IMPLEMENTATION SPECIFICATION FOR ROAD WORKS

SERIES IM/400 (IMPLEMENTATION)

ROAD RESTRAINT SYSTEMS

(VEHICLE AND PEDESTRIAN)

This Specification Series implements the requirements in Subsidiary Legislation 499.57, Part II (New Roads and Road Works Regulations) in accordance with the Agency for Infrastructure Malta ACT XXVIII, CAP. 588, Part I

Date: **February 2021**

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400 ROAD RESTRAINT SYSTEMS (VEHICLE AND PEDESTRIAN)

400 Road Restraint Systems - General

1 This Series is part of the Specification for Road Works (Implementation). Whilst this Series is particularly relevant to the subject matter in its title it must be read in conjunction with the general requirements in Series 000 and 100 and with all other Series relevant to the specification for the particular works to be undertaken.

2 The Contractor shall be required to perform all minor ancillary works associated with preparing and rendering the site ready for the installation of the vehicle and/or pedestrian barrier system.

3 Some sites - outside the main trafficked sections - may require abrupt barrier direction / alignment changes. The Contractor must ensure that all barrier sections are jointed as required by the road alignment (or as otherwise instructed by the Overseeing Organisation) using adequate jointing flanges. This form of jointing will not be permitted adjacent to road carriageways with a design or posted speed $\geq$ 30 km/h.

4 Road restraint systems (RRS) shall be able to achieve the specified performance at the temperatures described in the National Annex (NA) to MSA EN 1991-1-5:2003 figures NA.1 and NA.2 and determined in accordance with Figure 6.1 of MSA EN 1991-1-5 and the NA. Additionally, the recommended differences in the note to clause 6.1.6 of MSA EN 1991-1-5 shall be taken into account to determine the most severe temperature effect, assuming the rail of a parapet to be equivalent to a structural element in 6.1.6 (1).

Warranting and Performance Selection Guidance

5 Guidance for hazard risk assessment and barrier containment selection can be found in the document IM/TD19/18 - Vehicle Road Restraint Systems (VRS) :Criteria for Hazard Risk Analysis and VRS Performance Requirements.

401 Vehicle Restraint Systems - General

1 Vehicle restraint systems (VRS) shall conform to this Series and the requirements stated in contract specific IM Appendix 4/1. VRS, other than the following, shall conform to MSA EN 1317-5 and be CE marked:

a) Maintenance of legacy systems, as described in sub-Clause 402.1;

b) Transitions;

c) Crash Cushions;

d) Terminals;

e) Barrier gates (Removable Barrier Sections); and

f) Vehicle parapets and combined vehicle/pedestrian parapets constructed as bespoke.

Note 1: Legacy systems are those vehicle restraint systems already in service including those systems that pre-date the transposition of the EN 1317 standards.

2 These systems shall conform to the requirements stated in paragraphs (a) to (h) below.

a) Maintenance of legacy systems, as described in sub-Clause 402.1, shall conform to Clauses 402 and 406.

b) Vehicle Restraint Systems (VRS) shall conform to MSA EN 1317-2.

i. The VRS shall conform to MSA EN 1317-2;

ii. The minimum performance class shall be N2, H1 or H2 as described in IM Appendix 4/1 or in the bills.

iii. Severity Class: A or B

Class N2

Characteristic	Value	Notes
Containment	N2	
Working Width (Normalised)	Max *W*4	≤ 1.3m
Vehicle Intrusion (Normalised)	Not applicable	
ASI	Maximum B	THIV ≤ 33 km/h

Table 400 - 1 Class N2

Class H1

Characteristic	Value	Notes
Containment	H1	
Working Width (Normalised)	Max *W*4	≤ 1.3m
Vehicle Intrusion (Normalised)	Max VI_N 4	≤ 1.3m
ASI	Maximum B	THIV ≤ 33 km/h

Table 400 - 2 Class H1

Class H2

Characteristic	Value	Notes
Containment	H2	
Working Width (Normalised)	Max *W*4	≤ 1.3m
Vehicle Intrusion (Normalised)	Max VI_N 4	≤ 1.3m
ASI	Maximum B	THIV ≤ 33 km/h

Table 400 - 3 Class H2

c) Transitions to and between safety barriers (including vehicle parapets) shall conform to the requirements of DD ENV 1317-4.

d) Crash Cushions shall conform to MSA EN1317-3.

i. The minimum performance class shall be Class 80 (re-directive), taper (i.e non-parallel) to EN 1317-3 unless stated otherwise in IM Appendix 4/1.

ii. Class 80/1 shall not be permitted.

iii. Velocity Class: 80km/hr

iv. Severity Class: A or B

v. Lateral Displacement zone: D1

vi. Redirection Zone: Z1

vii. Front and side shall be treated with retroreflective yellow/black bands.

viii. The taper length and width shall be selected depending on the VRS arrangement and which the cushion must protect.

e) Terminals shall conform to the requirements of DD ENV 1317-4.

i. The minimum performance class for all leading terminals – excluding the Timber VRS - shall be Class P2.

ii. The minimum performance class for all trailing terminals shall be Class P1.

iii. Severity Class: A or B.

iv. Lateral Displacement: D1.

v. Exit box: Z2.

vi. The front and side of the P2 and the outer side only of P1 terminals shall be treated with retroreflective yellow / black bands.

vii. VRS ends shall always be “terminated” – No unprotected ends shall be permitted.

viii. The use of “Fish-Tail” terminations shall not be permitted unless approved in writing by the Overseeing Organisation and only for “trailing” ends.

Figure 400 - 1 "Fish-Tail End"

ix. The P1 terminations shall be appropriate for the selected system. Terminals shall be inclusive of any end anchorage concrete (minimum grade C30) and to the dimensions indicated by the manufacturer.

Figure 400 - 2 Terminal Anchorage Conrete Unit

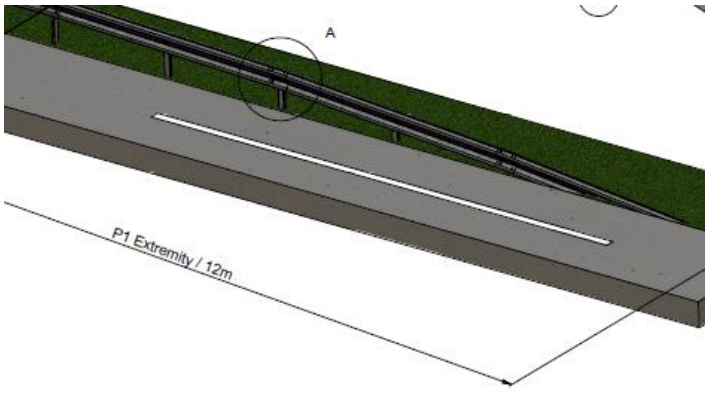

Figure 400 - 3 Terminal Anchorage (Illustrative)

f) Barrier gates (Removable Barrier Sections) shall conform to the requirements of DD ENV 1317-4.

g) Vehicle parapets and combined vehicle / pedestrian parapets constructed as bespoke elements shall conform to Clause 406.

3 Other requirements such as the Length of Need (as defined in IM/TD 19/18), the Setback (as defined in IM/TD 19/18), the minimum height of parapets, requirement for pedestrian provision and the maximum height of the road restraint that allows the required visibility shall be as described in contract specific IM Appendix 4/1.

VRS for Tight Radii (Curved Beam Sections)

4 These beam units shall be shop-rolled to the required curvature. No “edge rippling” will be permitted for radii greater than 8.0m. Some “edge rippling” will be permitted for radii tighter than 8.0m

5 The use of a fabricated mitred radius beam – alternative to the above – may be permitted for radii less than 8.0m.

6 This form of jointing will not be permitted in roads with a design or posted speed ≥ 30 km/h.

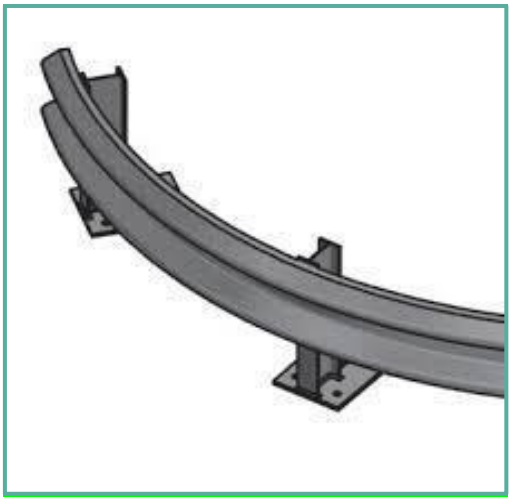

Figure 400 - 4 Tight Radius Arrangement (≤ 30 km/h)

Acceptance of proposals

7 Details of the vehicle restraint systems proposed by the Contractor for both new installations or for maintenance of existing systems shall be submitted to the Overseeing Organisation at least four weeks before the commencement of vehicle restraint system work for acceptance with the following supporting information demonstrating compliance with this specification, and the requirements set out in contract specific IM Appendix 4/1. Where a Declaration of Performance is required to be submitted this is as required by the Construction Products Regulation (EU No. 305/2011) (CPR) and the relevant harmonised standard.

a) For Safety Barriers (excluding vehicle parapets)

i) A Declaration of Performance demonstrating compliance with the contract requirements for the essential characteristics, plus additional information as

necessary to demonstrate that the chosen system(s) meets the location specific design criteria as stated in the contract specific specification.

b) For Vehicle Parapets

i) A Declaration of Performance demonstrating compliance with the contract requirements for the essential characteristics, plus additional information as necessary to demonstrate that the chosen system(s) meets the location specific design criteria as stated in the contract specific specification.

ii) When required in contract specific IM Appendix 4/1 the Contractor shall provide evidence that demonstrates the following: that the declared performance was achieved in testing, in accordance with MSA EN 1317 Parts 1 and 2 and that the test vehicle did not in any way touch or take advantage of structures which will not be present on the final bridge installation; that is, if the vehicle dropped down behind the bridge installation, it did not touch soil or other supporting devices, or any other feature.

c) For Crash Cushions

i) Declaration of Performance demonstrating compliance with the contract requirements for the essential characteristics, plus additional information as necessary to demonstrate that the chosen system(s) meets the location specific design criteria as stated in the contract specific specification.

d) For the maintenance and repair of Legacy Safety Barriers, as described in sub-Clause 402.1.

i) Documentation showing compliance with and operation of the Quality Management requirements of Clause 104. This shall include the quality plans required in sub-Clause 104.6 which shall make specific reference to the management of the vehicle restraint operations and all associated operations. The documentation shall identify quality management procedures for each vehicle restraint activity for each system included in the works.

e) For Vehicle Parapets and Combined Vehicle / Pedestrian Parapets constructed as bespoke.

i) Documentation showing compliance with BS 6779-2 as amended by this Series and CD377 (United Kingdom Design Manual for Roads and Bridges).

f) For Combined Vehicle/Pedestrian Parapets.

i) Declaration of Performance demonstrating vehicle containment achieves compliance with the contract requirements for the essential characteristics, plus additional information as necessary to demonstrate that the chosen system(s)

meets the location specific design criteria as stated in the contract specific specification.

ii) For maintenance of legacy systems as described in sub-Clause 402.1 documentation showing compliance with BS 6779-1 as amended by this Series 400 and CD377 (UK Design Manual for Roads and Bridges - DMRB) for pedestrian containment.

iii) For the pedestrian containment aspects documentation as per the requirements of sub-Clause 401.4. Where such documentation has previously been submitted to the Overseeing Organisation and the system has been listed as described in sub-Clause 104.30 further submission of this documentation may not be necessary. Where the Contractor proposes to use such systems, the Contractor shall confirm the relaxation of these documentation requirements with the Overseeing Organisation.

iv) When required in contract specific IM Appendix 4/1 the Contractor shall provide evidence that demonstrates the following: that the declared performance was achieved in testing, in accordance with MSA EN 1317 Parts 1 and 2 and that the test vehicle did not in any way touch or take advantage of structures which will not be present on the final bridge installation; that is, if the vehicle dropped down behind the bridge installation, it did not touch soil or other supporting devices, or any other feature.

g) For Transitions between vehicle restraint systems.

i) Documentation showing compliance with and operation of the Quality Management requirements of Clause 104 and associated quality management schemes listed in IM Appendix A, as required in sub-Clause 401.3 paragraph (d)(i).

ii) Documentation demonstrating compliance with DD ENV 1317-4 and the contract performance requirements.

iii) Documentation as per the requirements of sub-Clause 401.4. Where such documentation has previously been submitted to the Overseeing Organisation and the system has been listed as described in sub-Clause 104.30 further submission of this documentation may not be necessary. Where the Contractor proposes to use such systems, the Contractor shall confirm the relaxation of these documentation requirements with the Overseeing Organisation.

h) For Terminals to vehicle restraint systems.

i) Documentation showing compliance with and operation of the Quality Management requirements of Clause 104 and associated quality management

schemes listed in IM Appendix A, as required in sub-Clause 401.3 paragraph (d)(i).

ii) Documentation demonstrating compliance with DD ENV 1317-4 and the contract performance requirements.

iii) Documentation as per the requirements of sub-Clause 401.4. Where such documentation has previously been submitted to the Overseeing Organisation and the system has been listed as described in sub-Clause 104.30 further submission of this documentation may not be necessary. Where the Contractor proposes to use such systems, the Contractor shall confirm the relaxation of these documentation requirements with the Overseeing Organisation.

8 Where specified in sub-Clause 401.3 the following information shall be provided to the Overseeing Organisation. Where required the Contractor shall complete the proforma included in contract specific IM Appendix 4/2.

a) Test report in accordance with either MSA EN1317-2:2010, Annex A or MSA EN 1317-3:2010, Annex A or DD ENV 1317-4:2002, clause 7.8.

b) Video/high speed film of test annotated showing date, test number and performance class.

c) Still photographs of complete installation including anchorage points.

d) Still photographs of vehicle before and after impact.

e) Full drawings of tested items.

f) Certification from the manufacturer that the item tested complies with the drawings supplied.

g) Certificate from a test house accredited in accordance with the requirements of sub-Clause 105.7.

Durability

9 Safety barriers, vehicle parapets, terminals, transitions, removable barrier sections and crash cushions shall conform to the following.

a) All components shall be designed to achieve a serviceable life of not less than:

i) 20 years for metal safety barriers, terminals, transitions, removable barrier sections and crash cushions;

ii) 25 years for timber metal safety barriers, terminals, transitions;

iii) 50 years for concrete safety barrier systems, except for temporary safety barriers where the serviceable life shall be not less than 10 years;

iv) 30 years for metal vehicle parapets and metal components of combined metal and concrete vehicle parapets; and

v) 120 years for concrete vehicle parapets and concrete components of combined metal and concrete vehicle parapets; and

b) For metal vehicle parapets and metal components of combined metal and concrete parapets the serviceable life shall be obtained without the requirement for any maintenance other than that resulting from accidental damage. In addition, metal components of combined metal and concrete parapets shall be capable of replacement without damage to the concrete components.

Information required to be provided by the contractor prior to installation

10 The following information shall be provided by the Contractor to the Overseeing Organisation, all documentation shall be in English.

For all proposed road restraint systems:

a) Information as required in sub-Clause 401.3.

b) Installation drawings.

c) Manufacturer's installation instructions or installation manual including foundation requirements and test methods to verify their performance.

d) Manufacturer's repair and maintenance manual.

e) The contractor shall present documentation highlighting competence of the workforce in the installation of the system. This may be through registration with EU27 and the UK accredited schemes or specific training from the system provider. The certificate(s) of registration shall include in the scope of registration installation of the vehicle restraint system(s) being installed.

f) Where contract specific IM Appendix 4/1 specifies requirements for loads imposed by road restraint systems on foundations or structures the nominal loads (direct forces, moments and co-existent shears) that will be transferred from the barrier or parapet to the structure or foundation shall be provided.

Information required to be provided by the contractor after installation

11 The Contractor shall provide to the Overseeing Organisation as-built drawings which shall include plans and details of the constructed system. The Contractor shall also provide to the Overseeing Organisation for each proprietary system installed, a certificate certifying that it has been installed fully in accordance with the manufacturer's instructions.

Marking

12 All components of systems that fall within the scope of the Construction Products Regulation (EU No. 305/2011) (CPR) shall be marked in accordance with the requirements of the CPR and the relevant harmonised standard.

Handling and storage

13 All components shall be protected from damage and handled and stacked in such a way that permanent damage is not caused, particularly to threaded components. Means shall be provided to avoid damage to galvanized coatings and any damage that does occur shall be repaired in accordance with MSA EN ISO 1461.

Installation instructions

14 The Contractor shall ensure that the installation instructions, or installation manual as required by MSA EN 1317-5, for a proposed system includes all the information necessary to install the road restraint system in the locations shown on the drawings such that the system will meet its declared performance.

15 Installation instructions shall be appropriate to the road restraint system being installed and its location.

16 The use of the system relative to different ground and other conditions of installation and use, including limitations (e.g. permitted temperature range), shall be defined in the installation manual.

17 The installation manual shall also include the following information and any additional information appropriate to the system proposed and its proposed location.

a) Erection:

   i) Assembly drawings, of the product tested, including tolerances, anchorages, end parts – where relevant, installation height above pavement and/or ground levels, other installation details appropriate to the installation for the specific locations including changes relevant to different set-backs from the edge of carriageway, etc.;
   ii) Description of the installation works, including equipment and specific details for installation on a curve, with minimum allowed radius on a convex curve and concave curve;
   iii) Procedures for installation (erection, assembly, foundations, anchorages and bolt torques when relevant etc.);
   iv) All tools required to perform a proper installation of the system;

v) Ambient temperature and humidity at time of installation (if relevant) and how installation should be adjusted for the ambient conditions at the time of installation;

vi) Details of tensioning (if relevant);

vii) Particular conditions applicable to the use of the product (e.g. Provisions for use under certain conditions);

viii) Description of the soil, pavement and/or foundations characteristics and conditions suitable for the system and information about conditions which can influence the behaviour of the product;

ix) Details of any testing of the installation or other on installation specific testing; e.g. Post push tests to prove the proposed foundation system**;**

x) Any other relevant recycling information, details of toxic or dangerous materials present in the works.

b) Maintenance and inspection:

i) Provisions for repair, inspection and maintenance, including indications for disassembling and reassembling or reconstruction of damaged system;

ii) In service tolerances including for installation height.

c) The following information is applicable specifically to safety barriers:

i) Recommended range of length of the safety barrier (minimum / maximum), curve radius etc;

ii) provisions for installing lengths above the minimum;

iii) recommended arrangements for dealing with exposed rail ends (e.g. flaring, terminals, etc);

iv) recommended soils, slopes, possibility of plinth installation and specific instructions;

v) recommended arrangements for drainage through and/or in front of the safety barrier;

vi) other safety barrier types which can easily be connected with the product.

d) The following information is applicable specifically to terminals: safety barrier types which can be connected to the product.

Further Installation Requirements

18 All VRS shall be installed, refurbished, repaired and maintained by operatives that have been trained under a relevant EU27 and the UK Sector Schemes or equivalent as stated in sub-Clause 104.15. The Contractor shall, in accordance with sub-Clause 104.14, provide evidence to the Overseeing Organisation to demonstrate that the operatives' accreditation to the relevant scheme(s) is current and valid.

19 Alternatively, the Contractor may submit a declaration, signed by an Architect and Civil Engineer confirming that the operatives were supervised under his/her charge during installation and that the system fully complies with the manufacturer's installation requirements.

20 At parapet locations accessible to pedestrians and cyclists and where the VRS is lower than 1.2m the VRS shall have a combined top horizontal rail to bring up the height to 1.2m. The certification to EN 1317-2 of the parent system shall not be affected.

21 Connections to concrete and other structures and elements shall be of the recessed type whereby the structure or element shall be provided with a recess of sufficient depth to accommodate installation of the barrier flush with the surface.

22 VRS ends shall always be "terminated" – No unprotected ends shall be permitted.

23 "Fish-Tail" ends shall not be permitted on parapets. They may be approved by the Overseeing Organisation for non-parapet locations and only as "trailing" ends.

24 P1 "ramped" terminations shall not be permitted unless approved in writing by the Overseeing Organisation and only for "trailing" ends and at specific locations. Such terminations shall be appropriate for the parent system and shall be inclusive of end anchorage block in C30 (min.) concrete and to the dimensions indicated by the manufacturer.

25 Where P2 terminals are designed to connect to the parent VRS elements the connection shall be as approved by the terminal producer.

26 Crash cushion location may present longitudinal and transverse slopes and cross-falls. The levelling limits set by the crash cushion producer for installation shall be strictly adhered to.

27 Crash cushions installation may require anchorage onto a concrete base. The producer's installation method shall be strictly adhered to.

402 Components for Maintenance and Repair of Legacy Vehicle Restraint Systems

1 Legacy systems are VRS that are currently on the road network that are not CE marked. The requirements given in this Series with respect to legacy systems are for the maintenance and repair of such systems. All new VRS shall comply with the requirements of Clause 401.

2 For the purpose of vehicle parapet requirements, this Clause shall also be read in conjunction with Clause 406.

Materials

3 Materials and fabrication of components and fittings shall be as described and detailed on the drawings submitted by the Contractor, in compliance with Clause 104, sub-Clause 401.3 and other requirements of this Series. It shall be demonstrated that the materials are within the limits of statistical variation for the specified material and for the material of the prototype

tested system. Materials significantly exceeding the original specified strength shall not be accepted.

4 Structural concrete, reinforcement, workmanship and other requirements shall conform to the relevant requirements of Series 1700 and Appendices 17/1 to 17/5. Standardised prescribed concrete shall conform to Clause 2602 and contract specific IM Appendix 26/1.

Protection Against Corrosion

5 Protection against corrosion shall be as described in the manufacturer's specification and the following:

a) all steel components except stainless steel items, concrete foundation reinforcing rings and reinforcing bars that will be permanently embedded in concrete shall be galvanized after shop fabrication as described in Clause 1909; and

b) where required in contract specific IM Appendix 4/1, the surface preparation and protection against corrosion of all steel vehicle parapets and steel components of combined metal and concrete vehicle parapets shall comply with Series 1900.

Tolerances

6 Fabrication tolerances, including tolerance on hole diameters, shall be as shown and described on the drawings submitted by the Contractor in accordance with Clause 401.5. Components, which are to be galvanized or metal coated, shall be measured before galvanizing or metal coating.

Welding

a) General: Arc welding of ferritic steels shall conform to MSA EN 1011-1 and MSA EN 1011-2. Weld symbols shown on the drawings, submitted by the Contractor in accordance with sub-Clause 401.3 and 401.6, shall be as described in MSA EN ISO 2553:2013. Welding shall not be used except as where detailed on the drawings submitted by the Contractor in accordance with sub-Clause 401.3 and 401.6. Arc welding of stainless steels shall conform to MSA EN 1011-3. Arc welding of aluminium alloys shall conform to MSA EN 1011-1 and MSA EN 1011-4.

b) Procedures: Written welding procedures shall be used with testing to MSA EN ISO 15607, MSA EN ISO. 15609-1 and MSA EN ISO 15614-1 for steel and MSA EN ISO 15607, MSA EN ISO 15609-1 and MSA EN ISO 15609-2 for aluminium alloys and shall apply to all production and repair procedures. These shall be subject to re-approval after a period of seven years. When applying MSA EN ISO 15607, MSA EN ISO 15609-1 and MSA EN ISO 15614-1, the welding consumables and procedures used shall be such that the mechanical properties of deposited weld metal shall not be less than the

respective minimum specified values of the parent metal being welded. Weld testing shall be undertaken by an appropriate organisation accredited in accordance with sub-Clause 105.7. Approval shall be by an Independent Inspecting Authority using Registered Welding Engineers or Registered Welding Quality Engineers or equivalent. Welding procedures shall be approved in accordance with MSA EN ISO 15613. Pre-production test pieces shall represent the main assembly types.

c) Welder Qualification: All welders shall hold certificates of approval to MSA EN 287-1 and MSA EN 1418 for steel and MSA EN ISO 9606-2 for aluminium alloys. The tests shall include in addition an application test on transverse butt welds in beams. Welders carrying out fillet welds only may be approved to BS 4872-1. Certificates of approval shall be by an Independent Inspecting Authority using Registered Welding Engineers, Registered Welding Quality Engineers or Welding Inspectors or equivalent. Welders shall be registered on the Lloyd's Register's Weld Certification. Weld testing shall be undertaken by an appropriate organisation accredited in accordance with sub-Clause 105.7.

d) Production Inspection and Testing: The manufacturer shall provide suitable personnel to carry out inspection of production welds in (i) to (iii) below. Personnel conducting visual inspection shall be certified at a competency level appropriate to the type of weld inspected. Personnel conducting non-destructive testing (NDT) shall be certified appropriate to the equipment used and the weld groups inspected all in accordance with MSA EN ISO 9712. Evidence of training and qualification shall be retained and made available for examination when required. The results of all weld inspections shall be recorded.

Where required in contract specific IM Appendix 1/5 tests and associated sampling shall be undertaken by testing laboratories accredited in accordance with MSA EN ISO/IEC 17025. The accreditation shall be by UKAS or equivalent European accreditation organisation with a scope that includes MSA EN ISO/IEC 17025. Where UKAS or European laboratory accreditation is required the results shall be reported on an official UKAS or European equivalent accredited laboratory test report or certificate.

i) Visual Inspection: All welded joints shall be subject to visual inspection in accordance with MSA EN ISO 17637 prior to any NDT and galvanizing. Weld surfaces shall be free of slag residues and sharp edges. All surfaces shall be free of traces of weld splatter, arc strikes and contaminants. The apparent throat dimensions of butt welds and the apparent leg length and apparent throat dimensions of fillet welds, as measured by a welding gauge, taking into account any known lack of fit, shall not be less than those specified, except that local shortfalls up to 1 mm may be accepted, provided the average over any 50 mm length is not less than the specified dimension. All welds to be free of cold lap. The surface of all welds shall be free from cracks, lack of fusion including overlap,

and slag. Isolated discontinuous porosity may be accepted provided it is not detrimental to the galvanising process. Undercut shall not result in a section loss of more than 5% over any 50 mm length of joint, nor shall its depth exceed 0.5 mm or 10% of the thickness, whichever is the less.

ii) Magnetic Particle Inspection (MPI) and Liquid Penetrant Inspection (LPI): MPI shall be applied in accordance with MSA EN ISO 9934-1 to joints selected in accordance with (iv) below, where any of the material thickness exceeds 20 mm. Notwithstanding the requirements of (iv) below, MPI or LPI in accordance with MSA EN 571-1, shall be applied as appropriate where on visual inspection the presence of cracking or lack of fusion may be suspected. To aid inspection, the profile of the weld may be dressed by burr grinding provided that the specified throat size and leg length is still maintained. The surface of the weld shall be free of cracks, lack of fusion and slag.

iii) Ultrasonic Testing: All butt joints in material 8 mm thick or greater selected in accordance with (iv) below shall be ultrasonically tested in accordance with MSA EN ISO 17640. The weld shall be free of cracks. The height of buried slag, lack of fusion or lack of penetration shall not exceed 3 mm and within 6 mm of the outer surface their individual lengths shall not exceed 10 mm. The resulting net throat area loss over any 50 mm length of weld shall not exceed 5% of the specified throat area.

iv) Frequency of NDT: Joints shall be selected as follows:
All joints of each type up to a batch size of 10 components and 10% of additional components thereafter. If non- conformances are found the scope of NDT shall be doubled. If further non-conformances are found, the whole batch shall be tested.

v) Reporting: Inspection records for production welds shall be retained by the manufacturer for three years and those covering the production periods relating to the components supplied shall be made available for examination.

e) Destructive Testing: Copies of certified reports of destructive tests on components supplied under earlier contracts with the Overseeing Organisation shall be provided.

f) Frequency of Destructive Testing: The Contractor shall supply components, or sample joints cut from components, for destructive testing as selected on behalf of the Overseeing Organisation. The basis of selection shall be as follows:

i) For batches of less than 100 beam assemblies with transverse butt welds, 1 sample joint shall be supplied unless an identical sample joint from the same works has been destructively tested within the previous four weeks. For batches exceeding 100 or more, 1 sample joint shall be supplied for each subsequent sampling lot not exceeding 100.

ii) Welded adjuster brackets shall be supplied at a rate of 1 for each sampling lot not exceeding 300.

iii) Each type of post shall be supplied at a rate of 1 post for each sampling lot not exceeding 1000.

iv) Each type of surface mounted post shall be supplied at the rate of 1 post for each sampling lot not exceeding 100.

v) For batches of up to 150 vehicle parapet posts: No test required, provided that records certified by a representative of the Overseeing Organisation are produced of successful testing carried out on posts of the same weld group within the previous 3 months. If no satisfactory record is available, one post to be tested.

vi) For batches of 150 to 300 vehicle parapet posts: One post to be tested.

vii) For batches exceeding 300 vehicle parapet posts: Two posts to be tested.

viii) Each type of anchor frame, vehicle parapet connection and connection piece shall be supplied at an interval not exceeding 6 months for each manufacturer's works.

ix) For batches of up to 150 welded vehicle parapet splices, one splice shall be supplied for testing unless successful testing has been carried out within the previous 3 months on a similar splice(s), where the splice to be tested was selected by the Overseeing Organisation's representative and the welding is to be carried out by the same personnel. For batches greater than 150 welded vehicle parapet splices, two splices shall be tested.

x) Other welded components shall be supplied at an interval not exceeding 12 months for each manufacturer's works.

g) Acceptance Criteria: The acceptance criteria shall be as specified in sub-Clause 402.6(d), except that in sub-Clause 402.6(d)(i), the throat and leg dimension of the weld shall apply to the true rather than apparent dimension.

h) Non-conformance: In the event that there is a non-conformance arising from a deviation in materials, preparation, assembly or welding procedure, the batch concerned shall be rejected and further production of the components affected stopped until such time as the fault has been corrected. A minor non-compliance shall only be accepted on the basis that further sampling and testing shows that the fault is not repetitive and will not in that instance impair structural integrity. If the problem can be traced to a particular manufacturing period, operator, piece of equipment or batch of material and if proper traceability to individual batches of components can be assured, only those batches affected may be subjected to rejection.

i) Test Report: The destruction test reports shall be retained by the Contractor and recorded in a register for a period of three years. The destructive test samples shall be

retained for a period of 18 months. These shall be made available for examination on future contracts with the Overseeing Organisation.

j) Remedial Work: Welds which do not conform to the Specification may be repaired to an approved procedure as described in sub-Clause 402.6(b). Welds in aluminium alloys shall not be repaired more than once.

Marking

7 All components, excluding fasteners, reinforcing rings and bars, shall be clearly and durably marked with the manufacturer's identification mark and digits indicating month and year of manufacture. In addition to the marking requirements of MSA EN ISO 898-1, fasteners shall be clearly marked with the following:

a) safety barrier, terminal, transition, crash cushion manufacturer's identification mark; and

b) fastener number as referenced on the manufacturer's construction drawings.

Workmanship and Testing

8 All components shall be manufactured so as to permit the construction of the accepted systems within the tolerances described in sub-Clauses 403.2 and 403.4 and in accordance with the accepted drawings submitted by the Contractor. Changes in material properties outside those used in the type tests of the systems shall not be permitted.

9 Unless otherwise indicated on the accepted drawings submitted by the Contractor to the Overseeing Organisation, all fabrication of components shall be completed before the surface protection is applied.

10 The Contractor shall provide the Overseeing Organisation with evidence that the manufacturer has arranged for tensile tests to destruction to be carried out by a testing laboratory, accredited in accordance with sub-Clause 105.7, annually and whenever the production technique is changed.

Quality Management

11 Parapet legacy system components used for repair and maintenance shall be manufactured by an organisation registered to an EU27 and the UK Sector Scheme for the Manufacture of Parapets for Road Restraint Systems or equivalent. The Contractor shall submit a certificate of registration to the Overseeing Organisation. The scope of registration shall include the components being installed.

403 Safety Barriers, Terminals, Transitions, Removable Barrier Sections and Crash Cushions. Installation of Safety Barriers (Except Vehicle Parapets), Terminals, Transitions, Removable Barrier Sections and Crash Cushions - Overall Requirements

Layout

1 The overall layout and location of safety barriers, terminals, transitions, removable barrier sections and crash cushions shall be as indicated on the contract drawings and described in contract specific IM Appendix 4/1.

2 All safety barriers, terminals, transitions and removable barrier sections shall be erected to present a flowing alignment. Unless a requirement is given in the manufacturer's installation instructions or installation manual, all safety barriers, terminals and transitions shall be erected in accordance with the following:

a) The overall alignment on plan shall not depart from the prescribed alignment by the more onerous requirements of either:

i) the manufacturer's drawings; or

ii) more than ±30 mm, nor deviate in any 10 m length from the straight or required radius by more than ±15 mm.

b) Vertical alignment – this shall be in accordance with the manufacturer's installation instructions or installation manual except for works in relation to existing legacy safety barrier systems where the installation heights shall be as given on the installation drawings for those products.

Excavation for Concrete Foundations and Anchor Blocks

3 Excavations for concrete foundations and anchor blocks shall be in accordance with the manufacturer's instructions or installation manual, or for legacy systems to the detailed drawings, submitted by the Contractor to the Overseeing Organisation.

4 Where the sides of the excavations cannot be maintained vertical until concrete is placed, suitable permanent or temporary formwork shall be used. The formwork shall be installed immediately after excavation and any lateral overbreak of the excavation shall be filled with concrete conforming to MSA EN 206 or the accepted manufacturer's instructions or installation manual submitted by the Contractor to the Overseeing Organisation as appropriate.

5 Impermeable plastic sheeting 500 gauge thick shall be laid at the base of an in-situ concrete foundation located in filter drains.

Concrete in Foundations and Anchor Blocks

6 Concrete in foundations and anchor blocks shall be in accordance with the relevant Clauses of this series and the manufacturer's instructions, or for maintenance and repair works related to existing legacy systems.

7 The Contractor shall ensure that any concrete which constitutes part of the road restraint system has reached the specified strength stated on the accepted drawings prior to any tensioning of the road restraint system taking place.

Beams

8 Notwithstanding the manufacturing tolerances permitted for individual beams, the cumulative length tolerance shall be such that beams, and posts can be positioned in their prescribed location and the requirements of sub-Clauses 403.1 and 403.2 can be met. With the exception of any special closure pieces necessary to complete lengths of safety barriers, terminals, transitions or removable barrier sections, beam lengths shall not differ from those described on the accepted drawings submitted by the Contractor in accordance with sub-Clause 401.3 and 401.6.

Posts

9 Where applicable, posts, foundations and post sockets shall be in accordance with the manufacturer's instructions, or for legacy systems to the detailed drawings, submitted by the Contractor in accordance with sub-Clause 401.3 and 401.6.

10 Where posts are mounted in cast in post sockets these shall be protected to prevent the collection of detritus in the socket voids.

11 When steel posts are driven into the ground this shall be carried out without damage to the post and the protective coating. Any superficial damage to the galvanising shall be treated in accordance with MSA EN ISO 1461 unless the manufacturer's instructions require more comprehensive repairs.

Cutting of Components

12 No drilling, cutting (including flame cutting) or welding of beams and posts shall be permitted after the corrosion protection to the system has been applied.

13 Special closure pieces shall be fabricated before corrosion protection is applied.

Assembly

14 Direct contact between dissimilar metals shall be avoided. Where necessary to prevent direct contact, this shall be achieved by interposing a dielectric separator in accordance with the

manufacturer's instructions, or for legacy systems to the detailed drawings, submitted by the Contractor.

Anchorages and Attachment Systems for Surface Mounted Posts

15 Unless otherwise described in contract specific IM Appendix 4/1, the Contractor shall submit to the Overseeing Organisation, at least 4 weeks before installation, well attested and documented evidence that proposed anchorages and attachment systems in drilled holes, are capable of resisting the ultimate tensile loads resulting from failure of the proposed safety barrier, terminal, transition, removable barrier sections or crash cushion system. Where the ultimate capacity of a safety barrier, terminal, transition, removable barrier sections or crash cushion system, is governed by the failure of the attachment system the evidence shall demonstrate that the anchorages in drilled holes, are capable of resisting the ultimate tensile loads resulting from failure of the attached system. Anchorages of an expanding type, other than undercut anchorages, shall not be permitted.

16 Unless otherwise specifically indicated on the accepted manufacturer's instructions or installation manual submitted by the Contractor to the Overseeing Organisation, steel anchorages and attachment systems shall be used for securing surface mounted posts to a concrete or steel base.

17 Unless otherwise specifically indicated on the accepted manufacturer's instructions or installation manual submitted by the Contractor to the Overseeing Organisation, where surface mounted posts are to be installed on a highway structure, the anchorages shall include an internally threaded component to receive the attachment system. All parts of anchorages on bridge decks and other structures (where the anchorage is within 80mm of the upper surface of the supporting concrete or where the anchorage parts are threaded to receive the holding down bolt) shall be of stainless steel designation 1.4401, 1.4436, 1.4362 or 1.4462 to MSA EN 10088-1. Holding down bolts, studs and nuts on bridge decks and other structures shall be stainless steel grade A4-80 to MSA EN ISO 3506-1 and MSA EN ISO 3506-2. Washers on bridge decks and other structures shall conform to BS 4320 and be made from stainless steel strip designation 1.4401 or 1.4436 to MSA EN 10029, MSA EN 10048, MSA EN 10051and MSA EN ISO 9445. Unless specifically indicated on the accepted manufacturer's instructions submitted by the Contractor to the Overseeing Organisation direct metal to metal contact between dissimilar materials within the attachment system and anchorage shall be prevented by the use of non- conductive sleeves, washers or coatings to prevent bimetallic corrosion.

18 Unless specifically indicated on the accepted manufacturer's instructions or installation manual submitted by the Contractor to the Overseeing Organisation or where surface mounted posts are attached to a steel base the base plate shall be bedded on mortar conforming with Clause 2601 and contract specific IM Appendix 26/2. The bedding mortar

shall have a minimum thickness of 10 mm and a maximum thickness of 30 mm. An additional allowance may be made for longitudinal falls.

19 For anchorages in drilled holes, each hole location shall be checked to ensure that the hole will be clear of reinforcement before drilling is carried out. Where it is not possible to locate drilled holes without encountering reinforcement, the Contractor shall provide a specialist's report to the Overseeing Organisation on the consequences of drilling through or cutting the reinforcement. No drilling or cutting shall take place without the prior written acceptance of the Overseeing Organisation.

20 Before installation of anchorages in drilled holes, each hole shall be sound, clean and dry and the tolerance of the hole shall be within the values given by the anchorage manufacturer.

21 Attachment systems shall be tightened to the specified torque and have not less than the minimum thread engagement specified by the manufacturer of the system.

22 Stainless steel bolts, screws and nuts shall conform to MSA EN ISO 3506-1 and MSA EN ISO 3506-2, Grade A4-80. The dimensions and tolerances of the bolts, screws and nuts shall conform to MSA EN ISO 4016, MSA EN ISO 4018 and MSA EN ISO 4034.

23 Stainless steel washers shall conform to BS 4320 and be made from stainless steel strip designation 1.4401 or 1.4436 to MSA EN 10029, MSA EN 10048, MSA EN 10051, and MSA EN ISO 9445.

24 Unless expressly prohibited by the manufacturer's instructions or installation manual the threads of steel anchorages shall be lined with grease having a high resistance to creep and being suitable for hot or cold smearing.

25 Voids shall be sealed with a durable, non-structural and impermeable filler to prevent ingress of moisture and deleterious substances. Sealing of voids in anchorages, attachment systems and base plates with a non-structural impermeable durable filler is important to prevent water ingress and to avoid corrosion and damage. Fillers may be derived from polymers or elastomers but shall exclude acrylic or polyester based materials.

Concrete Barriers

26 The concrete barrier class of finish shall be as declared by the manufacturer.

27 The concrete barriers shall provide for cross-over drainage.

404 Site Testing for Contract Compliance

Anchorages in Drilled Holes for Safety Barriers, Terminals, Transitions and Crash Cushions

1 The Contractor shall carry out on-site tensile load tests on anchorages in drilled holes. For the purpose of this sub-Clause the types of fixing referred to in clause 1 of BS 8539 Code of practice for the selection and installation of post-installed anchors in concrete and masonry shall include “anchorages”. Unless more onerous or alternative testing is proposed in the manufacturer’s installation manual accepted by the Overseeing Organisation the following testing methodology shall be applied.

a) Where anchorages are tested they shall be loaded incrementally in tension in accordance with BS8539 except that they shall be capable of resisting a test load equal to 10 per cent above the nominal tensile load applied to the anchorage at failure of the safety barrier, terminal, transition or crash cushion system in lieu of testing to failure.

b) The nominal tensile load shall be determined by the manufacturer of the safety barrier, terminal, transition, removable barrier sections or crash cushion system. Where the failure of the attachment system (e.g., the holding down bolt) is the prescribed failure mode of the safety barrier, terminal, transition, removable barrier sections or crash cushion system, the test load shall be 90 per cent of the yield load of the attachment system. Incremental loads shall be held for not less than half a minute and the test load for not less than five minutes. Readings shall be taken immediately after applying load and at the end of the interval stated above.

c) The total movement of the anchorage shall not exceed 1.0 mm during the test. Any evidence of slip during loading as demonstrated by a significant change in the slope of the load/extension curve, shall constitute failure.

2 The testing frequency shall be in accordance with contract specific IM Appendix 1/5. In addition, testing shall comply with any special requirements given in contract specific IM Appendix 4/1.

Post Foundations

3 The Contractor shall provide the test equipment and carry out loading tests on post foundations to ascertain compliance with the manufacturer’s specification or installation manual for the proposed safety barrier, terminal, transition, removable barrier sections and crash cushion system. The tests shall be carried out and the results submitted to the Overseeing Organisation at least one week prior to installation of the relevant lengths of safety barrier, terminal, transition, removable barrier sections and crash cushion system. The testing frequency shall be in accordance with contract specific IM Appendix 1/5 or the manufacturer’s installation manual if this stipulates a more onerous testing regime.

4 Where stated in contract specific IM Appendix 4/1, the Overseeing Organisation shall provide the test equipment and carry out loading tests on post foundations installed by the Contractor for that purpose. The Contractor shall make available a vehicle of not less than 5 tonnes for the Overseeing Organisation's use while carrying out the tests.

5 The Contractor shall install test posts and foundations after completion of the finished ground.

6 On completion of loading tests the Contractor shall remove the test posts and foundations and reinstate the finished ground to meet the requirements of the Contract.

405 Temporary Barriers - General

1 The temporary barriers shall comply with the requirements of the UK Traffic Signs Manual, Chapter 8, Part 2, Section 04.11,O4.11.1 to O4 11.5.

406 Temporary Safety Barriers

1 Temporary traffic safety barriers shall in particular comply with the requirements of the UK Traffic Signs Manual, Chapter 8, Part 2, Section 04.11,O4.11.15 to O4 11.16.

2 The temporary safety barrier systems shall be used where so required in:

a) the Works permit conditions

b) the Works traffic management plan

c) the Overseeing Organisation instructions.

d) contract specific IM Appendix 4/1;

e) the traffic safety risk assessment;

3 The Contractor shall provide, install and maintain temporary safety barriers, terminals and transitions, and on completion of the works, remove them to the locations stated in contract specific IM Appendix 4/1.

4 Where temporary safety barriers, terminals and transitions are to be provided by the Overseeing Organisation, the Contractor shall remove them from the location stated in contract specific IM Appendix 4/1 and install and maintain them. On completion of the works, the Contractor shall remove the temporary safety barriers, terminals and transitions to the locations stated in contract specific IM Appendix 4/1.

5 The following shall also apply when temporary barriers are required to comply with EN 1317-2:

<u>"Routine" Traffic Temporary Safety Barriers to EN 1317-2 - Frequent shifting</u>

a) The temporary VRS shall have a containment class T2;

b) The system must be modular and permit easy and rapid shifting, without the need of holding down fixtures and capable of assembly to tight radii; Terminations shall be ramped.

c) It shall be capable of withstanding wind gusts of up to 37 m/s without displacement.

d) It shall be provided with retroreflective markers and night-time hazard warning lamps as per requirements in Series 100, IM Appendix 1/17.

Figure 1: Temporary VRS - Plastic (Illustrative only)

"Non-Routine" Traffic Safety Barriers to EN 1317-2 - Longer shifting need time-span

6 These shall be similar to the "Routine" units but comprising of concrete barriers to EN 1317-2, containment class T3.

Figure 2: Temporary VRS - Concrete

"Non-Routine" Traffic Safety Barriers to EN 1317-2 with Hoarding panels - Longer shifting need time-span

7 The Contractor shall provide temporary combined vehicle restraint systems (VRS) with hoarding panels to the requirements of the different project work phases in areas where hoarding of the site is required immediately adjacent to traffic passage.

8 The requirements are the same as for temporary "Non-Routine" concrete VRS, Class T3.

9 Additionally the units shall be installed with solid-type hoarding panels to provide a total combined height of 1.8m or close equivalent. These shall comply with the requirements in IM Series 100 – Traffic Management (IM Appendix 1/17).

407 Temporary Barriers

1 Temporary barriers shall in particular comply with the requirements of the UK Traffic Signs Manual, Chapter 8, Part 2, Section 04.11,O4.11.12 to O4 11.13.

Temporary Concrete “New Jersey Profile” Units for General Purpose Delineation

2 The Contractor shall provide as and where required general purpose (unclassified containment) temporary concrete “new jersey form” units to the requirements of the different project work phases and traffic management arrangements.

Temporary Concrete “New Jersey Profile” Units for General Purpose Delineation with Hoarding Panels

3 The Contractor shall provide as and where required general purpose (unclassified containment) temporary concrete “new jersey form” units with hoarding panel additions to the requirements of the different project work phases and traffic management arrangements. . These shall comply with the requirements in IM Series 100 – Traffic Management (IM Appendix 1/17).

408 Lightweight Barriers

1 Lightweight barriers shall in particular comply with the requirements of the UK Traffic Signs Manual, Chapter 8, Section 04.11,O4.11.14.

409 Openings in Carriageway

1 Temporary openings in the carriageway , especially trenches and pits shall be protected by barriers of the type, and containment identified following a dedicated risk assessment for the posted speeds.

410 Isolated Hazards in Carriageways

2 The length of need of barriers tapers before and after the isolated hazard shall be in accordance with the guidance for hazard risk assessment and barrier containment selection document IM/TD19/18 - Vehicle Road Restraint Systems (VRS) :Criteria for Hazard Risk Analysis and VRS Performance Requirements.

411 Vehicle Parapets (Including Vehicle / Pedestrian Parapets)

1 Unless otherwise described in contract specific IM Appendix 4/1, vehicle parapets shall be in accordance with the following requirements except where these conflict with MSA EN 1317-5 in which event MSA EN 1317-5 shall take precedence:

a) CD377 (United Kingdom Design Manual for Roads and Bridges)

b) Clause 401, contract specific IM Appendix 1/5 and contract specific IM Appendix 4/1;

c) Clauses 407 to 409.

2 Legacy systems, as described in sub-Clause 402.1, shall be in accordance with Clause 402 and MSA EN 1317-1: 1998. Vehicle parapets and combined vehicle / pedestrian parapets constructed as bespoke in concrete shall be in accordance with MSA EN 1317-1: 1998.

Aesthetic Requirements

3 Vehicle parapets shall comply with the aesthetic requirements given in contract specific IM Appendix 4/1.

Layout

4 The overall layout and location of vehicle parapets shall be as indicated on the contract drawings and described in contract specific IM Appendix 4/1.

Upper Horizontal Rail at Sectors Accessible by Pedestrians

5 At parapet locations accessible to pedestrian traffic and where the VRS is lower than 1.2m the VRS shall have a combined top horizontal rail. The certification to EN 1317-2 of the parent system shall not be affected.

Maintenance and Repair

6 Components used for maintenance and repair of parapets shall match the performance characteristics of the existing parapet and shall comply with the requirements stated in contract specific IM Appendix 4/1.Components are to be of identical design, detail, specification and geometry to the parapet components originally installed and are to be installed such that the completed repair is like for like. Except that in addition the requirements and standards current at the time of manufacture of the original parapet shall apply, subject to such revisions and modifications applicable to the parapet type during the period of original manufacture, the capacity of the components shall be comparable to that of the original components as tested.

7 The maintenance and/or repair of CE marked parapets shall be undertaken in accordance with the manufacturer's installation manual and requirements for the parapet using components which are identical in design, specification and geometry to the parapet components originally installed.

8 Steel parapets shall be galvanised, but not painted unless required for aesthetic reasons.

412 Anchorages and Attachment Systems for Vehicle Parapets

1 Unless otherwise described in contract specific IM Appendix 4/1 the following shall apply:

i. the design, fabrication, and installation of the anchorage and attachment system shall conform to the manufacturer's drawings and specifications, the requirements of MSA EN 1317-1&2, this Series 400 and CD377 (United Kingdom Design Manual for Roads and Bridges).

ii. the design shall ensure that the attachment (and not the anchorage) is the element that fails on impact. The transfer of the impact load to the anchorage shall be within the capacity of the anchorage and the concrete member to prevent detachment.

2 Unless otherwise covered under the CE marked system's Declaration of Performance and its supporting documentation or described in contract specific IM Appendix 4/1, the Contractor shall submit to the Overseeing Organisation, at least 4 weeks before installation, well attested and documented evidence that the proposed fixings, including all cradles, anchorages and attachment systems, are capable of resisting the applied load effects resulting from collision with the proposed vehicle parapet system. Where the ultimate capacity of a vehicle parapet system is governed by the failure of the attachment system, the evidence shall demonstrate that anchorages in drilled holes are capable of resisting the ultimate tensile loads resulting from the failure of the attachment system so that an anchorage is able to be reused in the event of the need to replace a parapet that has suffered collision damage.

3 Anchorages of an expanding type shall not be permitted.

4 Unless otherwise specifically indicated on the accepted manufacturer's drawings submitted by the Contractor to the Overseeing Organisation anchorages shall include an internally threaded component to receive the attachment system.

5 Where the anchorage is within 80mm of the upper surface of the supporting concrete or where the anchorage part is threaded to receive the holding down bolt all parts of the anchorage shall be of stainless steel designation 1.4401, 1.4436, 1.4362 or 1.4462 to MSA EN 10088-1.

6 Holding down bolts, studs and nuts shall be in stainless steel grade A4-80 to MSA EN ISO 3506-1 and MSA EN ISO 3506-2.

7 Unless specifically indicated on the accepted manufacturer's drawings submitted by the Contractor to the Overseeing Organisation direct metal to metal contact between dissimilar materials within the attachment system and anchorage shall be prevented by the use of non-conducting sleeves, washers or coatings to prevent bimetallic corrosion.

8 Unless specifically indicated in the manufacturer's installation manual submitted by the Contractor and accepted by the Overseeing Organisation, or where the vehicle parapet posts are attached to a steel base, the posts shall be bedded on mortar complying with Clause 2601 and contract specific IM Appendix 26/2. The bedding mortar shall have a minimum thickness of 10 mm and a maximum thickness of 30 mm. An additional allowance may be made for longitudinal falls.

9 For anchorages in drilled holes, each hole location shall be checked to ensure that the hole will be clear of reinforcement before drilling is carried out. Where it is not possible to locate drilled holes without encountering reinforcement, the Contractor shall provide a specialist's report to the Overseeing Organisation on the consequences of drilling through or cutting the reinforcement. No drilling or cutting shall take place without the prior written acceptance of the Overseeing Organisation.

10 Before installation of anchorages in drilled holes, each hole shall be sound, clean and dry and the tolerance of the hole shall be within the values given by the anchorage manufacturer.

11 Attachment systems shall be tightened to the torque given in the manufacturer's installation manual and have not less than the minimum thread engagement specified by the manufacturer of the system.

12 Stainless steel bolts, screws and nuts shall comply with MSA EN ISO 3506-1 and MSA EN ISO 3506-2, Grade A4-80. The dimensions and tolerances of the bolts, screws and nuts shall comply with MSA EN ISO 4016, MSA EN ISO 4018 and MSA EN ISO 4034.

13 Stainless steel washers shall comply with BS 4320 and be made from stainless steel strip designation 1.4401 or 1.4436 to MSA EN 10029, MSA EN 10048, MSA EN 10051 and MSA EN ISO 9445.

14 Unless expressly prohibited by the manufacturer's drawings, and to facilitate removal of holding down bolts for maintenance or repair, the threads of steel anchorages shall be coated with anti-seize compound having a high resistance to creep, intended for use with the materials that form both component thread faces and being suitable for hot or cold smearing.

15 All voids in anchorages, attachment systems and base plates shall be filled with a non-setting passive filler to prevent the ingress of moisture.

413 Inspection and Testing of Vehicle Parapet Components

1 Inspection and testing of vehicle parapet posts shall be carried out by the Contractor as per the manufacturer's installation manual.

2 When required in contract specific IM Appendix 4/1 components of legacy systems shall comply with the following.

a) The components for parapet posts and all completed parapet posts shall conform to the acceptance criteria described in clauses 9.4 and 9.5 of BS 6779-1.

b) The Contractor shall only supply vehicle parapet posts of a type which have certification for static destructive testing in accordance with clause 9.4.3.2.6.3 of BS 6779-1.

414 Site Tests on Anchorages in Drilled Holes for Vehicle Parapets for Contract Compliance

1 The Contractor shall carry out on-site tensile load tests on anchorages in drilled holes. For the purpose of this sub-Clause the types of fixing referred to in clause 1 of BS 8539- shall include 'anchorages'. Where anchorages are tested they shall be loaded incrementally in tension in accordance with BS 8539 except that they shall be capable of resisting a test load equal to 10 per cent above the nominal tensile load applied to the anchorage at failure of the vehicle parapet in lieu of testing to failure. The nominal tensile load shall be determined by the vehicle parapet manufacturer. Where the failure of the attachment system (e.g., the holding down bolt) is the prescribed failure mode of the vehicle parapet, the test load shall be 90 per cent of the yield load of the attachment system. Incremental loads shall be held for not less than half a minute and the test load for not less than five minutes. Readings shall be taken immediately after applying load and at the end of the time intervals stated above.

2 Unless specifically indicated on the accepted manufacturer's instructions submitted by the Contractor to the Overseeing Organisation the total movement of the anchorage shall not exceed 1.0mm during the test. Any evidence of slip during loading up to the test load, as demonstrated by a significant change in the slope of the load/ extension curve, shall constitute failure.

3 The Contractor shall test the anchorages at the frequency given in contract specific IM Appendix 1/5 and in accordance with any requirements given in contract specific IM Appendix 4/1.

415 Posts for Steel VRS

1 Standard posts for steel VRS shall be of length ≤ 1700 mm.

2 Other posts that are allowable in this specification are:

a) Long posts > 1700 mm and ≤ 1900 mm;

b) Extra Long Posts > 1900 mm;

c) Intermediate Posts ≤ 1200 mm.

3 The Contractor shall compile scheme specific IM Appendix 4/3 highlighting which of the posts in 0413.1 and 0413.2 have been utilised across the site.

4 All posts shall include the use of plastic caps or base caps for pedestrian areas to minimise water ingress.

416 Foundations for Posts

1 The acceptable foundation types for posts are:

a) Driven;

b) Socketed concrete foundations;

c) Surface Mounted with Detachable Fixings; or

d) Surface Mounted with Studded Fixings.

2 Socketed concrete foundations shall be 600 mm x 600 mm x 600 mm conforming to MSA EN 206 unless the Client approves the Contractor's alternative proposals as detailed in an installation manual.

3 The Contractor shall compile scheme specific IM Appendix 4/3 highlighting which of the foundations in 0414.1 and 0414.2 have been utilised across the site.

417 Motorcycle Road Restraint Strips (Rub Rails) - CMPS

1 Motorcycle strips (rub rails) where required shall be attached to steel VRS without affecting their compliance with MSA EN 1317 or the declared performance for legacy systems specified in Clause 402. The system must be covered by Annex A of EN 1317-5 as a modification to an EN 1317-2 certified system and must not invalidate that same certification.

a) The motorcycle road restraint CMPS (including attachments, fixtures and terminations) shall comply with any one of the following standards:

i) TS 1317-8: TM 1.60 and TM 3.60
ii) UNE 135900 (Spain): TM 1.60 and TM 3.60
iii) L.I.E.R (France): Class A (60 km/h, 80.5kg, 30 degrees)

b) The following limits shall also apply:

i) Speed Class: 60 km/h
ii) Maximum Working Width: The provisions in CEN/TS 1317-8, clause 8 shall apply.
iii) Maximum HIC36: ≤ 1000 (sliding dummy)
iv) Neck load levels: CEN/TS 1317-8 Table 4 for HIC36 100 or approved equivalent.

418 Pedestrian Barriers - General

1 Pedestrian barriers shall comply with the requirements of the UK Traffic Signs Manual, Chapter 8, Part 2, Section O4.11.6 to O4.11.11.

419 Pedestrian Safety Guard Rail (PGR)

1 Pedestrian safety guard rail (PGR) shall be manufactured from steel and conform to BS 7818 or CEN/TR 1317-6.

2 The particular requirements of the PGR shall be as specified in contract specific IM Appendix 4/1.

Visibility Requirements

3 Where visibility requirements are included in IM Appendix 4/1 the following shall apply:

a) New PGR shall be 1m high, Type 1, 2, 3, 4, 5 as illustrated in LBC-H08-4-1 and LBC-H08-4-2 and supplied with through visibility options V2, V4 or V8 or 'in line' verticals as follows:

a. V2 - visibility PGR providing a transparency of 75% at a sight angle of 2.5° to 5°;

b. V4 - visibility PGR providing a transparency of 75% at a sight angle of 5° to 14°;

c. V8 - visibility PGR providing a transparency of 80% at a sight angle of more than 14°;

d. S - Standard 'in line' bars.

b) Type 1, 2, 3, 4 & 5 PGR posts shall be integral to the panels.

c) Foundations to PGR posts shall be ST2 to Clause 2602, minimum of 100mm x 100mm in the plan of variable depth. The excavation depth shall be a minimum of 300mm below the bottom of the post which shall be set on a precast concrete slab.

d) The concrete shall be brought to surface level and smoothed off, or to the bottom of the footway construction, as required by the Overseeing Organisation.

e) For PGR repairs or infill the design shall match the immediately adjacent section existing or as directed by the Overseeing Organisation. The height of new panels installed into an existing arrangement meet the adjacent panels unless otherwise stated in the Task Order.

4 PGR and all component parts shall be galvanised by hot dip process conforming to MSA EN ISO 1461 or as described in IM Appendix 4/1.

5 PGR to BS 7818 – The following shall apply:

i. Height – Table 1, 1000mm (level); 1150mm (Bridge parapet);

ii. Design loading: Table 2, Class 2, 700 N/m transverse (level); Class 3, 1400 N/m transverse (Bridge parapet)

iii. Infill Class B, Table 3;

iv. Typical illustrative arrangement – Figure 4b (level); Figure 4a (Bridge parapet and similar at grade).

6 PGR to CEN/TR 1317-6 – The following shall apply:

i. Height – Table 1, Class A, 1.0m (level); Class C, 1.2m (Bridge parapet);

ii. Design loading – Table 3, Loading B, 0.8 kN/m (level); Loading C, 1.0 kN/m (bridge parapets);

iii. Infill – Ds1 = 110mm max.; Ds9 = 50mm max.

iv. Typical arrangement – Figure 2 + Figure E1.

7 An illustrative design concept arrangement is shown in RCD 400/01. This will requiring detailing to ensure conformity with clauses 418 and 419.

420 VRS Reflectors

1 Where reflectors are required to be installed onto the VRS beam sections the frequency of installation shall be as follows:

i. Straight sections:	Every 18.0m
ii. Curved sections:	Every 8.0m or as otherwise indicated by the Overseeing Organisation and using a gradual spacing.

2 The minimum retroreflection shall be Class R2 to EN 12899-3 and the colour shall be as indicated by the Overseeing Organisation (normally red/nearside, amber/offside).

3 Colours shall be amber or red depending on the location of the barriers.

4 The distance of the VRS reflectors from the carriageway edgeline must be more than 0.5m.

5 No VRS-mounted reflectors shall be installed in tandem with adjacent road studs or where the VRS set-back would not reflect the actual line of the carriageway edge.

6 Linear delineators shall have the reflective sheeting laminated onto a thin gauge of aluminium and corrugated for better reflection.

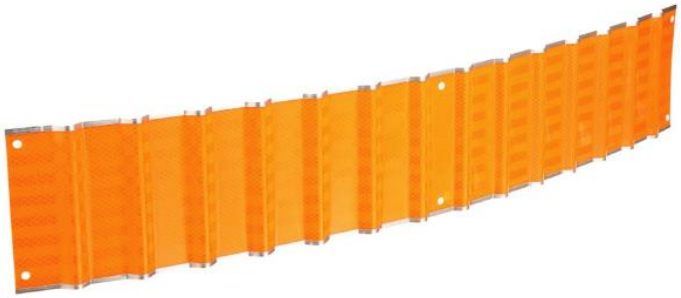

Figure 3 Corrugated Linear Delineation

421 VRS Reflectors

1 Where reflectors are required to be installed onto the VRS beam sections the frequency of installation shall be as follows:

i. Straight sections: Every 18.0m

422 Timber VRS - General

1 The timber - clad VRS shall comply to the EN 1317 Series of European Standards as follows:

i. BS EN 1317-1

ii. BS EN 1317-2

iii. EN 1317-5

2 The containment class shall be as described in IM Appendix 4/1 or as stated in the Bills of Quantities.

3 The value of the following characteristics shall be as follows:

Characteristic	Value	Notes
Working Width (Normalised)	Max *W*4	≤ 1.3m
Vehicle Intrusion (Normalised)	Not applicable	
ASI	Maximum B	THIV ≤ 33 km/h

Table 400 - 4 Timber Barrier Characteristics

4 The timber cladding shall extend over all parts of the exposed steel members and elements including the back.

5 An “illustrative” timber-clad system is shown below. Other “forms” (Eg. square or rectangular) will also be considered.

Figure 400 - 5 Timber-clad VRS (9llustrative – Round)

423 Timber VRS – Durability and Wood Preservative

1 The minimum durability shall be Class 4 (uncoated) to EN 335.

2 The timber shall be pressure treated with a copper preservative and an organic fungicide in an autoclave according to EN 351-1 and EN 335-1 wood preservation classes NP5 (penetration depth), A

Figure 400 - 6 Cladding at back of exposed members (Illustrative)

424 Timber VRS – Exposed Corten Steel Alternative

1 Alternatively to the total timber cladding of the exposed backside steel elements and members structural steel with improved atmospheric corrosion resistance (Corten type) to EN 10025-S355J0WP will be permitted.

Figure 400 - 7 Corten Steel Cladding Alternative

425 Timber VRS – Glued Laminated Wood

1 Alternatively to solid timber CE certified glued laminated wood for structural use according to EN 14080 may be permitted subject to equivalency of performance to solid timber.

2 The beams shall be fabricated to EN 386, for service Class 3 (uncoated), and the mechanical properties shall comply class GL24C according to EN 1194.

3 The bonding adhesive shall be is Type I to EN 301.

Timber VRS – Motorcycle Strip (Rub Rails CMPS)

4 The same requirements to those in clause 417 shall apply except that the strips shall be:

i. Steel panels with a powder coated finish to the same colour to that of the natural timber main beam;

ii. Linear Low-Density Polyethylene (LLDPE) and colour coded to the parent barrier or approved equivalent.