

REGLEMENT D'APPLICATION	TRA	413
	REV 6	2023/6

## REGLEMENT D'APPLICATION

DE LA MARQUE BENOR

DANS LE SECTEUR DES

PRODUITS EN ACIER

POUR BETON

Modalités de contrôle applicables

aux Usagers de la Marque - Producteurs de Poutres Treillis

REVISION 6

BENOR asbl

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## Application Regulation TRA 413 Revision 06

### Application regulation of the BENOR-mark in the sector of concrete reinforcements - Methods of assessment applicable to the “Users of the mark” – Producers of lattice girders

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## 1 Introduction

This Application Regulation (TRA<sup>1</sup>) was prepared by the Technical bureau 1 of OCAB-OCBS, sectoral organization, “Concrete reinforcing steels” for the BENOR certification of concrete reinforcements.

According to the regulation of use and control of the BENOR-mark<sup>2</sup> and its article 9, this Application Regulation of OCAB-OCBS constitutes the reference certification scheme to the BENOR-mark.

## 2 Reference documents and definitions

### 2.1 Reference documents

- Règlement d'usage et de contrôle de la marque BENOR / Algemeen reglement voor het beheer van het Benor-merk<sup>3</sup>.
- Règlement général pour la gestion de la marque BENOR / Algemeen reglement voor het beheer van het Benor-merk<sup>4</sup>.
- Règlement particulier d'usage et de contrôle de la marque BENOR dans le secteur des produits en acier laminés à chaud et dans le secteur des aciers écrouis à froid pour béton / Bijzonder reglement voor gebruik en controle van het BENOR-merk in de sector de warmgewalste staalproducten en in de sector van het koudvervormde staal voor gewapend beton, BRP 279<sup>5</sup>.

In theory, the last edition of the standards and PTV applies. If necessary, an addendum to the present regulation would be published in the event of incompatibility following the revision of one of the documents quoted hereafter.

- NBN A 24-301, Produits sidérurgiques - Aciers pour béton armé - Barres, fils et treillis soudés - Généralités et prescriptions communes / Staalproducten - Betonstaal - Staven, draden en gelaste wapeningsnetten - Algemeenheden en gemeenschappelijke voorschriften.
- NBN A 24-302, Produits sidérurgiques - Aciers pour béton armé - Barres lisses et wireres à nervures - Fils machine lisses et fils machine à nervures / Staalproducten - Betonstaal - Gladde en geribde staven - Gladde en geribde walsdraad.
- NBN A 24-303, Produits sidérurgiques - Aciers pour béton armé - Fils écrouis à froid lisses et fils écrouis à froid à nervures / Staalproducten - Betonstaal - Gladde en geribde koudvervormde draad.
- NBN EN ISO 15630-1, Aciers pour l'armature et la précontrainte du béton – Méthodes d'essai – Partie 1 : Barres, fils machine et fils pour béton armé / Staal voor de wapening en voorspanning van beton – Beproevingmethoden, Deel 1: Staven, draad en draad voor gewapend beton.
- NBN EN ISO 15630-2, Aciers pour l'armature et la précontrainte du béton – Méthodes d'essai – Partie 2 : Treillis soudés et treillis raidisseurs / Staal voor de wapening en voorspanning van beton – Beproevingmethoden, Deel 2: Gepuntlaste wapeningsnetten en tralieliggers.
- PTV 302, Aciers pour béton armé, Barres à nervures ou à empreintes et fils à nervures ou à empreintes à haute ductilité / Gewapend betonstaal, Geribde of gedeukte staven en Geribde of gedeukte draad met hoge ductiliteit betonstaal.
- PTV 303, Aciers pour béton armé, Fils écrouis à froid à nervures à basse ductilité / Gewapend betonstaal, Geribde koudvervormde draad met lage ductiliteit.
- PTV 305, Aciers pour béton armé, Poutres-treillis / Gewapend betonstaal, Tralieliggers.
- TRA 418, Modalités de contrôle applicables aux Usagers de la Marque – Annexes statistiques / Controlemodaliteiten toepasselijk op de gebruikers van het Merk - Bijlage statistiek.
- ECU 606, Application of the BENOR-mark in the sector of concrete reinforcements - Methods of assessment applicable to the “Users of the mark, Processors and Distributors of BENOR

<sup>1</sup> TRA : Toepassingsreglement – Règlement d'Application

<sup>2</sup> (Reference BENOR<sup>asblvzw</sup> : NBN/RVB.CA/RM2012-10-02 and following editions in force)

<sup>3</sup> (Reference: NBN/RVB.CA/RM2012-10-02 and following editions in force) with Document CM10 1998-12-09 in appendix

<sup>4</sup> (Reference: NBN/RVB.CA/RG2012-10-02 and following editions in force) with Document CM10 1998-12-09 in appendix

<sup>5</sup> According to the last edition in force

products” - Equipment of control, determination of the “ $\lambda$ -value” for the computation of  $f_R$  or  $f_P$ , simplified procedure for the setting of a straightening machine

- Manuel de qualité de l’OCAB / Kwaliteitshandboek van het OCBS<sup>6</sup>.

## 2.2 Basic definitions and requirements

### 2.2.1 Laboratories

#### 2.2.1.1 Internal laboratory

It is the own internal laboratory (laboratory of the producer<sup>7</sup>). To be recognized as such, this laboratory must fulfil the following requirements:

- The tensile testing machines of this laboratory must be calibrated in accordance with standard NBN EN ISO 15630-1. They must be of class 1 or better; the last calibration carried out by a service independent of the laboratory, cannot go back to more than one year. Moreover, they are equipped with a system of measurement of total elongation under the maximum load.
- All the tensile testing machines used within the framework of BENOR certification must be the subject of paired comparisons with the tensile testing machine of the control laboratory<sup>8</sup> according to the provisions of the preliminary examination.
- During the yearly check by the sectorial organization<sup>9</sup>, the test results of at least one testing machine must be subjected to the ones of a control laboratory. Each tensile testing machine must be subjected to a paired comparison with a control laboratory at least once every three years. If the producer uses other tensile machines in the internal laboratory, those machines are yearly compared with the machine for which the comparison with the control laboratory is carried out. If it is not possible to compare those other tensile machines with this machine (e.g. because of different capacity), a yearly comparison with a control laboratory must be carried out for each machine concerned.
- All the other measurement and testing devices must be calibrated at least once a year.

#### 2.2.1.2 Control laboratory

Laboratory accredited according to ISO 17025 and quoted by document OCAB-OCBS 503a<sup>10</sup>.

## 3 Preliminary examination prior to the granting of the authorization of use of the BENOR-mark

### 3.1 General information

#### 3.1.1 Principle

The conformity of the products to the prescriptions being the subject of standards NBN A 24-301, -302 and -303 and technical specifications PTV 302, 303 and 305<sup>11</sup> is checked by a preliminary examination prior to the granting of the authorization of use of the BENOR-mark.

<sup>6</sup> According to the last edition in force

<sup>7</sup> COUNCIL DIRECTIVE of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products (85/374/EEC), Article 3.1: **‘Producer’** means the manufacturer of a finished product, the producer of any raw material or the manufacturer of a component part and any person who, by putting his name, trade mark or other distinguishing feature on the product presents himself as its producer.

<sup>8</sup> See definition in 2.2.1.2

<sup>9</sup> OCAB-OCBS

<sup>10</sup> Document 503 a, “Lijst – Liste – List, Keuringsinstellingen (OCI), Laboratoria (Labs), Organismes de contrôle (OCI), Laboratoires (Labs), Control Bodies (OCI), Laboratoires (Labs) »

<sup>11</sup> In the continuation of the text, for simplification, the term “standard(s)” covers the most recent version from standards NBN A24-301, -302 and -303 including addendum, as well as normative OCAB-OCBS documents OCAB PTV 302, 303 and 305.

The authorization of use of the mark is granted by product. The four types of lattice girders, the lattice girders worked out according to different processes, the lattice girders manufactured starting from wires with different grades for the upper wires, for the diagonal wires as for the lower wires being able to intervene in the calculation of stability are regarded as different products.

For a defined product, a model is an assembly made up of a upper wire for which the diameter and the grade are specified, of two lower wires for which the diameter and the grade are specified, and of two diagonal wires for which the diameter and the grade are specified.

The purpose of this preliminary examination is to check that the producer can manufacture the products for which he asks for the authorization of use of the mark and to maintain a regularity for the properties of these products in current manufacturing.

### 3.1.2 Preliminary examination

The preliminary examination is based on the tests of current control carried out by the services of the producing factory and on complementary tests carried out by an external laboratory on request of the sectoral organization or his representative<sup>12</sup>.

### 3.1.3 Random sampling

The sectoral organization selects, as much as possible randomly, the applicable number of products for control among the available products (see §§ 3.1.6 and 3.1.8).

All these available products come from the installations planned for the manufacturing of these products.

### 3.1.4 Requirements

It is necessary to check that the specified properties fulfil the criteria defined in the above-mentioned standards and technical specifications and clarified in articles 4.2 and 4.3 of this document.

### 3.1.5 Marking and Identification

The wires with ribs (or indentations) bear rolling marks in conformity with standard NBN A24-301 or PTV 302 and 303 making it possible to identify the origin as well as the grade of steel. The producer indicates to the sectoral organization the marking he has chosen; this marking is also reproduced on the various delivery forms.

Moreover, each burden of lattice girder (types 1-2-3-4) is provided with one or more labels carrying at least the following information (see also PTV 305 and chapter on *Designation*):

- the reference to "Lattice girder"
- the type (1, 2, 3 or 4)
- the grade of steel and the diameter for the upper wire, the lower wires and the diagonals, the height
- a reference number allowing to ensure the traceability of the autocontrol (see 4.1.4)
- the name of the producer and the seat of manufacturing.

The labels must be indelible and sufficiently robust to support the handling of the lattice-girders. The labels must be subjected to the approval of the sectoral organization. After attribution of the BENOR-mark, the labels are provided with the BENOR logo together with the distinctive number of the user of the mark. The lattice girders must be provided with BENOR labels and be delivered with delivery sheets conform to the prescriptions of BRP 279 §7.

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<sup>12</sup> In the following of the text and for simplification reasons, the term "sectoral organization" includes her representative as well as the inspection body and his representative, as it is defined in the quality handbook of OCAB-OCBS.

### 3.1.6 Presentation and sampling

#### 3.1.6.1 Presentation

##### 3.1.6.1.1 First certification

The producer declares for which products which grades and which diameters in these products he asks for the authorization of use of the BENOR-mark.

For the control of the mechanical and geometrical properties, the producer presents to the sectoral organization per product for which the producer requests the use of BENOR-mark a quantity of product in the state such as they leave the factory according to the following indications:

- During the examination for the issue of a first authorization of use of the BENOR-mark, the producer presents at least 20 tons of product. Out of those, the sectoral organization chooses 2 models of lattice girders; the 2 models are characterized by a diameter different from the lower wire and upper wire and if possible, by a diameter different from the diagonal wire. In the case where the product includes several grades of steel corresponding to the high ductility, these various grades must be taken again in the models.
- **By model of lattice girder of type 1**, the sectoral organization takes 15 sections. Each section is selected in a different lattice girder. Of these sections are taken -5 samples of upper wires, 2 \* 15 samples of lower wires and sufficient points of welding for the shear test; for the checking of the diagonal wire, 5 samples divided between the two diagonal wires are taken before welding.
- **By model of lattice girder of type 2**, the sectoral organization takes 5 sections. Each section is selected in a different lattice girder. Of these sections 5 samples of upper wires are taken, 2 \* 5 samples of lower wires and sufficient points of welding for the shear test; for the checking of the diagonal wire, 5 samples divided between the 2 diagonal wires are taken before welding.
- **By model of lattice girder of type 3**, the sectoral organization takes 30 sections. Each section is selected in a different lattice girder. Of these sections 30 samples of upper wires are taken, 5 samples of lower wires and sufficient points of welding for the shear test; for the checking of the diagonal wire, 5 samples divided between the two diagonal wires are taken before welding.
- **By model of lattice girder of type 4**, the sectoral organization takes 30 sections. Each section is selected in a different lattice girder. Of these sections 30 samples of upper wires are taken, 2 \* 15 samples of lower wires and sufficient points of welding for the shear test; for the checking of the diagonal wire, 5 samples divided between the two diagonal wires are taken before welding.

The samples mentioned above are suitable to undertake the measurements indicated in the following tables:

	Type 1				Type 2			
	LW	D	UW	LG	LW	D	UW	LG
Height				5x (A)				5x (A)
Width				5x (A)				5x (A)
Pitch		5x (A)				5x (A)		
Slope				5x (A)				5x (A)
SG	5/30x (A) <sup>13</sup>							
Section	30x (A)	5x (A)	5x (A)		5x (A)	5x (A)	5x (A)	
Rm	30x (S)	5x (A)	5x (A)		5x (A)	5x (A)	5x (A)	
OTP	30x (S)							
Bending	5x (A)							
CA	5x (A)							
SS	5x (A)		5x (A)		5x (A)		5x (A)	

	Type 3				Type 4			
	LW	D	UW	LG	LW	D	UW	LG
Height				5x (A)				5x (A)
Width				5x (A)				5x (A)
Pitch		5x (A)				5x (A)		
Slope				5x (A)				5x (A)
SG			5/30x (A) <sup>14</sup>		5/30x (A) <sup>15</sup>	5x (A)	5/30x (A) <sup>16</sup>	
Section	5x (A)	5x (A)	30x (A)		30x (A)	5x (A)	30x (A)	
Rm	5x (A)	5x (A)	30x (S)		30x (S)	5x (A)	30x (S)	
OTP			30x (S)		30x (S)	5x (A)	30x (S)	
Bending			5x (A)		5x (A)		5x (A)	
CA			5x (A)		5x (A)	5x (A)	5x (A)	
SS	5x (A)		5x (A)		5x (A)		5x (A)	

**Legend:**

- LW: Lower wire, D: diagonal, UW: Upper wire, LG: Lattice-girder, SG: Surface Geometry, CA: Chemical analysis, OTP: Other tensile properties, SS: Shear Strength, LG: Lattice Girder
- 5x, 30x: 5 measurements, 30 measurements
- A, S: control by attribute, statistical control by measurements (cf. respectively 3.2.2 and 3.2.1)

**3.1.6.1.2 Extension**

When the producer asks for the authorization of use of BENOR-mark for an extension, the producer presents at least 10 tons.

The numbers of samplings of sections are equivalent to those given to item 1. or reduced according to the tests to realize, the samples enable to undertake the measurements listed in the following tables:

<sup>13</sup> 5x in case of measurement of the height and the spacing of the ribs, 30x in case of measurement of the relative rib or indentation area  $f_R$  ( $f_P$ )

<sup>14</sup> See previous note

<sup>15</sup> See previous note

<sup>16</sup> See previous note

**3.1.6.1.3 Extension for the lower wires to another grade or range of diameters**

	Type 1	Type 2 and type 3	Type 4	
	LW	LW	LW	D
SG	5/30x (A) <sup>17</sup>		5/30x (A) <sup>18</sup>	
Section	30x (A)	5x (A)	30x (A)	5x (A)
Rm	30x (S)	5x (A)	30x (S)	5x (A)
OTP	30x (S)		30x (S)	5x (A)
Bending	5x (A)		5x (A)	
CA	5x (A)		5x (A)	
SS	5x (A)	5x (A)	5x (A)	

**3.1.6.1.4 Extension for the diagonals to another grade or range of diameters**

	Type 1			Type 2		
	LW	D	UW	LW	D	UW
Section	30x (A)	5x (A)			5x (A)	
Rm	30x (S)	5x (A)			5x (A)	
OTP	30x (S)					
SS	5x (A)		5x (A)	5x (A)		5x (A)

	Type 3			Type 4		
	LW	D	UW	LW	D	UW
SG					5x (A)	
Section		5x (A)	30x (A)	30x (A)	5x (A)	30x (A)
Rm		5x (A)	30x (S)	30x (S)	5x (A)	30x (S)
OTP			30x (S)	30x (S)	5x (A)	30x (S)
CA					5x (A)	
SS	5x (A)		5x (A)	5x (A)		5x (A)

**3.1.6.1.5 Extension for the upper wires to another grade or range of diameters**

	Type 1 and type 2	Type 3	Type 4	
	UW	UW	UW	D
SG		5/30x (A) <sup>19</sup>	5/30x (A) <sup>20</sup>	
Section	5x (A)	30x (A)	30x (A)	5x (A)
Rm	5x (A)	30x (S)	30x (S)	5x (A)
OTP		30x (S)	30x (S)	5x (A)
Bending		5x (A)	5x (A)	
CA		5x (A)	5x (A)	
SS	5x (A)	5x (A)	5x (A)	

<sup>17</sup> See previous note

<sup>18</sup> See previous note

<sup>19</sup> See previous note

<sup>20</sup> See previous note



### 3.1.6.2 Sampling

During the examination for the issue of a first authorization of use of the BENOR-mark, each sample is divided into three thirds: the first third is intended for control by the internal laboratory, the second third of one of the series is sent to the control laboratory, the third and last third of all the samples and the rest of the second thirds is to be kept in reserve. The length of each third of sample must make it possible to carry out all tests following the prescriptions above.

The producer carries out for each lattice girder among the selected types the above-mentioned tests in the presence of the sectoral organization. The control laboratory indicated by the sectoral organization proceeds in its turn with tensile tests on the 30 corresponding sections. The tests are carried out in accordance with the specifications of the standards.

In the case of an extension, the tests are carried out only in factory.

In the case of products already having an authorization of use of BENOR-mark, the tests are in general carried out by a control laboratory only once a year.

### 3.1.7 Equipment of the internal laboratory

The equipment of the internal laboratory must be in conformity with the provisions of ECU 606.

### 3.1.8 Chemical properties

The producer must have the certificates of analysis of the semi-finished products with which he manufactures the wire unless this wire is a product delivered under the BENOR-mark. The results of this analysis must satisfy the criteria of "cast analysis" of the standard.

### 3.1.9 Authorization of use of BENOR-mark

The authorization of use of BENOR-mark cannot be granted before the prior examination is completed.

## 3.2 Interpretation of the results

The results of the factory must be in conformity with paragraphs 3.2.1, 3.2.2 and 3.2.4. In addition, in the case of the examination for the delivery of the authorization of use of the BENOR-mark, the statistical comparison must be in conformity with § 3.2.3.

### 3.2.1 Controls by measurements

For each property where a control by measurements is required following § 3.1.6.1, the interpretation of the results of the tests is done using the statistical methods:

1. by adopting a reliable failure rate of 5 % [ $p = 0,95$ ] at a probability of 90 % (risk of 10 %) for the yield and tensile strength ( $R'm$ ,  $R'e$ ) and for the the relative rib or indentation area ( $f_R$  or  $f_P$ )<sup>21</sup>
2. by adopting a reliable failure rate of 10 % [ $p = 0,90$ ] at a probability of 90 % (risk of 10 %) for the other properties (ratio  $R'm/R'e$  and  $Agt$ ).

One calculates, by diameter, the average "m", the estimate of the standard deviation "s" and the estimate of the characteristic value "m - k.s"<sup>22</sup>.

One compares the estimates of the characteristic values with the values specified in the standards.

### 3.2.2 Controls by attributes

The evaluation will be performed by attributes for the properties designated in § 3.1.6.1.

One compares each individual value with the values specified in the standards.

<sup>21</sup> In the case that the determination of surface configuration is achieved through the relative rib or indentation area  $f_R - f_P$ .

<sup>22</sup> The coefficient k for  $m = 30$  is equal to 2,08 (reliable failure rate 5% - probability  $\beta$  risk 10%); and 1,66 (reliable failure rate 10% - probability  $\beta$  risk 10%) (see tables 4.2.2).

### 3.2.3 Comparison between the results of the tests carried out in the factory and those of the control laboratory

For the tensile strength and the yield strength, one proceeds to the statistical comparison of the results of the tests carried out with the factory with those of the control laboratory by the method of the paired observations (see TRA 418).

The comparison must show that the series of tests are statistically identical.

If the comparison shows that the series of tests are not statistically identical, it is necessary to search the causes of them:

- if it appears that the causes are inherent to control by the internal laboratory, this one adapts its test procedure and starts again the tests on the products kept in reserve,
- if it appears that the causes are inherent to the control laboratory or, if it is not possible to detect the cause of the divergences, the sectoral organization considers measures to be taken.

The flow chart at the end of present chapter 3 summarizes the process to be followed.

### 3.2.4 Conditions of acceptance

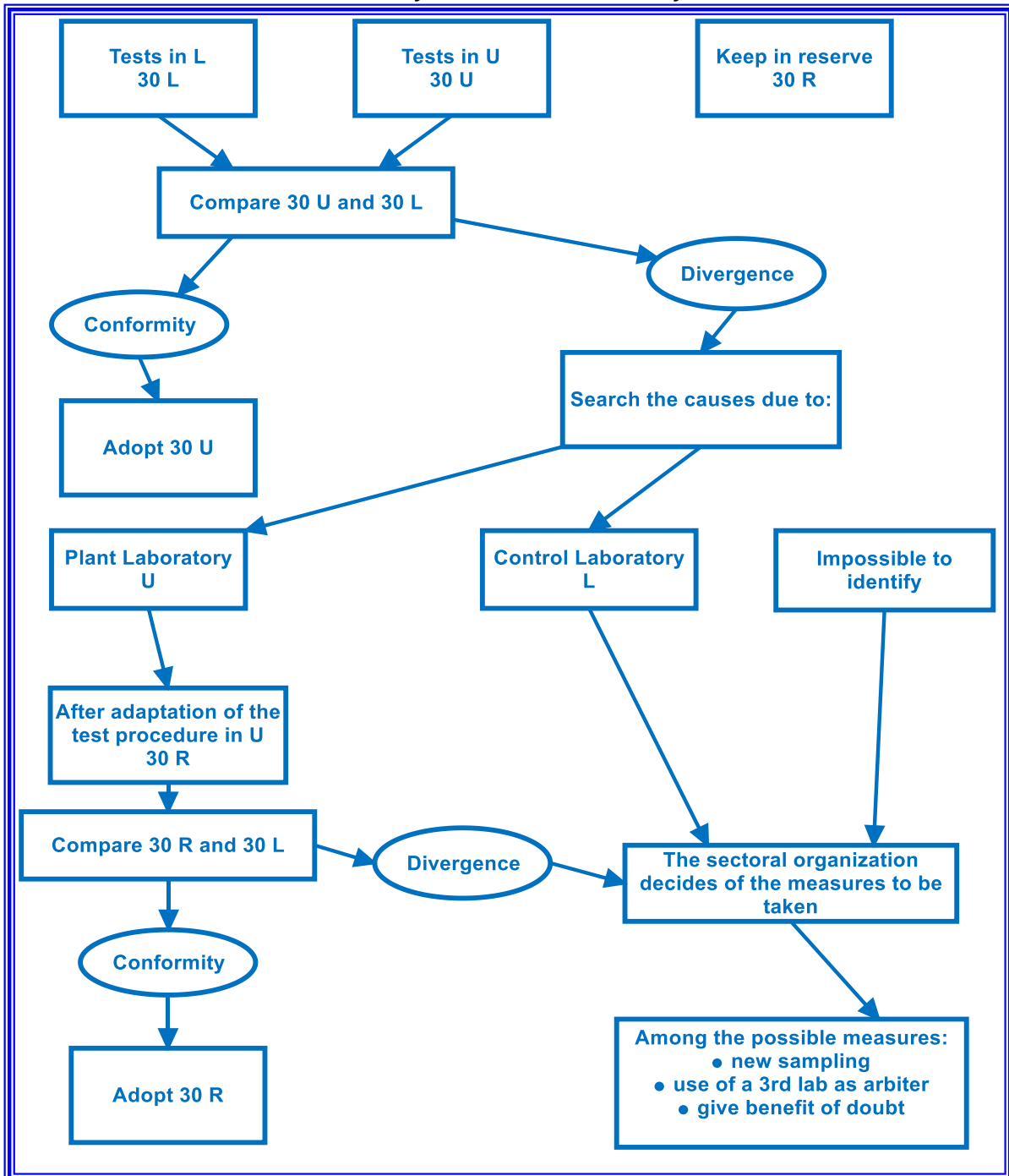
It is needed that, for each group of products of types 1, 3 and 4 chosen according to the indications of paragraphs 3.1.6 and 3.1.8, all the criteria of the standard are satisfied, namely:

- for the properties controlled by measurements, values "m - k.s" must answer the criteria of the standard,
- for the properties controlled by attribute there can be no unsatisfactory specimen,
- the comparison of the tensile characteristics must show that they are statistically equivalent.

It is necessary that, for each group of lattice girders of type 2, selected according to the indications of paragraph 3.1, all the criteria of the standard are satisfied, namely:

- for the properties controlled by attribute, there can be no non-satisfactory specimen.

**Flow chart for 1 diameter**  
L = control laboratory / U = internal laboratory / R = reserve



## 4 Industrial autocontrol

### 4.1 General information

#### 4.1.1 Methods of control

The producer must have the methods of control allowing to check, during the manufacturing of one or several product(s) for which he obtained the authorization of use of the BENOR-mark, the respect of

the criteria fixed by the standards relating to it for the entirety of the production bearing the recorded rolling marks (see § 3.1.5).

#### **4.1.2 Sampling and tests (by product)**

In all the cases the statistical exploitation (lower wires of lattice girders of type 1, upper wire of lattice girders of type 3 and all wires for lattice girders of type 4) requires to have at least 30 test results, resulting from continuous or non-continuous productions of the same diameter during the last three months. This period may be extended to be able to present the last 30 successive results, without however being able to exceed twelve months.

The sampling and the tests cover all the teams and equipments of production.

By 20 tons of products of same geometrical characteristics, the producer takes at least a sample intended for the controls envisaged by the standard on the wires composing the lattice girders, namely:

- Lattice girder of type 1:
  - control of dimensions of the lattice girder
  - determination of the tensile properties of the lower wire
  - rebend test on the lower wire
  - determination of the geometry of surface of the lower wire
  - determination of Rm of the diagonal and upper wire
  - determination of the conventional section of all the wires
  - shear strength
- Lattice girder of type 2:
  - control of dimensions of the lattice girder
  - determination of Rm of all the wires
  - determination of the conventional section of all the wires
  - shear strength.
- Lattice girder of type 3:
  - control of dimensions of the lattice girder
  - determination of the tensile properties of the upper wire
  - rebend test on the upper wire
  - determination of the geometry of surface of the upper wire
  - determination of Rm of the diagonal and lower wire
  - determination of the conventional section of all the wires
  - shear strength
- Lattice girder of type 4:
  - control of dimensions of the lattice girder
  - determination of the tensile properties of the upper wire, diagonal and lower wires
  - rebend test on the upper and lower wires
  - determination of the geometry of surface of the upper wire, diagonal and lower wire
  - determination of the conventional section of all the wires
  - shear strength

The samples of diagonal wires can be taken before welding on the lattice girder.

The samplings are to be distributed in the monthly production bearing the approved marking at a rate of a maximum sampling per bundle of lattice girders.

For the lattice girders, it is necessary when machines of the different types are used:

- either to separately consider the reinforcements produced by the machines of the same type
- or to distribute the series of tests on the production of the various machines.

The tests are carried out in accordance with the standards.

### 4.1.3 Chemical analysis

#### 4.1.3.1 Method and equipment of analysis

The method and the device used for the chemical analyses must give results representative of the product, whatever its possible structural heterogeneity.

#### 4.1.3.2 Chemical analysis on semi-finished product

For the semi-finished products from which the lower wires of the lattice girder of type 1, the upper wire of the lattice girder of type 3 and all wires of the lattice girder of type 4 is manufactured, the producer must have a certificate of analysis by cast, unless these semi-finished products are delivered under the BENOR-mark. Moreover, all semi-finished products are provided with an identification such as the traceability of corresponding cast is possible.

#### 4.1.3.3 Chemical analysis on end products

The producer is not held to carry out the chemical analyses on end products; however checks can be carried out by the sectoral organization at the time of the periodic visits at the same time as the calibration of the devices of chemical analysis.

If the producer does not have the necessary equipment, the chemical analysis can be required at his expenses in an external laboratory.

#### 4.1.4 Recording and analysis of the results of the autocontrol

All the results of controls are numbered and recorded. The classification of the tests is done in particular in reference to the numbers of manufacturing and identification of the products (see § 3.1.5) so as to ensure the traceability. One uses a register in pre-numbered and pre-signed pages by the sectoral organization. The register can be made up of loose sheets. If the monitoring service of the factory uses a system of continuous classification of the test results, or a computerized system, the aforementioned register is not essential. This system of classification must offer all the guarantees and be approved by the sectoral organization.

After classification, the results of the lower wire of the lattice girders of type 1, those of the upper wire of the lattice girders of type 3 and those of all wires of the lattice girders of type 4 are gathered by diameter. The results of all the other wires per type (lower wire, diagonal wire, upper wire) are also gathered by diameter.

For the shear strength of the welded node, the results are regarded as a result got on the lower wire or the upper wire.

The results are kept for a period of 10 years by the producer.

The results are exploited statistically by the producer according to a calculation program approved by the sectoral organization and the results of this statistical exploitation are sent to the sectoral organization in the thirty end days of the month concerned. The producer can eliminate from this statistical exploitation the results coming from products withdrawn of the trade-circuit (see § 4.4) and certain too favourable aberrant results (see § 4.2.2). The attachments relating to the encountered problems and their solutions must be joined (see § 4.3.2).

## 4.2 Statistical control by measurements

This control applies to the lower wire of the lattice girders of type 1, to the upper wire of the lattice girders of type 3 and to all wires of the lattice girders of type 4 for the determination of:

1. yield strength
2. tensile strength
3.  $R'_m/R'_e$  ratio
4. total elongation under maximum load ( $A_{gt}$ )
5. the relative rib or indentation area ( $f_R$  or  $f_P$ ).

#### 4.2.1 Principle

The interpretation of the results of the tests is done using the statistical methods:

- by adopting a reliable failure rate of 5 % [ $p = 0,95$ ] at a probability of 90 % (risk of 10 %) for properties 1 and 2 ( $R'_m$ ,  $R'_e$ ) and 5 ( $f_R$  or  $f_P$ )
- by adopting a reliable failure rate of 10 % [ $p = 0,90$ ] at a probability of 90 % (risk of 10 %) for properties 3 and 4 (ratio  $R'_m/R'_e$  and  $A_{gt}$ ).

#### 4.2.2 Statistical interpretation of the results of the tests

The statistical interpretation of the results of the tests is to be carried out monthly by product coming from the production over the period defined in § 4.1.4 for each group.

However, the manufacturer is free to divide his production into several homogeneous batches. In this case, this division must appear clearly in the documents of statistical interpretation which he submits for control to the sectoral organization.

For each examined property, one determines for  $n$  available results, the arithmetic mean "m" and the estimate of the standard deviation "s". One calculates the estimate of the characteristic value "m - k.s".

The tables hereafter give the constant of acceptance "k" according to the number of available results (according to NBN EN 10080: 2005).

**4.2.2.1 Coefficient k as a function of the number (n) of test results for a reliable failure rate of 5 % (p = 0,95) at a probability of 90 %**

n	k	n	k
5	3,40	30	2,08
6	3,09	40	2,01
7	2,89	50	1,97
8	2,75	60	1,93
9	2,65	70	1,90
10	2,57	80	1,89
11	2,50	90	1,87
12	2,45	100	1,86
13	2,40	150	1,82
14	2,36	200	1,79
15	2,33	250	1,78
16	2,30	300	1,77
17	2,27	400	1,75
18	2,25	500	1,74
19	2,23	1000	1,71
20	2,21	∞	1,64

**4.2.2.2 Coefficient k as a function of the number (n) of test results for a reliable failure rate of 10 % (p = 0,90) at a probability of 90 %**

n	k	n	k
5	2,74	30	1,66
6	2,49	40	1,60
7	2,33	50	1,56
8	2,22	60	1,53
9	2,13	70	1,51
10	2,07	80	1,49
11	2,01	90	1,48
12	1,97	100	1,47
13	1,93	150	1,43
14	1,90	200	1,41
15	1,87	250	1,40
16	1,84	300	1,39
17	1,82	400	1,37
18	1,80	500	1,36
19	1,78	1000	1,34
20	1,77	∞	1,28

If this value does not satisfy the specified value, the producer has the ability to draw aside no more than half of the values provided for control under consideration, but on the condition that doing it in the order of the values classified while starting with most favourable and to calculate: “ $m_i - k_i \cdot s_i$ ”.

If these new values still do not satisfy the specified value, the whole of the products considered is to be sheared to scrap in accordance with Article 2.6.1. of the Particular Regulation BRP 279.

### 4.3 Statistical control by attributes

This control applies to the following properties:

- the dimensions of the lattice girder (height and width, pitch and slope)
- the conventional section of all wires
- for
  - Lower wires for lattice girders of type 1,
  - Upper wire for lattice girders of type 3,
  - All wires for lattice girders of type 4.
    - the height of the ribs (depth of the indentations)<sup>23</sup>
    - spacing of the ribs (spacing of the indentations)<sup>24</sup>
    - rebend test (not for the diagonal wire)
    - chemical analysis of semi-finished product from which the wire is produced
- on
  - the other wires:
    - tensile strength
- shear strength.

#### 4.3.1 Principle

The interpretation of the results of the tests is based on a simple sampling, by adopting a reliable failure rate of 10 % [ $p = 0,90$ ] at a probability of 95 % (risk of 5 %).

#### 4.3.2 Interpretation of the test results

The interpretation of the chemical analysis applies to all casts of steel. This interpretation takes place, prior to the production, on the basis of certificate of analysis of cast (see 4.1.3.2). No unsatisfactory result is accepted.

For the other examined properties, the interpretation of the results of the tests is to be carried out monthly for the products coming from the production the last three months in the same diameter. One admits a maximum number of insufficient results according to the number of results necessary to respect the criterion, as indicated in the table hereafter.

As soon as an unsatisfactory result arises and leads to the going beyond the admitted number, either the producer shears to scrap the concerned unit of autocontrol in accordance with article 2.6.1 of the Particular Regulation BRP 279, or he samples from this unit (40 tons, 100 tons or 200 tons according to the test – cf. § 4.1.2) a minimum of 5 samples including one in the same coil or the same bundle of wires and 4 others in a random way.

If all the results are satisfactory, the unit of autocontrol is accepted and the first result is not taken any more into account. In the contrary case, the products are sheared to scrap.

The anomaly, the results of the complementary tests, its probable cause as well as that the pursuant taken action (measurements taken to cure it or put to scrap) must always be consigned and be the subject of an attachment to the transmitted results of autocontrol.

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<sup>23</sup> In the case that the determination of surface configuration is achieved through the height and the spacing of the ribs (depth and spacing of the indentations). The determination of the height and the spacing of the ribs (depth and spacing of the indentations) may, at the request of the producer, be replaced by the determination of the relative rib or indentation area  $fR$  ( $fP$ ) and shall in this case be evaluated following § 4.2.

<sup>24</sup> See above footnote over the determination of the surface configuration.



Maximum admitted amount of unsatisfactory results	Minimum amount of results necessary to respect the criterion
0	29
1	46
2	63
3	78
4	92
5	106
6	119
7	132
8	145
9	158
10	170
11	182
12	195
13	207
14	219
15	231
16	243
17	255
18	267
19	279
20	291
21	303

**4.4 Products not likely to bear the BENOR-mark**

All precautions must be taken so that the products which do not fulfil the requirements of the standard and which cannot bear the BENOR-mark cannot be confused with those which bear the BENOR-mark.

**4.5 Register of the claims**

All the complaints being technical and relating to the delivered products are gathered in a register. They are transmitted to the persons in charge concerned for treatment. The register is held with provision of the sectoral organization.

## 5 Periodical checking by the sectoral organization

### 5.1 Products being in the producing factory

#### 5.1.1 General information

The requirements on the authorization of use of the BENOR-mark (regularity in the manufacturing of the products and conformity of the products bearing the BENOR-mark to the standards) are checked periodically by the sectoral organization.

This checking consists in being ensured:

- that the equipment of the internal laboratory is in conformity with the provisions of ECU 606,
- that the producer has certificates of cast analysis of all the semi-finished products implemented,
- that the industrial autocontrol is carried out correctly,
- that the results of the industrial autocontrol are correctly interpreted.
  - With this intention, the sectoral organization carries out the checking of the statistical exploitation of at least two series of results a year.
- that the results of the industrial autocontrol are satisfactory,
- that the results obtained and recorded during this industrial autocontrol are in conformity with reality by carrying out check tests on products manufactured under the BENOR-mark and autocontrolled,
- that all actions were taken so that the products already provided with the BENOR-mark, but which must be sheared, are stored separately from conform BENOR steels,
  - The proof of shearing must be presented at initiative of the producer to the sectoral organization.
- that when anomalies were noted, necessary corrective actions were taken to cure it.

The producer makes all the provisions to facilitate this checking; in particular, he communicates to the sectoral organization:

- the name of the person in charge of the quality control services of the factory,
- the date of the start-up of a slightly modified production, i.e. products lying within the perimeter of the certification but comprising certain minor modifications.

He keeps at disposal all the results of autocontrol according to § 4.1.4.

He also communicates to the sectoral organization, for each monthly period starting from the date of delivery of the authorization of use of the BENOR-mark, the quantity of products delivered under the BENOR-mark as well as the quantity of sheared products. The quantities are clearly subdivided by type of product (coil, wires, rod resulting from straightened coil, manufacturing processes, geometrical profile) and by diameter.

#### 5.1.2 Periodicity of the visits of monitoring

For the period following a decision of the first certification, the user of the mark is subjected to a one-year probationary period comprising six visits.

During this period, documentary audits or complementary visits can be applied based on result of the initial audit (in function in particular of the number of nonconformities) and of a decision of the Certification Committee.

The same principles are applicable in the event of extension during a one-year period, the number of basic visits being in this case limited to 4.

The audits which are conducted by the sectoral organization during the current time of certification, are made in theory four times a year.

This periodicity is of once a month in the following cases:

- on decision of the sectoral organization, when the results obtained on the samples taken during a routine checking and those obtained by the internal laboratory on the samples coming from the industrial autocontrol present a statistically significant difference (see § 5.1.4.2) and that the producer could not justify it satisfactorily,
- on decision of the sectoral organization, when other situations make it possible to question the level of product quality or its regularity.

### 5.1.3 Test sample selection

#### 5.1.3.1 Routine checking

At the time of the audit, the sectoral organization chooses at least 1 product.

If the scope of the producer contains several types, the sectoral organization shall sample

- lattice girders of type 1 at least twice a year and
- lattice girders of types 3 and 4 at least once a year.

By product, he samples 8 pieces of type 1, or 3 of type 2 or 15 of type 3 and 4 of the same geometry of the end products (= same model).

If end products are not available, the sectoral organization checks by consultation of the books of production and the delivery forms that the theoretical stock is indeed null.

When usually the stock of the products is too small to carry out the sampling of the necessary specimens, the producer regularly transmits to the sectoral organization the program of production by announcing the probable dates of forwarding.

These samples are the subject of tests according to the indications of the table below (the chemical analysis is optional).

The artificial ageing is obligatorily carried out immediately before the tensile test and in the presence of the sectoral organization.

	Type 1				Type 2			
	LW	D	UW	LG	LW	D	UW	LG
Height				3x (A)				3x (A)
Width				3x (A)				3x (A)
Pitch		3x (A)				3x (A)		
Slope				3x (A)				3x (A)
SG	3x (A)							
Section	15x (A)	3x (A)	3x (A)		3x (A)	3x (A)	3x (A)	
Rm	15x (S)	3x (A)	3x (A)		3x (A)	3x (A)	3x (A)	
OTP	15x (S)							
Bending	3x (A)							
CA	3x (A)							
SS	3x (A)		3x (A)		3x (A)		3x (A)	

	Type 3				Type 4			
	LW	D	UW	LG	LW	D	UW	LG
Height				3x (A)				3x (A)
Width				3x (A)				3x (A)
Pitch		3x (A)				3x (A)		
Slope				3x (A)				3x (A)
SG			3x (A)		3x (A)	3x (A)	3x (A)	
Section	3x (A)	3x (A)	15x (A)		15x (A)	3x (A)	15x (A)	
Rm	3x (A)	3x (A)	15x (S)		15x (A)	3x (A)	15x (S)	
OTP			15x (S)		15x (S)	3x (A)	15x (S)	
Bending			3x (A)		3x (A)		3x (A)	
CA			3x (A)		3x (A)	3x (A)	3x (A)	
SS	3x (A)		3x (A)		3x (A)		3x (A)	

### Legend:

- LW: Lower wire, D: diagonal, UW: Upper wire, LG: Lattice-girder, SG: Surface Geometry, CA: Chemical analysis, OTP: Other tensile properties, SS: Shear Strength, LG: Lattice Girder
- 3x, 15x: 3 measurements, 15 measurements
- A, S: control by attribute, statistical control by measurements (cf. respectively 3.2.2 and 3.2.1)

#### 5.1.3.2 Annual checking

Once a year, at the time of one of its audits the sectoral organization takes 8 samples of a lattice girder of the type 1, or 15 samples of a lattice girder of the type 3 and 4 of the same geometry of the end products (= same model); each sample comes from a different lattice girder; the sectoral organization let cut out the 15 samples of the lower wire for type 1, of the upper wire for type 3 and of all wires for type 4 in two equal parts. First half is subjected to the tensile test at the internal laboratory within the framework of routine checking according to § 5.1.3.1, the second half is sent for the execution of the tensile test in a control laboratory, indicated by the sectoral organization.

For the producers already having an authorization of use of BENOR-mark, one admits that the tests are carried out that only once a year by a laboratory indicated by the sectoral organization.

For the producers who profit from an authorization of use of the BENOR-mark for several products, the tests in a control laboratory take place only once a year.

#### 5.1.4 Tests and interpretation of the results

##### 5.1.4.1 Tests

The internal laboratory proceeds, in the presence of the sectoral organization, with the tests referred to in the tables of § 5.1.3.1.

The samples for the possible chemical analysis are controlled in the internal laboratory otherwise in a laboratory selected by the producer and accepted by the sectoral organization. The calibration of the devices used for this purpose is controlled via representative samples (see § 3.1.9).

##### 5.1.4.2 Interpretation of the results

###### 5.1.4.2.1 Case of routine checking

**For the lower wires of the lattice girders of type 1, the upper wires of the lattice girders of type 3 and all wires of lattice girders of type 4**, the interpretation of the test results of tensile consists in:

1. comparing the results of yield strength  $R'_e$  and tensile strength  $R'_m$  with those obtained during the autocontrol of the corresponding production. For this purpose, appendix B of TRA 418 is used.
2. checking that the results of  $R'_e$  and  $R'_m$  satisfy the following regulations
  - each individual value is higher than the specified characteristic value
  - and the mean value of  $R'_e$  and  $R'_m$  is higher than the specified characteristic value increased by 10 N/mm<sup>2</sup>
3. to check that for the  $R'_m/R'_e$  ratio and total elongation  $A_{gt}$  each individual value is higher than the specified value.

For the conventional section, the rebend test, the geometry of ribs or indentations, the shear strength of the welded nodes and the possible chemical analyses, the results must meet the standard.

**For the diagonal and upper wires of the lattice girders of the type 1, for the wires composing the lattice girders of the type 2, for the diagonal and lower wires of the lattice girders of the type 3, for the diagonal wires of the lattice girders of the type 4, for dimensions of the lattice girders**, the interpretation of the test results of the characteristics searched according to the table of the 5.1.3.1 paragraph. consist in checking that all the results meet the standard.

#### **5.1.4.2.2 Case of the annual checks in control laboratory**

For the results of the yield and tensile strength obtained in the control laboratory, the interpretation consists in checking by the method of the paired observations (see Appendix A of document TRA 418) that there is conformity between these results and those obtained by the internal laboratory on the specimens coming from the same samples.

For information, the results of  $R'_e$ ,  $R'_m$ ,  $R'_m/R'_e$ ,  $A_{gt}$  and of the conventional section are interpreted as described with 5.1.4.2.1.

#### **5.1.5 Official report of monitoring**

The results of the monitoring are consigned to each visit in a report.

This report must include the following indications:

1. producer and factory
2. identification of the products
3. data on the test sample selection
4. results of the tests carried out in the presence of the sectoral organization and corresponding results of the industrial autocontrol
5. overall evaluation
6. place and date
7. signatures.

The report, if necessary, is supplemented later by a copy of the official report of the tensile tests carried out in a control laboratory.

The report must be kept for a period of at least 10 years by the producer and by the sectoral organization.

## **5.2 Products bearing the BENOR-mark and being apart from the producing factory**

### **5.2.1 Controls carried out on the initiative of the sectoral organization**

#### **5.2.1.1 Principle**

If the sectoral organization judges it necessary, samples can be taken in the stores of the stockists-distributors, a processor-distributor or on a building site in order to check that the products there

stored and considered to bear the BENOR-mark, answer the applicable criteria of the Belgian standards.

According to the agreement taken beforehand and for the mechanical tests only, the tests are carried out in a control laboratory or, in the presence of the sectoral organization, in the internal laboratory.

#### **5.2.1.2 Conditions for implementation of control**

The taken samples are numbered and cut in 3 equal parts. A series of tests is carried out in a control laboratory as described in 5.2.1.1. The two other series are preserved for possible complementary tests in the producer or in a second control laboratory.

During the sampling, the sectoral organization takes note of markings, and copies of all the documents concerning to the controlled products. It preserves the labels attached there so as to find, if necessary, the results of the tests of autocontrol.

The results of the tests are communicated to the producer. In case anomalies or irregularities are noted, the producer is invited to provide a justification within a fixed deadline.

The costs of the tests are charged to the producer when anomalies or irregularities are noted.

In the event of registration of non-observance of the provisions of the regulations of the BENOR-mark or Particular Regulation (cf. chapter 2 of BRP 279), the concerned procedures are applied by OCAB-OCBS to the users of the mark.

In the event of disclosure of fraud, OCAB-OCBS reserves the right to prosecute the person in charge of the fraud.

#### **5.2.2 Controls carried out by the sectoral organization in the case of an external claim**

One or more samplings are carried out, contradictorily, on the products being the subject of the litigation, by the sectoral organization, the producer or his representative in Belgium and the distributor having been duly convened.

The tests are carried out on the first and second thirds of samples during normal periodic controls in the internal laboratory and a control laboratory. The third and last third of the samples is preserved for possible complementary tests.

The possible chemical analyses on products are carried out in a laboratory selected by mutual agreement. The methods and devices used must give results representative of the average of the product, whatever the structural heterogeneity of this last.

The results of the tests are communicated to the producer. In case anomalies or irregularities are noted, the producer is invited to provide a justification within a fixed deadline.

After assessment of the results, the conclusions of the decision-making bodies of the sectoral organization are communicated to the producer, to the plaintiff and to the concerned internal bodies of the sectoral organization.

The costs of the tests are charged to the producer when anomalies or irregularities are noted.

In the event of registration of non-observance of the provisions of the regulations of the BENOR-mark or Particular Regulation (cf. chapter 2 of BRP 279), the concerned procedures are applied by OCAB-OCBS to the users of the mark.

In the event of disclosure of fraud, OCAB-OCBS reserves the right to prosecute the person in charge of the fraud.

#### **5.2.3 Controls carried out on the initiative of a user**

Whatever the results of the tests, the expenses of those are with exclusive charge of the user who took the initiative of it unilaterally.

The users who estimate themselves injured can address their claim justified to OCAB-OCBS.

As soon as possible, OCAB-OCBS rules on the admissibility of the claim and possibly decides to carry out controls and tests. OCAB-OCBS then applies the procedure described into 5.2.2 if the products being the subject of the litigation are still available or according to the procedure described into 5.2.1 in the contrary case.

## **6 History of the revisions**

### **Revisions 0 to 3**

- Creation, updates

**Revision 4**

- Implementation of lattice girders of type 4.
- Reference to BENOR<sub>asbl</sub><sup>VZW</sup>.

**Revision 5**

- Reformatting of the whole document.
- Edition in the English language.

**Revision 6**

- Deletion of §3.1.10, §3.2.1 first paragraph, §3.2.2