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Fabricators in Aluminium and Steel to the Construction and Engineering Industries

ALUMINIUM VGAN 300 SERIES VEHICLE RESTRAINT SYSTEM SPECIFICATION MANUAL.

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SECTION ‘A’ – SPECIFICATION MANUAL.

1.0 List of Drawings.

1.1 System Drawings.

DRAWING NUMBER	DRAWING TITLE.
VGAN 300-01.C:	STANDARD ARRANGEMENT DRAWINGS OF VGAN 300 SERIES ALUMINIUM PARAPET SYSTEM. **VGAN 301.**
VGAN 300-02.A:	STANDARD ARRANGEMENT DRAWINGS OF VGAN 300 SERIES ALUMINIUM PARAPET SYSTEM. **MAIN RAIL CONNECTION DETAILS.**
VGAN 300-03.B:	STANDARD ARRANGEMENT DRAWINGS OF VGAN 300 SERIES ALUMINIUM PARAPET SYSTEM. **PEDESTRIAN RAIL CONNECTION DETAILS.**
VGAN 300-04:	STANDARD ARRANGEMENT DRAWINGS OF VGAN 300 SERIES ALUMINIUM PARAPET SYSTEM. **PARAPET MESHING DETAILS.**

2.0 List of Varley and Gulliver Limited Company Procedures for Production.

All procedure references relate to Varley and Gulliver Limited Quality Assurance manual in accordance with **ISO 9001:2008** approved procedures.

Name of procedure:	**Procedure Reference Number:**
Product Realisation (Inspection of Raw Materials):	7.1
Inspection of Components and Fasteners:	7.1
Routine inspections carried out during manufacture:	7.1
Handling and Storage of Materials:	7.1
Control of measuring equipment:	4.2.4 and 7.1
Assessment of Personnel:	6.2
Control of Specification Manual:	4.2.4
Control on incoming Materials:	7.1 and 7.4.2
Traceability of Materials:	7.1
Corrective and preventive actions to be taken:	8.5.2 and 8.5.3
Continuous surveillance via Internal Audits:	8.2.2
Appointment and control of suppliers and subcontractors:	7.4.1

Table 1.

3.0 Product Description:

The VGAN 300 series aluminium parapet is a **modular system** providing supporting posts are spaced at **3.000m centres**. Exceptions are at Type 3 expansion joint locations where posts spanning the joint should not exceed 1.5m and the penultimate bays either side of the joint should not exceed 1.0m centres.

The system consists of 3 horizontal extruded aluminium rail sections.
The lower two main traffic rails are 152mm x 98mm located to supporting posts at heights specified on system drawings. The rails are nominally 8.975m long with square cut ends to receive sliding rail to rail connection joints. Shorter rail lengths are utilised at expansion joints and ends of runs.
Rails are joined together with internal extruded aluminium rail joint sleeves 139mm x 85mm which are fitted with a standard 8mm diameter coiled spring pin.
The top pedestrian rail is 114mm x 72mm located to supporting posts at heights specified on system drawings. The rails are nominally 8.975m long with square cut ends to receive sliding rail to rail connection joints. Shorter rail lengths are utilised at expansion joints and ends of runs.
Rails are joined together with internal extruded aluminium rail joint sleeves 104mm x 64mm which are fitted with a standard 8mm diameter coiled spring pin.

There are three types of rail joint to accommodate varying degrees of expansion or contraction.
Type 1 joint (Standard) accommodates movement range upto +/- 9mm.
Type 2 joint (Expansion) accommodates movement range upto +/- 26mm.
Type 3 joint (No-Tension Expansion) accommodates movement range upto +/- 150mm.

The rails are attached to the supporting posts with 2no. M16 stainless steel setpins fixings located and secured into the rear of the rail with a sliding rail nut.

The supporting posts are a single cast aluminium alloy:

Posts are usually attached to the bridge structure or retaining wall with 4No. M20 stainless steel holding down bolts into approved cast-in anchorage units or resin fixed drilled anchorages. The holding down bolts and washers are isolated from the aluminium baseplate with a nylon top hat washer.

4.0 Durability:

The durability of a product is dependent upon numerous factors such as weather conditions, air pollution, location, handling, repair and routine maintenance.

Aluminium weathers to a dull grey finish due to the formation of an impervious oxide layer which is integral with the base metal on exposed surfaces, which is highly resistant to atmospheric corrosion. The rapid forming of the oxide layer and reforming of the layer when scratched is a main reason for the good corrosion characteristics of aluminium and an **almost unlimited life expectancy**.

The use of stainless steel fixings in aluminium can raise concern of bi-metallic corrosion (Galvanic corrosion).
Galvanic corrosion takes place when two different metals have contact with each other in the presence of an electrolyte and is also dependent upon the relative masses of the two materials and the level of current density in the sacrificial anode which would be the aluminium extrusions. The high relative mass of the aluminium compared with the stainless steel fixings would result in a low current density. The extent of isolation between stainless steel fixings in aluminium components, in our opinion, is over specified and the use of stainless steel in contact with aluminium in several existing parapet systems used for over 30 years in the UK would verify.
The main area of concern would be the holding down bolts and the baseplate which would be prone to standing water and road salts and for this reason a nylon isolation washer is utilised.

Splashes of alkaline building materials like grout and concrete cause visible spots on the surface of the Aluminium. These are difficult to remove and for this reason Aluminium should be protected on site. The underside of the Aluminium baseplate is painted with two coats of bitumastic paint to prevent alkaline contact during the grouting process. After the cementation of the grout corrosion cannot happen.

Pitting corrosion can occur on aluminium surfaces frequently in contact with a humid environment. In general, the consequence is only aesthetical.
Accumulation of dirt and debris on surfaces can cause a reduced durability due to the consequence of long-term moisture. Dirt and debris should be removed during routine inspections.

In 1998 Mouchel Consulting Limited produced a report for The Highway Agency on the Opportunities for Use of Aluminium in Highway Structures, and we have listed below several relevant extracts regarding durability from this report.

- “If the Skin is broken by actions such as scraping, a new oxide layer will form on the exposed aluminium so it is considered to be **self healing**.”
- “Aluminium Alloys are **highly resistant to corrosion**. For this reason they are often used in marine structures such as navigation buoys, life boats and general shipping.” “It is the experience of military equipment that any aluminium alloy surface which is free draining and exposed to the full force of the weather will not corrode and will not noticeably deteriorate over very long periods. The military experience covers 20 to 30 years and if this is extrapolated it shows that the **120 year life of a civil bridge is easily met**, and the infinite life predicted by some manufacturers is only a modest exaggeration.”

- “The greatest long term advantage of aluminium alloys is their durability and the consequent reduction in maintenance costs.”
- “Aluminium alloys will suffer from pitting corrosion and this is increased in a marine environment. However the rate of such pitting is so slow that it will not have a significant effect on the life of structural sections. This is supported by the experience of a long life of structures in ships, buoys, and other marine structures in extremely aggressive environments.”
- “Aluminium alloys without coatings are less susceptible to the consequences than painted steel structures, where local damage by vandals can initiate unsightly breakdown of the protective system and subsequent corrosion.”
- “Reduced maintenance can be confidently anticipated as a consequence of the use of aluminium alloy, with a significant reduction in access and delay costs.”

For additional information we have also listed extracts regarding the environment.

- ”The environmental advantages of aluminium alloys are particularly applicable to structural applications. The reduction in maintenance will have a greater effect when applied to long life structures, and highway bridges have a much longer design life than building or the more usual applications for the material. In addition, the traffic delay cost savings are a particularly significant factor in this application.”
- “Materials themselves must be sustainable, and of low energy content when recycled. The highway network must not be burdened with a rate of replacement and maintenance in the future that imposes unacceptable delays on traffic.”
- “There is very strong case to make for aluminium alloy on environmental and sustainability grounds. The material is plentiful, but more importantly can be easily recycled using only 5% of its original energy consumption. Reduced need for maintenance also has significant environmental and sustainability advantages.”

Based on an EAA report on the average depth of weathering of a 0.91mm aluminium sheet exposed for 20 years in a tropical, industrial and marine environment resulted in a loss of thickness of 0.02mm, 0.05mm and 0.08mm respectively with 85% of reduction occurring within the first 3 years of exposure.

Therefore to specify exact working life duration is virtually impossible but based on the above would predict durability in accordance with the requirements of Manual of Contract Documents for Highway Works Volume 1 for parapets of 60 years or more dependent upon routine inspection, repair and maintenance.

5.0 Compliance:

5.1 AASHTO 17th Edition and Aluminium Association 8th Edition.

The **VGAN 300** series aluminium vehicle restraint system as shown on drawing **VGAN 300-01** has been designed and calculated in compliance with the American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Highway Bridges 17th Edition and the Aluminium Association Design Manual 8th Edition for Allowable Stress Design to Aluminium structures.

5.2 NCHRP 350.

The **VGAN 300** series aluminium vehicle restraint system as shown on drawing **VGAN 300-01** has been crash tested and certified reports prepared in compliance with the National Cooperative Highway Research Program (NCHRP) Report 350, Recommended Procedures for the Safety Performance Evaluation of Highway Features.

Texas Transportation Institute (TTI) undertook a Test Designation **3-10** crash test on the **27th April 2010** and subsequently prepared report number **401761-VGL1-3** dated **August 2010** (revised).

Texas Transportation Institute (TTI) undertook a Test Designation **3-11** crash test on the **28th April 2010** and subsequently prepared report number **401761-VGL1-3** dated **August 2010** (revised) which certifies the Containment level **TL3**.

Texas Transportation Institute (TTI) undertook a Test Designation **4-12** crash test on the **29th April 2010** and subsequently prepared report number **401761-VGL1-3** dated **August 2010** (revised) which certifies the Containment level **TL4**.

6.0 Recommendations for Use.

This vehicle restraint system is suitable for use on highways with a speed limit of **less than 70mph** where the following provisions can be met:-

6.1 Minimum plinth dimensions.
The minimum width of the bridge or retaining wall stringcourse (plinth) shall be **450mm** wide.
The upstand at the traffic face adjacent to the paved surface shall be a minimum of 50mm and the maximum cross sectional profile of the plinth shall not exceed 100mm.

6.2 Minimum Length of parapet.
The minimum recommended length for the product installation to **TL3** is **15m**.
The minimum recommended length for the product installation to **TL4** is **30m**

6.3 Horizontal and Vertical Alignment.
The minimum horizontal curvature without pre-curving of main rails is 150m.
Smaller radii can be accommodated by special arrangement with pre-curving.

Posts can accommodate vertical alignments of upto +/-2.5º.
However, when the vertical alignment results in a longitudinal fall in excess of 2.5° the posts should be fixed square to the concrete plinth transversely and perpendicular to the concrete longitudinally.

7.0 Technical Information.

7.1 Post Capacity:

7.1.1 Unfactored Moment of Resistance of Post.
The unfactored moment of resistance of the posts at the underside of the post baseplate = **71.7 kNm.**

7.1.2 Shear Force Resistance of post.
The shear for resistance of the post = **152.6 kN.**

7.2 Anchorage Capacity:

7.2.1 Characteristic Load Value.
The characteristic value of actions due to loads = **64.08 kN.**

7.2.2 Serviceability Limit State Value.
The serviceability limit state value = **70.49 kN.**

7.2.3 Ultimate Limit State Value.
The ultimate limit state value = **115.34 kN.**

7.3 System Weights:

Weights are based on 3.000m centres and anchorage units type VGAS/1

7.3.1 **VGAN 301** (1.00m high.)
Weight per metre = **25.4 kg/m.**

The stated values could vary due to material, fabrication and installation tolerances, however, these values should be utilised for any design purposes.

8.0 Certification.

8.1 BS.EN.ISO 9001:2008 Quality Management Certificate.

Certificate of Approval

This is to certify that the Management System of:

Varley & Gulliver Ltd

57-70 Alfred Street, Sparkbrook, Birmingham, B12 8JR, United Kingdom

has been approved by LRQA to the following standards:

ISO 9001:2015

National Highway Sector Scheme No 2B - For the supply, installation, maintenance and repair of Vehicle Restraint Systems
National Highway Sector Scheme No 5A - for the Manufacture of Parapets for Road Restraint Systems
National Highway Sector Scheme No 5B - for the Installation of Parapets for Road Restraint Systems

David Derrick
Issued by: Lloyd's Register Quality Assurance Ltd

This certificate is valid only in association with the certificate schedule bearing the same number on which the locations applicable to this approval are listed.

Current Issue Date: 03 May 2018
Expiry Date: 31 January 2019
Certificate Number: 10084850

Original Approvals:
ISO 9001 – 14 February 1989
NHSS 2b – 14 February 1989
NHSS 5a – 14 February 1989
NHSS 5b – 14 February 1989

Approval Numbers: ISO 9001 - 00005957 / NHSS 2b – 00005958 / NHSS 5a – 00005959 / NHSS 5b - 00005960

The scope of this approval is applicable to:

The manufacture, supply and installation of aluminium and steel parapets including collision damage repairs and refurbishment. The management of installation of parapets for road restraint systems:
a) Vehicle parapets for bridges and other highway structures
b) Pedestrian parapets for bridges and other highway structures
The manufacture and supply of passively safe sign support posts.
The manufacture, supply and installation of aluminium and steel guard rails
The manufacture of cradle anchorages
Contract management of supply and installation of safety fences (Flex Beam, TCB, DROBB and OBB) and crash cushions
The sub-contract manufacture of general engineering products to client specifications.
Sales of aluminium and steel parapets including collision damage repairs and refurbishment.

UKAS MANAGEMENT SYSTEMS 001

NHSS national highway sector schemes

Certificate Schedule

Certificate Identity Number:

Location	Activities
57-70 Alfred Street, Sparkbrook, Birmingham, B12 8JR, United Kingdom	The manufacture, supply and installation of aluminium and steel parapets including collision damage repairs and refurbishment. The management of installation of parapets for road restraint systems: a) Vehicle parapets for bridges and other highway structures b) Pedestrian parapets for bridges and other highway structures The manufacture and supply of passively safe sign support posts. The manufacture, supply and installation of aluminium and steel guard rails The manufacture of cradle anchorages Contract management of supply and installation of safety fences (Flex Beam, TCB, DROBB and OBB) and crash cushions The sub-contract manufacture of general engineering products to client specifications.
Varley and Gulliver Steel Parapets, Marsh Road, Middlesbrough, TS1 5JS, United Kingdom	Sales of aluminium and steel parapets including collision damage repairs and refurbishment. The management of installation of parapets for road restraint systems: a) Vehicle parapets for bridges and other highway structures b) Pedestrian parapets for bridges and other highway structures

UKAS MANAGEMENT SYSTEMS 001

NHSS national highway sector schemes

9.0 Design of Parapet System.

The parapet system has been designed following the general principles defined in the following standards:

- **BS.EN.ISO 9606-2:2004** – Qualification test of welders. Fusion welding. Aluminium and aluminium alloys.
- **BS.EN.ISO 15614-2:2005** - Specification and qualification of welding procedures for metallic materials. Welding procedure test. Arc welding of aluminium and its alloys.
- **American Association of State Highway and Transportation Officials** – Standard Specifications for Highway Bridges 17th Edition.
- **The Aluminium Association** – Design Manual 8th Edition for Allowable Stress Design in Aluminium Structures.
- **BS.8118-1:1991** - Structural use of aluminium. Code of practice for design.

SECTION ‘B’ – INSTALLATION MANUAL.

1.0 Scope:

1.1 This Method Statement encompasses the work involved to erect **VGAN 300 Series** Aluminium Vehicle parapet.

2.0 Safety:

2.1 All work will comply with the following:

2.1.1 The Health and Safety at Work Act.

2.1.2 Varley and Gulliver associated Method Statement(s) & Risk Assessment(s).

2.1.3 Any Site Inductions given by the Main Contractor**.**

2.2 All Site operatives should be experienced tradesmen. The nominated Contract Manager and Installation Supervisor will ensure safe working practices are adhered to.

2.3 All operatives will comply with Site Safety Procedures as specified by the Main Contractor. All Plant operators will be trained and certified in the safe operation and use of the equipment they are utilising.

2.4 All personnel will wear the correct PPE for the task in hand. High Visibility clothing, Safety Footwear and Hard Hats will be worn as a matter of course.

2.5 All personnel should be given a copy of this Method Statement and associated Risk Assessments prior to commencement of work.

2.6 Clear vehicular access must be provided for lorries to load/unload materials.

2.7 Care to be taken when other trades are operating whilst the parapet is being erected.

2.8 Appropriate temporary edge protection should be installed to the rear of the parapet edge beam and independent of the VGAN 300 parapet system or its baseplates.

3.0 Sequence of Operations:

3.1 Installation of Posts and Rails:

3.1.1 No work will commence until items 2.6 & 2.7 have been met.

3.1.2 Identify positions from the General Arrangement (GA) drawings and place all posts and rails in the required locations. To adequately identify parapet components please refer to the standard detail drawings.

3.1.3 Layout in front of each post location the M20 stainless steel holding down bolts c/w stainless steel washers and plastic top hats as required. Place washers onto holding down bolts to ensure that the plastic top hat washer is in contact with the baseplate upon installation.

3.1.4 Ensure that the threads of all bolts have a thin coat of grease applied (copper slip or similar – not supplied) prior to fitting.

3.1.5 Check that anchorage sockets are clean and free of debris.

3.1.6 Locate post over anchor cluster and insert the M20 bolts with washers through the baseplate into the anchorage sockets. Ensure minimum bolt engagement into the anchorage socket, but do not tighten down as the post has to be lifted approximately 25mm. (see 3.1.7.)

3.1.7 Lift post and place solid inert packer(s) in the centre of the anchor cluster along the stringcourse. Refer to standard detail drawings to ensure **1067mm MINIMUM height** above datum is achieved.

3.1.8 Plumb posts in both elevations using the central packer, and by rocking front to side. Do not apply final torque to the M20 bolts at this stage, bolts should be tightened no more than approximately hand tight turn at this stage.

3.1.9 Repeat items **3.1.3** – **3.1.8** along length of work area.

3.1.10 Starting at one end of the structure begin erecting the rails by laying them on battens/packers, to avoid damage, on the structure. Insert the rail connection nuts and slide along the back of the rails. The quantity of rail connection nut clamp bars required is dependant upon the number of posts the rail is fixed too. Two rail connection nuts per post to rail location are required. Therefore if the rail is connected to three posts then six rail connection nuts are required.

3.1.11 Offer the rails up into position (starting with the bottom rail) and fit the post/rail fixings. M16x45 long for the bottom two rails and M16x35 long for the top rail. We would advise that bolt are kept separate to ensure bolts are not fitted at the wrong locations.

3.1.12 Once the first set of rails are installed, plumb the end of the rails and tighten post/rail bolts. **Do not** apply the required torque to the post/rail bolts at this stage.

3.1.13 Insert the rail to rail joints pieces Type 1, 2 or 3 as determined from the GA layout and set the appropriate joint gap.

3.1.14 Repeat steps **3.1.11** – **3.1.13** along entire length of the work area, ensuring the correct rail joint gaps are set (see GA drawing).

3.1.15 Line and level by means of eying in the top rail, lifting and lowering posts using thin shims for level and using rocking action for alignment. Refer to standard detail drawings to ensure **1067mm MINIMUM height** above datum is achieved.

3.1.16 Check and tighten down all holding down bolts (approximately hand tight plus half a turn), apply the correct torque of **40Nm** to the lower two main rail post / rail bolts only. The top rail fixings are to be tightened until the spring washer is flat.

3.1.17 When parapets are attached to Varley and Gulliver Limited anchorage units the length of bolt engagement needs to be a **minimum of 25mm.**

When parapets are attached to anchorage provided **by others** the following equation should be followed:

$$LE = 0.7 \times \frac{\text{Ultimate Tensile Strength of Fixings}}{\text{0.2\% Proof Stress of Anchorage Socket}} \times D$$

Where:
LE = Length of Engagement
D = Bolt Diameter.

3.1.18 Line and Level to be passed off and Job Instruction Sheets to be completed and passed to the relevant representative from the client for approval and signature.

3.2 Grouting under Baseplates:

3.2.1 When extreme weather temperatures prevail, please follow the grout manufacture's recommendations.

3.2.2 Using 2" x 1" wood, construct a grouting frame slightly bigger than the baseplate. (See Figure 1.)

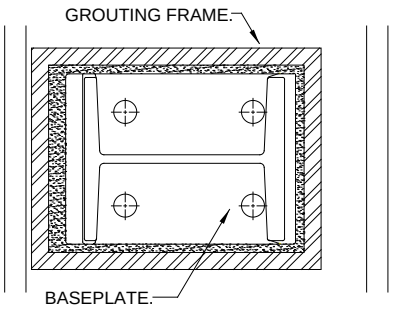
3.2.3 Nail the frame together and apply silicone sealant (where appropriate) to the outside of the frame when positioning, to stop any grout from seeping out.

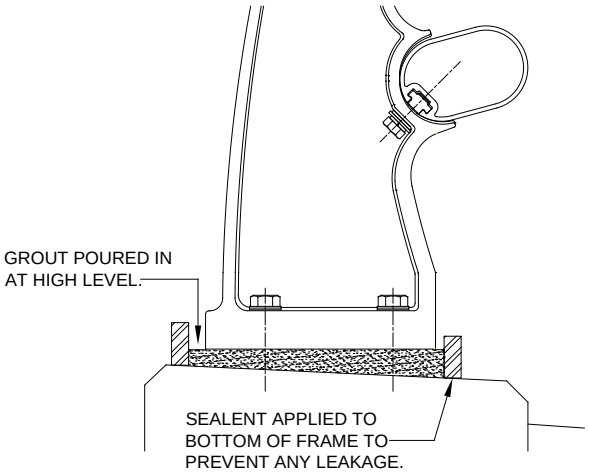
3.2.4 Place the frame around the baseplate and pour in an approved non-shrink grout at the high end (See Figure 2.) Ensure that the grout runs through to all sides.

3.2.5 Leave the grout to set. (as per manufacturers' recommendations).

3.2.6 Once set remove the frame.

Figure 1.





3.2.7 When grout boxes are removed the holding down bolts are to be torqued to between **50Nm** and **70Nm.**

3.2.8 Job Instruction Sheets to be completed and passed to relevant representative from the client for approval and signature.

3.3 Mesh Infilling:

If required, please refer to drawing number VGAN 300 – 04, for mesh installation details.
Please see special fixing note, any fixing within 380mm of the end of a rail with an internal sleeve, must have a drilled and tapped M5 fixing.

3.3.1 Starting from one end proceed to layout the mesh panels and the mesh retaining clips, along length of work area, ensure that the horizontal mesh bar is fitted away from the rail.

3.3.2 Prior to securing the mesh panels, check the vertical alignment, ensuring that the gap at the bottom of the mesh panels does not exceed 25mm and the gap between the mesh panels is a nominal 5mm. (Only secure with mesh clips to the lower two rails if top flashing is required.)

3.3.3 Secure the mesh panel to front face of rails by means of drilling a 4.9mm holes, mesh retaining clips using Amfast drive rivets (extra short) code: HSBN 48100, or equivalent. At the rail ends adjacent to the rail joints, drill a 4.2mm hole and tap for a M5 x 8mm fixing.

3.3.4 Cut panels at rail joints to suit, fit plastic caps, fix vertical end flashings at the start and ends of runs, at rail to rail and expansion joint locations, using M5 x 12mm tapped fixings.

3.3.5 Proceed along entire length of work area repeating step **3.3.2** to **3.3.4**.

3.3.6 Ensure that the bottom edge of adjacent mesh panels are connected using nylon coated 'C' clips. (Please see detail "B" on drawing VGAN 300 – 04.)

If optional top flashing is required

Please refer to drawing number VGAN 300 – 04, for mesh installation details. Please see special fixing note, any fixing within 380mm of the end of a rail with an internal sleeve, must have a drilled and tapped M5 fixing.

Top flashing to stop / start at all rail joint locations, between vertical flashing strips.

3.3.7 After following steps **3.3.1** to **3.3.3**, when fixing the top flashing, check the vertical alignment prior to securing the flashing to top rail, securing the flashing to top rail along entire run, drilling 4.9mm and 4.2mm holes as appropriate, at centres not exceeding 203mm, fixed with Amfast drive rivets (extra long) code: HSBN 48180 or equivalent or M5 x 12mm drilled and tapped fixing as required. Ensure that the top flashing fixing passes through the flashing strip and under the top horizontal mesh bar, thus trapping the top mesh panel bar under the flashing and above the fixings.

3.3.8 After steps **3.3.1** – **3.3.7** remove all swarf from rails and posts using a soft hand brush. Collect up all off cuts and dispose of off.

4.0 Routine Inspections:

4.1 It is recommended that a general inspection of the aluminium parapet is carried out during routine and principle inspections of the main structure.

4.2 Guidance for Inspection:

The following items should be reviewed as part of the inspection:

- Absence or looseness of bolts or nuts.
- Absence of or damage to grout pad.
- Build up of debris and dirt.
- Adequate attachment of mesh infill. (where applicable.)

4.3 Accident Damage Inspection:

The following items should be reviewed as part of the inspection:

- Any damage to posts and rail sections.
- Absence or looseness of bolts or nuts.
- Absence of or damage to grout pad.
- Build up of debris and dirt.

If in any doubt contact Varley & Gulliver Limited who can offer advice.