



The Product Certification Scheme for Steel for Reinforcement of Concrete

1.0 Introduction

This guide, which is the first in a series of ten describing the reinforcing steel supply chain in some technical detail, gives a general description of the CARES certification scheme for reinforcing steel adopted within the UK. It outlines the reasons for its necessity and how it is structured, managed and applied.

The prime objective of CARES was "To operate and promote certification schemes to ensure consistent compliance of products with appropriate product standards and customer specifications".

Prior to CARES, supply of reinforcing steels to the UK suffered by:

- use of steel not complying with British Standards. Material arrived on construction sites that failed to meet all the requirements of the appropriate British standard resulting in expensive additional testing and site delays.
- misleading use and falsification of test certificates. Test certificates have been used to represent material from different sources to those stated and in some cases fraudulently altered to cover material that did not comply with the standard.
- excessive variabilities in mechanical properties, which in some cases have been seen to fall below the minimum required in the British Standard.
- ignorance of bar marking systems. There was a lack of awareness of methods used for marking deformed bar and very little knowledge of the identity system for any mill. Some mills have used the same bar marking for differing grades of steel from different national standards.
- interface difficulties between supplier and customer. There are many cases where a gap in technical appreciation has been found between purchaser and supplier. On occasions this has been a simple case of a failure to supply test certificates on time, in others there has been major differences between tender documents, purchase orders and client expectations.

As certification is not called up by construction regulations and can be therefore regarded as voluntary in the UK, CARES set out to convince major construction clients, specifiers and contractors that use of its certification in specifications and quality management systems would provide the confidence to use such material with no further testing required. Government support, for both financial assistance and practical support via specification, required that CARES be set up in an open and transparent manner that complied with international criteria for such an independent third party body.

2.0 Management and Administration of the CARES Scheme

CARES is a legal entity set up as a company limited by guarantee under the Companies Act of the UK of 1948 to 1981. It is a not-for-profit organisation with no share capital.

In order to enable use in major specifications, including those of public purchasers, the management structure of CARES was designed to satisfy the international standard for independent third party product certification bodies, ISO Guide 65. This standard requires important conditions for the acceptance of a certification body, vital in providing confidence to all parties in the supply chain. In particular it must ensure:

Integrity

- access to the service of the Body is available to all.
- there shall be no undue financial conditions to restrict participation.
- certification procedures must be administered in a non-discriminatory manner.
- there shall be no single interest predominating in the governing board.
- permanent staff shall be free from control by those who have a direct commercial interest.

Technical Competence

- assessors of CARES are Registered ISO 9001 Lead Assessors and are also experts in the products and processes of the reinforcing steel industry.
- the operation is managed by a team of highly competent technical staff.
- all independent testing is carried out by UKAS accredited laboratories.

Independence

- the active participation of organisations representing all interests in the building and construction industry who are willing to demonstrate a commitment to quality for this material supply sector. CARES, began operating in the UK in 1984, with the support of the UK Government and an across-industry group of organisations constituting the major sectors of the supply chain for concrete construction. These became its Members, each of whom nominate an individual to sit on the CARES Board of Management. Members change with time and the list as of 2004 is shown in Table 1.

Subsequent to its formation, CARES became accredited by the National Accreditation Council for Certification Bodies (NACCB), an organisation established by the UK government as the means by which conformity with the principles and detail of the above ISO Guides would be verified. CARES was issued with Accreditation Certificate 002 and was originally the only certification body accredited for both quality systems and product conformity assessment. CARES continues to be accredited through the now reorganised accreditation body, UKAS.

Members of CARES

- | | |
|---------------------------------------|---|
| ■ Highways Agency | ■ Civil Engineering Contractors Association |
| ■ British Airports Authority | ■ CONSTRUCT |
| ■ Association of Consulting Engineers | ■ Post Tensioning Association |
| ■ Institution of Structural Engineers | ■ UK Steel Association |
| ■ Southern Water | ■ Independent Reinforcement Producers Association |
| ■ Construction Confederation | |

Table 1



3.0 Requirements of Reinforcing Steel

Detailed aspects of reinforcing steel, its products processes and properties, follow later in the series but the basics are introduced below. Reinforcing steel is required to be fixed in a construction and must satisfy a defined set of criteria. It must:

- Be bent into shape with sufficient precision to fit complicated structures and not cause loss of cover.
- Possess a minimum strength to discharge its load bearing function.
- Possess ductility to satisfy the formability requirements to be bent into the designed shape and also sufficient ductility to provide progressive failure under certain conditions.
- Possess good weldability, in part for site fabrication and in part to minimise accidental damage.
- For many structures of particular design, possess good fatigue properties.
- Possess good bond properties.

There are conflicts between these properties however, e.g. between Strength and Ductility or between Strength and Weldability, and it is important to note that metallurgical controls and processes which exist to accommodate these must be in place at the manufacturer in order to ensure the achievement of these properties. Furthermore, the degree of process control used in the production and downstream processing of reinforcing bar and coil is of vital importance in the achievement of consistency of these properties and compliance with product standards. Primarily it is the role of the steel mill metallurgist to ensure that the correct property requirements are met and, with the correct equipment, procedures and controls, this is readily achievable.

4.0 Methods of Manufacture

The principal routes used to achieve bar properties are shown in **Table 2** and these account for the vast majority of reinforcing steel used around the world today. These are described in more detail in part 3 of this Guide.

There is however another route that is found in many parts of the world, including Europe, although it is not permitted in the majority of product standards. This is by re-rolling finished products (e.g. sheet or rails). The main sources of this raw material are permanent way rails and railway axles that have reached the end of their service and also demolition scrap, generally arising from ships. There are major disadvantages of this

Material Flow in the Reinforcing Steel Industry

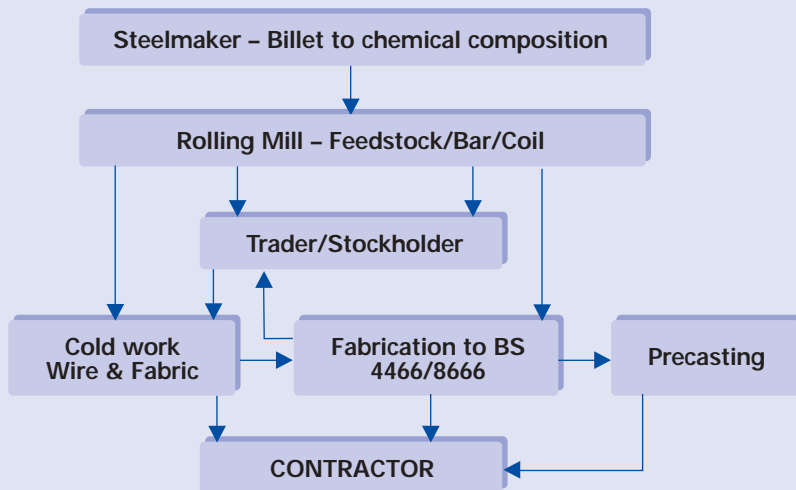


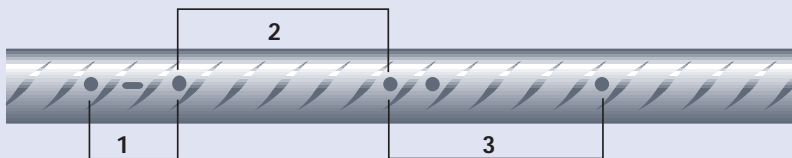
Figure 1

Principal Process Routes to Achieving Strength

MICROALLOYED	VANADIUM	EXPENSIVE	DUCTILE
IN LINE HEAT TREATMENT	TEMPCORE	COMMON	DUCTILE
COLD WORKED	ROLLED/STRETCHED/TWISTED	SMALL SIZES	LIMITED DUCTILITY

Table 2

CARES Identification System



Country or Regional Grouping is as follows:-

Germany	1 rib
Belgium, Netherlands, Luxembourg	2 ribs
France	3 ribs
Italy	4 ribs
United Kingdom, Eire	5 ribs
Scandinavia	6 ribs
Spain, Portugal	7 ribs
Greece, Turkey	8 ribs
Outside Europe	9 ribs

Figure 2

production route however. It will result in steel that is unweldable, with a high degree of variability in properties. Importantly such steel will also be lacking in any form of traceability. The British Standard, BS4449, does not allow for the use of re-rolling scrap materials. This does not however prevent small manufacturing units coming into operation to provide such reinforcing steels and, any markets that are not regulated in terms of product certification, such as the UK, are at risk from this. CARES has in the past found need to refuse or actually remove certification from producers who have wished to operate by using these materials.

5.0 The CARES Scheme Design

Taking all preceding factors into account, the founding Members of CARES created what in the UK was at that time a unique form of Product Certification scheme. It was concluded that, for certification to achieve real client confidence and to remove the need for on-site product testing, and its associated delays, its requirements must relate to the manufacturer, the product itself, its manufacturing process and also the industry in which it is being applied. Typically, in the UK alone, there is around 1 million tonnes of reinforcing steel, in all forms, used each year. Because of this and the complicated commercial route from steel making to the construction site (**Figure 1**), which involves inter-trading between reinforcement fabricators.

The CARES scheme for steel for the reinforcement of concrete would therefore go beyond product testing and would include:

- the ability to trace material from hot metal through to the process of fixing it into the ground prior to concrete pour.
- evaluation of process capability and an ongoing evaluation of quality performance through statistical analysis of results
- a feedback mechanism through an ongoing evaluation of customer complaints throughout the supply chain from mill to site.

In this way it would provide a genuinely useful service to clients, specifiers and contractors. Furthermore, it would also serve to create an environment for the improvement and development of the reinforcing steel product and its supply chain.

The scheme was therefore specifically designed to include four carefully integrated components:

- ISO 9001, as defined by CARES Quality and Operations Assessment Schedules.
- Extensive product sampling and testing.
- Traceability of producer and properties.
- Analysis of customer complaints.

5.1 ISO 9001 and the CARES Quality and Operations Assessment Schedules

The requirements for an acceptable quality system are of universal application and must determine the quality management of every supplier's organisation. It is essential however to identify certain critical areas that require assessment in depth. This is particularly true for product conformity certification, where assurance must be provided for both the quality management system and the manufacturing techniques in order to meet product property requirements regularly and consistently, and this is the purpose of the CARES Quality and Operations Assessment Schedules.

CARES' performs product certification on each layer of the supply chain, with a requirement that, to maintain approval, steel must be purchased from a supplier within the approved chain.

The main Quality and Operations Assessment Schedules cover:

- Carbon steel bars and coils
- Stainless reinforcing steels
- Processing, stockholding and supply of bar, coil and fabric
- Cold worked wire
- Welded fabric
- Welded prefabrications
- Mechanical couplers

In all CARES assessment schedules, emphasis is placed on the control of processes that influence the conformity of the material with the product standard. These draw attention to critical aspects of manufacture, process and quality control, but they do not seek to specify how the manufacturer must conduct his operation. They ask the manufacturer to demonstrate that the procedures are fully controlled and to convince the CARES assessors that the processes operate satisfactorily. For example, the production of carbon steel bars and coils require producers to employ a set of procedures which cover their operation from purchase and receipt of raw materials, through melting, casting, billet reheating and rolling through to despatch. These procedures must include sampling and testing to the requirements of the relevant product standard.

5.2 Product Sampling and Testing

Product testing is central to all assessment schedules contained within the CARES Scheme. Where activities influencing the specified properties of the steel are carried out, e.g. in the production of reinforcing bar, wire and fabric, product conformity assessment is applied in four interlocking stages. In the production of bar and fabric, statistical sampling and analysis of test data is employed, which is summarised below:

- The supplier's records of routine tests are examined to determine compliance of both the product and the quality level achieved over defined periods of time.
- In the case of reinforcing bar or coil, ten samples are selected by the assessor from each of three casts, in each of three sizes covering the manufactured range, and the testing is witnessed by the CARES assessor. The results of this witness testing are then statistically compared with the manufacturer's routine test results.
- Duplicates of the above samples are submitted to an independent UKAS accredited test laboratory, and the results are compared with the witness testing.
- The magnitude of the standard deviation of results from each ten sample lot, from each cast, is examined for "within cast" variability, in order to determine the degree of process control.

5.3 Traceability of Producer and Properties

Traceability to both the producer of the steel and to its specific production data, including test results, is of major importance. It provides the capability to locate materials that have emerged as problematic after despatch by the producer and to detect the source of both producer and problem. It also provides the fabricator and contractor with the test data to enable him to perform subsequent processing with the full knowledge of material properties.

CARES adopts a system of marking of the rolled reinforcing bar, coil or wire, which follows European convention. In the rolling mill, when the ribs are rolled on to the bar, the CARES mark is also rolled on, together with a series of dots, to identify the country and mill of origin (**Figure 2**).

In addition, approved firms are required to use the CARES logo and certificate number on all test and delivery documentation. In the case of test certificates, the CARES logo and certificate number are embossed on the certificate to minimise fraudulent copying (**Figure 3**).

The concept of Electronic Data Interchange (EDI) is now being pursued to minimise the use of hard copy and security of information is part of this process.



Figure 3

Product traceability, and the use of the CARES logo and certificate number, applies to all certificated companies throughout the supply chain. This includes those whose manufacturing operations do not materially change the specified properties of the steel, for example in the case of cutting and bending.

5.4 Customer Complaints

At quarterly intervals, each CARES approved firm, at each level of the supply chain, is required to submit to CARES details of all customer complaints that have been received in relation to compliance of the products for which they are approved. In this way, CARES can assess the ability of the approved firm to comply with customers' requirements as well as monitor trends throughout the entire supply chain. In addition, as an accredited third party product certification body, CARES must operate a procedure that can deal with any complaint by a construction client or contractor against the performance of one of its approved firms.

6.0 The Importance of the CARES Approved Fabricator

The integration of each part of the reinforcement supply chain is key to achieving the full benefit of the CARES Scheme and therefore the reinforcement fabricator has a vital role to play in the achievement of product compliance as delivered to the construction site. In the case of cutting and bending, product conformity is assessed by an examination of the equipment, measurement of fabricated pieces and an inspection of the bent bars to

ensure that no damage has taken place. Such processors must:

- purchase only from CARES approved sources of production and supply.
- maintain a system enabling full traceability of cut and bent items back to cast information, involving suitably endorsed bundle labels.
- comply with the requirements of the standard or customer specification regarding dimensional tolerances, former diameters, inspection, training and material handling.
- Use the CARES logo and approval number on bundle labels and associated paperwork.

All CARES approved fabricators operate a quality system to the requirements of ISO9001 in relation to the production of reinforcement to the British Standard, BS8666 as well as the superseded version, BS4466. Failure to use such approved processors places the onus of product compliance squarely on the shoulders of the contractor. In the majority of cases however this situation does not arise in the UK as CARES certification (or equivalent) is now included in the major UK construction specifications including the National Structural Concrete Specification, the National Building Specification and the Specification for Highway Works.

7.0 The CARES List of Approved Firms

The outcome of a satisfactory assessment by CARES assessors is the issue of a CARES Certificate of Approval, with a closely defined scope of approval. A typical certificate of approval, as shown in Figure 4, states the name of the company, the factories to which the successful assessment applies and the products covered, including size range.

Significant changes to the producers system, process and product result in a re-assessment in order that approval can continue. Following approval of all types of producers, processors and stockists, surveillance inspections are



Figure 4

carried out at least twice annually. The surveillance inspection covers all aspects of the initial assessment.

The details of all approved firms are published in a list, which is now located, in an easily searchable form, on the CARES website: www.UKCARES.com. Hard copies may be obtained from CARES at the address below;

8.0 References

1. ISO/IEC Guide 65:1996, "General requirements for bodies operating product certification systems".
2. BRITISH STANDARDS INSTITUTION. BS EN ISO 9001:2000, "Quality Management Systems - Requirements".
3. BRITISH STANDARDS INSTITUTION. BS 4449:1997, "Carbon steel bars for the reinforcement of concrete".
4. BRITISH STANDARDS INSTITUTION. BS 8666:2000, "Specification for scheduling, dimensioning, bending and cutting of steel reinforcement for concrete".
5. BRITISH STANDARDS INSTITUTION. BS 4466, "Specification for scheduling, dimensioning, bending and cutting of steel reinforcement for concrete" (Superseded).

