# CE marking of steel elements according to EN 1090-1

## *Summary*

CE marking is quite essential. It is a consequence of the declaration of performances (DoP).
The DoP may cover different variants of a reference product. Since it can be placed on an internet site, it does not need to accompany the delivered product.
CE marking is directly linked to each delivery.
CE marking and DoP are thus linked and complementary to each other.
DoP's and CE marking are a must for eligible products and are obviously to be offered free of charge.
**According to CPR, if a harmonized standard exists, the only relevant documents to check whether a product is conforming are the DoP and the CE marking**.

Inspection documents according to EN 10204 offer not only many options but also quite different sorts of information, among others based on non-specific results (2.2), meaning that the customer receives information that may be not strictly bound to the product he uses...
Inspection documents based on specific control (like 3.1 or 3.2) have a sound technical background; depending on the products or the kind of production, they may be interesting, useful or necessary (especially for large projects involving high execution classes and specific welding procedures).
According to Annex ZA of some harmonized standards that quote them (EN 10025-1), inspection documents are considered as "commercial documents", thus documents binding only the purchaser and the customer on contractual voluntary matters.
**Therefore, in no cases, inspection documents should be imposed by a third party for CE marking certification purposes**.

The present non-harmonized EN 1090-2 does not deal with inspection documents in a manner that is compatible with CPR. The same may be said as regards other materials standards (like EN 10025). This is a source of confusion. This kind of situation is tackled by the European Commission in a quite clear way (see FAQ 9 on CPR on the web):

- "*What shall a manufacturer do if certain clauses in the harmonised standard are not in line with the provisions of the Construction Products Regulation (CPR)?*
- *The Construction Products Regulation (CPR) is the directly applicable legislation in every EU Member State. Therefore in such cases, of course, it is this legislation which prevails. The consequence is that such* ***conflicting clauses of standards cannot be applied****. The CEN Technical Committees have undertaken the work to iron out the soonest possible any such inconsistencies in the harmonised standards but it cannot be excluded that some inconsistencies may remain after 01/07/2013, presumably for a short time only.*"

That means that these questions are to be approached and tackled in a comprehensive and flexible way, avoiding dogmatic positions in one or the other directions but according to the basic principles of wisdom and safety, a priority being anyway given without any compromise to the essential question of traceability, this in a chain routing process involving cascading actors.

As regards steel elements, not only the major constructors but also any company dealing with steel products purchased from steel producers and placing afterwards such steel elements on the market are concerned by EN 1090-1.

Such any company who wishes to be in line with CPR and to carry out professionally should be able to build up a "*factory production control*" ("*FPC*") ensuring at least traceability, to be certified according to Annex ZA of EN 1090-1:2009+A1:2011, to emit a free of charge "*Declaration of performance*" or "*DoP*" according to that standard and to CE mark at no cost for the customer, this with the possibility to rightly use the "*NPD*" option ("no performance determined, a term used if the actual characteristic has not been tested").

European standards ruling the qualification of welding procedures or welders are based on a rather simple grouping of steel qualities involving for each subgroup a wide range of properties. None of these standards refers to inspection documents according to EN 10204. This simply means that qualified welding processes must cover a range of properties, among other the chemical contents, whose acceptable upper values are ruled by an official generic document, namely the value listed in the relevant product standard and not in another document of specific nature. Exceptions to that obvious evidence could only apply when formal contractual robust documents build for given projects an anticipated clear scope differing from that one defined by the standard. Such special situations disclose an objective need for inspection documents of types 3.1 or 3.2.

Now for usual cases of current execution works on steel structures, the situation is as follows. Provided the declaration of performance and the CE marking contain the necessary legal requested information, a manufacturer operating under EN 1090 and related CE does not need further information when he purchases steel elements either directly from the producer or from a certified distributor.

According to Article 15 of CPR, a distributor who places his products on the market under his own name must draw up an own declaration of performance and affix his own CE marking.

# 1 EN 1090, CPR, CPR vs. CPD, CE marking

## 1.1 EN 1090

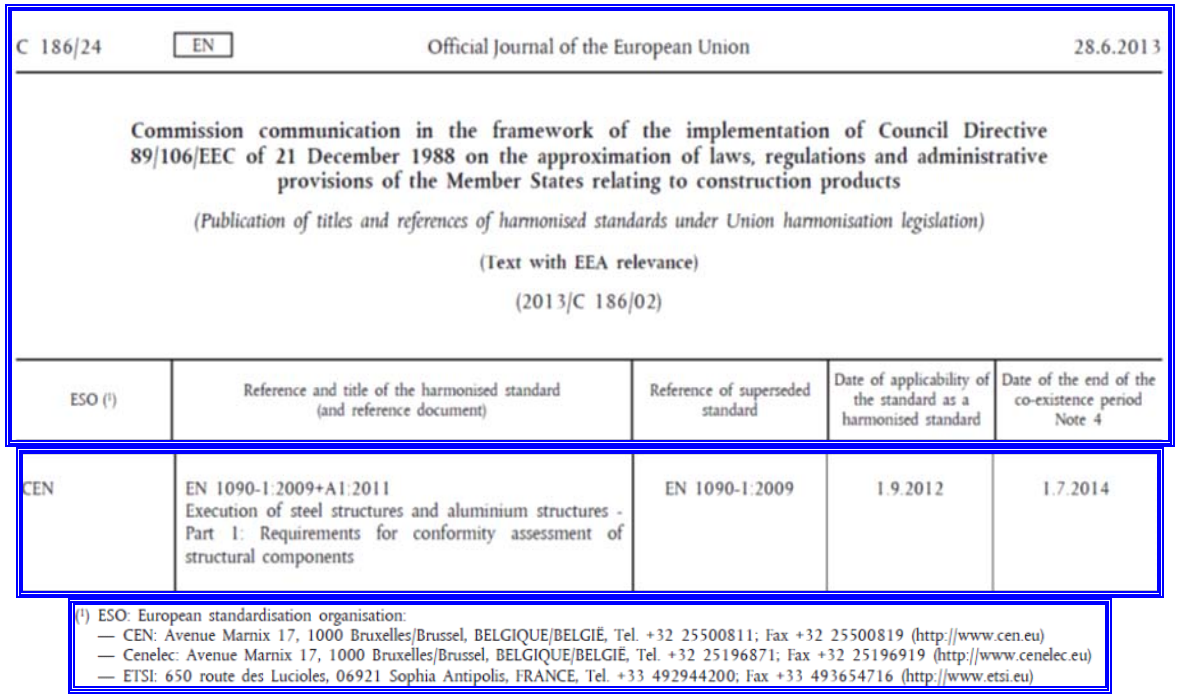
Annex ZA of the harmonized standard EN 1090-1:2009+A1:2011 is the text of reference for the CE marking regarding the "*Execution of steel structures and aluminium structures - Part 1: Requirements for conformity assessment of structural components*". Since July 01, 2014, CE marking according to EN 1090-1:2009+A1:2011 is a legal and mandatory obligation[1].

Contrary to EN 1090-1, EN 1090-2:2008+A1:2011 is a **non**-harmonized standard. EN 1090-2 lists technical rules. **Only the technical rules of EN 1090-2 underlying the CE marking to EN 1090-1:2009+A1:2011 are eligible**.
The other rules are simply not applicable to CE marking[2].
As a typical example of that legal fact, EN 1090-2 deals with more than two kinds of tolerances:

1. "*3.16.1 **essential tolerance**, basic limits for a geometrical tolerance necessary to satisfy the design assumptions for structures in terms of mechanical resistance and stability*"
2. "*3.16.2 **functional tolerance**, geometrical tolerance which might be required to meet a function other than mechanical resistance and stability, e.g. appearance or fit up*"
3. "*3.16.3 special tolerance, geometrical tolerance which is not covered by the tabulated types or values of tolerances given in this European Standard, and which needs to be specified in a particular case*"
4. "*3.16.4 manufacturing tolerance, permitted range in the size of a dimension of a component resulting from component manufacture*"

According to **Annex ZA of EN 1090-1, only the essential tolerances are covered by CE marking**:

[1] See:



C 186/24 EN Official Journal of the European Union 28.6.2013

**Commission communication in the framework of the implementation of Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products**

*(Publication of titles and references of harmonised standards under Union harmonisation legislation)*

**(Text with EEA relevance)**

(2013/C 186/02)

| ESO (1) | Reference and title of the harmonised standard (and reference document) | Reference of superseded standard | Date of applicability of the standard as a harmonised standard | Date of the end of the co-existence period Note 4 |
|---|---|---|---|---|
| CEN | EN 1090-1:2009+A1:2011 Execution of steel structures and aluminium structures - Part 1: Requirements for conformity assessment of structural components | EN 1090-1:2009 | 1.9.2012 | 1.7.2014 |

(1) ESO: European standardisation organisation:
— CEN: Avenue Marnix 17, 1000 Bruxelles/Brussel, BELGIQUE/BELGIË, Tel. +32 25500811; Fax +32 25500819 (http://www.cen.eu)
— Cenelec: Avenue Marnix 17, 1000 Bruxelles/Brussel, BELGIQUE/BELGIË, Tel. +32 25196871; Fax +32 25196919 (http://www.cenelec.eu)
— ETSI: 650 route des Lucioles, 06921 Sophia Antipolis, FRANCE, Tel. +33 492944200; Fax +33 493654716 (http://www.etsi.eu)

[2] but possibly in the frame of a voluntary certification.

| Table ZA.1 – Clauses where the performance characteristics are dealt with | | | | |
|---|---|---|---|---|
| ER [a] | Performance characteristic | Requirement Clause | Levels or classes | Notes |
| 1 | Tolerances on dimensions and shape | 4.2, 5.3 | | Tolerances to be declared according to the limits for essential tolerances in EN 1090-2 or EN 1090-3 |

Thus clearly, **functional tolerances are not relevant to CE marking and have to be ignored when CE marking is dealt with**. Regarding "special" and "manufacturing" tolerances, they should be dealt with only they are related to essential tolerances[3].

### 1.2 CPR

Since July 01, 2013, a regulation (CPR) has repealed the directive (CPD) for the CE marking of construction products.

### 1.3 CPR vs. CPD

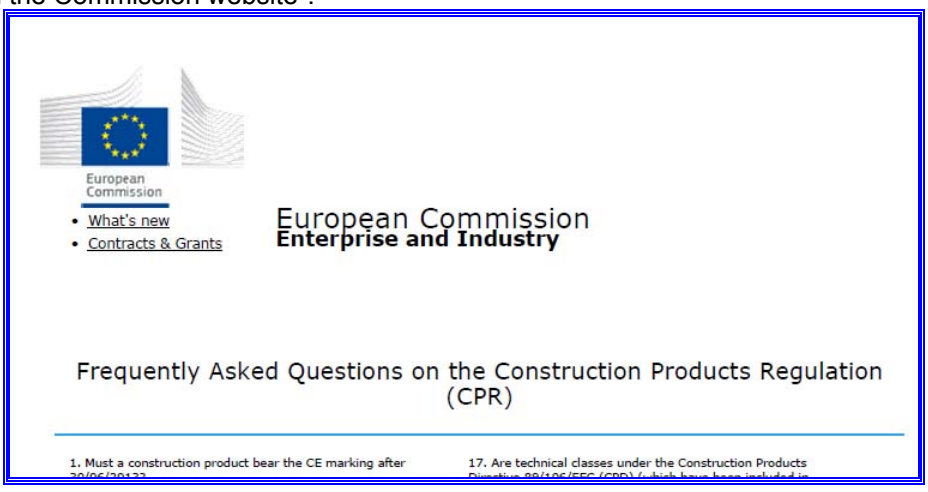
A main difference regarding the CE marking accompanying the placing on the market is that the "*Declaration of conformity*" referred to in CPD and still mentioned in section ZA.2.3 of Annex ZA of EN 1090-1:2009+A1:2011 has to be replaced by the "*Declaration of performance*" referred to in CPR.

### 1.4 CE marking

A general question that arises regarding CE marking is the following one:

- "***What shall a manufacturer do if certain clauses in the harmonised standard are not in line with the provisions of the Construction Products Regulation (CPR)?***"

The position of the European Commission in this regard is approached in a document entitled: "***Frequently Asked Questions on the Construction Products Regulation (CPR)***". This document is available on the Commission website[4]:

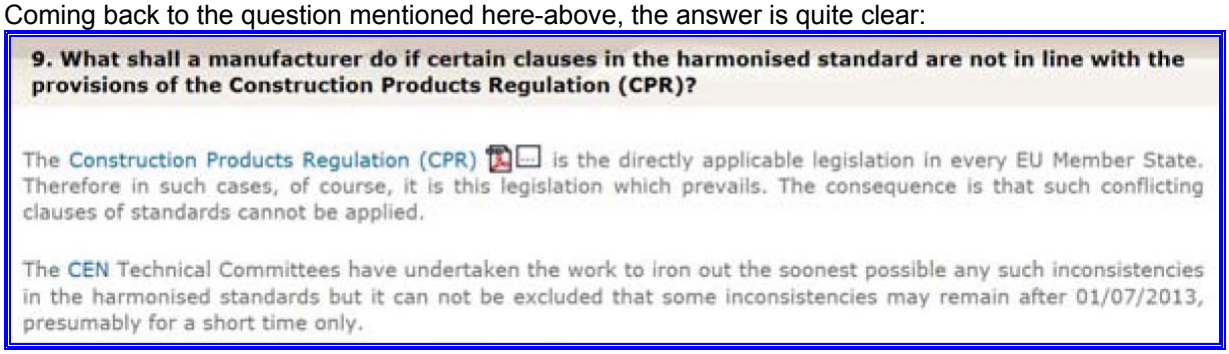



It is also reproduced in an OCAB-OCBS file[5].

[3] This does not mean that EN 1090-2 cannot be applied for certification purposes on a **voluntary basis**, but that certainly not in the frame of legal CE marking. An auditor acting on behalf of CE marking would thus be quite wrong in requesting the application of EN 1090-2 specifications which rely on pure voluntary aspects.

[4] https://www.google.com/url?q=http://ec.europa.eu/enterprise/sectors/construction/faq/index_en.htm&sa=U&ei=uJUcVP69FsHIaN2YgvgL&ved=0CAYQFjAA&client=internal-uds-cse&usg=AFQjCNFEOegwKTamJCIR0Y3_ozKwi6pQng

Coming back to the question mentioned here-above, the answer is quite clear:



**9. What shall a manufacturer do if certain clauses in the harmonised standard are not in line with the provisions of the Construction Products Regulation (CPR)?**

The Construction Products Regulation (CPR) is the directly applicable legislation in every EU Member State. Therefore in such cases, of course, it is this legislation which prevails. The consequence is that such conflicting clauses of standards cannot be applied.

The CEN Technical Committees have undertaken the work to iron out the soonest possible any such inconsistencies in the harmonised standards but it can not be excluded that some inconsistencies may remain after 01/07/2013, presumably for a short time only.

Clearly:

### 1.4.1 Question:

What shall a manufacturer do if certain clauses in the harmonised standard are not in line with the provisions of the Construction Products Regulation (CPR)?

### 1.4.2 Answer:

The Construction Products Regulation (CPR) is the directly applicable legislation in every EU Member State. **Therefore in such cases, of course, it is this legislation which prevails. The consequence is that such conflicting clauses of standards cannot be applied**. The CEN Technical Committees have undertaken the work to iron out the soonest possible any such inconsistencies in the harmonised standards but it cannot be excluded that some inconsistencies may remain after 01/07/2013, presumably for a short time only."

# 2 Position of the European Commission regarding EN 1090 standards

A presentation about European Standards in terms of CPR was recently given by the European commission[6]:

European Standards in support of the Construction Products Regulation 305/2011

G. Katsarakis
European Commission,
DG Enterprise and Industry
Unit B-1: Sustainable Industrial Policy and Construction

**The elaboration of harmonised European standards**

**Scope of the standard must be absolutely clear and correspond to the mandate (EN 1090-1 is an example to be avoided).**

**The product standard is expected to contain all necessary provisions in order to allow the manufacturer to assess the performance of the product (here again EN 1090-1 is example to be avoided as the manufacturer is obliged to apply also EN 1090-2 in order to issue the DoP for the product).**

In one of the slides, the European Commission expresses concern about the scope of the EN 1090-1 standard which is considered not enough clear and self-supporting, this mainly because too much reference is given to the non-harmonized EN 1090-2 in order to issue the DoP for the product:

**The elaboration of harmonised European standards**

[5] OCAB-OCBS file: "*From European Commission - Enterprises and Industry: Frequently Asked Questions on the Construction Products Regulation (CPR)*"
[6] Presentation of Mr KATSARAKIS about European Standards in terms of CPR

**The product standard is expected to contain all necessary provisions in order to allow the manufacturer to assess the performance of the product (here again EN 1090-1 is example to be avoided as the manufacturer is obliged to apply also EN 1090-2 in order to issue the DoP for the product).**

Consequently, there is a priority for the concerned Technical Committee to rapidly update EN 1090-1 together with EN 1090-2 so as to avoid once and for all these discrepancies between both these standards and the CPR.

# 3 Execution classes and traceability

## 3.1 EN 1090

Two major concepts sustain and govern the set of EN 1090 European standards and are indeed closely interacting together, these are the concepts of so-called "**execution class**" and of **traceability**.

According to Article 4.1.2 of EN 1090-2, **four execution classes 1 to 4, denoted EXC1 to EXC4, are given, for which requirement strictness increases from EXC1 to EXC4**.
According to Article 6.3.5 of EN 1090-1, **the requirements for traceability are dependent on execution class**.

## 3.2 CPR

CPR never quotes the topic of **execution class**. This does not mean that this concept is absent from CPR principles. Indeed CPR deals among others with the concepts of "***performance***", "***level***" and "***class***". CPR quotes three times the term "**traceability**". The details are listed in Appendix 1

## 3.3 CPR vs EN 1090 regarding traceability and execution classes

There is not per se any conflict between CPR and EN 1090 regarding both **concepts** of traceability and execution classes.

On the contrary, CPR and EN 1090 could not be in phase regarding the modalities to appraise the questions linked to traceability and execution classes. Should a conflict exist in this regard, the legal rule is clear: **conflicting clauses of EN 1090-1 or EN 1090-2 cannot be applied**.

## 3.4 A source of conflict between CPR and EN 1090

A source of conflict between CPR and EN 1090 could emerge from the following situation.

On the one hand, CPR states in its article 8.3 that for any construction product covered by a harmonised standard[7] the **CE marking shall be the only marking which attests conformity of the construction product with the declared performance in relation to the essential characteristics**, covered by that harmonised standard. CPR also states that the CE marking shall be made according to **one** of the five systems for assessment and verification of constancy of performance of construction products in relation to their essential characteristics set out in its Annex V (systems **1+**, **1**, **2+**, **3** and **4**).

On the other hand, EN 1090-2 makes several references to inspection documents according to EN 10204 that could attest for the conformity of the products. The details are listed in Appendix 2.

[7] or by a European Technical Assessment

Indeed, **inspection documents according to EN 10204 can neither be considered as part of CE marking nor can be systematically requested as a must by auditors who carry out the certification of manufacturers according to Annex ZA of EN 1090-1**.

The reasons for that are obvious:

- Certification against EN 1090-1 is made according to the **2+** system (**certification of conformity of the factory production control by the notified body**);
- For constituents products covered by a harmonized standard, **CE marking is the only way to attest their conformity**;
- Imposing inspection documents together with CE marking would simply result in a CE-certification scheme combining the applicable **2+** system to
    - Either the non-eligible **4** system (self-certification by the sole manufacturer without the intervention of any notified body) (with inspection certificates of types 2.1, 2.2 or 3.1);
    - Or a part of the non-eligible **1+** system (certification of constancy of performance of the construction product on the basis among others of audit-testing of samples taken by the notified product certification body at the manufacturing plant) (with inspection certificates of type 3.2).

### 3.5 Arguments related to inspection documents

It may be still heard that inspection documents according to EN 10204 are a mandatory need to apply CE marking according to EN 1090-1. The arguments underlying this standpoint are based on **traceability** and **weldability**. These arguments are not supported by the legal facts regarding CE marked products. This question is dealt with in details in appendixes 3 to 7[8] of the present document but it is obvious that neither traceability nor weldability request inspection documents.

### 3.6 Traceability

Since the existence of CE marking, traceability is ensured by CE marking as far as a product falls under a harmonized European standard. This was a fact for construction products under the CPD; this simply remains under the CPR. The CE marking must contain all information regarding the traceability of a product.

Should it not be the case, a complaint against that infringement has to be addressed to the competent authority of the Member State according to the rules of CPR (see among others articles 13, 14 or 56).

### 3.7 Weldability and welding

As explained in details in Appendix 8, weldability and welding are ruled as far as EN 1090 is concerned by a set of specific European standards dealing with guidance for welding (EN 1011-1,-2,…), qualification of welding procedures (EN ISO 15609-1, EN ISO 15614-1, …), qualification of welders, (EN ISO 9606-1,…) and grouping of metallic material (CEN ISO TR 15608).

On the one hand, none of these standards quotes inspection documents according to EN 10204.

On the other hand, all carbon steels with a level of yield stress up to 355 MPa are integrated in two subgroups 1.1 and 1.2 (see Appendix 9):

| | |
|---|---|
| 1.1 | Steels with a specified minimum yield strength $R_{eH} \leq 275$ N/mm² |
| 1.2 | Steels with a specified minimum yield strength 275 N/mm² < $R_{eH} \leq 360$ N/mm² |

EN 1011-2 defines safe and economic welding conditions without preheating levels for the prevention of hydrogen cracking from the carbon equivalent (CE) as follows: "***The most effective assurance of avoiding hydrogen cracking is to reduce the hydrogen input to the weld metal from the welding consumables. The benefits resulting from a growing number of possibilities where no preheat temperature > 20 °C is required, can - as shown by examples in table C.1 - be increased by using filler materials with lower hydrogen content***."

[8] See chapters 15 to 19

| Table C.1 — Examples of maximum combined thickness (see C.2.4) weldable without preheat | | | | |
|---|---|---|---|---|
| Diffusable hydrogen content[a] ml/100 g of deposited metal | Maximum combined thickness | | | |
| | *CE* of 0,49 | | *CE* of 0,43 | |
| | Heat input | | Heat input | |
| | 1,0 kJ/mm | 2,0 kJ/mm | 1,0 kJ/mm | 2,0 kJ/mm |
| | mm | mm | mm | mm |
| > 15 | 25 | 50 | 40 | 80 |
| 10 ≤ 15 | 30 | 55 | 50 | 90 |
| 5 ≤ 10 | 35 | 65 | 60 | 100 |
| 3 ≤ 5 | 50 | 100 | 100 | 100 |
| ≤ 3 | 60 | 100 | 100 | 100 |
| [a] Measured in accordance with ISO 3690 | | | | |

Without entering into detailed technical considerations, it is clear that it is quite feasible to weld thick plates without preheat at carbon equivalent up to 0,43 % provided low hydrogen consumables are used.

# 4 Inspection documents are not quoted in Annex ZA of EN 1090-1:

### ZA.3 CE marking and labelling

#### ZA.3.1 General

The manufacturer or his authorised representative established within the EEA is responsible for the affixing of the CE marking. The CE marking symbol affix shall be in accordance with directive 93/68/EC and shall be shown on the component or may be on the accompanying label, the packaging or on the commercial documentation.

As a confirmation of this, EN 1090-1 gives an example of CE marking of a steel element, a welded beam which may be quite comparable to a hot rolled section that would have been delivered according to EN 10025-2 and CE marked according to EN 10025-1.

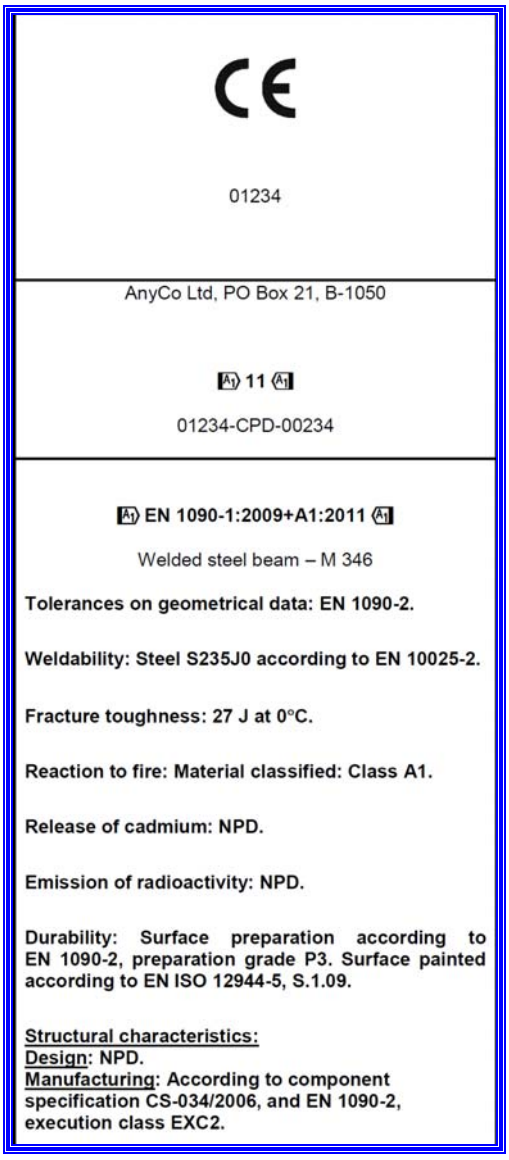
No mention at all of any inspection document appears here, although for instance weldability is declared.

Appendix 10 lists the clauses of EN 1090-1 or EN 1090-2 that are obviously not yet in phase with CPR (article 8.3) as far as CE marking is available for the construction products referred to.

The consequence is that such conflicting clauses of standards cannot be applied.

EN 1090 standards are thus to be corrected.

Fortunately, corrections are already found in the draft of future EN 1090-1, but the task is not yet ended.


CE

01234

AnyCo Ltd, PO Box 21, B-1050

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01234-CPD-00234

EN 1090-1:2009+A1:2011

Welded steel beam – M 346

**Tolerances on geometrical data: EN 1090-2.**

**Weldability: Steel S235J0 according to EN 10025-2.**

**Fracture toughness: 27 J at 0°C.**

**Reaction to fire: Material classified: Class A1.**

**Release of cadmium: NPD.**

**Emission of radioactivity: NPD.**

**Durability: Surface preparation according to EN 1090-2, preparation grade P3. Surface painted according to EN ISO 12944-5, S.1.09.**

**Structural characteristics:**
**Design: NPD.**
**Manufacturing: According to component specification CS-034/2006, and EN 1090-2, execution class EXC2.**

# 5 The main issue

The main point with CE marking in line with CPR is therefore not to vainly dispute about the question of inspection documents but

- On the one hand, to adopt robust basis for the editing of valid declarations of performances and CE marking;
- On the other hand, to carefully define the status and the possible usefulness of inspection documents.

Both these questions will be tackled at the end of this document. Meanwhile, it is essential to review the scope covered by EN 1090 as regards steel components and the role to be exerted by any company dealing with steel components even for very simple operations. This is approached in the following chapters.

# 6 Scope of EN 1090-1

The scope covered by EN 1090-1:2009+A1:2011 is quite broad in so far as "*This European Standard specifies requirements for conformity assessment of performance characteristics for structural steel and aluminium components as well as for kits placed on the market as construction products. The*

*conformity assessment covers the manufacturing characteristics, and where appropriate the structural design characteristics.*"[9]

# 7 Scope of EN 1090-1 for steel elements

As far as steel is concerned, the technical rules underlying the CE marking to EN 1090-1:2009+A1:2011 are defined in EN 1090-2:2008+A1:2011 whose scope is also broad although clear[10].

As a consequence, any operation - even as simple as cutting[11] - made on a steel constituent responding to a product standard like EN 10025-2 for instance implies that this operation be under control. If that element is placed on the market, **it must thus be CE marked according to EN 1090-1**

[9] The scope of EN 1090-1 is often criticised because it interferes with other product standards or with European technical agreements. This delicate question is not concerned with the themes developed in the present document; therefore, no specific concern about the scope is here relevant.

[10] "*This European Standard specifies requirements for execution of structural steelwork as structures or as manufactured components, produced from:*

- *hot rolled, structural steel products up to and including grade S690;*
- *cold formed components and sheeting up to and including grades S700;*
- *hot finished and cold formed austenitic, austenitic-ferritic and ferritic stainless steel products;*
- *hot finished and cold formed structural hollow sections, including standard range and custom-made rolled products and hollow sections manufactured by welding.*

*This European Standard may also be used for structural steel grades up to and including S960, provided that conditions for execution are verified against reliability criteria and any necessary additional requirements are specified.*
*This European Standard specifies requirements independent of the type and shape of the steel structure (e.g. buildings, bridges, plated or latticed components) including structures subjected to fatigue or seismic actions.*
*The requirements are expressed in terms of execution classes.*
*This European Standard applies to structures designed according to the relevant part of EN 1993.*
*This European Standard applies to structural components and sheeting as defined in EN 1993-1-3.*
*This European Standard applies to steel components in composite steel and concrete structures designed according to the relevant part of EN 1994.*
*This European Standard may be used for structures designed according to other design rules provided that conditions for execution comply with them and any necessary additional requirements are specified.*
*This European Standard does not cover requirements for watertightness or air permeability resistance of sheeting.*"

[11] According to that standard, "*execution*" implies "*all activities performed for the physical completion of the works, i.e. procurement, fabrication, welding, mechanical fastening, transportation, erection, surface treatment and the inspection and documentation thereof*" while "*preparation*" implies "*all activities performed on the constituent steel products to produce the parts ready for assembly and inclusion in components. As relevant, this comprises e.g.* ***identification, handling and storage, cutting, shaping and holing***". It is said for instance that "***Cutting shall be carried out in such a way that the requirements for geometrical tolerances, maximum hardness and smoothness of free edges as specified in this European Standard are met****. NOTE Known and recognised cutting methods are sawing, shearing, disc cutting, water jet techniques and thermal cutting… Hand thermal cutting should be used only if it is not practical to use machine thermal cutting. Some cutting methods can be unsuitable for components subject to fatigue. If a process does not conform, it shall not be used until corrected and checked again. It may be used on a restricted range of constituent products that do produce conforming results. If coated materials are to be cut, the method of cutting shall be selected to minimize the damage on the coating. Burrs that could cause injury or prevent the proper alignment or bedding of sections or sheeting shall be removed.*"

and no more according to EN 10025-1, this **because all relevant essential characteristics are to be certified** and this with regards to the eligible topics.

# 8 Companies concerned by EN 1090-1

That means that not only the major constructors are concerned by EN 1090-1 but also any company dealing with steel products purchased from steel producers and placing afterwards such steel elements on the market.

Such any company who wishes to be in line with CPR and to carry out professionally should be able to build up a "*factory production control*" ("*FPC*") **ensuring at least traceability**, to be certified according to Annex ZA of EN 1090-1:2009+A1:2011 and to emit a "*Declaration of performance*" or "*DoP*" according to that standard, **with possibilities to rightly use the "*NPD*" option** ("*no performance determined, a term used if the actual characteristic has not been tested*"[12]) when for instance not all activities are performed on the constituent steel products to produce the parts ready for assembly and inclusion in components. **Obviously, the "NPD" option is, in the present case, in no way eligible as regards traceability**. As a consequence, such a company that ensures traceability under the cover of a CE marking certified by a Notified Body must be able to emit any legal or commercial document in a way that is in phase with the so consequently certified FPC according to EN 1090-1 Annex ZA.

This is understood as evident and unavoidable according to the rules presently edited and written down in official documents by the Authorities in force (European Commission and CEN).

Therefore, distributors of steel elements are concerned by EN 1090 in so far as they install an FPC that at least covers traceability.

The same applies to batch galvanizers who would be in a similar situation. Obviously, both distributors and galvanizers could state that they are not concerned by EN 1090, especially the latter because claiming they are just subcontractors never placing a product on the market. Nevertheless, any company liable to place a product on the market and to edit DoPs concerned by EN 1090 can request a CE certification and nobody is allowed to dispute that right.

**As CE marking is scheduled to be workable in a cascading way, any company should neither be discouraged nor be refused to play the game as far as it fits the rules**.

# 9 Article 15 of CPR

According to Article 15 of CPR "*Cases in which obligations of manufacturers apply to importers and distributors*":

- "*An importer or distributor shall be considered a manufacturer for the purposes of this Regulation and shall be subject to the obligations of a manufacturer pursuant to Article 11, where he places a product on the market under his name or trademark or modifies a construction product already placed on the market in such a way that conformity with the declaration of performance may be affected.*"

A distributor that places his products on the market under his own name **must respond** to Article 11 and thus "*shall draw up a declaration of performance in accordance with Articles 4 and 6, and affix the CE marking in accordance with Articles 8 and 9.*"

# 10 Delegated acts regarding DoPs under the CPR

For the purposes of achieving the objectives of the regulation, in particular removing and avoiding restrictions on making construction products available on the market, Articles 60 to 62 of the CPR delegate to the Commission the possibility to amend or update different matters, this till to April 24,

[12] Cf. §3.2 Abbreviations in EN 1090-1:2009+A1:2011 (E) and CPR Article **6** "*Content of the declaration of performance*" **(f)** "*for the listed essential characteristics for which no performance is declared, the letters 'NPD' (No Performance Determined);*"

2016. This regards among others the declaration of performance. Presently, two delegated acts have been published in this regard:

COMMISSION DELEGATED REGULATION (EU) No 157/2014

of 30 October 2013

on the conditions for making a declaration of performance on construction products available on a website

COMMISSION DELEGATED REGULATION (EU) No 574/2014

of 21 February 2014

amending Annex III to Regulation (EU) No 305/2011 of the European Parliament and of the Council on the model to be used for drawing up a declaration of performance on construction products

Both these documents shall be carefully read but it is worth shortly stressing those key points:

- The model of DoP should be adapted, in order to respond to technological progress, to allow the flexibility required by different kinds of construction products and manufacturers as well as to simplify the declaration of performance.
- Manufacturers need further instructions for drawing up declarations of performance on construction products in line with applicable legislation.
- The manufacturers should be allowed some flexibility for drawing up declarations of performance as long as they provide, in a clear and coherent manner, the essential information required by Article 6 of CPR.
- The purpose of Article 11(4) of CPR is to enable the identification and the traceability of any single construction product by the indication, by the manufacturers, of a type, batch or serial number. This purpose is not served by a declaration of performance, which should be subsequently used for all products corresponding to the product-type defined in it. Therefore, the information required by Article 11(4)[13] should not be required to be contained in the declaration of performance.
- In order to enhance the efficiency and competitiveness of the European construction sector as a whole, manufacturers providing declarations of performance wishing to benefit from the simplification and instructions for the purposes of facilitating the provision of such declarations should be able to do so as soon as possible,

Under given conditions, delegated act N° 574 offers a manufacturer the possibility to issue a single declaration of performance covering different variations of a product-type.

# 11 Some sensitive questions that the CE marking should clearly address

As already said above, article 8.3 of CPR states that the CE marking shall be the only marking which attests conformity of the construction product with the declared performance in relation to the essential characteristics. Consequently, the declaration of performance must be clear and must bring the necessary information.

Some essential characteristics may raise sensitive questions that are approached hereunder.

[13] Article 11.4: "*Manufacturers shall ensure that their construction products bear a type, batch or serial number or any other element allowing their identification, or, where the size or nature of the product does not allow it, that the required information is provided on the packaging or in a document accompanying the construction product.*"

## 11.1 Weldability

Weldability is first governed by the chemical composition of the steel but also by its manufacturing process. That is why the materials standards distinguish between:

- steel **j**ust hot rolled (**J** grades);
- fine grain steel subjected to a **n**ormalizing treatment (after or during rolling) (**N** grades);
- steel thermo**m**echanically treated during rolling (**M** grades);
- steel **q**uenched and tempered (after or during rolling) (**Q** grades).

Simply speaking, welding conditions must first avoid embrittlement. This is done on basis of the carbon equivalent (CEV) whose maximum allowable value is limited by the materials standards and has to be declared (see for instance EN 10025 standards). On that basis, the manufacturer can choose a safe minimum heat input for welding.

Welding conditions must also avoid excessive grain coarsening in the heat affected zone so that maximum heat inputs should not be exceeded. Information in this regard is available in the literature for many years. It is well-known that thermomechanical steels are more sensitive to high heat input than just rolled steels and may suffer from softening. However, thermomechanical steels offer indeed a lower carbon equivalent and enable to save costs in welding by reducing the necessary preheating. This is clearly shown hereunder when comparing the maximum allowable CEV on ladle analysis for the following grades (thickness of 25 mm):

- S355J2, CEV ≤ 0,45 % (according to EN 10025-1 + EN 10025-**2**);
- S355N, CEV ≤ 0,43 % (according to EN 10025-1 + EN 10025-**3**);
- S355M, CEV ≤ 0,39 % (according to EN 10025-1 + EN 10025-**4**).

To provide the necessary information to the welder, the DoP should thus clearly indicate both the maximum CEV and the rolling process applicable to the delivered steel element.

## 11.2 The right references to the steel grade

Many constructions are made from hot rolled non-alloy structural steels according to EN 10025-2[14] and this in the grades showing a level of guaranteed yield stress of either 235 or 275 MPa and no severe requirement for impact energy, these are the grades S235JR and S275JR.

It is important also to recall that the EN 10025-2 standard includes in its definitions three ways for producing such steel grades or three kinds of delivery conditions[15], namely:

[14] EN 10025-2: "*Hot rolled products of structural steels - Part 2: Technical delivery conditions for non-alloy structural steels*"

**3 Terms and definitions**

For the purposes of this document, the terms and definitions given in EN 10025-1:2004 and the following apply.

**3.1**
**normalizing rolling**
rolling process in which the final deformation is carried out in a certain temperature range leading to a material condition equivalent to that obtained after normalizing so that the specified values of the mechanical properties are retained even after normalizing

The abbreviated form of this delivery condition is +N

NOTE In international publications for both the normalizing rolling, as well as the thermo-mechanical rolling, the expression "controlled rolling" may be found. However in view of the different applicability of the products a distinction of the terms is necessary.

**3.2**
**as-rolled**
delivery condition without any special rolling and/or heat treatment condition.

The abbreviated form of this delivery condition is +AR

**3.3**
**thermomechanical rolling**
rolling process in which the final deformation is carried out in a certain temperature range leading to a material condition with certain properties which cannot be achieved or repeated by heat treatment alone

NOTE 1 Subsequent heating above 580 °C may lower the strength values. If temperatures above 580 °C are needed reference should be made to the supplier.

NOTE 2 Thermomechanical rolling leading to the delivery condition M can include processes with an increasing cooling rate with or without tempering including self-tempering but excluding direct quenching and quenching and tempering.

[15] NOTE 3 In some publications the word TMCP (Thermomechanical Control Process) is also used.

- as-rolled delivery condition without any special rolling and/or heat treatment condition with the abbreviated form "**+AR**";
- normalizing rolling, rolling process in which the final deformation is carried out in a certain temperature range leading to a material condition equivalent to that obtained after normalizing so that the specified values of the mechanical properties are retained even after normalizing, with the abbreviated form "**+N**";
- thermomechanical rolling, rolling process in which the final deformation is carried out in a certain temperature range leading to a material condition with certain properties which cannot be achieved or repeated by heat treatment alone[16], with the abbreviated form "**+M**".

The classification and designation of steel grades is defined in chapter 4 of that standard. Key points are as follows:

- Steel grades shall be classified as **non-alloy quality steels** according to EN 10020;
- Eight steel grades are specified of whom four with a required impact energy[17] (Charpy V): **S235**, **S275**, **S355**, **S450**;
- Steel grades S235 and S275 may be supplied in qualities JR, J0 and J2;
- Steel grade S355 may be supplied in qualities JR, J0, J2 and K2
- Steel grade S450 is supplied in quality J0;
- The qualities differ in specified impact energy requirements.
- The designation shall be in accordance with EN 10025-1:
    - **EN 10025-2**
    - symbol **S** (for structural steel)
    - indication of the minimum specified yield strength (**235**, **275**, **355**, **450**)
    - quality designation in respect of specified impact energy values (**JR**, **J0**, **J2**, **K2**)
    - if applicable, the additional symbol **C** for the suitability for cold flanging, cold roll forming or cold drawing
    - **+AR**, **+N**, **+M** according to the delivery condition.

It is thus considered that the above-mentioned should be available in the DoP.

### 11.3 Welding consumables

EN 13749 is a harmonized standard and CE marking of filler metals and fluxes for fusion welding of metallic metals is mandatory since October 01, 2006:

| ESO ([1]) | Reference and title of the harmonised standard (and reference document) | Reference of superseded standard | Date of applicability of the standard as a harmonised standard | Date of the end of the co-existence period Note 4 |
|---|---|---|---|---|
| CEN | EN 13479:2004 Welding consumables — General product standard for filler metals and fluxes for fusion welding of metallic materials | | 1.10.2005 | 1.10.2006 |

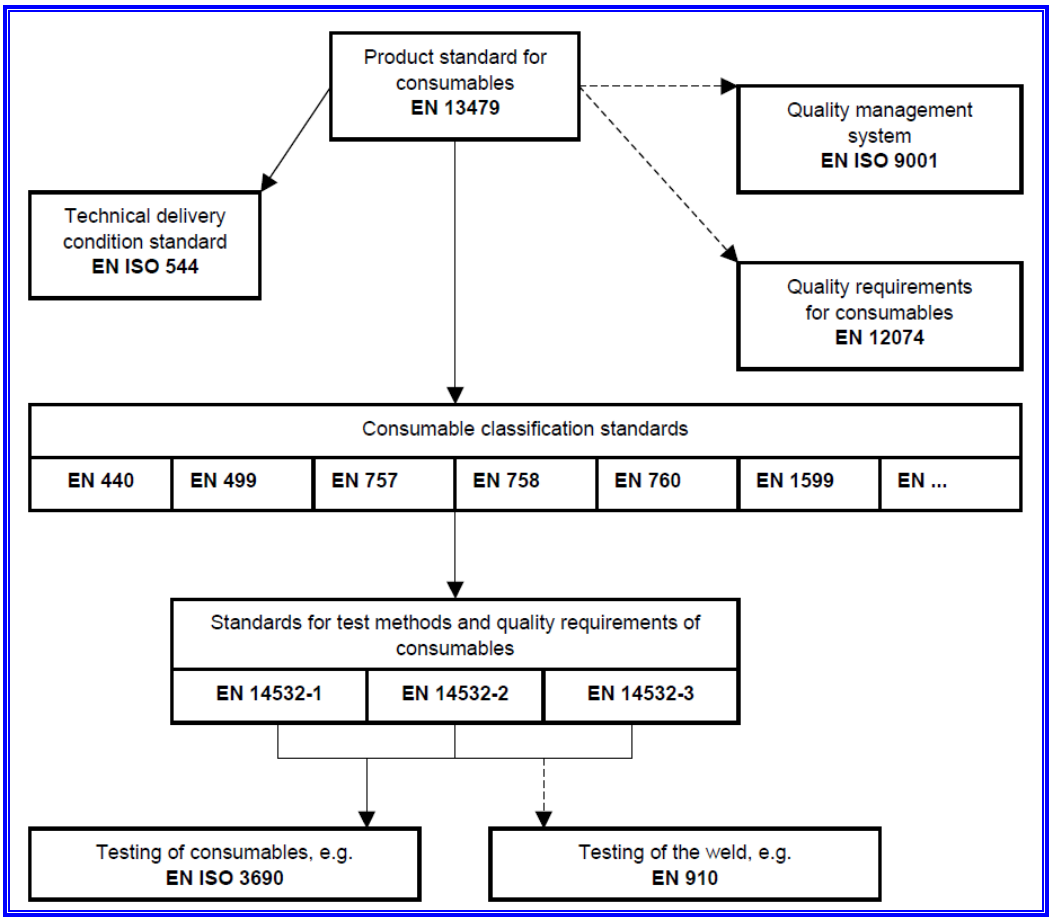
Annex ZA of EN 13479:2004 defines:

- the attestation of conformity system: **2+**;
- the essential characteristics covered by CE marking, among which elongation, tensile strength, yield strength, impact strength and chemical composition of deposited metal.

In its introduction, EN 13479 illustrates the family of standards that it covers.

[16] As written in the standard, subsequent heating above 580 °C may lower the strength

[17] S185, E295, E335 and E360 without requirements for impact energy




EN 13479 does not apply to auxiliaries like shielding gases. During the last meeting of the group of notified bodies in Hamburg (SG17, meeting of 20140923), it was mentioned by the Chairman that many welding consumables are not yet CE marked. It is not known why and supposed that this is not caused by the question of the shielding gas. Manufacturers of welding consumables should be encouraged to CE mark their eligible products.

### 11.4 Aptitude to galvanizing

If galvanizing is planned, suitability of the steel for hot-dip zinc-coating is important[18]. EN 10025 standards refer in this regard to EN ISO 1461 and EN ISO 14713 norms:

- ISO 1461, Third edition 2009-05-15 Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods;
- ISO 14713-1, First edition 2009-12-15 Zinc coatings - Guidelines and recommendations for the protection against corrosion of iron and steel in structures - Part 1: General principles of design and corrosion resistance;
- ISO 14713-2, First edition 2009-12-15 Zinc coatings - Guidelines and recommendations for the protection against corrosion of iron and steel in structures - Part 2: Hot dip galvanizing.

The hereunder tables are respectively extracted from ISO 14713-2 and from EN 10025-2:

[18] Appendix 11 deals with the basic principles of that question.

**Table 1 — Coating characteristics related to steel composition**

| Category | Typical levels of reactive elements | Additional information | Typical coating characteristics |
|---|---|---|---|
| A | ⩽ 0,04 % Si and < 0,02 % P | See Note 1 | Coating has a shiny appearance with a finer texture. Coating structure includes outer zinc layer. |
| B | 0,14 % Si to 0,25 % Si | Fe/Zn alloy may extend through to the coating surface. Coating thickness increases with increasing silicon content. Other elements may also affect steel reactivity. In particular, phosphorus levels greater than 0,035 % will give increased reactivity. | |
| C | > 0,04 % Si to ⩽ 0,14 % Si | Excessively thick coatings may be formed. | Coating has a darker appearance with a coarser texture. Iron/zinc alloys dominate coating structure and often extend to the coating surface, with reduced resistance to handling damage. |
| D | > 0,25 % Si | Coating thickness increases with increasing silicon content. | |

NOTE 1 Steels with compositions satisfying the formula Si + 2,5P ⩽ 0,09 % are also expected to exhibit these characteristics. For cold rolled steels, these characteristics are expected to be observed when the steel composition satisfies the formula Si + 2,5P ⩽ 0,04 %.

NOTE 2 The presence of alloying elements (e.g. nickel) in the zinc melt can have a significant effect on the coating characteristics indicated in this table. This table does not provide relevant guidance for high-temperature galvanizing (i.e., immersion in molten zinc at 530 °C to 560 °C).

NOTE 3 The steel compositions indicated in this table will vary under the influence of other factors and the boundaries of each range will vary accordingly.

**Table 1 - Classes for the suitability for hot-dip zinc-coating based on the ladle analysis (for guidance)**

| Classes | Elements % by mass | | |
|---|---|---|---|
| | Si | Si + 2,5 P | P |
| Class 1 | ≤ 0,030 | ≤ 0,090 | - |
| Class 2 [a] | ≤ 0,35 | - | - |
| Class 3 | 0,14 ≤ Si ≤ 0,25 | - | ≤ 0,035 |

[a] Class 2 applies only for special zinc alloys.

For class 1 the maximum carbon equivalent value of Table 6 shall be increased by 0,02. For class 3 the maximum carbon equivalent value of Table 6 shall be increased by 0,01. These increases apply for S275 and S355 (see 7.2.5).

It comes that CATEGORY B of ISO 14713-2 fits exactly with CLASS 3 of EN 10025-2.

EN 10025-2 defines the chemical composition of a steel grade S275JR as follows:

**Table 2 - Chemical composition of the ladle analysis for flat and long products of steel grades and qualities with values for the impact strength [a]**

| Designation | | Method of deoxi-dation [b] | C in % max. for nominal product thickness in mm | | | Si % max. | Mn % max. | P % max. [d] | S % max. [d, e] | N % max. [f] | Cu % max. [g] | Other % max. [h] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| According EN 10027-1 and CR 10260 | According EN 10027-2 | | ≤ 16 | > 16 ≤ 40 | > 40[c] | | | | | | | |
| S275JR | 1.0044 | FN | 0,21 | 0,21 | 0,22 | - | 1,50 | 0,035 | 0,035 | 0,012 | 0,55 | - |

According to Table 6 of that standard, the maximum CEV up to 30 mm is 0,40 %. This value should be increased 0,01 % if class 3 is adopted for suitability to galvanizing, thus **CEV ≤ 0,41 %**.

### 11.5 Aptitude to hot forming

Hot forming may be necessary to bend or to straighten. If steel has undergone some thermomechanical rolling, it might be sensitive to softening after hot forming at temperatures exceeding 580 °C.

The manufacturer applying EN 1090 should be aware of that.

This information is automatically available for a steel quality like S355M according to EN 10025-4 or as S275JR+M according to EN 10025-2[19].

### 11.6 Practical situations

A practical example may be given by a steel 275 with requested impact energy of 27 J at +20 °C while that steel should be suitable to batch galvanizing. A sound economical solution is a heat treatment during rolling of a steel grade type **S275JR** with a **Si content** between **0,14** and **0,25 %** whose maximum allowable **CEV** would be **0,41 %**.

As such, the information necessary to the manufacturer who applies EN 1090 must include the suitability to batch galvanizing and the application of a heat treatment during rolling, this to avoid problems when hot forming. Such information may easily be brought in a declaration of performance including

- "**S275 JR+M**";
- "**Steel suited to hot dip galvanizing, Si content between 0,14 and 0,25 %**";
- "**Weldability ensured by CEV not greater than 0,41%**".

As discussed in details in Appendix 12, safe welding conditions avoiding the risk of cold cracking may be easily be applied with that level of carbon equivalent **without preheating** provided low hydrogen consumables are used. This is illustrated in the Table hereunder:

[19] It is to be noted that steel grades standardized under EN 10025-4 must show high impact energies (CHARPY V value) at different temperatures from +20 to -20 °C (55 to 40 J for M) and not only 27 J at a given temperature for JR, J0 and J2.

| | Weld temperature = 0 °C | | | |
|---|---|---|---|---|
| | Combined thickness (mm) | | | |
| HI (kJ/cm) | H2> 15 | 10<H2≤15 | 5<H2≤10 | H2≤5 |
| 6 | 16 | 20 | 26 | 40 |
| 8 | 23 | 26 | 35 | 50 |
| 10 | 30 | 33 | 43 | 59 |
| 12 | 34 | 40 | 51 | 71 |
| 14 | 40 | 47 | 60 | no limit |
| 16 | 46 | 54 | 69 | no limit |
| 18 | 52 | 62 | 79 | no limit |
| 20 | 58 | 69 | 87 | no limit |
| 22 | 63 | 76 | 95 | no limit |
| 24 | 70 | 84 | 104 | no limit |
| 26 | 75 | 90 | no limit | no limit |
| 28 | 80 | 97 | no limit | no limit |
| 30 | 85 | 104 | no limit | no limit |

This approach is legal, economic and safe.

On the contrary, another approach that would be based on a 2.2 certificate as shown hereunder announcing, without any consideration, a CEV for that steel of 0,25 % based on a non-specific control would be quite questionable in case of problems involving claims or actions at law.

**Test report according to EN 10204:2004 / 2.2**

*A02*

| Identification nr | Heat analysis (%) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | C | Mn | P | S | Si | N | Al | Cu | Ni | Cr | V | Nb | Mo | Ti | B | CEV |
| Min | | | | | 0,14 | | | | | | | | | | | |
| Max | 0,21 | 1,50 | 0,035 | 0,040 | 0,25 | 0,012 | | 0,55 | | | | | | | | 0,41 |
| R4151240 | 0,09 | 0,60 | 0,017 | 0,029 | 0,16 | 0,009 | 0,000 | 0,34 | 0,14 | 0,12 | 0,001 | 0,003 | 0,020 | 0,000 | 0,0001 | 0,25 |

## 12 Conclusions

According to CPR, CE marking is quite essential. It is a consequence of the declaration of performances (DoP).

The DoP may cover different variants of a reference product. Since it can be placed on an internet site, it does not need to accompany the delivered product.

CE marking is directly linked to each delivery. It should thus in no case be occulted, biased or neglected by or because of the DoP's. CE marking must link to the relevant DoP.

DoP's and CE marking are a must for eligible products and are obviously to be offered free of charge.

As duly explained, inspection documents according to EN 10204 offer not only many options but also quite different sorts of information. The information they relate may be a simple declaration of conformity (2.1) with no technical data or can be accompanied by non-specific results (2.2), meaning that the customer receives information that may be not strictly bound to the product he uses... Such information may be therefore quite misleading. Inspection documents based on specific control (like 3.1 or 3.2) have a sound technical background; depending on the products or the kind of production,

they may be interesting, useful or necessary (especially for large projects involving high execution classes and specific welding procedures). Inspection documents are not per se free of charge for the customer. Documents 3.2 involve a third party and might be assessed as a kind of 3rd party product certification on the same essential characteristics as those covered by the DoP and CE marking (documents 3.1 could be considered as a 1st party product certification). Articles 8.3 and 28 of CPR should thus be carefully approached.

Therefore, in no cases, inspection documents should jeopardize the value of a DoP and CE marking.

The present non-harmonized EN 1090-2 does not deal with inspection documents in a manner that is compatible with CPR. The same may be said as regards other materials standards (like EN 10025). This is a source of confusion.

This kind of situation is tackled by the European Commission in a quite clear way (see FAQ 9 on CPR on the web):

- "*What shall a manufacturer do if certain clauses in the harmonised standard are not in line with the provisions of the Construction Products Regulation (CPR)?*
- *The Construction Products Regulation (CPR) is the directly applicable legislation in every EU Member State. Therefore in such cases, of course, it is this legislation which prevails. The consequence is that such* ***conflicting clauses of standards cannot be applied****. The CEN Technical Committees have undertaken the work to iron out the soonest possible any such inconsistencies in the harmonised standards but it cannot be excluded that some inconsistencies may remain after 01/07/2013, presumably for a short time only.*"

This above-mentioned inconsistency seems obviously to be dealt with for proper correction in the present draft of future EN 1090-1.

That means that these questions are to be approached and tackled in a comprehensive and flexible way, avoiding dogmatic positions in one or the other directions but according to the basic principles of wisdom and safety, a priority being anyway given without any compromise to the essential question of traceability, this in a chain routing process involving cascading actors.

As regards steel elements, not only the major constructors but also any company dealing with steel products purchased from steel producers and placing afterwards such steel elements on the market are concerned by EN 1090-1.

Such any company who wishes to be in line with CPR and to carry out professionally should be able to build up a "*factory production control*" ("*FPC*") ensuring at least traceability, to be certified according to Annex ZA of EN 1090-1:2009+A1:2011, to emit a free of charge "*Declaration of performance*" or "*DoP*" according to that standard and to CE mark at no cost for the customer, this with the possibility to rightly use the "*NPD*" option ("no performance determined, a term used if the actual characteristic has not been tested").
European standards ruling the qualification of welding procedures or welders are based on a rather simple grouping of steel qualities involving for each subgroup a wide range of properties. None of these standards refers to inspection documents according to EN 10204. This simply means that qualified welding processes must cover a range of properties, among other the chemical contents, whose acceptable upper values are ruled by an official generic document, namely the value listed in the relevant product standard and not in another document of specific nature. Exceptions to that obvious evidence could only apply when formal contractual robust documents build for given projects an anticipated clear scope differing from that one defined by the standard. Such special situations disclose an objective need for inspection documents of types 3.1 or 3.2.

Now for usual cases of current execution works on steel structures, truth and reality are as follows. Provided the declaration of performance and the CE marking contain the necessary legal requested information, a manufacturer operating under EN 1090 and related CE does not need further

information when he purchases steel elements either directly from the producer or from a certified distributor.

According to Article 15 of CPR, a distributor that places his products on the market under his own name must draw up an own declaration of performance and affix his own CE marking.

Jacques DEFOURNY

# 13 Appendix 1, Execution classes and traceability

## 13.1 EN 1090

Two major concepts sustain and govern the set of EN 1090 European standards and are indeed closely interacting together, these are the concepts of so-called "**execution class**" and of **traceability**.

According to Article 4.1.2 of EN 1090-2, **four execution classes 1 to 4, denoted EXC1 to EXC4, are given, for which requirement strictness increases from EXC1 to EXC4**.
According to Article 6.3.5 of EN 1090-1, **the requirements for traceability are dependent on execution class**.

## 13.2 CPR

CPR never quotes the topic of **execution class**. This does not mean that this concept is absent from CPR principles. Indeed CPR deals among others with the concepts of "***performance***", "***level***" and "***class***":

- Whereas (13)
  - "*Where appropriate, classes of performance in relation to the essential characteristics of construction products should be encouraged to be used in harmonised standards, so as to take account of different levels of basic requirements for construction works for certain construction works as well as of the differences in climate, geology and geography and other different conditions prevailing in the Member States. On the basis of a revised mandate, the European standardisation bodies should be entitled to establish such classes in cases where the Commission has not already established them.*"
- Article 2 Definitions
  - *5. "performance of a construction product" means the performance related to the relevant essential characteristics, expressed by level or class, or in a description;*
  - *6. "level" means the result of the assessment of the performance of a construction product in relation to its essential characteristics, expressed as a numerical value;*
  - *7. "class" means a range of levels, delimited by a minimum and a maximum value, of performance of a construction product;*

CPR quotes three times the term "**traceability**" as follows:

- "*test equipment has an appropriate calibration system and the traceability of the measurements is guaranteed;*"
- "*Ensure consistency, reliability, objectivity and traceability through the constant application of appropriate management methods.*"
- "*(c) a document control system to ensure registration, traceability, maintenance and archiving of all relevant documents;*"

## 13.3 CPR vs EN 1090 regarding traceability and execution classes

There is not per se any conflict between CPR and EN 1090 regarding both **concepts** of traceability and execution classes.

On the contrary, CPR and EN 1090 could not be in phase regarding the modalities to appraise the questions linked to traceability and execution classes. Should a conflict exist in this regard, the legal rule is clear: **conflicting clauses of EN 1090-1 or EN 1090-2 cannot be applied**.

# 14 Appendix 2 - A source of conflict between CPR and EN 1090

### 14.1.1 CPR, Articles 8 and 28

#### 14.1.1.1 CPR, Article 8 "General principles and use of CE marking"

In its part 3, this article states:

- "*3. For any construction product covered by a harmonised standard, or for which a European Technical Assessment has been issued, the CE marking shall be the only marking which attests*

*conformity of the construction product with the declared performance in relation to the essential characteristics, covered by that harmonised standard or by the European Technical Assessment.*"

#### 14.1.1.2 CPR, Article 28 "Assessment and verification of constancy of performance"

1. "*Assessment and verification of constancy of performance of construction products in relation to their essential characteristics shall be carried out in accordance with one of the systems set out in Annex V.*
2. *By means of delegated acts in accordance with Article 60, the Commission shall establish and may revise, taking into account in particular the effect on the health and safety of people, and on the environment, which system or systems are applicable to a given construction product or family of construction products or a given essential characteristic. In doing so, the Commission shall also take into account the documented experiences forwarded by national authorities with regard to market surveillance. The Commission shall choose the least onerous system or systems consistent with the fulfilment of all basic requirements for construction works.*
3. *The system or systems thus determined shall be indicated in the mandates for harmonised standards and in the harmonised technical specifications.*"

### 14.1.2 EN 1090-2, Articles 6.2, 12.2.1 and 5[20]

#### 14.1.2.1 EN 1090-2, Article 6.2 "*Identification*"

"*At all stages of manufacturing each piece or package of similar pieces of steel components shall be identifiable by a suitable system. For EXC3 and EXC4 finished components shall be identified to inspection certificates…*"

#### 14.1.2.2 EN 1090-2, Article 12.2.1 "*Constituent products*"

"*Documents supplied with constituent products in accordance with the requirements of Clause 5 shall be checked to verify that the information on the products supplied matches those ordered.*
*NOTE 1 These documents include inspection certificates, test reports,* ***declaration of compliance*** *as relevant for plates, sections, hollow sections, welding consumables, mechanical fasteners, studs etc.*
*NOTE 2 This documentation check is intended to obviate the need for testing products generally.*
*… There are no requirements for specific testing of products unless otherwise specified.…*"

#### 14.1.2.3 EN 1090-2, Article 5 "*Constituent products*"

"*5.1 General*
*Generally constituent products to be used for the execution of steel structures shall be selected from the relevant European Standards listed in the following clauses. If constituent products that are not covered by the standards listed are to be used, their properties shall be specified…*
*5.2 Identification, inspection documents and traceability*
*The properties of supplied constituent products shall be documented in a way that enables them to be compared to the specified properties. Their conformity with the relevant product standard shall be checked in accordance with 12.2. For metallic products, the inspection documents according to EN 10204 shall be as listed in Table 1*."

# 15 Appendix 3 - The question of inspection documents

EN 10204:2004 deals with "*Metallic products - Types of inspection documents*". This standard specifies the different types of inspection documents supplied to the purchaser, in accordance with the requirements of the order, for the delivery of all metallic products e.g. plates, sheets, bars, forgings, castings, whatever their method of production. It may also apply to non-metallic products. It is used in conjunction with the product specifications which specify the technical delivery conditions of the products.

Much has been said regarding these inspection documents and a possible request that such documents should be part of the CE marking.

[20] For clarity purposes, the terms "inspection certificates" and "declaration of compliance" are here written by the author as "*inspection certificates" and "**declaration of compliance***"

The answer must be quite clear and expressed as follows. Inspection documents are not concerned by CE marking. They are not part of harmonized specifications.

The reasons are that these documents are qualified as “commercial documents” in Annex ZA of EN 10025-1:

> **ZA.3 CE marking and labelling**
>
> The manufacturer or his authorised representative established within the EEA is responsible for the affixing of the CE marking. The CE marking symbol to affix shall be in accordance with Directive 93/68/EC and shall be shown on the [construction product] (or when not possible it may be on the accompanying label, the packaging or on the accompanying commercial documents (inspection document) (see Table B.1). The following information shall accompany the CE marking symbol:

Inspection documents are not quoted in Annex ZA of EN 1090-1:

> **ZA.3 CE marking and labelling**
>
> **ZA.3.1 General**
>
> The manufacturer or his authorised representative established within the EEA is responsible for the affixing of the CE marking. The CE marking symbol affix shall be in accordance with directive 93/68/EC and shall be shown on the component or may be on the accompanying label, the packaging or on the commercial documentation.

As a confirmation of this, EN 1090-1 gives an example of CE marking of a steel element, a welded beam which may be quite comparable to a hot rolled section that would have been delivered according to EN 10025-2 and CE marked according to EN 10025-1. No mention at all of any inspection document appears here, although for instance weldability is declared (see CE marking example in chapter 4).

# 16 Appendix 4 - The possible use of inspection documents

## 16.1 Inspection documents in the frame of FPC

For the suppliers in charge of delivering the CE marking, the inspection documents may obviously be part of their factory production control. This is why reference to inspection documents is made in both EN 10025 and EN 1090 series of standards.

The necessary handling of inspection documents is then part of the factory production control which relies either on documents or on own testing. This is a quite specific matter which regards among others the notified bodies in charge of certifying the producers or the suppliers of constructional steel pieces.

## 16.2 Inspection documents in the frame of certification

A possible use of inspection documents must be understood as a function of the guarantees already given by the supplier to the customer.

In the past, there was no CE marking, therefore inspection documents could be the only guaranty that was available.

This may explain their need when for instance no voluntary certification mark was available, like for instance BENOR in Belgium.

It is clear that for reinforcements or for prestressing steels which are BENOR certified since 1977 no inspection documents are delivered and are needed, **although reinforcements may be welded**[21]. Reinforcements are the object of national voluntary certification in nearly all countries of the European Economic Area (EEA) with mutual bilateral agreements so that certification of these products is a reliable fact since several decades.

Till September 01, 2006[22], there was no such wide voluntary certification for structural steel according to EN 10025 for instance and no CE marking. Therefore, inspection documents were the only way to get a kind of declaration of performance by the producer possibly without the involvement of any third party[23].

It is to be recalled that an inspection document type 2.1 gives no technical data at all about the product. An inspection document type 2.2 gives values of test results but based on a non-specific inspection[24]. A type 3.1 or 3.2 inspection document is based on a specific inspection[25].

Worth to be mentioned is the fact that EN 10025-1 offers 10 options regarding the information that could be reported in inspection documents by the steelmaker, as recalled hereunder:

> For products according to EN 10025-2:2004 to EN 10025-6:2004 the following options apply, if required:
>
> 1) The steel making process of the relevant quality shall be reported to the purchaser (see 6.1).
>
> 2) Product analysis shall be carried out; the number of samples and the elements to be determined shall be as agreed (see 7.2.2, 8.3.3 and 8.4.2 of EN 10025-2:2004 to EN 10025-6:2004).
>
> 3) The impact properties of a quality shall be verified at an agreed temperature (see 7.3.2.2 and 8.4.2 of EN 10025-2:2004 to EN 10025-6:2004).

[21] It should be reminded that **concrete reinforcements used in most European countries are high strength steels** (with a guaranteed yield stress of **500** MPa, thus far above that of an S235JR grade for non-alloy structural steels).

[22] Date of mandatory CE marking for products covered by EN 10025-1

[23] This is roughly said and does not mean that a voluntary or even mandatory certification scheme might exist in a given member State, but clearly such a practice was not comparable to that still in force for reinforcements or prestressing steels.

[24] "*inspection carried out by the manufacturer in accordance with his own procedures to assess whether products defined by the same product specification and made by the same manufacturing process, are in compliance with the requirements of the order or not. The products inspected are not necessarily the products actually supplied*" ("*manufacturer organization that manufactures the respective products according to the requirements of the order and to the properties specified in the referenced product specification*")

[25] "*inspection carried out, before delivery, according to the product specification, on the products to be supplied or on test units of which the products supplied are part, in order to verify that these products are in compliance with the requirements of the order*"

4) Products of the relevant quality shall comply with one of the improved properties perpendicular to the surface of the product as specified in EN 10164 (see 7.3.3).

5) The product shall be suitable for hot-dip zinc-coating (see 7.4.3).

6) For flat products in thickness ≥ 6 mm the freedom from internal defects shall be verified in accordance with EN 10160 (see 7.6 and 10.3).

7) For H beams with parallel flanges and IPE beams the freedom from internal defects shall be verified in accordance with EN 10306 (see 7.6 and 10.3).

8 For bars the freedom from internal defects shall be verified in accordance with EN 10308 (see 7.6 and 10.3).

9) Inspection of surface condition and dimensions shall be witnessed by the purchaser at the manufacturer's works (see 8.2.2).

10) The type of marking required (see 11.1).

Other complementary numerous options are even offered by EN 10025-2 to -6 standards, such as:

In addition to the options of EN 10025-1:2004 the following options apply to products according to EN 10025-2:

11) Sheet, plate, strip, wide flats and flats (width < 150 mm) with a nominal thickness ≤ 30 mm shall be suitable for flanging without cracking (see 7.4.2.2.2).

12) Plate and strip with nominal thickness ≤ 8 mm shall be suitable for the production of sections by cold rolling with bend radii given in Table 13 (see 7.4.2.2.3).

…

26) The limitation of the maximum carbon content shall be provided for sections with nominal thickness > 100 mm (see Tables 2 and 4).

27) For long products the max. S content can be increased for improved machinability by 0,015 % if the steel is treated to modify the sulphide morphology and the chemical composition shows min. 0,0020 % Ca (see Tables 2 to 5).

28) The minimum impact values shall be provided for sections with a nominal thickness > 100 mm (see Table 9).

As just an example of these options, the purchaser may decide or not to rely on the chemical composition based on ladle analysis or on product analysis.

These options demonstrate the voluntary nature underlying the requirement or delivery of inspection documents by or to customers of constructional steels.

# 17 Appendix 5 - About the technical use of inspection documents regarding welding

## 17.1 Technical content

A type 2.1 inspection document contains no test result and is of no technical need.

A type 2.2 inspection document contains test results based on a non-specific inspection, which means on products possibly different from those delivered to the customer. Any technical use of such a document is quite questionable and risky.

Only a type 3.1[26] or 3.2[27] inspection document is reliable for the steel actually used because of the specific nature of the test.

### 17.2 Influence on welding procedure

Does that mean that a user consulting such documents would adapt his welding procedure as a function of the actual analysis while the welding qualification was performed on other batches of steel?

The question is quite open.

Now, one may imagine that for quite specific purposes, a customer adapts precisely a fabrication technique to the actual properties of a steel quality supplied from a given manufacturer under strictly controlled reproducible conditions. This is a possible situation that should be ruled by a contract between the supplier and the purchaser but surely not the general way of doing that underlays the execution of steel structures according to EN 1090 standards.

From a practical point of view, when CE marking is affixed, the user is aware of the maximum carbon equivalent value which will be used to estimate the necessary heat input or preheat temperature to avoid cracking as a function of diffusible hydrogen and product thickness.

The welding conditions ensuring safe welds can be readily defined on such a basis. This is illustrated by some excerpts from the well-known book "*Welding Steels without hydrogen cracking*" reported in chapter 25.

Consequently, the comments which are emitted regarding an absolute need for inspection documents when welding is concerned are not receivable. Literature demonstrates that welding can be safely applied on basis of upper limits for carbon equivalent and not on actual values of this characteristic for any batch of steel. This evidence does not mean that an inspection document is not useful or even necessary when dealing with more sophisticated high strength grades of steels, like quenched and tempered or thermomechanically rolled qualities because for such grades, other risks than hydrogen cracking has to be seriously tackled, like those of grain coarsening in the heat affected zone with lack of toughness or softening in this area with lack of strength. In such cases, an inspection document (**at least of 3.1 type**) will be requested for certain specific characteristics and thus with quite other objectives than just being able to calculate a carbon equivalent value[28].

---

[26] "*Document issued by the manufacturer in which he declares that the products supplied are in compliance with the requirements of the order and in which he supplies test results. The test unit and the tests to be carried out are defined by the product specification, the official regulation and corresponding rules and/or the order. The document is validated by the manufacturer's authorized inspection representative, independent of the manufacturing department. It shall be permissible for the manufacturer to transfer on to the inspection certificate 3.1 relevant test results obtained by specific inspection on primary or incoming products he uses, provided that the manufacturer operates traceability procedures and can provide the corresponding inspection documents required.*"

[27] "*Document prepared by both the manufacturer's authorized inspection representative, independent of the manufacturing department and either the purchaser's authorized inspection representative or the inspector designated by the official regulations and in which they declare that the products supplied are in compliance with the requirements of the order and in which test results are supplied. It shall be permissible for the manufacturer to transfer on to the inspection certificate 3.2 relevant test results obtained by specific inspection on primary or incoming products he uses, provided that the manufacturer operates traceability procedures and can provide the corresponding inspection documents required.*"

[28] Doing that computation of carbon equivalent with a type 2.2 inspection document would **not be responsible**, from both technical and scientific points of view, just because of the non-specific character of the inspection.

### 17.3 Improvable practices

Nevertheless, different practices based on inspection documents are not deemed acceptable. For instance, this excerpt form an FPC file certified for EN 1090 refers to wrong materials references (steel **J4**?) and to unclear requirements regarding the carbon equivalent (<0,43 % for S355J..).

- Voor S355 materiaal moet het koostofequivalent (CEV) < 0,43% (om voorwarmen te vermijden bij groter diktes)
- De geleverde materialen moeten geleverd worden ***met volgende inspectie materiaalcertificaten van de fabrikant*** (EN10204), bij voorkeur vóór levering:

| (Staal)type | Kerfslagwaarden | Materiaalcertificaat volgens EN 10204:2004 |
|---|---|---|
| S235/S275 | JR, J0 | 2.2 |
| S235/S275 | J2, J4 | 3.1 |
| S355 | JR, J0, J2 & J4 | 3.1 |
| Constructieve boutsets | | 2.1 |

Such requirements are not in phase with the relevant standards. As already mentioned[29], a maximum carbon equivalent of 0,43 % applies to S355**N** and not to S355**Jx**. Should preheating be avoided on greater thicknesses, a decrease of the carbon equivalent by more than 0,02 % should be envisaged, possibly with S355M steels.

## 18 Appendix 6 - About inspection, testing and correction

The requirements for inspection and testing with respect to the quality requirements are specified in clause 12 of EN 1090-2:2008+A1:2011. This concerns not only constituent products but also components. The requirements of the standard are as follows:

**12.2.1 Constituent products**

Documents supplied with constituent products in accordance with the requirements of Clause 5 shall be checked to verify that the information on the products supplied matches those ordered.

NOTE 1 These documents include inspection certificates, test reports, declaration of compliance as relevant for plates, sections, hollow sections, welding consumables, mechanical fasteners, studs etc.

NOTE 2 This documentation check is intended to obviate the need for testing products generally.

The inspection of the surface of product for defects revealed during surface preparation shall be included in the inspection and test plans.

If surface defects in steel products revealed during surface preparation are repaired using methods that are in accordance with this European Standard, the repaired product may be used provided that it complies with the nominal properties specified for the original product.

There are no requirements for specific testing of products unless otherwise specified.

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- S355J2, CEV ≤ 0,45 % (according to EN 10025-1 + EN 10025-**2**);
- S355N, CEV ≤ 0,43 % (according to EN 10025-1 + EN 10025-**3**);
- S355M, CEV ≤ 0,39 % (according to EN 10025-1 + EN 10025-**4**).

**12.2.2 Components**

Documents supplied with components shall be checked to verify that the information on the components supplied matches those ordered.

NOTE This applies to all delivered and part-fabricated products received into a constructor's works for further processing (e.g. welded I-sections for incorporation into plate girders), and to products received on site for erection by the constructor if these are not manufactured by the constructor.

It is clear that the goal to achieve here is "***to verify that the information on the products or component supplied matches those ordered.***"

As the standard explicitly mentions, such information may be brought by a "*declaration of compliance*", in other terms according to CPR a "**declaration of performances**".

Clause 5 of the standard is, however, quite questionable and indeed not eligible as a harmonized specification.

# 19 Appendix 7 - Clause 5 of EN 1090-2

Clause 5 of EN 1090-2:2008+A1:2011 deals with "***Constituent products***" and states among others the following:

- "*5.1 General*
  - *Generally constituent products to be used for the execution of steel structures shall be selected from the relevant European Standards listed in the following clauses. If constituent products that are not covered by the standards listed are to be used, their properties shall be specified…*
- *5.2 Identification, inspection documents and traceability*
  - *The properties of supplied constituent products shall be documented in a way that enables them to be compared to the specified properties. Their conformity with the relevant product standard shall be checked in accordance with 12.2. For metallic products, the inspection documents according to EN 10204 shall be as listed in Table 1.*"

**Table 1 — Inspection documents for metallic products**

| Constituent product | Inspection documents |
|---|---|
| Structural steels (Tables 2 and 3) | according to Table B.1 of EN 10025-1:2004 [a b] |
| Stainless steels (Table 4) | 3.1 |
| Steel castings | according to Table B.1 of EN 10340:2007 |
| Welding consumables (Table 5) | 2.2 |
| Structural bolting assemblies | 2.1 [c] |
| Hot rivets | 2.1 [c] |
| Self-tapping and self-drilling screws and blind rivets | 2.1 |
| Studs for arc studs welding | 2.1 [c] |
| Expansion joints for bridges | 3.1 |
| High strength cables | 3.1 |
| Structural bearings | 3.1 |

[a] For structural steel grade S355 JR or J0 inspection document 3.1 is required for EXC2, EXC3 and EXC4.

[b] EN 10025-1 requires that the elements included in the CEV formula shall be reported in the inspection document. The reporting of other added elements required by EN 10025-2 should include Al, Nb, and Ti.

[c] If a 3.1 certificate is required, this may be substituted by a manufacturing lot identification mark.

This content raises the following comments:

- Ce marking is totally ignored both in the text and in the Table;
- As regards structural steels, **EN 1090-2 disagrees with EN 10025-1 as regards S355 steels** (see remark “a” requesting 3.1 certificates while EN 10025 refers to 2.2 certificates);
- For some products, EN 1090-2 mixes 2.1 with 3.1 certificates and with identification marks;
- On the other hand, the reading of Table 1 demonstrates that an inspection document may be substituted by another type of information.

One may find that Table 3 of Clause 5 has been amended in the last addendum of 2011 by the inclusion of new European products standards like EN 10149, EN 10346 and EN 10169:

**Table 3 — Product standards for sheet and strip suitable for cold forming**

| Products | Technical delivery requirements | Tolerances |
|---|---|---|
| Non-alloy structural steels | EN 10025-2 | EN 10051 |
| Weldable fine grain structural steels | EN 10025-3, EN 10025-4 | EN 10051 |
| High yield strength steels for cold forming | A1 EN 10149 A1, EN 10268 | A1 EN 10029, EN 10048, EN 10051, EN 10131, EN 10140 A1 |
| Cold reduced steels | ISO 4997 | EN 10131 |
| Continuously coated hot dip coated steels | A1 EN 10346 A1 | EN 10143 |
| Continuously organic coated steel flat products | A1 EN 10169 A1 | A1 EN 10169 A1 |
| Narrow strips | EN 10139 | EN 10048<br>EN 10140 |

Indeed these new grades included in the addendum of 2011 of EN 1090-2 are not covered by CE marking because their underlying European standard is not harmonised as demonstrated hereunder[30]:

| | | | | |
|---|---|---|---|---|
| CEN | EN 10088-5:2009<br>Stainless steels - Part 5: Technical delivery conditions for bars, rods, wire, sections and bright products of corrosion resisting steels for construction purposes | | 1.1.2010 | 1.1.2011 |
| CEN | EN 10210-1:2006<br>Hot finished structural hollow sections of non-alloy and fine grain steels - Part 1: Technical delivery conditions | | 1.2.2007 | 1.2.2008 |

…

| | | | | |
|---|---|---|---|---|
| CEN | EN 10255:2004+A1:2007<br>Non-Alloy steel tubes suitable for welding and threading - Technical delivery conditions | | 1.1.2010 | 1.1.2011 |
| CEN | EN 10311:2005<br>Joints for the connection of steel tubes and fittings for the conveyance of water and other aqueous liquids | | 1.3.2006 | 1.3.2007 |

…

| | | | | |
|---|---|---|---|---|
| CEN | EN 10343:2009<br>Steels for quenching and tempering for construction purposes - Technical delivery conditions | | 1.1.2010 | 1.1.2011 |
| CEN | EN 12004:2007+A1:2012<br>Adhesives for tiles - Requirements, evaluation of conformity, classification and designation | EN 12004:2007 | 1.4.2013 | 1.7.2013 |

On the contrary, for stainless steel, Table 4 of EN 1090-2:2008+A1:2011 does not refer to EN 10088-4 and EN 10088-5, both these standards are, however, harmonised since February 2010:

[30] See "*C 186/36 Official Journal of the European Union 28.6.2013*".

**Table 4 — Product standards for stainless steels**

| Products | Technical delivery requirements | Tolerances |
|---|---|---|
| Sheets, plates and strips | EN 10088-2 | EN 10029, EN 10048, EN 10051, EN ISO 9445 |
| Tubes (welded) | EN 10296-2 | EN ISO 1127 |
| Tubes (seamless) | EN 10297-2 | |
| Bars, rods and sections | EN 10088-3 | EN 10017, EN 10058, EN 10059, EN 10060, EN 10061 |
| NOTE Steel designations by name and number are given in EN 10088-1. | | |



| | | | | |
|---|---|---|---|---|
| CEN | EN 10088-4:2009<br>Stainless steels - Part 4: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for construction purposes | | 1.2.2010 | 1.2.2011 |
| CEN | EN 10088-5:2009<br>Stainless steels - Part 5: Technical delivery conditions for bars, rods, wire, sections and bright products of corrosion resisting steels for construction purposes | | 1.1.2010 | 1.1.2011 |

Therefore, it comes out clearly that any intelligent reading of EN 1090-2 cannot result in a rough and dogmatic position regarding inspection documents.

Indeed, the presence of clause 5 in EN 1090-2 constitutes the major reproach addressed by the European Commission against EN 1090-2 because this non-harmonized standard tends to impose specifications regarding the conformity of performance, while it should not because:

- such a task is devoted to EN 1090-1;
- such specifications are in contradiction with article 8.2 of the CPR.

It might be argued that EN 1090 standards do not necessarily have to tackle only steel grades corresponding to harmonized standards. This is quite true. Obviously, for such steels there will exist no declaration of performance according to CPR. A specific answer has thus to be given for these cases.

**For steel products not covered by a harmonized standard, this specific answer could rely on an acceptance procedure possibly including inspection documents according to EN 10204**.

Clearly, this specific answer shall never rely on a rough table listing steel products standards against given types of inspection documents, just because any such table is per se "***indicative and non-***

***exhaustive***", exactly as the list demanded to CEN regarding the scope of EN 1090[31]. Indeed, the only objective that any detailed list would claim is to be outdated a few weeks after it was published… Such a work would be worthless and confusing…

**In short words, clause 5 of EN 1090-2 should be entirely reviewed to be fully in phase with CPR, otherwise, it will remain widely neither eligible nor applicable, this with regards to the legal issues induced by CPR (see FAQ N° 9 already approached)**.

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

CEN/TC 135 — **Execution of steel structures and aluminium structures** — **N 686**

Secretariat: Norway — Date: 2013-07-08

Roald Sægrov

## Discussion on Products under the Scope of EN 1090-1 and proposed CEN/TR to clarify the scope

Dear Members

Mandatory CE-marking of products under the scope of EN 1090-1:2009+A1:2011 (in short: EN 1090-1) came into force 2014-07-01.

The Commission has uploaded on its web-site a response to frequently asked questions (FAQ) on the scope of EN 1090-1.

The FAQ on EN 1090-1 includes an indicative list of products not covered by the scope of EN 1090-1, i.e. where CE-marking under EN 1090-1 is not allowed.

The list is an updated version based on the list provided by TC135 in May 2014 as described in N684. Request for an updated indicative list of products not covered by EN 1090-1 to be used by the Commission in its FAQ web site was received by the secretary of TC135 2014-07-02 with a deadline date to respond within 2014-07-04, i.e. within two days. Both the CEN/CENELEC Management Centre (CCMC) and the TC135 secretariat have expressed to the Commission the impossibility to respond in a formally satisfactory manner within such an unrealistic deadline date. However, noting that the Commission in lack of other information planned to use preliminary lists, CCMC agreed that CEN would send to the Commission an updated version of the TC135 May list (of N684) where products which may be disputed was to be taken out.

The updated list was sent from TC135 to CEN on Friday 2014-07-04 and by CEN to the Commission on Monday 2014-07-07, see attachment.

Due to the short time available only the experts contributing to the list of N684 were consulted. Though the experts contributed to the update, they also clearly expressed that they did not accept the lack of respect for the formal processes implied by the short deadline date.

To respond to the discussion with the stakeholders on the scope of EN 1090-1, including the items above, CCMC has proposed to develop a formal document within TC135 which can meet the demands. Such a document may be a CEN Technical Report, a CEN/TR. Due to the urgent needs among stakeholders, the aim may be to finalize such a document within the TC135-meeting of December 2014. The content of the CEN/TR should be both the principles of the scope and an updated list of products not covered by it.

Kind regards
Roald Sægrov
Secretary of CEN/TC 135

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# 20 Appendix 8 - Weldability and welding

European standards of the EN 1011 series give the "*Recommendations for welding of metallic materials*" with Parts 1 and 2 respectively devoted to "*General guidance for arc welding*" and "*Arc welding of ferritic steels*". None of these standards makes any mention of inspection documents.

EN 1011-2 states that the determination of safe, but economic, preheating levels for the prevention of hydrogen cracking is critically dependent on an accurate knowledge of parent metal composition and carbon equivalent, CE, and on the weld metal composition with the carbon equivalent defined as follows within a valid range between 0,30 and 0,70 %:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15} \quad \text{in \%}$$

EN 1011-2 clearly approaches the risks associated with the occurrence of hydrogen cracking depending on a number of factors such as composition of the steel, the welding procedure, welding consumables and the stress involved.
According to EN 1011-2: "***The most effective assurance of avoiding hydrogen cracking is to reduce the hydrogen input to the weld metal from the welding consumables. The benefits resulting from a growing number of possibilities where no preheat temperature > 20 °C is required, can - as shown by examples in table C.1 - be increased by using filler materials with lower hydrogen content***."

**Table C.1 — Examples of maximum combined thickness (see C.2.4) weldable without preheat**

| Diffusable hydrogen content[a] ml/100 g of deposited metal | Maximum combined thickness | | | |
|---|---|---|---|---|
| | *CE* of 0,49 | | *CE* of 0,43 | |
| | Heat input | | Heat input | |
| | 1,0 kJ/mm | 2,0 kJ/mm | 1,0 kJ/mm | 2,0 kJ/mm |
| | mm | mm | mm | mm |
| > 15 | 25 | 50 | 40 | 80 |
| 10 ≤ 15 | 30 | 55 | 50 | 90 |
| 5 ≤ 10 | 35 | 65 | 60 | 100 |
| 3 ≤ 5 | 50 | 100 | 100 | 100 |
| ≤ 3 | 60 | 100 | 100 | 100 |

[a] Measured in accordance with ISO 3690

Without entering into detailed technical considerations, it is clear that it is quite feasible to weld thick plates without preheat at carbon equivalent up to 0,43 % provided low hydrogen consumables are used.

Not any mention of inspection documents according to EN 10204 is referred to in EN ISO 15609-1 listing the "*Specification and qualification of welding procedures for metallic materials - Welding procedure specification - Part 1: Arc welding*".

Not any mention of inspection documents according to EN 10204 is referred to in EN ISO 15614-1 listing the "*Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*".

Not any mention of inspection documents according to EN 10204 is referred to in EN ISO 9606-1 listing the rules for the "*Qualification testing of welders - Fusion welding - Part 1: Steels*".

Not any mention of inspection documents according to EN 10204 is referred to in CEN ISO TR 15608 listing the "*Guidelines for a metallic materials grouping system*". In this document, all steels are organised through 11 groups altogether (see Table 1 of that technical report in Appendix 9). The carbon steel grades covered by EN 1090 are found indeed in groups 1, 2 and partly 3 under 7 subgroups:

| | |
|---|---|
| 1.1 | Steels with a specified minimum yield strength $R_{eH} \leq 275$ N/mm² |
| 1.2 | Steels with a specified minimum yield strength 275 N/mm² < $R_{eH} \leq 360$ N/mm² |
| 1.3 | Normalized fine-grain steels with a specified minimum yield strength $R_{eH} > 360$ N/mm² |
| 1.4 | Steels with improved atmospheric corrosion resistance whose analysis may exceed the requirements for the single elements as indicated in group 1 |
| 2.1 | Thermomechanically treated fine-grain steels and cast steels with a specified minimum yield strength 360 N/mm² < $R_{eH} \leq 460$ N/mm² |
| 2.2 | Thermomechanically treated fine-grain steels and cast steels with a specified minimum yield strength $R_{eH} > 460$ N/mm² |
| 3.1 | Quenched and tempered fine-grain steels with a specified minimum yield strength 360 N/mm² < $R_{eH} \leq 690$ N/mm² |

The main point with CE marking in line with CPR is therefore not to vainly dispute about the question of inspection documents but

- On the one hand, to adopt robust basis for the editing of valid declarations of performances and CE marking;
- On the other hand, to carefully define the status and the possible usefulness of inspection documents.

## 21 Appendix 9, Table 1 of CEN ISO/TR 15608

TECHNICAL REPORT **CEN ISO/TR 15608**

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

April 2013

Welding - Guidelines for a metallic materials grouping system (ISO/TR 15608:2013)

**Table 1 — Grouping system for steels**

| Group | Subgroup | Type of steel |
|---|---|---|
| 1 | | Steels with a specified minimum yield strength $R_{eH} \leq 460$ N/mm² [a] and with analysis in per cent (%): |
| | | C ≤ 0,25[d] |
| | | Si ≤ 0,60 |
| | | Mn ≤ 1,8 |
| | | Mo ≤ 0,70[b] |
| | | S ≤ 0,045 |
| | | P ≤ 0,045 |
| | | Cu ≤ 0,40[b] |
| | | Ni ≤ 0,5[b] |
| | | Cr ≤ 0,3 (0,4 for castings)[b] |
| | | Nb ≤ 0,06 |
| | | V ≤ 0,1[b] |
| | | Ti ≤ 0,05 |
| | 1.1 | Steels with a specified minimum yield strength $R_{eH} \leq 275$ N/mm² |
| | 1.2 | Steels with a specified minimum yield strength 275 N/mm² < $R_{eH} \leq 360$ N/mm² |
| | 1.3 | Normalized fine-grain steels with a specified minimum yield strength $R_{eH} > 360$ N/mm² |
| | 1.4 | Steels with improved atmospheric corrosion resistance whose analysis may exceed the requirements for the single elements as indicated in group 1 |
| 2 | | Thermomechanically treated fine-grain steels and cast steels with a specified minimum yield strength $R_{eH} > 360$ N/mm² |
| | 2.1 | Thermomechanically treated fine-grain steels and cast steels with a specified minimum yield strength 360 N/mm² < $R_{eH} \leq 460$ N/mm² |
| | 2.2 | Thermomechanically treated fine-grain steels and cast steels with a specified minimum yield strength $R_{eH} > 460$ N/mm² |
| 3 | | Quenched and tempered and precipitation hardened fine-grain steels except stainless steels with a specified minimum yield strength $R_{eH} > 360$ N/mm² |
| | 3.1 | Quenched and tempered fine-grain steels with a specified minimum yield strength 360 N/mm² < $R_{eH} \leq 690$ N/mm² |
| | 3.2 | Quenched and tempered fine-grain steels with a specified minimum yield strength $R_{eH} > 690$ N/mm² |
| | 3.3 | Precipitation-hardened fine-grain steels except stainless steels |
| 4 | | Low vanadium alloyed Cr-Mo-(Ni) steels with Mo ≤ 0,7 % and V ≤ 0,1 % |
| | 4.1 | Steels with Cr ≤ 0,3 % and Ni ≤ 0,7 % |
| | 4.2 | Steels with Cr ≤ 0,7 % and Ni ≤ 1,5 % |
| 5 | | Cr-Mo steels free of vanadium with C ≤ 0,35 % |
| | 5.1 | Steels with 0,75 % ≤ Cr ≤ 1,5 % and Mo ≤ 0,7 % |
| | 5.2 | Steels with 1,5 % < Cr ≤ 3,5 % and 0,7 % < Mo ≤ 1,2 % |
| | 5.3 | Steels with 3,5 % < Cr ≤ 7,0 % and 0,4 % < Mo ≤ 0,7 % |
| | 5.4 | Steels with 7,0 % < Cr ≤ 10,0 % and 0,7 % < Mo ≤ 1,2 % |

**Table 1** *(continued)*

| Group | Subgroup | Type of steel |
|---|---|---|
| 6 | | High vanadium alloyed Cr-Mo-(Ni) steels |
| | 6.1 | Steels with 0,3 % ≤ Cr ≤ 0,75 %, Mo ≤ 0,7 % and V ≤ 0,35 % |
| | 6.2 | Steels with 0,75 % < Cr ≤ 3,5 %, 0,7 % < Mo ≤ 1,2 % and V ≤ 0,35 % |
| | 6.3 | Steels with 3,5 % < Cr ≤ 7,0 %, Mo ≤ 0,7 % and 0,45 % ≤ V ≤ 0,55 % |
| | 6.4 | Steels with 7,0 % < Cr ≤ 12,5 %, 0,7 % < Mo ≤ 1,2 % and V ≤ 0,35 % |
| 7 | | Ferritic, martensitic or precipitation-hardened stainless steels with C ≤ 0,35 % and 10,5 % ≤ Cr ≤ 30 % |
| | 7.1 | Ferritic stainless steels |
| | 7.2 | Martensitic stainless steels |
| | 7.3 | Precipitation-hardened stainless steels |
| 8 | | Austenitic stainless steels, Ni ≤ 35 % |
| | 8.1 | Austenitic stainless steels with Cr ≤ 19 % |
| | 8.2 | Austenitic stainless steels with Cr > 19 % |
| | 8.3 | Manganese austenitic stainless steels with 4 % < Mn ≤ 12 % |
| 9 | | Nickel alloy steels with Ni ≤ 10,0 % |
| | 9.1 | Nickel alloy steels with Ni ≤ 3,0 % |
| | 9.2 | Nickel alloy steels with 3,0 % < Ni ≤ 8,0 % |
| | 9.3 | Nickel alloy steels with 8,0 % < Ni ≤ 10,0 % |
| 10 | | Austenitic ferritic stainless steels (duplex) |
| | 10.1 | Austenitic ferritic stainless steels with Cr ≤ 24 % |
| | 10.2 | Austenitic ferritic stainless steels with Cr > 24 % |
| | 10.3 | Austenitic ferritic stainless steels with Ni ≤ 2 % |
| 11 | | Steels covered by group 1[c] except 0,25 % < C ≤ 0,85 % |
| | 11.1 | Steels as indicated under 11 with 0,25 % < C ≤ 0,35 % |
| | 11.2 | Steels as indicated under 11 with 0,35 % < C ≤ 0,5 % |
| | 11.3 | Steels as indicated under 11 with 0,5 % < C ≤ 0,85 % |

Based on the actual product analysis, group 2 steels may be considered group 1 steels.

If a material has different minimum specified yield strengths depending on the thickness, the highest yield strength shall be used for the determination of the subgroup.

[a] In accordance with the specification of the steel product standards, $R_{eH}$ may be replaced by $R_{p0,2}$ or $R_{t0,5}$.

[b] A higher value is accepted, provided Cr + Mo + Ni + Cu + V ≤ 0,75 %.

[c] A higher value is accepted, provided Cr + Mo + Ni + Cu + V ≤ 1 %.

[d] A higher value is acceptable, provided Cr + Mo + Ni + Cu + V ≤ 1 % and CE (IIW) ≤ 0,55. The CE (IIW) is specified in ISO/TR 17671-2.

# 22 Appendix 10, Clauses of EN 1090 not in phase with CPR

Any clause of EN 1090-1 or EN 1090-2 quoting inspection documents as a request are obviously not in phase with CPR (article 8.3) as far as CE marking is available for the construction products referred to.

**The consequence is that such <u>conflicting clauses of standards cannot be applied.</u>**

Such conflicting clauses are listed hereunder.

## 22.1 Clauses of EN 1090-1 not in phase with CPR

**5.2 Constituent products**

The constituent products shall be evaluated by checking that the inspection documents for the products used comply with the requirements of the component specification.

**5.4 Weldability**

For weldability, reliance may be placed on properties associated with constituent materials and components provided these are given by reference to a European Technical Specification and inspection documents.

**5.5 Fracture toughness**

For fracture toughness of the constituent products, reliance may be placed on properties for impact strength associated with materials and components used as constituent products provided these are given by reference to a European Technical Specification and inspection documents.

**Table 1 – Sampling, evaluation and conformity criteria for initial type testing and initial type calculation**

| Characteristic | Requirement Clause | Evaluation method | Number of samples | Conformity criteria |
|---|---|---|---|---|
| Tolerances on dimensions and shape | 4.2 | Inspection and test in accordance with EN 1090-2 or EN 1090-3 | 1 | 5.3 |
| Weldability | 4.3 | Checking of inspection documents for compliance with the specified requirements to the constituent product. | 1 | 5.4 |
| Fracture toughness / brittle strength (steel components only) | 4.4 | Checking of inspection documents for compliance with the specified requirements to the constituent product | 1 | 5.5 |

**Table 2 – Frequency of product testing as part of factory production control**

| Characteristic | Requirement Clause | Evaluation method | Sampling | Conformity criteria |
|---|---|---|---|---|
| Tolerances on dimensions and shape | 4.2 | Inspection and test in accordance with EN 1090-2 or EN 1090-3 | Each component [a] | 5.3 |
| Weldability | 4.3 | Checking of inspection documents for compliance with the specified requirements to the constituent product | Documentary checks of all constituent products used in manufacture | 5.4 |
| Fracture toughness / brittle strength (steel components only) + Impact resistance [b] | 4.4<br><br>4.8 | Checking of inspection documents for compliance with the specified requirements to the constituent product | Documentary checks of all constituent products used in manufacture | 5.5<br><br>5.10 |
| Yield, proof or tensile strength of constituent products used in manufacture | 4.5 | Checking of inspection documents for compliance with the specified requirements to the constituent product | Documentary checks of all constituent products used in manufacture | 5.2 |

## 22.2 Clauses of EN 1090-2 not in phase with CPR

### 5.2 Identification, inspection documents and traceability

The properties of supplied constituent products shall be documented in a way that enables them to be compared to the specified properties. Their conformity with the relevant product standard shall be checked in accordance with 12.2.

For metallic products, the inspection documents according to EN 10204 shall be as listed in Table 1.

**Table A.3 — Requirements to each execution class**

| Clauses | EXC1 | EXC2 | EXC3 | EXC4 |
|---|---|---|---|---|
| 4 – Specifications and documentation | | | | |
| 4.2 Constructor's documentation | | | | |
| **4.2.1 Quality documentation** | Nr (No requirement) | Yes | Yes | Yes |
| 5 – Constituent products | | | | |
| *5.2 Identification, inspection documents and traceability* | | | | |
| **Inspection documents** | See Table 1 | See Table 1 | See Table 1 | See Table 1 |
| **Traceability** | Nr (No requirement) | Yes (partial) | Yes (full) | Yes (full) |
| **Marking** | Nr | Yes | Yes | Yes |

### 22.3 What to write in EN 1090 standards?

EN 1090 standards are to be corrected. Obviously several items are addressed.
The present chapter focuses on the question of inspection documents.

First of all, a clear distinction must be made in EN 1090 standards between constituent basic construction products covered by a harmonized standard and those **not** covered by a harmonized standard.
The reason is clear.
Structural elements (steel or aluminium) made according to EN 1090 must be CE marked whatever the kind of constituent basic construction products (CE marked or not CE marked).

For construction products covered by a harmonized standard, any reference to ~~inspection document~~ must be replaced by a reference to "**declaration of performance**".

For construction products **not** covered by a harmonized standard, any reference to ~~inspection document~~ must be suppressed and replaced by a guideline stating that:

- "The constituent products shall be evaluated by checking any eligible declaration of conformity regarding these products. Such a declaration of conformity may emerge from a third party voluntary certification or from inspection documents according to EN 10204."

### 22.4 What to do now?

The conflicting clauses of EN 1090 standards quoting inspection documents as a request cannot be applied.

These clauses of the standards must thus be understood from now on as follows:

1. For construction products covered by a harmonized standard, the constituent products shall be evaluated by checking their declaration of performance together with the content of the accompanying CE marking.

2. For construction products **not** covered by a harmonized standard, the constituent products shall be evaluated by checking any eligible declaration of conformity regarding these products, like a declaration of conformity from a third party voluntary certification or an inspection document according to EN 10204.

3. Construction products covered by a harmonized standard whose declaration of performance does not yet contain all the necessary technical content should be treated as construction products **not** covered by a harmonized standard.

### 22.5 Principle lack of information found in DoPs from basic steel products

Mainly, the following information is missing:

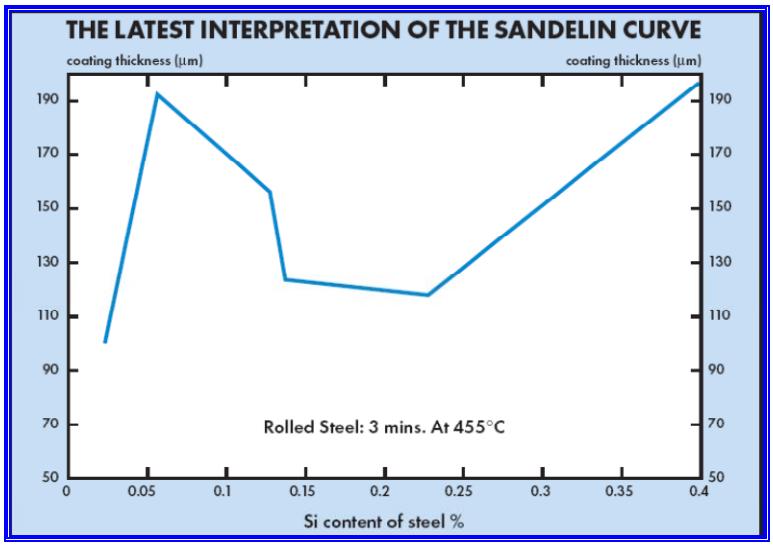
- Type of processing route (as hot rolling [AR], hot rolling with normalizing [N] or hot rolling with thermomechanical treatment [M]);
- Suitability to batch galvanizing.

## 23 Appendix 11 - Other important topics for constructional steels

Durability is a major topic for constructional steel. The ability of a given steel grade to be batch galvanized may be of major significance in many occasions. To our opinion, an improvement of some declarations of performance so as to better document the risk of SANDELIN's peak[32] is necessary.

This matter is now covered by standardization and can easily be integrated in the declaration of performances.

[32] The SANDELIN's peak is mainly linked to silicon content with possible interference with phosphorous.




| CLASSIFICATION | SILICON CONTENT (mass %) | PHOSPHORUS CONTENT (mass %) | STEEL REACTIVITY | COATING APPEARANCE |
|---|---|---|---|---|
| 1 | 0 – 0.035 | 0 – 0.025 | Generally normal but occasionally low | Few defects. Occasional thin coatings that are below specification. |
| 2 | 0 – 0.04 | 0.025 – 0.035 | Generally normal. | Localised defects due to outbursts of zeta alloy. (eg 'pimples' or 'tree bark' effect, particularly on tubular and curved sections) |
| 3 | 0 – 0.04 | >0.035 | High, especially with high phosphorus content | Pronounced surface defects high tendency to flake |
| 4a (low phosphorus) | 0.04 – 0.135 | <0.01 | Moderate, increasing with silicon content | May appear normal with few defects |
| 4b (high phosphorus) | 0.04 – 0.135 | 0.01 to 0,03 | High | Generally few defects |
| 5a (low phosphorus) | 0.135 – 0.35 | <0.03 | High, but generally thinner coatings than on class 5b | May appear normal with few defects |
| 5b (high phosphorus) | 0.135 – 0.35 | >0.03 | High | Tendency to flake, especially with high phosphorus content |
| 6 | >0.35 | >0 | High, and increasing with silicon content | Tendency to flake, increasing with phosphorus content |

# 24 Appendix 12, How to weld steels of the grades S235 and S275?

## 24.1 Definition of weldability

According to EN 10025-2, weldability of such grades is ruled by the chemical composition of the products and by limitations on several elements, among others the carbon equivalent CEV.

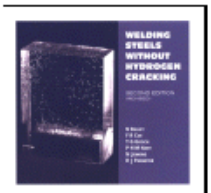
As a result, **CEV has to be limited to a maximum value of 0,41 % for S 275 steel suitable to hot galvanizing** (Si-content not greater than 0,25 %).

The welding conditions ensuring safe welds can be readily defined on such a basis.

## 24.2 Reference technical basis for the definition of safe welding conditions

### 24.2.1 "Welding Steels without hydrogen cracking"

This is illustrated by applying the recommendations from the well-known book "*Welding Steels without hydrogen cracking*". This book is a recognized worldwide accepted reference for safe welding against hydrogen cracking. It was published in 1973, confirmed and enlarged in 1993 and is now available in an electronic format:



**Welding Steels Without Hydrogen Cracking** (Second Edition)

A volume in Woodhead Publishing Series in Welding and Other Joining Technologies

About this Book

*Author(s):*

*N. Bailey, F.R. Coe, T.G. Gooch, P.H.M Hart, N. Jenkins and R.J. Pargeter*

ISBN: 978-1-85573-014-4

http://www.sciencedirect.com/science/book/9781855730144

This book is shortly presented in Appendix 13. The reader who is interested in details should obviously consult it. Some Figures and Tables are illustrated below (chapter 24.2.3)

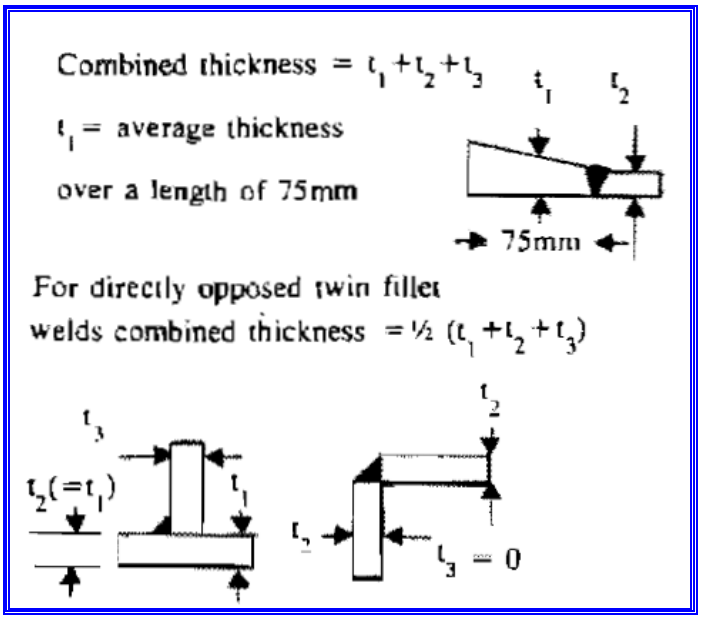
### 24.2.2 Approach adopted

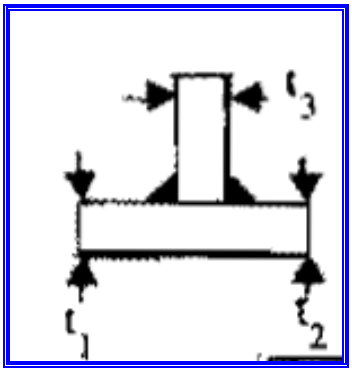
The approach which is adopted is summarized hereunder:

- The applicable welding conditions are defined by the heat input and the preheat temperature;
- The heat input is expressed as gross heat input for manual metal arc welding (welding process efficiency of 80 %);
- The geometry of the weld joint is defined in terms of butt or fillet welds through the concept of combined thickness;
- The weldability of the steel is defined by the CEV formula.
- The accuracy of the value affixed to CEV is quantified at ±0.02 %, this tolerance is included in the welding recommendations as a margin of safety;
- Different levels for the diffusible hydrogen of the deposited metal are considered;
- The welding conditions are defined from a set of charts including heat input, combined thickness, CEV, hydrogen level, preheat temperature;
- The minimum heat input considered by the charts is 6 kJ/cm (or 0,6 kJ/mm).

### 24.2.3 Some Tables and Figures

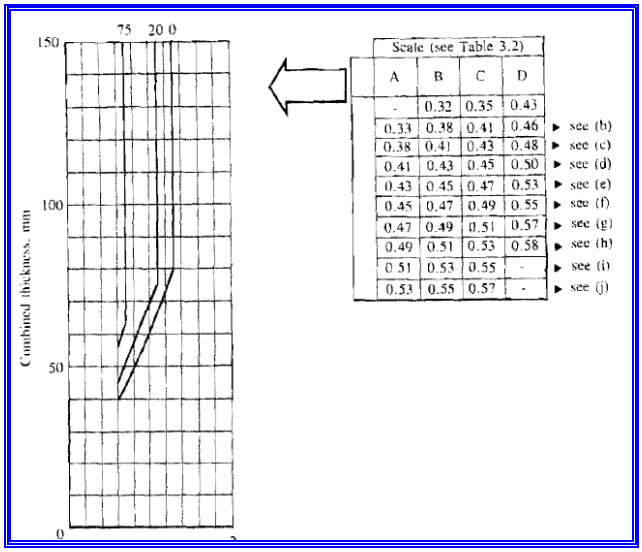
| | |
|---|---|
| Manual metal-arc | 80% |
| Tungsten inert gas | 60% |
| Submerged-arc | 100% |
| Gas shielded metal-arc | 80% |

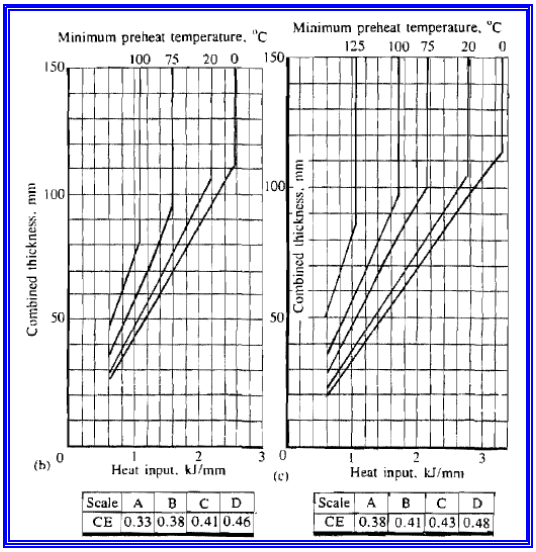



CE level reproducibility (BS method) ±0.018

| Hydrogen level (mL/100 g deposited metal) | CE axis |
|---|---|
| >15 | A |
| ≤15, >10 | B |
| ≤10, >5 | C |
| ≤5 | D |




## 24.3 How to weld a steel with a maximum CEV of 0,41 %?

The safe welding conditions for such a steel are summarized in the Table hereunder.

These welding conditions are given for different levels of diffusible hydrogen and for a welding temperature of 0 °C.

This Table lists the maximum combined thickness acceptable as a function of the heat input depending on the hydrogen level.

| | Weld temperature = 0 °C | | | |
|---|---|---|---|---|
| | Combined thickness (mm) | | | |
| HI (kJ/cm) | H2> 15 | 10<H2≤15 | 5<H2≤10 | H2≤5 |
| 6 | 16 | 20 | 26 | 40 |
| 8 | 23 | 26 | 35 | 50 |
| 10 | 30 | 33 | 43 | 59 |
| 12 | 34 | 40 | 51 | 71 |
| 14 | 40 | 47 | 60 | no limit |
| 16 | 46 | 54 | 69 | no limit |
| 18 | 52 | 62 | 79 | no limit |
| 20 | 58 | 69 | 87 | no limit |
| 22 | 63 | 76 | 95 | no limit |
| 24 | 70 | 84 | 104 | no limit |
| 26 | 75 | 90 | no limit | no limit |
| 28 | 80 | 97 | no limit | no limit |
| 30 | 85 | 104 | no limit | no limit |

Such a Table confirms the major limitation on weldability induced by weld products with high hydrogen levels. Such products should for obvious safe reasons be avoided for structural welds.

Nowadays, low hydrogen levels, less than 5 ml/100 g deposited metal are achieved with basic electrodes or gas shielded metal arc welding. Welding with low hydrogen is no more a limitation for the modern welder.

Under these low hydrogen welding conditions, it comes that safe welding can be achieved without any preheat with a heat input as low as 6 kJ/cm up to a combined thickness of 40 mm, thus for :

- Butt welding of 20 mm thick plates;
- Fillet welding of 25 mm thick plates with two opposite welds.

From 14 kJ/cm, any limit on the combined thickness has no more to be considered.

### 24.4 Synthesis

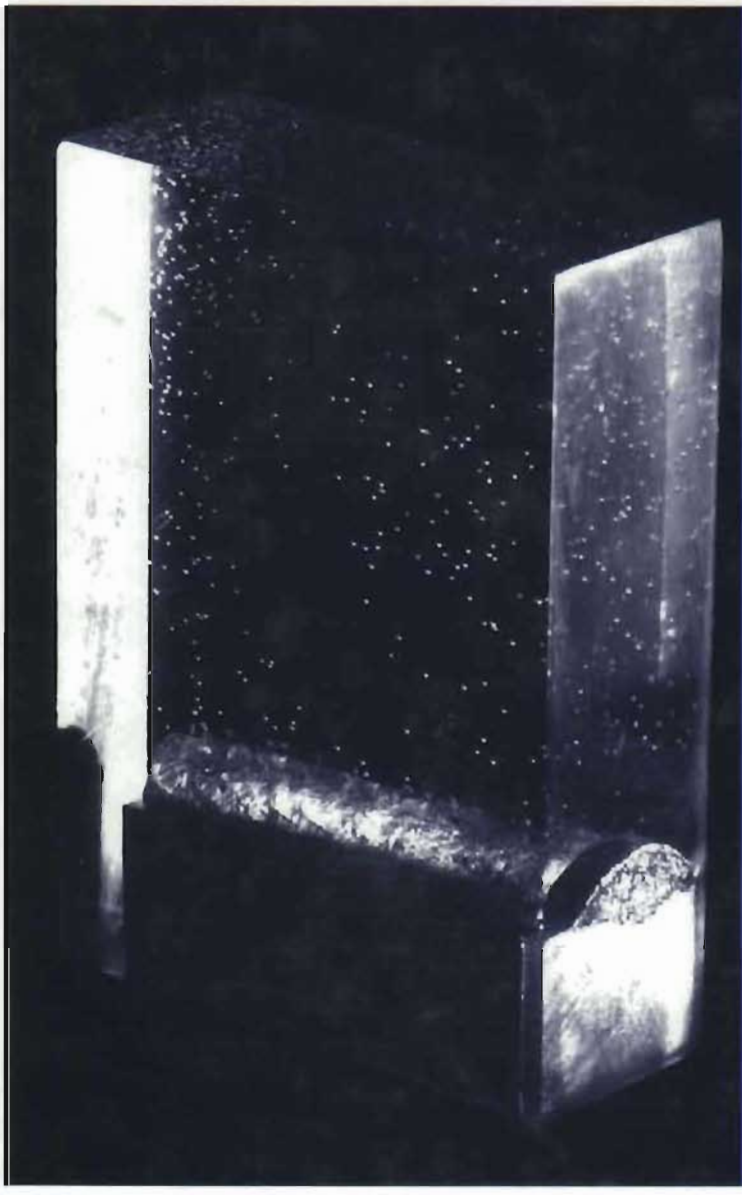
Steel low strength steel grades like S235 and S275 JR to J2 are quite easy to weld **provided**:

1. their traceability is dully ensured through a valid declaration of performance and CE marking ensuring a maximum carbon equivalent value of 0,41 %;
2. Low Hydrogen welding is applied like manual metal arc welding with LH basic electrode or gas shielded metal arc welding under here above mentioned heat inputs.

Inspection documents based on specific control like 2.2 documents are of no need provided conditions 1 and 2 are met.

On the contrary, dealing with such 2.2 documents to justify other welding procedures not based on low hydrogen concepts would raise an evident risk and would consist in an unacceptable approach against the rules of the art.

# 25 Appendix 13 - Excerpts from “Welding Steels without hydrogen cracking”



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SECOND EDITION

N BAILEY
F R COE
T G GOOCH
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ASM INTERNATIONAL®
The Materials Information Society

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47/51

# Preface

Research is useless if the results obtained do not find practical application and thus make their contribution to the improved efficiency of industrial production and the consequent increase in the amenities of our daily life.

Sir William J Larke, KBE, 1947, *Founder President of BWRA*

Hydrogen cracking represents the most common problem encountered when welding steel structures. The major variables influencing the incidence of cracking have been defined for many years and the design of welding procedures is dominated by the need to incorporate appropriate safeguards. The previous edition of 'Welding steels without hydrogen cracking' described these factors and further presented nomograms on the basis of which cracking could be reliably and economically avoided in steels of different types. The success of this approach was such that, with only minor changes, the appropriate part of the book formed the basis of the guidelines in the British Standard BS 5135: 1974 'Arc welding of carbon and carbon-manganese steels', and was retained in the latest, 1984 version.

Since publication of the first edition, significant changes have taken place in steel compositions and production routes, many of which have been intended primarily to obtain improved weldability, especially in the sense of avoiding hydrogen cracking. In consequence, materials now commonly welded have compositions outside those used from the derivation of the nomograms in the first edition. Appropriate experimental work has been carried out to define the effects of such material changes on cracking behaviour. This edition has been produced to recognise both changes in steel formulation and the body of data which now exists regarding cracking sensitivity. In large part, the original format of 'Welding steels without hydrogen cracking' remains untouched, indicative of the soundness of the methodology presented. However, a number of changes have been required and these are presented in this second edition. In Chapter 4, dealing with welding procedures, these include modifications to the nomograms for steels having carbon

equivalents below 0.40 and the addition of a diagram to show conditions to avoid hydrogen cracking in C-Mn weld metals.

The original edition was produced with a major contribution from F R Coe, with support from others cited in the preface. This revised edition owes a considerable debt to Mr Coe. The revisions were made most especially by N Bailey, T G Gooch, P H M Hart, N Jenkins and R J Pargeter.

It is hoped that this second edition will be of assistance to all concerned in welding transformable steels, whether metallurgists, welding or mechanical engineers, or designers. Because technology is continually advancing, it is essential that new information should be incorporated as soon as possible and, as was the case of the first edition, TWI remains anxious to obtain practical feedback from users of the book, both on its application to the practical situation, and on new data that may become available.

Although hydrogen cracking is usually the major technological problem to overcome when welding ferritic steels, the reader is also recommended to study a companion volume, 'Weldability of ferritic steels', which is being prepared as an introduction to the topic by one of the authors of the present text, Norman Bailey. In addition to a short chapter on hydrogen cracking, other topics related to fabrication cracking, the achievement of required properties and service metallurgical problems, are covered.

T G Gooch
*Head of Materials Department*

It is now just over ten years since the publication of the second edition of this book, and thirty since the original version. However, hydrogen cracking remains a significant issue in the fabrication of steel structures, and the clear and practical exposition of the subject matter remains as relevant as when it was first published. Nevertheless, over the last ten years there have been developments in various standards, and in particular, European standards have moved to a universal description of welding conditions in terms of heat input, rather than arc energy. The opportunity has therefore been taken to revise and update the text and diagrams, and to bring them into line with current practice. These revisions were principally made by Briony Lee, Richard Pargeter and Peter Hart.

49/51P H M Hart
*Manager, Metallurgy, Corrosion, Arcs & Surfacing Group*

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