Max Frank Ltd
Whittle Road
Meir
Stoke on Trent
Staffordshire ST3 7HF

Tel: 01782 598041 Fax: 01782 315056
email: shearail@maxfrank.co.uk
website: www.maxfrank.co.uk

Agrément Certificate
14/5112
Product Sheet 1

MAX FRANK LTD REINFORCEMENT SYSTEMS

SHEARAIL PUNCHING SHEAR REINFORCEMENT SYSTEM

This Agrément Certificate Product Sheet(1) relates to the Shearail Punching Shear Reinforcement System, comprising ribbed reinforcing bars with forged heads and steel flat rails for use as an integrated shear reinforcement to increase shear resistance in concrete slabs.

(1) Hereinafter referred to as 'Certificate'.

CERTIFICATION INCLUDES:

- factors relating to compliance with Building Regulations where applicable
- factors relating to additional non-regulatory information where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production
- formal three-yearly review.

KEY FACTORS ASSESSED

Structural performance — the system will provide additional shear resistance when used as punching shear reinforcement for reinforced concrete slabs provided it is designed and installed properly (see section 6).

Behaviour in relation to fire — the system will not affect the fire resistance of the reinforced concrete structures as long as suitable concrete cover is provided (see section 7).

Durability — under normal service conditions and protected by minimum concrete cover, the system can achieve a service life of at least 60 years (see section 9).

The BBA has awarded this Certificate to the company named above for the system described herein. This system has been assessed by the BBA as being fit for its intended use provided it is installed, used and maintained as set out in this Certificate

On behalf of the British Board of Agrément

Date of Second issue: 7 June 2018

Originally certificated on 16 April 2014

Paul Valentine
Technical Excellence Director

Claire Curtis-Thomas
Chief Executive

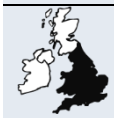
The BBA is a UKAS accredited certification body – Number 113.
The schedule of the current scope of accreditation for product certification is available in pdf format via the UKAS link on the BBA website at www.bbacerts.co.uk
Readers are advised to check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA direct.
Any photographs are for illustrative purposes only, do not constitute advice and should not be relied upon.

British Board of Agrément
Bucknalls Lane
Watford
Herts WD25 9BA

tel: 01923 665300
clientservices@bbacerts.co.uk
www.bbacerts.co.uk

Regulations

In the opinion of the BBA, the Shearail Punching Shear Reinforcement System, if installed, used and maintained in accordance with this Certificate, can satisfy or contribute to satisfying the relevant requirements of the following Building Regulations (the presence of a UK map indicates that the subject is related to the Building Regulations in the region or regions of the UK depicted):



The Building Regulations 2010 (England and Wales) (as amended)

Requirement:	**A1**	**Loading**
Comment:		The system has sufficient strength and stiffness to sustain the design loads in accordance with section 6 of this Certificate.
Regulation:	**7**	**Materials and workmanship**
Comment:		The system is acceptable. See section 9.1 and the *Installation* part of this Certificate.

The Building (Scotland) Regulations 2004 (as amended)

Regulation:	**8(1)**	**Durability, workmanship and fitness of materials**
Comment:		The system is an acceptable material. See section 9.1 and the *Installation* part of this Certificate.
Regulation:	**9**	**Building standards applicable to construction**
Standard:	1.1(a)(b)	Structure
Comment:		The system will have sufficient strength and stiffness to transmit the design load, with reference to clause 1.1.1[(1)(2)] of this Standard, in accordance with section 6 of this Certificate.
Standard:	7.1(a)(b)	Statement of sustainability
Comment:		The system can contribute to meeting the relevant requirements of Regulation 9, Standards 1 to 6 and therefore will contribute to a construction meeting a bronze level of sustainability as defined in this Standard. See section 9.1 of this Certificate.

(1) Technical Handbook (Domestic).
(2) Technical Handbook (Non-Domestic).

The Building Regulations (Northern Ireland) 2012 (as amended)

Regulation:	**23**	**Fitness of materials and workmanship**
Comment:		The system is acceptable. See section 9.1 and the *Installation* part of this Certificate.
Regulation:	**30**	**Stability**
Comment:		The system has sufficient strength and stiffness to sustain the design loads in accordance with section 6 of this Certificate.

Construction (Design and Management) Regulations 2015
Construction (Design and Management) Regulations (Northern Ireland) 2016

Information in this Certificate may assist the client, designer (including Principal Designer) and contractor (including Principal Contractor) to address their obligations under these Regulations.

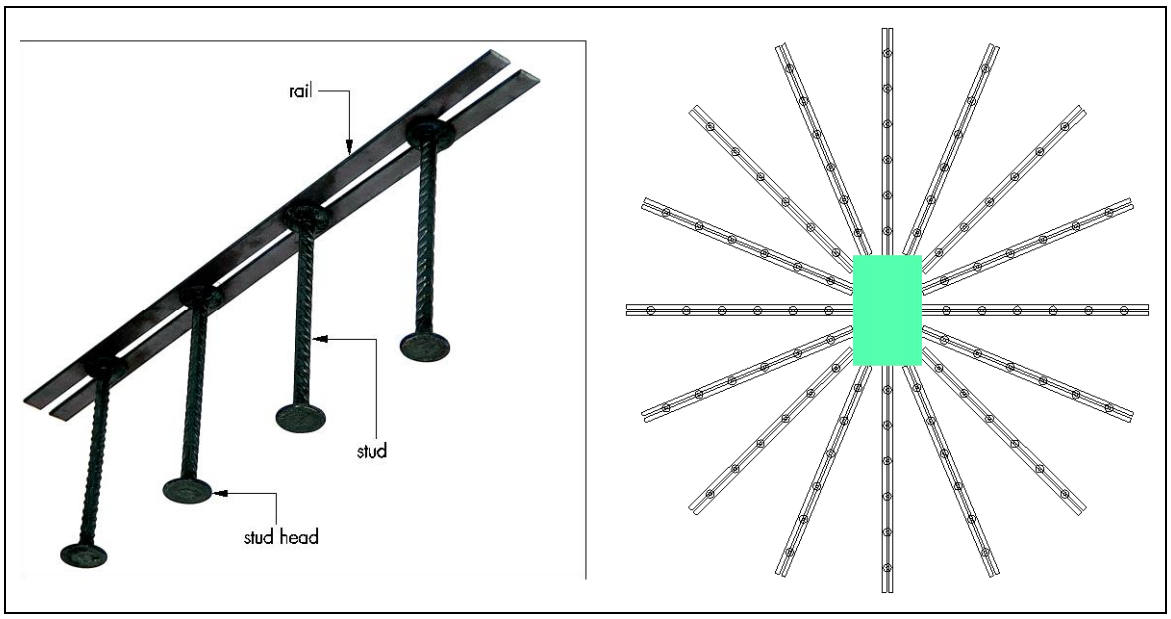
See section: 3 *Delivery and site handling* of this Certificate.

Technical Specification

1 Description

1.1 The Shearail Punching Shear Reinforcement System comprises a range of stud and rail elements each fabricated using double headed steel studs formed from ribbed reinforcement bar and welded to steel strip supporting rails (see Figure 1).

Figure 1 Typical Shearail detailing arrangements



1.2 The studs are manufactured from ribbed weldable reinforcement steel bar with a minimum characteristic yield strength of 500 MPa in accordance with BS EN 10080 : 2005 or BS 4449 : 2005. The studs are available in diameters of 10, 12, 14, 16, 20 and 25 mm. The diameter of the shear heads is three times the diameter of the parent bar.

1.3 Two flat steel rails, manufactured from mild steel S275JR in compliance with BS EN 10025-1 : 2004 are welded to the top, bottom or both the top and the bottom of the studs to form the shearail. The dimensions of each rail are 16 by 3 mm (for 10 to 16 mm diameter studs) and 20 by 5 mm (for 20 to 25 mm diameter studs).

2 Manufacture

2.1 The incoming components forming the elements are bought in to an agreed specification and completed for final assembly. Reinforcing bars are sourced from suppliers of CARES approved steel. The fabrication process includes cutting the reinforcing bar and hot forging the double heads into shape and quenching, then welding the studs to the support rails at the required centres.

2.2 Frequent checking and testing of the properties of double headed studs after hot forging heat treatment is carried out.

2.3 As part of the assessment and ongoing surveillance of product quality, the BBA has:

- agreed with the manufacturer the quality control procedures and product testing to be undertaken
- assessed and agreed the quality control operated over batches of incoming materials
- monitored the production process and verified that it is in accordance with the documented process
- evaluated the process for management of nonconformities
- checked that equipment has been properly tested and calibrated
- undertaken to carry out the above measures on a regular basis through a surveillance process, to verify that the specifications and quality control operated by the manufacturer are being maintained.

2.4 The management system of Max Frank Ltd has been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2008 by BM TRADA (Certificate 7005).

3 Delivery and site handling

3.1 The system elements are delivered to site in banding and packaging on wooden pallets. Each element is identified by a label that indicates the diameter, length and spacing of studs, overall length of element and location in which it is to be used in the slab.

3.2 Individual elements can be handled on site manually; banded packs of elements will require the use of mechanical lifting for offloading and movement on site.

3.3 The elements should be stored on a firm, dry base with original packaging to protect against damage and moisture.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on the Shearail Punching Shear Reinforcement System.

Design Considerations

4 Use

4.1 The Shearail Punching Shear Reinforcement System, when designed and installed in accordance with the recommendations of the Certificate holder and this Certificate, is satisfactory for providing punching shear resistance in reinforced concrete slabs designed in accordance with BS EN 1992-1-1 : 2004 and its UK National Annex.

4.2 The design of any structures incorporating the system must be carried out by a suitably qualified and experienced individual familiar with reinforced concrete structures.

5 Practicability of installation

The system must be installed by competent steel fixers in accordance with the Certificate holder's installation instructions.

6 Structural performance

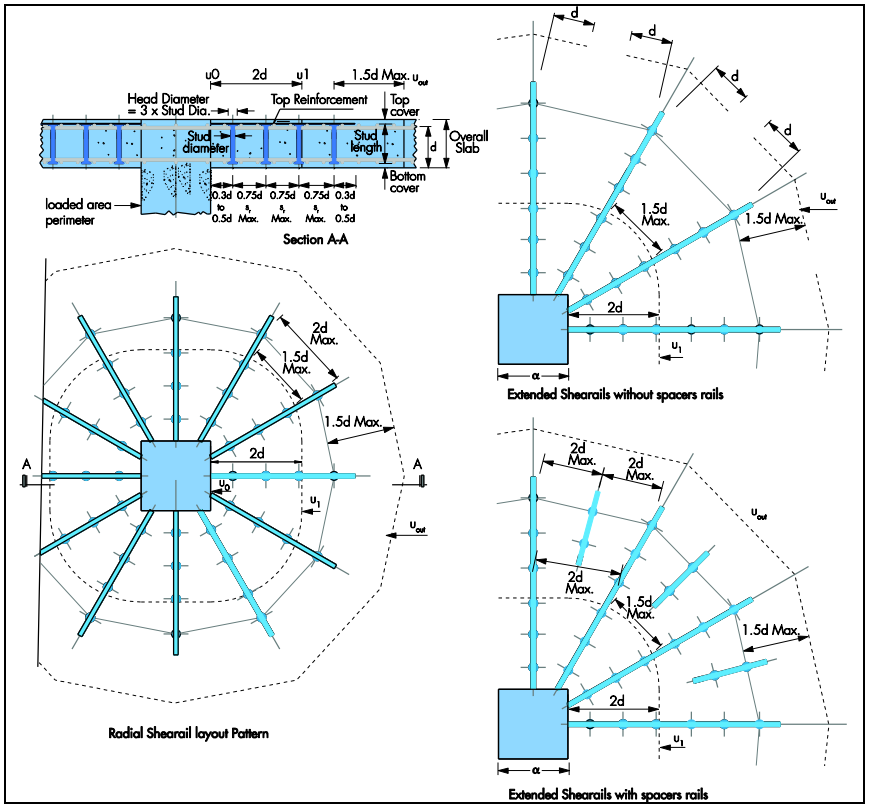
6.1 The number, length and diameter of shear studs to be provided within each of the elements, to resist the applied loads, must be designed by a suitably qualified and experienced engineer based on the principles relating to design resistance of direct and punching shear in accordance with Clause 6.4 of BS EN 1992-1-1 : 2004 and its UK National Annex. The general design principles described in section 6.2 of this Certificate applies to situations where the loaded area is not at the corner or on the edge of the slab. When the loaded area is located near the edge or the corner of the slab or for further details, contact the Certificate holder.

6.2 Design of the Shearail Punching Shear Reinforcement System, in accordance with BS EN 1992-1-1 : 2004 and its UK National Annex, for a concrete slab with an effective depth, d [as defined in Clause 6.4.3(3) of BS EN 1992-1-1 : 2004] under a local action imposing a design applied shear force, V_{Ed}, on a loaded area of dimension, a, as illustrated in Figure 2, is as per the following steps:

- checking direct shear at the perimeter of the loaded area [refer to Part (3) of Clause 6.4.3 of BS EN 1992-1-1 : 2004]:
  - calculation of the design value of the direct shear stress at the perimeter of the loaded area, v_{Ed0} (refer to equation 6.38 in BS EN 1992-1-1 : 2004)
  - calculation of the design value of the maximum punching shear resistance along the control section considered, $v_{Rd,max}$, in accordance with BS EN 1992-1-1 : 2004 and its UK National Annex
  - If $v_{Ed0} > v_{Rd,max}$ then the thickness of the slab must be increased
- checking punching shear at a distance of $2d$ from the perimeter of the loaded area [refer to Part (3) of Clause 6.4.3 of BS EN 1992-1-1 : 2004]:

- calculation of the design value of the punching shear stress at a distance $2d$ from the perimeter of the loaded area, v_{Ed1}. (Refer to equation 6.38 in BS EN 1992-1-1 : 2004.)
- calculation of the design value of the punching shear resistance, $v_{Rd,c}$ as per formula 6.47 in BS EN 1992-1-1 : 2004
- If $v_{Ed1} < v_{Rd,c}$ then no punching shear reinforcement is required
- If $v_{Ed1} > 2v_{Rd,c}$ then the thickness of the slab must be increased
- If $v_{Ed1} > v_{Rd,c}$ and $v_{Ed1} < 2v_{Rd,c}$ then punching shear reinforcement should be provided to increase the effective resistance of the slab. The punching shear reinforcement must be extended to $1.5d$ beyond where the normal reinforced slab is able to resist the applied shear loads. The area of shear reinforcement requirement must be calculated in accordance with Clause 6.4.5 of BS EN 1992-1-1 : 2004, using formula 6.52.

Figure 2 Design details for Shearail with radial layout pattern



7 Behaviour in relation to fire

7.1 When installed in accordance with the Certificate holder's instructions, the use of the elements incorporated in reinforced concrete slabs will not introduce any additional hazard in respect of behaviour in a fire situation. The minimum concrete cover required to comply with fire requirements must be provided to the rail.

7.2 The design fire resistance period for reinforced concrete structures, incorporating the system, designed and constructed in accordance with BS EN 1992-1-1 : 2004 and its UK National Annex, is determined from Tables 5.8 to 5.11 of BS EN 1992-1-2 : 2004.

8 Maintenance

As the system is confined within a concrete construction and has suitable durability in the normal use (see section 9), maintenance is not required.

9 Durability

9.1 The system, when installed in accordance with the Certificate holder's instructions and this Certificate, and with the nominal concrete cover, to reinforcement appropriate to the exposure conditions and requirements of fire resistance in accordance with BS EN 1992-1-1 : 2004 and BS EN 1992-1-2 : 2004 and their UK National Annexes, will have a service life of at least 60 years.

9.2 For slabs used externally, the exposure Class for the concrete should be appropriate to the environmental conditions at the location of use in accordance with BS 8500-1 : 2015.

10 Reuse and recyclability

The steel elements can be recycled at the end of the life of the structure in which they are incorporated, provided an appropriate method is used to retrieve them.

Installation

11 General

11.1 Installation of the Shearail Punching Shear Reinforcement System should be carried out by experienced steel fixers in accordance with the Certificate holder's *Design Manual* and *Detailers Manual*, and in accordance with the design drawings.

11.2 In line with normal procedures, the quality of installation and workmanship of individual projects is subject to appropriate checks on the site by a competent person.

11.3 The elements are generally designed symmetrically in each direction wherever possible, so they can be placed either way round to avoid errors. It must be ensured that studs are properly upright and suitable covers are maintained on both ends of the studs during application of concrete.

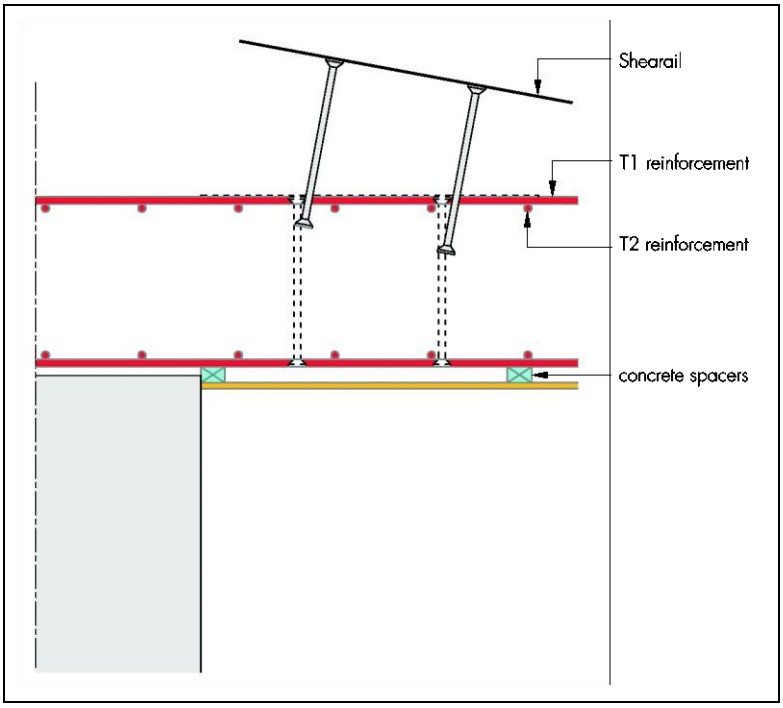
12 Procedure

12.1 The elements should be positioned in the required location in accordance with the reinforced concrete detailing drawings and as indicated in the label for each element.

Top down method (Figure 3)

12.2 When using the top down installation method, the top and bottom main reinforcement is placed as usual, then the studs are placed through the rebar with the rails supported on T1 rebars and secured with wire to prevent movement during concrete pour. If it is supported on T2 rebars, then spacers are needed to raise it to the level flush with the top of T1 rebars.

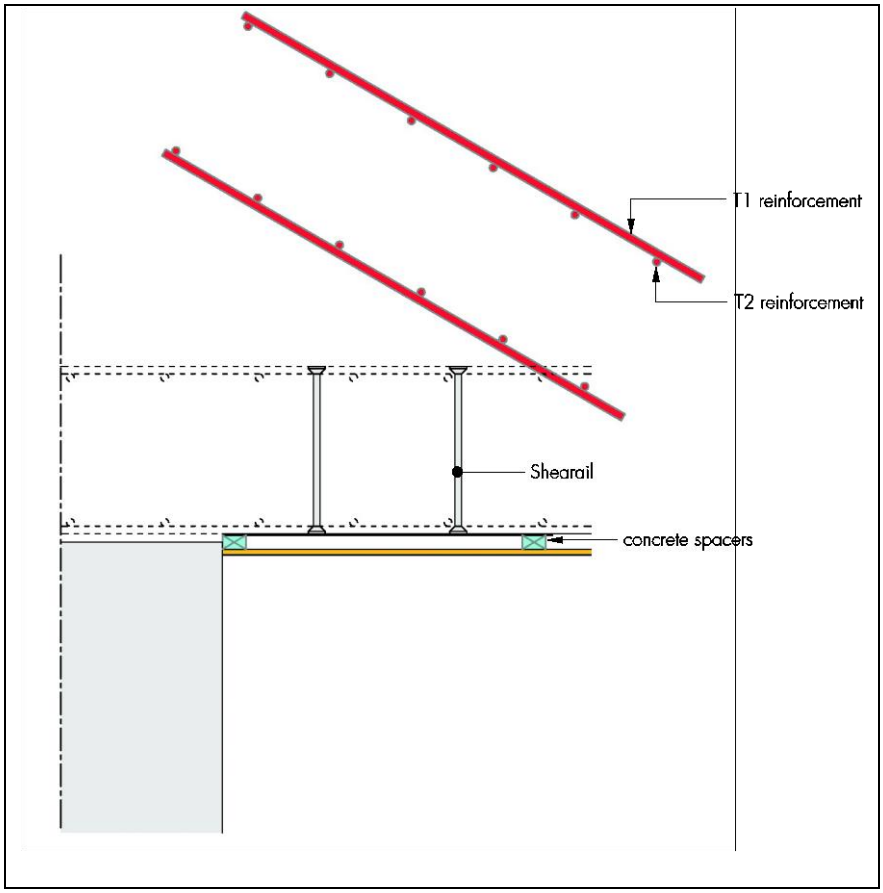
Figure 3 Top down installation



Bottom up method (Figure 4)

12.3 Alternatively, rails are fitted by spacing off the formwork using concrete spacers. The bottom and top reinforcement can be laid as usual around the Shearail.

Figure 4 Bottom up installation

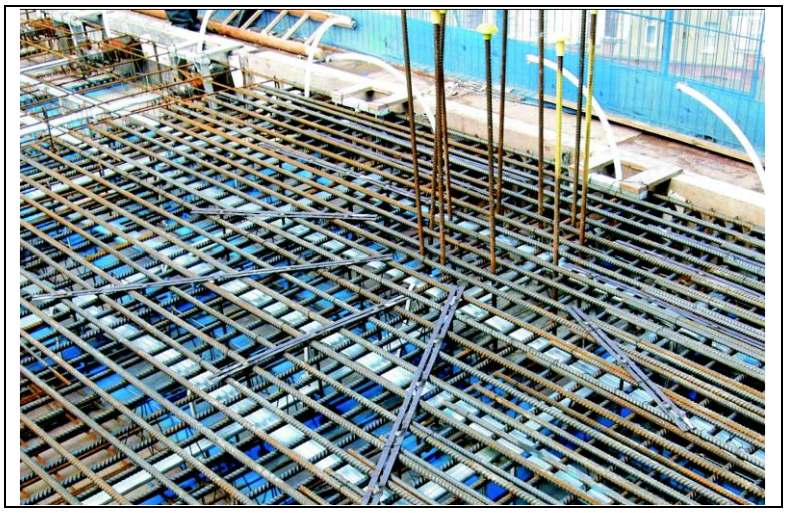


13 Finishing

13.1 A final check of the position of the elements is carried out prior to pouring concrete (see Figure 5).

13.2 During pouring, the concrete should be evenly distributed around the elements. Care should be taken not to dislodge the elements, when using concrete vibration equipment.

Figure 5 Completed Shearail installation



Technical Investigations

14 Investigations

14.1 An assessment was made of data relating to:

- structural strength and performance to BS EN 1992-1-1 : 2004 and its UK National Annex
- calculations to confirm the results of tests on structural performance
- fire resistance
- durability and practicability of installation
- material specification.

14.2 The manufacturing process was evaluated, including the methods adopted for quality control, and details were obtained of the quality and compositions of the materials used.

Bibliography

BS 4449 : 2005 + A3 : 2016 *Steel for the reinforcement of concrete — Weldable reinforcing steel — Bar, coil and decoiled product — Specification*

BS 8500-1 : 2015 + A1 : 2016 *Concrete — Complementary British Standard to BS EN 206 — Method of specifying and guidance for the specifier*

BS EN 1992-1-1 : 2004 + A1 : 2014 *Eurocode 2: Design of concrete structures — General rules and rules for buildings*
NA + A2 : 2014 to BS EN 1992-1-1 : 2004 + A1 : 2014 *UK National Annex to Eurocode 2: Design of concrete structures — General rules and rules for buildings*

BS EN 1992-1-2 : 2004 *Eurocode 2 : Design of concrete structures — General rules*
NA to BS EN 1992-1-2 : 2004 UK National Annex to *Eurocode 2 : Design of concrete structures — General rules*

BS EN 10025-1 : 2004 *Hot rolled products of structural steels — General technical delivery conditions*

BS EN 10080 : 2005 *Steel for the reinforcement of concrete — Weldable reinforcing steel — General*

BS EN ISO 9001 : 2008 *Quality management systems — Requirements*

15 Conditions

15.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is issued only to the company, firm, organisation or person named on the front page – no other company, firm, organisation or person may hold claim that this Certificate has been issued to them
- is valid only within the UK
- has to be read, considered and used as a whole document – it may be misleading and will be incomplete to be selective
- is copyright of the BBA
- is subject to English Law.

15.2 Publications, documents, specifications, legislation, regulations, standards and the like referenced in this Certificate are those that were current and/or deemed relevant by the BBA at the date of issue or reissue of this Certificate.

15.3 This Certificate will remain valid for an unlimited period provided that the product/system and its manufacture and/or fabrication, including all related and relevant parts and processes thereof:

- are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA
- continue to be checked as and when deemed appropriate by the BBA under arrangements that it will determine
- are reviewed by the BBA as and when it considers appropriate.

15.4 The BBA has used due skill, care and diligence in preparing this Certificate, but no warranty is provided.

15.5 In issuing this Certificate the BBA is not responsible and is excluded from any liability to any company, firm, organisation or person, for any matters arising directly or indirectly from:

- the presence or absence of any patent, intellectual property or similar rights subsisting in the product/system or any other product/system
- the right of the Certificate holder to manufacture, supply, install, maintain or market the product/system
- actual installations of the product/system, including their nature, design, methods, performance, workmanship and maintenance
- any works and constructions in which the product/system is installed, including their nature, design, methods, performance, workmanship and maintenance
- any loss or damage, including personal injury, howsoever caused by the product/system, including its manufacture, supply, installation, use, maintenance and removal
- any claims by the manufacturer relating to CE marking.

15.6 Any information relating to the manufacture, supply, installation, use, maintenance and removal of this product/system which is contained or referred to in this Certificate is the minimum required to be met when the product/system is manufactured, supplied, installed, used, maintained and removed. It does not purport in any way to restate the requirements of the Health and Safety at Work etc. Act 1974, or of any other statutory, common law or other duty which may exist at the date of issue or reissue of this Certificate; nor is conformity with such information to be taken as satisfying the requirements of the 1974 Act or of any statutory, common law or other duty of care.

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