



Model Specification for the Purchase of Structural Bolting Assemblies and Holding Down Bolts

1.0 Introduction

This specification is for the purchase of structural bolting assemblies and holding down bolts for constructional steelwork and should be used in conjunction with the *National Structural Steelwork Specification for Buildings* (6th edition) and the *Steel Bridge Group: Model Project Specification for the Execution of Steelwork in Bridge Structures*.

Acceptance of structural fasteners from a supplier is conditional on the supplier complying with the full requirements of this model specification.

2.0 General

All fasteners to Tables 1 and 2 shall be supplied with a colour coded system. The colour coding system shall identify the diameter of the fastener and the type of protective treatment used. Example colour coding systems for the fastener diameter shown on the bag or drum and protective treatment shown on a label are given below. Manufacturers/suppliers may use alternative colour coding systems provided the system is agreed with the purchaser in advance; especially if fasteners above M30 diameter are supplied.

Fastener diameter

M12	=	RED
M16	=	BLUE
M20	=	YELLOW
M24	=	GREEN
M30	=	BLACK

Type of protective treatment

Electroplating	=	BLUE
Galvanized	=	ORANGE
Sherardized	=	PINK

If a technical non-conformity is discovered after delivery, the supplier shall replace the product or rectify the problem immediately and make available to the purchaser the results of the corrective action taken.

3.0 Technical Specification

Fasteners shall be supplied in accordance with the following tables or in the case of proprietary fasteners in accordance with clauses 4 and 5.

Fasteners outside the scope of BS EN ISO 898-1 (See section 5 c) e.g. $d > 39$ mm) may also be supplied in accordance with this specification provided the requirements in Tables 2 and 3 of BS EN ISO 898-1 are complied with. In such circumstances it is recommended that the requirements are discussed and agreed between the specifier and manufacturer of the fasteners prior to order. For property classes 8.8 and 10.9 refer to sections 8 and 9 of this specification.

Note: Fasteners supplied in accordance with Tables 3, 4, 5 and 6 are not CE Marked.

Table 1: MATCHING ORDINARY ASSEMBLIES			
Property Class	Incorporating fully threaded length bolts		
	Bolt	Nut ⁽¹⁾	Washer
4.6	BS EN ISO 4018	BS EN ISO 4034 (Property Class 5) ⁽³⁾	BS EN ISO 7091 (100HV)
8.8	BS EN ISO 4017 ⁽²⁾	BS EN ISO 4032 ⁽²⁾ (Property Class 8) ⁽³⁾	BS EN ISO 7091 (100HV)
10.9	BS EN ISO 4017 ⁽²⁾	BS EN ISO 4032 ⁽²⁾ (Property Class 10) ⁽³⁾⁽⁴⁾	BS EN ISO 7091 (100HV)
Incorporating part threaded length bolts			
4.6	BS EN ISO 4016	BS EN ISO 4034 (Property Class 5) ⁽³⁾	BS EN ISO 7091 (100HV)
8.8	BS EN ISO 4014 ⁽²⁾	BS EN ISO 4032 ⁽²⁾ (Property Class 8) ⁽³⁾	BS EN ISO 7091 (100HV)
10.9	BS EN ISO 4014 ⁽²⁾	BS EN ISO 4032 ⁽²⁾ (Property Class 10) ⁽³⁾⁽⁴⁾	BS EN ISO 7091 (100HV)
<p>(1) Nuts of a higher property class may also be used</p> <p>(2) Bolts of property classes 8.8 and 10.9 to BS EN ISO 4014 or BS EN ISO 4017 (dimensions and tolerances of BS EN ISO 4016 or BS EN ISO 4018) may also be used, with matching nuts of the same property classes to BS EN ISO 4032 (dimensions and tolerances of BS EN ISO 4034).</p> <p>(3) Nuts for galvanized or sherardized bolts shall be tapped over-size to tolerance 6AZ to accommodate the thickness of galvanizing/sherardizing. This over-tapping reduces the strength of the nut and therefore a nut that has a proof load higher than the minimum ultimate tensile load of the assembly must be used. Nuts for galvanized or sherardized 4.6 bolts shall be property class 8; nuts for galvanized or sherardized 8.8 bolts shall be property class 10 and nuts for galvanized or sherardized 10.9 bolts shall be property class 12 to BS EN ISO 4033.</p> <p>(4) The BS EN ISO 4033 nut standard does not include sizes M22, M27, M33 or sizes greater than M36; it is therefore not possible to supply assemblies in these diameters which comply with this Model Specification for property class 10.9 in the hot dip galvanized or sherardized condition.</p>			

Table 2: MATCHING PRELOADED ASSEMBLIES⁽¹⁾⁽²⁾			
	System HR		System HRC
	Hexagon bolt	Countersunk bolt	HRC bolt⁽³⁾
Bolt/nut assembly	BS EN 14399-3	BS EN 14399-7	BS EN 14399-10
Bolt marking	HR	HR	HRC
Nut marking	HR	HR	HR or HRD
Property class	8.8/8;8.8/10 or 10.9/10	8.8/8; 8.8/10 or 10.9/10	10.9/10
Washers	BS EN 14399-5 or BS EN 14399-6		
Washer marking	H		
DTI ⁽⁴⁾ , nut and bolt face washers	BS EN 14399-9		At user's discretion
DTI marking ⁽⁴⁾	H8 or H10		
Nut face washer marking	HN		
Bolt face washer marking	HB	Not applicable	
<p>(1) In terms of suitability for preloading, fasteners shall meet the test requirements of BS EN 14399-2 and any additional testing specified in the product standard.</p> <p>(2) Bolt lengths shall be selected to ensure that a minimum number of four full threads (in addition to the thread run-out) remain clear between the bearing surface of the nut and the unthreaded part of the shank.</p> <p>(3) Commonly known as a “tension control bolt”. BS EN 14399-10 system HRC assemblies with calibrated preload depend on accurate control of the torque-tension characteristics to achieve the specified axial tensile loads as with other torque methods.</p> <p>(4) DTI – direct tension indicator.</p>			

Table 3: HOLDING DOWN ASSEMBLIES			
Property class	Bolt	Nut⁽¹⁾	Washer⁽⁴⁾
4.6	BS 7419	BS EN ISO 4032 ⁽²⁾ (Property Class 5) ⁽³⁾	BS EN ISO 7091 (100HV)
8.8	BS 7419	BS EN ISO 4032 ⁽²⁾ (Property Class 8) ⁽³⁾	BS EN ISO 7091 (100HV)
<p>(1) Nuts of a higher property class may also be used.</p> <p>(2) Nuts of property classes to BS EN ISO 4032 with dimensions and tolerances of BS EN ISO 4034 may also be used.</p> <p>(3) Nuts for galvanized or sherardized bolts shall be tapped over-size to tolerance 6AZ to accommodate the thickness of galvanizing/sherardizing. This over-tapping reduces the strength of the nut and therefore a nut that has a proof load higher than the minimum ultimate tensile load of the assembly must be used. Nuts for galvanized or sherardized 4.6 bolts shall be property class 8 and nuts for galvanized or sherardized 8.8 bolts shall be property class 10.</p> <p>(4) As an alternative BS 4320 form G may be used.</p>			

Table 4: CUP BOLTS and COUNTERSUNK BOLTS IN NON-PRELOADED ASSEMBLIES			
Property class	Bolt	Nut⁽¹⁾	Washer
4.6	BS 4933	BS EN ISO 4032 ⁽²⁾ (Property Class 5) ⁽³⁾	BS EN ISO 7091 (100HV)
8.8	BS 4933	BS EN ISO 4032 ⁽²⁾ (Property Class 8) ⁽³⁾	BS EN ISO 7091 (100HV)
<p>(1) Nuts of a higher property class may also be used.</p> <p>(2) Nuts of property classes to BS EN ISO 4032 with dimensions and tolerances of BS EN ISO 4034 may also be used.</p> <p>(3) Nuts for galvanized or sherardized bolts shall be tapped over-size to tolerance 6 AZ to accommodate the thickness of galvanizing/sherardizing. This over-tapping reduces the strength of the nut and therefore a nut that has a proof load higher than the minimum ultimate tensile load of the assembly must be used. Nuts for galvanized or sherardized 4.6 bolts shall be property class 8 and nuts for galvanized or sherardized 8.8 bolts shall be property class 10.</p>			

Table 5 Ordinary Tie Bar Assemblies⁽¹⁾		
Material	Steel	
Thread	Tolerance Class	6g or 8g ⁽²⁾
	Standards	BS 3643-1 and BS 3643-2
Mechanical properties	Property Classes	d ≤ 39mm: 4.6, 8.8, 10.9
	Standard	BS EN ISO 898-1
Tolerance	Product grade	C ⁽³⁾
	Standard	BS EN ISO 4759-1
Associated nuts	Standards	BS EN ISO 4032, BS EN ISO 4034 and BS EN ISO 4033 ⁽⁴⁾
	Property Classes	5, 8, 10, 12 ⁽⁴⁾
	Standard	BS EN ISO 898-2
	Thread Tolerance	6H, 7H or 6AZ
	Standards	BS 3643-2 or BS ISO 965-5
Associated washers (if required)	Standards	BS EN ISO 7091
	others	to be agreed ⁽⁵⁾
Suitability test	Standard	BS EN 15048-2
<p>(1) These ordinary tie-bar assemblies are threaded bars supplied with nuts and, if required, washers and are suitable for non-preloaded applications.</p> <p>(2) The tolerance class is at the option of the manufacturer, dependant on the manufacturing method, and applies before hot dip galvanizing or coating with any thick protective coating.</p> <p>(3) Other product grades may be supplied by agreement between the purchaser and the manufacturer.</p> <p>(4) Recommended bolt and nut combinations are shown in Table 6.</p> <p>(5) Other washers may be supplied by agreement between the purchaser and the manufacturer.</p>		

Table 6: Matching Ordinary Tie Bar Assemblies		
Property Class Tie Bar	Nut⁽¹⁾	Washer (if required)
4.6	BS EN ISO 4032 ⁽²⁾ (Property Class 5) ⁽³⁾	BS EN ISO 7091 ⁽⁵⁾ (100 HV)
8.8	BS EN ISO 4032 ⁽²⁾ (Property Class 8) ⁽³⁾	BS EN ISO 7091 ⁽⁵⁾ (100 HV)
10.9	BS EN ISO 4032 ⁽²⁾ (Property Class 10) ⁽³⁾⁽⁴⁾	BS EN ISO 7091 ⁽⁵⁾ (100 HV)

(1) Nuts of a higher property class may also be used.
(2) Nuts of property classes to BS EN ISO 4032 with the dimensions and tolerances of BS EN ISO 4034 may also be used.
(3) Nuts for galvanized or sherardized tie bars shall be tapped over-size to tolerance 6AZ to accommodate the thickness of galvanizing/sherardizing. This over-tapping reduces the strength of the nut and therefore a nut that has a proof load higher than the minimum ultimate tensile load of the assembly must be used. Nuts for galvanized or sherardized 4.6 tie bars shall be property class 8; nuts for galvanized or sherardized 8.8 tie bars shall be property class 10 and nuts for galvanized or sherardized 10.9 tie bars shall be property class 12 to BS EN ISO 4033.
(4) The BS EN ISO 4033 nut standard does **not** include sizes M22, M27, M33 or sizes greater than M36; it is therefore not possible to supply assemblies in these diameters which comply with this Model Specification for property class 10.9 in the hot dip galvanized or sherardized condition.
(5) Other washers may be supplied by agreement between the purchaser and the manufacturer.

If specified coatings are required, they shall be provided by the fastener manufacturer and comply with the requirements of the standards listed in Table 7.

Table 7: PROTECTIVE COATINGS	
Galvanizing	BS EN ISO 10684
Zinc Electroplating	BS EN ISO 4042
Sherardizing	BS 7371-8

Note: Attention is drawn to the risk of hydrogen embrittlement during electroplating or hot dip galvanizing of 10.9 bolts. Further guidance is given in Section 9.0 of this Model Specification.

4.0 Proprietary Products

All proprietary items shall be used in accordance with the manufacturer's recommendations and instructions if relevant.

5.0 CE Marking

All fastener assemblies manufactured to harmonised BS EN standards shall be supplied complete with CE marking as follows and a Declaration of Performance shall be available:

Note: This may be on a website

- Ordinary (non-preloaded) assemblies to BS EN 15048-1
- Preloaded assemblies to BS EN 14399-1

Fasteners supplied as proprietary items shall either be CE marked as being in accordance with a European Technical Approval or be treated as special fasteners to BS EN 1090-2. Special fasteners shall only be used if the manufacturer publishes suitable product information in the form of a component specification and provides a declaration of conformity that the fasteners have been supplied in accordance with the component specification.

6.0 Inspection certificates

All goods shall be supplied with a Type 3.1 Inspection certificate from the manufacturer/supplier to BS EN 10204: 2004 verifying compliance with this specification. If the fastener is surface coated this shall be included.

The manufacturer's Inspection certificate and the supplier's Inspection certificate which is traceable to the manufacturer's Inspection certificate must be retained by the supplier for a period of not less than 10 years and made available on request.

When agreed with the purchaser, the supplier may provide a certificate of conformance created by the supplier that references the original manufacturer's conformance documents. The original manufacturer's conformance documents shall be retained by the supplier and the supplier's certificate of conformance shall be traceable to the manufacturer's original conformance documents.

7.0 Service temperature

If bolts are intended for use at a service temperature below -20°C, the purchase order shall specify the temperature at or below which the bolts have a minimum impact strength of 27J according to BS EN ISO 898-1.

8.0 Quality Management

8.1 ISO 9001 and National Highways Sector Scheme 3

Manufacturers, importers, suppliers and distributors of structural fasteners shall be ISO 9001 certified by a certification body accredited by UKAS or equivalent European accreditation organisation which is party to a multi-lateral agreement (MLA) with UKAS. For projects in the UK manufacturers, importers, suppliers and distributors of structural fasteners shall comply with National Highways Sector Scheme 3 (NHSS3). This applies to all structures not just highway structures. For projects outside the UK it is recommended that the scheme is adopted by all suppliers and distributors of structural fasteners and shall be adopted by suppliers and distributors of all structural fasteners supplied for use in the UK.

The manufacturer, importer, supplier or distributor shall have a system of receipt and despatch in place to ensure continued traceability from manufacture to despatch of the goods to the client.

Verification of continued quality assurance/quality control by the manufacturer shall be provided by the importer, supplier or distributor

8.2 Inspection, testing and product requirements

Each manufacturing lot¹ of product shall be subjected to sample inspection and mechanical testing at the point of entry into the EU market place and shall be organized by the manufacturer, importer, supplier or distributor in accordance with 8.2.1 or 8.2.2.

¹ Note: A manufacturing lot is described as a quantity of products of a single property class and size, manufactured from bar, wire or rod from a single cast, processed through the same steps at the same time or over continuous time period through the same heat treatment process and / or coating process, if any.

Same heat treatment or coating process means:

- for a continuous process, the same treatment cycle without any setting modification;
- for a discontinuous process, the same treatment cycle or identical consecutive loads (batches).

8.2.1 Property class 4.6 in all diameters and 8.8 and 10.9 up to M39

Sample inspection and testing shall be completed in accordance with table 8. The entity conducting the inspection and testing must as a minimum be part of an ISO9001 certified management system.

Table 8: Inspection and testing requirements property class 4.6 in all diameters and 8.8 and 10.9 up to M39					
	Property	Reference	Sample quantity		Requirements
			8.8 and below	10.9	
1	Visual and dimensional inspection	Product standard	3	5	As per the product standard
2	Strength under wedge	ISO898-1:2013 section 9.1	3	5	ISO898-1:2013
3	Core hardness	ISO898-1:2013 section 9.9.4.2	3	5	ISO898-1:2013
4	Suitability test ¹	EN 14399-2 or EN 15048-2	3	5	EN 14399-2 or EN 15048-2

¹ Only conducted on assemblies

8.2.2 Diameters above M39 property classes 8.8 and 10.9 only

Bolts and studs shall be produced from steel in accordance with ISO898-1:2013 table 2 with the following restrictions; the as cast (mill certificate) percentage content of both Phosphorous and Sulphur shall be less than or equal to 0.015%.

Mechanical testing shall be completed at an ISO17025 accredited laboratory within the EU in accordance with table 9, all mechanical testing shall be conducted prior to any surface coating being applied. (Visual and dimensional

inspection does not need to be conducted at an ISO17205 accredited laboratory)

Table 9: Inspection and testing requirements above M39 8.8 and 10.9 only				
Property		ISO898-1:2013 reference	Sample quantity	Requirements
1	Visual and dimensional inspection	---	3	As per the product standard
2	Minimum Tensile Strength, R_m	Section 9.7	1	ISO898-1:2013
3	Stress at 0.2% non-proportional elongation, $R_{p0.2}$			
4	Percentage elongation after fracture, A			
5	Percentage reduction of area after fracture, Z			
6	Vickers hardness, HV 98N ¹	Section 9.9.4.2 ²	1 set of 3 hardness indents at 0.25D/2, 0.5D/2 and 0.75D/2; see figure 1	Each reading must meet ISO898-1:2013 and the difference between the hardness readings shall be equal to or less than 30HV
7	Micro-hardness test, HV 2.942N	Section 9.10.3 ²	1 set of 2 hardness indents at positions 0.15mm from the surface edge and > 3mm from the surface edge; see figure 2	
8	Impact strength, K_v	Section 9.14	1 set of 3	ISO898-1:2013

¹Bolts and studs which have a length of more than 10 times diameter shall be hardness tested in this manner at both ends of the fastener
²Testing conducted generally in accordance with ISO898-1:2013 but in positions show in figures 1 and 2 respectively

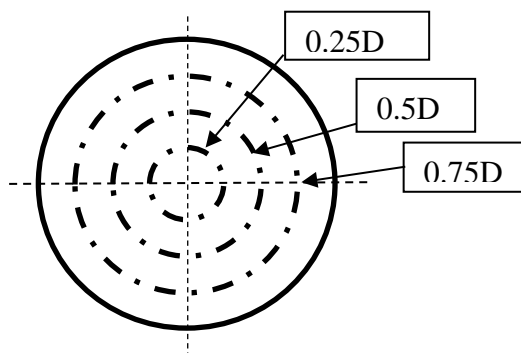


Figure 1 – Hardness positions for HV 98N tests

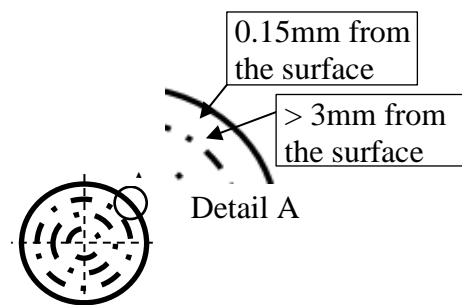


Figure 2 – Hardness positions for HV 2.942N

9.0 Hydrogen Embrittlement in Structural Fasteners

Hydrogen embrittlement occurs when a process used in the production of structural fasteners or from environmental corrosion generates nascent hydrogen that can be absorbed into the steel of the fasteners. The effect of the absorbed hydrogen becomes more critical with the increasing tensile strength of the fastener steel; property class 8.8 is considered to be the highest strength level that does not require special precautions during surface coating treatments.

Methods such as low temperature ‘baking’ can be used to reduce the possibility of hydrogen embrittlement with higher strength fasteners such as property class 10.9; however, BS 7371 part 1:2009 Annex B includes the following warning.

Most electrolytic and acidic processes are liable to produce hydrogen and, though baking after coating will minimize the risk of failure, the process can never be guaranteed to be completely effective.

There is no known test procedure which can satisfactorily guarantee that the heat treatment (baking) process has successfully eliminated all traces of hydrogen embrittlement from all parts of a processed batch. If the risk of failure is unacceptable, cleaning and coating specifications which do not involve electrolysis from aqueous solutions should be used.

Annex B of BS 7371 part 1:2009 ‘Avoidance of Hydrogen Embrittlement’ gives additional information.

Protective Coatings

Neither the Galvanizing process nor the process of applying a coating by the thermal diffusion of zinc powder e.g. Sherardizing generates nascent hydrogen during the coating process.

However, if prior to coating the pre-cleaning method uses acid (such as pickling) or any other method that generates nascent hydrogen there is a risk of hydrogen embrittlement. With property class 10.9 fasteners acid cleaning is not permitted and other cleaning methods shall be used, such as shot blasting.

The use of electroplating for property class 10.9 fasteners is not recommended.

Property Class 10.9 fasteners may be galvanised or coated via a thermal diffusion method provided the pre-cleaning method conforms to the guidance above.

10.0 References

The following dated standards and specifications are referenced in this specification. For dated references only the edition cited applies.

BS 3643-1:2007. ISO metric screw threads. Principles and basic data, 2007

BS 3643-2:2007. ISO metric screw threads. Specification for selected limits of size, 2007

BS 4933: 2010, ISO metric black cup and countersunk head bolts and screws with hexagon nuts, 2010.

BS 7371-8: 2011, Coatings on metal fasteners – Part 8. Specification for sherardized coatings, 2011.

BS 7419: 2012, Specification for holding down bolts, 2012

BS EN 1090-2: 2008, Execution of steel structures and aluminium structures – Part 2: Technical requirements for steel structures, 2008 + A1, 2011.

BS EN 1090-2: 2018, Execution of steel structures and aluminium structures – Part 2: Technical requirements for steel structures, 2018.

BS EN ISO 9001: 2015, Quality management systems – Requirements, 2015.

BS EN 10204: 2004, Metallic materials, Types of inspection documents, 2004.

BS EN 14399-1: 2015, High-strength structural bolting assemblies for preloading – Part 1: General requirements, 2015.

BS EN 14399-2: 2015, High-strength structural bolting assemblies for preloading – Part 2: Suitability test for preloading, 2015.

BS EN 14399-3: 2015, High-strength structural bolting assemblies for preloading – System HR – Hexagon bolt and nut assemblies, 2015.

BS EN 14399-5: 2015, High-strength structural bolting assemblies for preloading – Part 5: Plain washers, 2015.

BS EN 14399-6: 2015, High-strength structural bolting assemblies for preloading – Part 6: Plain and chamfered washers, 2015.

BS EN 14399-7: 2018, High-strength structural bolting assemblies for preloading – Part 7: System HR – Countersunk head bolts and nut assemblies, 2018.

BS EN 14399-9: 2018, High-strength structural bolting assemblies for preloading – Part 9: System HR or HV – Bolt and nut assemblies with direct tension indicators, 2018.

BS EN 14399-10: 2018, High-strength structural bolting assemblies for preloading – Part 10: System HRC – Bolt and nut assemblies with calibrated preload, 2018.

BS EN 15048-1: 2007, Non preloaded structural bolting assemblies – Part 1: General requirements, 2007.

BS EN ISO 898-1: 2013, Mechanical properties of fasteners made of carbon steel and alloy steel – Part 1: Bolts, screws and studs, 2013.

BS EN ISO 898-2:2012. Mechanical properties of fasteners made of carbon steel and alloy steel. Nuts with specified property classes. Coarse thread and fine pitch thread, 2012

BS EN ISO 4014: 2011, Hexagon head bolts. Product grades A and B, 2011.

BS EN ISO 4016:2011, Hexagon head screws. Product grades C, 2011.

BS EN ISO 4017: 2014, Hexagon head screws. Product grades A and B, 2014.

BS EN ISO 4018: 2011, Hexagon head screws. Product grade C, 2011.

BS EN ISO 4032: 2012, Hexagon nuts, style 1. Product grades A and B, 2012.

BS EN ISO 4033: 2012, Hexagon nuts, style 2. Product grades A and B, 2012.

BS EN ISO 4034: 2012, Hexagon nuts. Product grade C, 2012.

BS EN ISO 4042: 2000, Fasteners, Electroplated coatings, 2000.

BS EN ISO 4759-1:2001. Tolerances for fasteners. Bolts, screws, studs and nuts. Product grades A, B and C, 2001

BS EN ISO 7091: 2000, Plain washers – Normal series – Product grade C, 2000.

BS EN ISO 10684: 2004, Fasteners – Hot dip galvanized coatings, 2004.

BS ISO 965-5:1998. ISO general purpose metric screw threads. Tolerances. Limits of sizes for internal screw threads to mate with hot-dip galvanized external screw threads with maximum size of tolerance position h before galvanizing, 1998

National Highways Sector Schemes for Quality Management in Highway Works 3, Stocking and Distribution Activities for Mechanical Fasteners, Published by Sector Scheme Advisory Committee for Mechanical Fasteners (SSACMF), UKAS, 2016.

National Structural Steelwork Specification for Buildings (6th edition), British Constructional Steelwork Association Ltd. and the Steel Construction Institute, 2017.

Steel Bridge Group: Model Project Specification for the Execution of Steelwork in Bridge Structures, Steel Construction Institute, SCI Publication P382, 2012.

11.0 Undertaking

I/we the undersigned agree to supply products in accordance with this specification and any variation from this agreement will be sought in writing.

Signed: _____

Print: _____

Date: _____