



9.1 Compatibility of modules for nonautomatic weighing instruments (NAWIs)

9.1.1 Common requirements

A manufacturer or his in the EC authorized representative declares including the verification of conformity, that the NAWI meets the essential requirements. Referring to regulation 90/384/EEC he confirm correspondence with the requirements resp. with the pattern of the approval. In Germany a declaration of conformity in accordance to German "Verwaltungsvorschriften Gesetzliches Messwesen" GM-P9 No 3 may be given by the notified body to the manufacturer of the NAWI or with proviso clause to the manufacturer of the indicator. The declaration of conformity only becomes valid in combination with the check of conformity by the notified body.

With the proposal for verification to the notified body the demonstration of compatibility of the modules according to No 11 of WELMEC 2 (Issue 3) becomes necessary for EC- verification for approvals referring to the general statement for load cells and for EC-unit verification.

In particular the demonstration of compatibility is demanded

- 1 for (high capacity) weighbridges, designed as multiple range or multi-interval weighing instrument and
2. for national verification after replacement of modules (load cells, indicators) by modules of different type, if the approvals contain the general statement for load cells (see No 9.1.3)

The demonstration of compatibility of the modules **will not be necessary** if:

- the applied load receptors and load cells are listed explicitly in the type approval or
- the applicant of the type approval has provided PTB with a document *Register of Compatible Modules* and uses provable standard applications of this register. This register (or abstracts) has to be submitted to the notified body for EC-verification e.g. as a part of the declaration of compatibility.

Note:

Other measuring transformers than strain gauge load cells and also digital load cells (load cells with binary output) are not freely changeable with the general statement for load cells. These systems are not fitted with normalized interfaces and therefore they are not treated by this paper for demonstration of compatibility. This measuring devices still must be comprehended by the annex of the type approval certificate.

Manufacturers with an accredited quality assurance system demonstrate the compatibility of the modules themselves. These compatibility demonstration are under control of the notified body that has accredited the quality assurance system.

The Annex 1 to 3 of this chapter of the German "Verwaltungsvorschrift gesetzliches Messwesen GM-P9" keep improved Forms of WELMEC 2, (Issue 3, 2000).

Besides this Forms an evaluation program using Excel 97: *Verification of Compatibility for Modules of Non Automatic Weighing Instruments (NAWI)* will be accepted.

It may be loaded down from web sides of AGME (www.agme.de) or PTB-Arbeitsgruppe 1.12 (<http://www.ptb.de/org/1/11/112/>)



9.1.2 Definitions

9.1.2.1 Module

A Module is a part of a NAWI, necessary to gain a weighing result and all primary indications presenting the weighing result (compare T.1.3.1 and Chapter 4.14.1 and 4.15.1 EN 45501). A module can be examined separately and is subject to specified partial error limits (fraction p_i).

Every device connected to the NAWI over **non-interacting** interface, will be dealt with as a module. The connection has to be sealed in every case. If no device is connected to an existing non-interacting interface this interface has to be sealed too.

Examples for modules of a NAWI: Load cell, indicator, display, point of sales, software, weighing module (the last one means a complete weighing instrument: load receptor including all mechanical parts, load cell, and all signal processing, with digital interface, but **without** final display or printer and so it is no NAWI).

9.1.2.2 Type approval

In a type approval all modules and supplementary devices are listed, which can be used in weighing instruments for purpose subject to legal control. The metrological data of the NAWI and the supplementary devices are documented and are in accordance with the essential requirements of Directive 90/384/EEC.

A type approval may refer to test certificates and test reports and determine under which condition supplementary devices or modules with test certificate or test report may be connected to resp. applied or replaced in the NAWI.

9.1.2.3 Type approval including general statement

The application of modules on one hand may be limited, that means the conditions are laid down in the type approval (eg conditions for design of mechanics) or on the other hand may be general accepted, if the type approval contains a general statement, eg the weighing instrument may be equipped with “every defined module, regarding certain conditions“ and under this condition may be submitted for verification.

In practice general acceptance exists for modules under defined conditions in type approvals (mainly printer). The general acceptance further is applied for load cells (see WELMEC 2.4 Guide for load cells) and for point of sales devices (see WELMEC 2.2 Guide for Guide for testing point of sale (POS) devices

A general acceptance for indicators is not possible, the type approvals contain explicitly certain indicator(s) resp. test certificates for indicator(s). Normally the module indicator defines the type of the weighing instrument and the metrological properties.



9.1.2.4 Test certificate

Test certificates are useful documents to make type testing some more easy. They are applied for modules and supplementary devices for NAWIs. For issuing a test certificate modules and supplementary devices have to meet all essential requirements of Directive 90/384/EEC, all applicable requirements of EN 45501 and meet the requirements of the corresponding WELMEC Guides. The latter guides keep constructions of good sound and serve for uniform application of the regulations.

Test certificates have their meaning only in combination with an EC-type approval; it is fixed with the wording of the type approval whether a supplementary devices may be connected or a modules may be applied in a NAWI.

9.1.2.5 Test report

For modules or supplementary devices not fully in accordance to EN 45501 and the corresponding WELMEC Guides, but tested with the essentially requirements, a test report may be issued, to make type approval more easy.

Devices with test reports are not suited for general acceptance. A general statement in the type approval is not possible.

9.1.3 Load cells and load receptors

For Load cells and load receptors the guide WELMEC 2.4 is valid, it contains requirements for load introduction for the load cells and general requirements for load receptors.

Other load introductions are considered as verified too, when the pattern approval tests according to EN 45501, No 8.2.2, have been passed.

For the application of strain gauge load cells according to EN 45501 No 4.12, Annex 1 and Annex 2 have to be applied.

Load cells and load receptors of weighing instruments, which have been verified before and now have been rebuild by changing the indicator are generally acceptable if the following conditions are met:

- *Max* and *e* of the weighing instrument are maintained,
- the load receptor has not been changed at all and
- the compatibility of the modules must be verified, using existing test certificates, test reports or pattern approvals.

In these cases normally the demonstration of compatibility according to No 5, 6 and 7 of Annex 2 is not necessary. Otherwise the evaluation is to coordinate with the responsible authority.



9.1.4 Specialities of the EC-unit verification

Only particular unit constructions of weighing instruments, which are created by their special application shall achieve an EC-unit verification. The proposal shall keep the following declaration:

“A proposal for EC-unit verification for weighing instruments of this type or a similar type

- has not been made before
- has been made in ..(number).. to following authorities:
Explanations to the applied EC-unit verification: ...,“

The notified body ordered with the EC-unit verification, has to be provided with the design documentation according to Annex III of the Directive 90/384/EEC by the manufacturer of the weighing instrument or his representative.

The manufacturer further should add a confirmation that the requirements of standard EN 45501 are met. Discrepancies to this standard have to be described and are permissible, but in this case it has to be shown unambiguously how the requirements of the Directive 90/384/EEC are met.



Annex 1: Metrological and technical Data

Manufacturer:

Weighing instrument	accuracy class		<i>class</i>				-			
	Serial number:		maximum capacity	verification interval	<i>Max</i>	<i>e</i>			kg	kg
	Type of weighing instru-		(multi-interval WI multiple range WI)		<i>(Max₁)</i>	<i>(e₁)</i>			kg	kg
					<i>(Max₂)</i>	<i>(e₂)</i>			kg	kg
					<i>(Max₃)</i>	<i>(e₃)</i>			kg	kg
	reduction ratio				<i>R</i>				-	
	number of load cells				<i>N</i>				-	
	initial zero setting range				<i>IZSR</i>				kg	
	correction for non uniform distributed load				<i>NUD</i>				kg	
	TAC (Type Appr. Certific.)		dead load of load receptor		<i>DL</i>				kg	
			additive tare		<i>T+</i>				kg	
			limits of temperature range		<i>T_{min}</i>	<i>T_{max}</i>			° C	° C
	Owner of TAC:		length of cable		<i>L</i>				m	
		cross section of wire		<i>A</i>				mm ²		
Electronic indicator	accuracy class		<i>class</i>						-	
	Manufacturer:		max. number verification scale intervals		<i>n_{ind}</i>				-	
	Type:		load cell excitation voltage		<i>U_{exc}</i>				V	
			general min. input voltage for indicator		<i>U_{min}</i>				mV	
			min. input voltage per verification scale interval		ΔU_{min}				μV	
	TC (Test certificate):		minimum/maximum load cell resistance		<i>R_{Lmin}</i>	<i>R_{Lmax}</i>			Ω	Ω
			limits of temperature range		<i>T_{min}</i>	<i>T_{max}</i>			° C	° C
	and/or		fraction of the maximum permissible error		ρ_{ind}				-	
	TAC (Type Approval Certificate)		cable connection (4- or 6 wire)		number of wires				-	
			max. value of cable length per wire cross sec-		$(L/A)_{max}$				m/mm ²	
Load cell(s) (LC)	accuracy class		<i>class</i>						-	
	Manufacturer :		maximum capacity		<i>E_{max}</i>				kg	
	Type:		minimum dead load		<i>E_{min}</i>				kg	
			rated output		<i>C</i>				mV/V	
			max. number verification scale intervals		<i>n_{LC}</i>				-	
	TC (Test certificate):		minimum verification scale interval or		<i>v_{min}</i>				kg	
			the ratio $Y = E_{max} / v_{min}$		<i>Y</i>				-	
			ratio $Z = E_{max} / (2 DR)$ or		<i>Z</i>				-	
	or TAC (Type Approval Certificate)::		minimum dead load output return		<i>DR</i>				kg	
			input resistance of single load cell		<i>R_{LC}</i>				Ω	
		limits of temperature range		<i>T_{min}</i>	<i>T_{max}</i>			° C	° C	
		fraction of the maximum permissible error		ρ_{LC}				-		
Connecting elements		fraction of the maximum permissible error		ρ_{con}				-		

This Forms have been applied with no change to the original Forms.

Date and signature of an authorized representative of the WI-Manufacturer:



Annex 2: Verification of Compatibility

(1) Accuracy class of load cell (LC), indicator (IND) and weighing instrument (WI)

LC	&	IND	equal or better	WI	passed	failed
	&		equal or better		<input type="checkbox"/>	<input type="checkbox"/>

(2) Temp.limits of the weighing instr.(WI) compared with the temp.limits of the load cell (LC) and the indicator (IND) in °C

	LC	IND		WI	passed	failed
T_{min}		&	\leq		<input type="checkbox"/>	<input type="checkbox"/>
T_{max}		&	\geq		<input type="checkbox"/>	<input type="checkbox"/>

(3) Sum of the squares of the fractions p_i of the max. permissible errors of connecting elements, indicator and load cells

p_{con}^2	+	p_{ind}^2	+	p_{LC}^2	≤ 1	passed	failed
	+		+		≤ 1	<input type="checkbox"/>	<input type="checkbox"/>

(4) Maximum number of verification scale intervals of the indicator and number of scale intervals of the weighing instrument

	n_{ind}	\geq	$n_{(i)} = Max_{(i)} / e_{(i)}$	passed	failed
One range weighing instrument		\geq		<input type="checkbox"/>	<input type="checkbox"/>
Multi-interval or multiple range WI	i = 1	\geq		<input type="checkbox"/>	<input type="checkbox"/>
	i = 2	\geq		<input type="checkbox"/>	<input type="checkbox"/>
	i = 3	\geq		<input type="checkbox"/>	<input type="checkbox"/>

(5) Maximum capacity of load cells must be compatible to Max of the weighing instrument

Factor Q (EN 45 501 No 4.12.1): Factor $Q = (Max_r + DL + IZSR + NUD + T+) / Max_r = \dots$

$Q * Max * R / N$	\leq	E_{max}	passed	failed
	\leq		<input type="checkbox"/>	<input type="checkbox"/>

(6a) Maximum number of verification scale intervals of the load cell and number of scale intervals of the weighing instrument

	n_{LC}	\geq	$n_{(i)} = Max_{(i)} / e_{(i)}$	passed	failed
One range weighing instrument		\geq		<input type="checkbox"/>	<input type="checkbox"/>
Multi-interval or multiple range WI	i = 1	\geq		<input type="checkbox"/>	<input type="checkbox"/>
	i = 2	\geq		<input type="checkbox"/>	<input type="checkbox"/>
	i = 3	\geq		<input type="checkbox"/>	<input type="checkbox"/>

(6b) Minimum dead load output return of the load cell and smallest verification scale interval e_1 of a multi-interval WI

n_{LC} or $Z = E_{max} / (2 * DR)$	\geq	Max_r / e_1	passed	failed
	\geq		<input type="checkbox"/>	<input type="checkbox"/>

(6c) Minimum dead load output return of the load cell and smallest verification scale interval e_1 of a multiple range WI

n_{LC} or $Z = E_{max} / (2 * DR)$	\geq	$0,4 * Max_r / e_1$	passed	failed
	\geq		<input type="checkbox"/>	<input type="checkbox"/>

(6d) Actual dead load of the load receptor to the minimum dead load of the load cells in kg

$DL * R / N$	\geq	E_{min}	passed	failed
	\geq		<input type="checkbox"/>	<input type="checkbox"/>

(7) Verification scale interval of the weighing instrument and minimum load cell scale interval (in kg) must be compatible

$e * R / \sqrt{N}$	\geq	$v_{min} = E_{max} / Y$	passed	failed
	\geq		<input type="checkbox"/>	<input type="checkbox"/>

(8) Minimum input voltage per verification scale interval and minimum input voltage in general for the electronic indicator

and actual output of the load cells

$\Delta u = C * U_{exc} * R * e / (E_{max} * N)$	\geq	Δu_{min}	passed	failed
	\geq		<input type="checkbox"/>	<input type="checkbox"/>
$U = C * U_{exc} * R * DL / (E_{max} * N)$	\geq	U_{min}	passed	failed
	\geq		<input type="checkbox"/>	<input type="checkbox"/>

(9) Allowed impedance range for the electronic indicator and actual load cell impedance in Ω

R_{Lmin}	\leq	R_{LC} / N	\leq	R_{Lmax}	passed	failed
	\leq		\leq		<input type="checkbox"/>	<input type="checkbox"/>

(10) Length of extension cable between the load cell(s) and indicator per wire cross section of this cable in m/mm^2

(L/A)	\leq	$(L/A)_{max}$	passed	failed
	\leq		<input type="checkbox"/>	<input type="checkbox"/>



Annex 3: Explanations to Forms of Annex 1 and 2

The succession follows the sequence of Annex 1

Annex 1 terms	Annex 2 condition-No	Description																								
<i>class</i>	1	<p>Accuracy class</p> <p>The accuracy classes of weighing instrument (NAWI), indicator(IND) and load cell(s) (LC) are compatible if they correspond to following table (EN 45501 No 4.12):</p> <table border="1"> <thead> <tr> <th></th> <th colspan="4">Accuracy class</th> <th>Reference</th> </tr> </thead> <tbody> <tr> <td>NAWI</td> <td>I</td> <td>II</td> <td>III</td> <td>IIII</td> <td>90/384/EEC resp. EN 45501</td> </tr> <tr> <td>IND</td> <td>I</td> <td>I⁾, II</td> <td>II⁾, III</td> <td>III, IIII</td> <td>EN 45501, WELMEC 2.1</td> </tr> <tr> <td>LC</td> <td>A</td> <td>A⁾, B</td> <td>B⁾, C</td> <td>C, D</td> <td>OIML R60, WELMEC 2.4</td> </tr> </tbody> </table> <p>⁾ if temperature ranges are sufficiently and the evaluation of stability against humidity and creep correspond to the requirement in the lower class</p>		Accuracy class				Reference	NAWI	I	II	III	IIII	90/384/EEC resp. EN 45501	IND	I	I ⁾ , II	II ⁾ , III	III, IIII	EN 45501, WELMEC 2.1	LC	A	A ⁾ , B	B ⁾ , C	C, D	OIML R60, WELMEC 2.4
	Accuracy class				Reference																					
NAWI	I	II	III	IIII	90/384/EEC resp. EN 45501																					
IND	I	I ⁾ , II	II ⁾ , III	III, IIII	EN 45501, WELMEC 2.1																					
LC	A	A ⁾ , B	B ⁾ , C	C, D	OIML R60, WELMEC 2.4																					
<i>Max, Max₁ ... Max_r</i>	4,5, 6a-c	Maximum capacity of weighing instrument (WI), resp. maximum capacity of the weighing ranges of multi-interval WI or multiple range Wi (<i>Max₁</i> = smallest range; <i>Max_r</i> = biggest range)																								
<i>e, e₁, e₂, e₃</i>	4,6a-c, 7,8	Verification scale intervals of the weighing instrument resp. verification scale intervals for the weighing ranges of multi-interval WI or multiple range WI (<i>e₁</i> = smallest verification interval)																								
<i>R</i>	6d,7,8	<p>Reduction ratio</p> <p>The reduction ratio, eg of a lever work according to EN 45501 T.3.3, is the ratio (Force onto the load cell) / (Force onto the load receptor).</p> <p>Normally the number of load cells in NAWIs with lever work is $N=1$ and $R<1$. In very specially cases a load receptor with lever work may have more than one LC. In every case the value of <i>R</i> has to be indicated by the manufacturer of the WI.</p> <p>NAWIs without lever work always have $R = 1$.</p>																								
<i>N</i>	5,6d,7,8,9	Number of the load cells																								
<i>IZSR</i>	5	<p>Initial Zero Setting Range</p> <p>Range in which the indication automatically is set to zero when the weighing instrument is switched on, before any weighing.</p> <p>If the load receptor is changeable by the user of the WI, eg for retail scales, 20% of <i>Max</i> (so far possible with the indicator) in other cases 4% of <i>Max</i>.</p>																								
<i>NUD</i>	5	<p>Addition for Non Uniform Distribution of the load</p> <p>This addition takes care for eccentric loading on the load receptor in practice, when the load receptor is loaded with <i>Max</i>. According to WELMEC 2 (Issue 3) Nr. 3.1.6.6 following values for <i>NUD</i> might be assumed:</p> <ul style="list-style-type: none"> - Weighing instruments (WIs) with lever work and one LC, WIs with one single point LC, WIs with load receptors which allow only minimal eccentric load application, 0% of <i>Max</i> eg hopper or funnel hopper with a symmetric arrangement of the load cells, but without shaker for material flow on the load receptor - other conventional WIs: 20% of <i>Max</i> - Fork lift scales, over head track scales and weighbridges 50% of <i>Max</i> - Multi-platform weighing machine fix combined 50% of <i>Max</i>_{total} variable selection or combined 50% of <i>Max</i>_{single bridge} 																								



DL	5,6d	Dead Load Weight of the load receptor himself resting upon the load cells and additionally fix mounted constructions on the load receptor.
$T+$	5	Maximum value of additive Tare (if possible!)
Q	5	Q-factor $Q = (Max_r + DL + ISZR + NUD + T+)/Max_r$ For weighing instruments with lever work Q is assumed 1,1 to 1,3 .
$T_{min},$ T_{max}	2	Limits of temperature range Lowest and highest limit for the environment temperature. The permissible temperature limits of the load cell(s) and the indicator must meet the temperature limit of the weighing instrument.
L	10	Length of connection cable Length of the extension cable between connection box of load cell(s) and indicator.
A	10	Cross section of wire of the connection cable of a 4 or 6 wire connection between connection box of load cell(s) and indicator. <i>Notes:</i> For cable with different cross sections of the wires by 4-wire connection the excitation-wire by 6-wire connection the sense-wire is of interest. By application of lightning barriers, the excitation voltage must be checked, to prove condition (8) using excitation voltage to calculate minimum input voltage per verification scale interval.
n_{ind}	4	Maximal number of verification scale intervals of the indicator The maximal number of verification scale intervals of the indicator n_{ind} must not be smaller than the maximal number of verification scale intervals of the weighing instrument $n = Max/e$. For multiple range WIs and multi-interval WIs this is required for every weighing range.
U_{exc}	8	Load cell excitation voltage
U_{min}	8	General minimum input voltage for indicator An indicator may need a bias if the input amplifire cannot measure accurate both positiv and negativ voltage.
ΔU_{min}	8	Minimum input voltage per verification scale interval for the indicator The signal per verification scale interval Δu is calculated as follows: $\Delta u = \frac{C}{E_{max}} \cdot U_{exc} \cdot \frac{R}{N} \cdot e$, for multiple range WIs or multi-interval WIs $e = e_1$.
R_{Lmin}, R_{Lmax}	9	Limits of allowed load impedance range for the electronic indicator caused by the actual load cell(s) input impedance.



$\rho_{ind},$ $\rho_{LC},$ ρ_{con}	3	<p>Fractions of the maximum permissible error (mpe) of the WI for the indicator ρ_{ind}, the load cell(s) ρ_{LC} and the connecting elements ρ_{con}.</p> <p>The sum of the squares of the fractions ρ_{con}, ρ_{ind} and ρ_{LC} has to be smaller or equal the value "1" (EN 45501 No 3.5.4).</p> <p>According to EN 45501 No 3.5.4 for any module the values may be $0,3 \leq \rho \leq 0,8$, but normally following values are applied:</p> <p>Indicator $\rho_{ind} = 0,5$</p> <p>If no value for ρ_{LC} is documented in the load cell test certificate, $\rho_{LC} = 0,7$.</p> <p>The fraction for the connecting elements ρ_{con} between load cell(s) and indicator might be assumed with $\rho_{con} = 0,5$.</p>
Number of wires	10	<p>Connection (4- or 6-wires)</p> <p>In case of 4-wire load cell connection cable the original cable supplied by the load cell manufacturer must be maintained in every case. The connection of some load cell cables right before the indicator is permitted.</p>
$(L/A)_{max}$	10	Maximal allowed ratio of cable length and cross section
E_{max}	5,6b,6c,7,8	<p>Maximum capacity of the load cell</p> <p>By measurements near the maximum capacity <i>Max</i> of weighing instrument the active load on the load cell is not allowed to exceed the maximum capacity E_{max} of the load cell :</p> $E_{max} \geq \frac{Q \cdot Max_r \cdot R}{N}$
E_{min}	6d	<p>Minimum dead load on a load cell</p> <p>The minimum load caused by the load receptor must be equal or exceed the minimum dead load of a load cell (A lot of load cells have $E_{min} = 0$) :</p> $E_{min} \leq \frac{DL \cdot R}{N}$
C	8	<p>Rated output</p> <p>Change of output signal of the load cell related to input voltage after loading with E_{max}, normally in mV/V .</p>
n_{LC}	6a-c,7	<p>Maximum number of verification scale intervals for the load cell</p> <p>The maximal number of verification scale intervals of the load cell n_{LC} must not be smaller than the maximal number of verification scale intervals of the weighing instrument $n = Max / e$. For multiple range WIs and multi-interval WIs this is required for every weighing range i.</p>
v_{min}	7	<p>Smallest verification scale interval of a load cell</p> $v_{min} = \frac{E_{max}}{Y} \leq \frac{e \cdot R}{\sqrt{N}}, \text{ for multiple interval WIs or multi-interval WIs } e = e_1 .$
Y	7	<p>Ratio $Y = E_{max} / v_{min}$ of a load cell :</p> <p>If Y or v_{min} is not documented in the test certificate, replace Y by n_{LC} .</p>
Z	6b,6c	<p>Creep ratio $Z = E_{max} / 2 \cdot DR$ of a load cell :</p> $Z = \frac{E_{max}}{2 \cdot DR} \geq \frac{Max_r}{e_1} \quad \text{for multi-interval WIs, resp.}$ $Z = \frac{E_{max}}{2 \cdot DR} \geq 0,4 \cdot \frac{Max_r}{e_1} \quad \text{for multiple range WIs.}$



DR	6b,6c	Minimum D ead load output R eturn If DR or Z is not documented in the test certificate, replace Z by n_{LC} .
R_{LC}	9	Input impedance of a single load cell There may be N load cells in a load receptor . R_{LC} / N has to meet the range of the indicator $R_{L\ min}$ to $R_{L\ max}$.

Annex 4: Addresses and sources for regulations

WELMEC-Documents:

1. [WELMEC 2](#) (2000) Directive 90/384/EEC: Common Application
2. [WELMEC 2.1](#) (1998) Guide for testing of indicators (NAWIs)
3. [WELMEC 2.4](#) (2001) Guide for load cells
4. [WELMEC 2.5](#) (2000) Guide for modular approach and testing of PCs and other digital peripheral devices (NAWIs)

All WELMEC-Documents are available under (Web: www.welmec.org), but also may be ordered in printed form by:

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