen, there is the test : - Electrical transient conduction for instruments powered from a road vehicle battery the appropriate test specification is given in "ISO 7637-2 test pulse 5a" which is not included in the A.6.3.6.1 of R51.
	Text to be added when necessary.

7 Contents of the OIML test report

If applicable: Information about the family of automatic catchweighing instruments.

When it is not possible to perform tests on a complete instrument, the reasons should be stated and the test set-up should be described.

In the case of duplication of dynamic operation of a front-end loader in the laboratory full details shall be included.

8 Required documentation

- 1 General description of type, explanations necessary to understand the functioning of the instrument
 - 1.1 Intended purpose of use, kind of instrument (e.g. checkweigher, weigh price labeller)
 - 1.2 General characteristics (manufacturer; Class, Max, Min, e, n, rate of operation, range of temperature, voltage ...)
- 2 List of descriptions and characteristic data of all devices incorporated in the instrument
 - 2.1 Adjustment devices
 - 2.2 Indication or printout for test purposes
 - 2.3 Indication or printout for normal operation
 - 2.4 Printing devices
 - 2.5 Zero-setting, zero-tracking devices
 - 2.6 Tare devices
 - 2.7 Preset tare devices
 - 2.8 Levelling device and level indicator, maximum value of tilt
 - 2.9 Functions of price-computing instruments
Weigh price labellers
 - 2.10 Interfaces
 - Type(s), intended use, immunity to external influences instructions
 - Peripheral devices presented to be connected for the disturbance tests
 - 2.11 Peripheral devices, e.g. printers, remote displays, that are to be included in the type approval certificate
 - 2.12 Other devices or functions, e.g. for purposes other than determination of mass (not subject to conformity assessment)
- 3 Information concerning special cases
 - 3.1 Subdivision of the instrument in modules - e.g. load cells / hydraulic pressure sensors, mechanical system, indicator, display - indicating the functions of each module and the fractions π of the maximum permissible errors
- See also point 6 -
 - 3.2 Special operating conditions
 - 3.3 Reaction of the instrument to significant faults
 - 3.4 Functioning of the display after switch-on
 - 3.5 Any other special information

- 4 Conceptual designs, drawings and plans of components, sub-assemblies, electric circuits etc. in particular of:
 - load receptor
 - lever systems and material of the levers
 - devices to apply the force to the load cells / hydraulic pressure sensors
 - electrical connection elements, e.g. for connecting load cells / hydraulic pressure sensors to the indicator
 - load cells / hydraulic pressure sensors, if not presented as modules under point 3.1
 - indicator:
 - block diagram
 - schematic diagram
 - keyboard with function assigned to any key
 - samples of all intended printouts, see also point 2.4
 - means for securing and sealing

- 5 The applicant may submit results of tests performed by the manufacturer or other laboratories, on protocols from R51-2, including proof of competence.

- 6 The applicant may submit certificates of other type approvals or separate tests, relating to modules or other parts mentioned in the documentation, together with test protocols where possible - see also point 3.1.

- 7 For hydraulic pressure sensors: relevant properties of the fluid used for transmitting the pressure.