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VRS Maintenance Guidance Handbook

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AM Asset Management & Maintenance

Technical

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TII Publications

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1. Executive Summary

1.1 Introduction

The road network in Ireland is a highly valued infrastructural asset and is key to the social and economic function and development of the country. Effective asset management and maintenance of the network is therefore crucial for the needs of the population both in terms of the here and now, but also the future.

One of the important assets on the existing road network is vehicle restraint systems (VRS) which protect road users from hazards and contribute significantly to overall road safety. However, the maintenance of all the different types of VRS that are currently in use on the network, and particularly on the legacy network, is challenging and there is little guidance available to ensure that maintenance practices are standardised and consistent.

This document aims to give guidance to those involved in the maintenance of all types of VRS in Ireland (with the exception of parapets on structures).

1.2 VRS Maintenance

VRS are designed and installed to minimise the risk of errant vehicles, which run off the road, colliding with oncoming traffic or with hazards, and to reduce the severity of collisions. However, a damaged, end of life, out of tolerance, or poorly installed VRS can instead present a significant hazard and therefore requires repair or rectification in a timely fashion.

Like road authorities across the developed world, TII and Local Authorities expend considerable resources on an ongoing basis in repairing and replacing damaged or old VRS. As budgets are limited, not all repair works can be carried out immediately and not all systems can be maintained in an ideal as-built condition. Instead, road authorities must focus on prioritising repair and maintenance work, based on high-risk locations and damage which is considered to have a detrimental effect on the safety performance of the VRS.

1.3 Structure of this Guidelines Documents

This VRS Maintenance Guidelines document is set out in 6 parts as follows:

Section 1: Executive summary including introduction to the guidelines, scope and purpose;

Section 2: Policy and requirements for carrying out VRS maintenance, including hazard mitigation, standards for inspections and surveys, assigning priorities, etc;

Section 3: VRS repairs after collisions including reporting, inspecting, making safe, assessing damage, detailing a response, and common repair issues;

Section 4: VRS planned maintenance;

Section 5: VRS improvements;

Section 6: Appendices including a list of abbreviations, references, inspection and certification templates.

1.4 Aims of this Document

- To encourage high standards and consistency of VRS maintenance practice and repair;
- To encourage the timely and appropriate rectification of VRS defects arising from inspections and to guide priority setting based on a risk management basis;
- To provide additional and complimentary guidance to existing TII VRS standards, specifications and publications;
- To encourage an efficient and consistent approach to the collection, processing and recording of VRS data, certification of maintenance works, and to assist with VRS asset management and monitoring.

1.5 Scope and Implementation

This guidance document while not mandatory represents current TII best practice for the maintenance of VRS on the national road network and on TII funded schemes. The guidance provided in the document is also commended to Local Authorities in maintaining VRS on their regional and local road networks.

These guidelines assume that funding for VRS maintenance is available to carry out the relevant inspections and works. Where this is not the case the Road Authority should prioritise works based on risk assessment and in consideration of the funding that is, or may become, available.

1.6 Definitions

VRS maintenance can be considered as the combination of all measures carried out in order to maintain the functionality of a VRS system. It can therefore be divided into the following basic steps:

- **Maintenance:** a periodically recurring measure to maintain the ‘target state’ of the VRS e.g. re-tightening, re-tensioning, removing vegetation, washing reflectors, etc.
- **Inspection:** a survey carried out to ascertain the current state of a VRS. It generally is a check carried out by an experienced inspector or designer. The aim is to check if the VRS is of sound condition or to ascertain the extent of any intervention required.
- **Repair work:** measures undertaken to restore a damaged VRS through the refurbishment or replacement of parts of the VRS on the basis of the inspection results e.g. replace damaged beams/posts, repair or replace impacted terminal, etc.
- **Improvement work:** measures undertaken to improve an existing VRS via modification or augmentation e.g. replace a terminal or section of barrier with a higher performance system, extend the length, improve the anchorage, adjust the working width, adjust or re-profile the verge, exchange an obsolete VRS, etc.

2. Policy and General Requirements

2.1 Forgiving Roadsides

Safety barriers and end terminals themselves may be a hazard to traffic and their use should be avoided wherever practicable. It is always preferable to remove, relocate or mitigate the hazard in some way and provide space for an errant vehicle to regain control i.e. create a forgiving roadside.

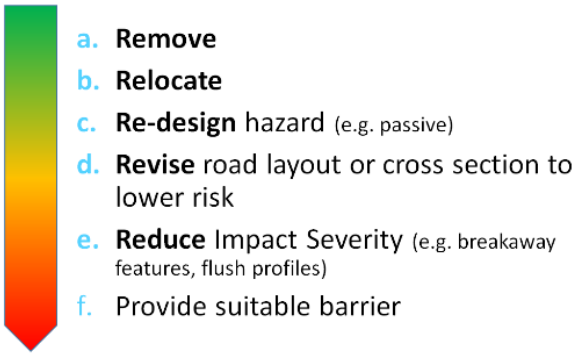


Figure 2.1 - Hazard Mitigation Process

In many circumstances, it may be possible to relocate a hazard sufficiently far from the road such that the protection of a VRS is not warranted. Designers should also consider re-designing the hazard so that it is no longer a risk to road users and reducing the impact severity of any potentially hazardous roadside features.

Figure 2.2 - Example of a road with forgiving roadsides

Providing a VRS should always be considered the measure of last resort.

2.2 Training & Qualifications

A successful VRS maintenance regime can only succeed in delivering its objectives if those involved at the various stages have the appropriate training and knowledge.

Figure 2.3 - VRS Designer Training Course

Recommended training and qualifications for those involved in VRS maintenance are shown in Table 2-1.

Table 2.1 - Training and qualifications requirements for those involved in VRS maintenance

	Essential	**Desirable**
Client		
Client PM		• VRS designer training course
Inspection Teams		
Team Lead	• VRS designer training course	• Other inspector's course • System specific installation training
Designers		
Team Lead	• Chartered Engineer • VRS designer training course	
Designer	• VRS designer training course	• System specific installation training
Installers		
Contracts Manager	• VRS designer training course	
Lead Installer	• VRS designer training course • LANTRA NHSS 10b foundation course • LANTRA NHSS 10b installer course • System specific installation training	
Installer	• LANTRA NHSS 10b foundation course	

	Essential	Desirable
	• LANTRA NHSS 10b installer course • System specific installation training (for every system being installed)	

2.2.1 VRS Inspection Team

Other requirements for VRS Inspection Teams include:

- Comprise two or more personnel.
- Have a Team Lead.
- Have adequate training/experience to identify large scale and minor damage.
- Have a detailed knowledge of TII Publication's DN-REQ-03034 – The Design of Road Restraint Systems (Vehicle and Pedestrian) for Roads and Bridges and CC-SPW-00400 – Specification for Road Restraint Systems (Vehicle and Pedestrian).
- Have adequate experience and knowledge of the VRS industry in order to identify systems and ensure they have been installed to their required specification.
- Have the appropriate documentation (e.g. installation / maintenance manuals) available.

2.3 Understanding the Asset

There is a myriad of different VRS currently in use across the road network in Ireland. There are rigid and deformable systems, pre-EN1317 and post-EN1317 systems, systems on timber posts, concrete posts and various types of steel posts, driven systems and systems installed in concrete or surface mounted, normal, high and very high containment systems, A-profile (corrugated) and B-profile systems, timber clad, wire rope and concrete systems, etc. Therefore, it is crucial that anyone involved in the maintenance of VRS, in the design office or on site, has a thorough understanding of what they are looking at and what they are maintaining.

2.3.1 VRS Asset Database

The most important information required to effectively manage, inspect and maintain a VRS asset is that contained within the VRS database. An accurate and complete database is an essential tool for engineers and decision makers in allowing them to evaluate and plan specific interventions that are required to ensure the asset remains fit for purpose.

TII (or their delegated Agents) currently operate and manage a database of all VRS on the national road network in Ireland.

For non-national roads, it is the responsibility of Road Authorities to identify and record all VRS in an asset database, inventory system or Routine Maintenance Management System (RMMS).

Key VRS Database Details:

- Location / Route No
- Design / performance characteristics
- VRS Type / Manufacturer

- Installation date
- Foundation type
- Length / height
- Speed limit of road
- Historical maintenance records
- Inspection dates / references
- Scheme / contract reference

2.3.2 Key Condition Characteristics

According to research carried out by CEDR in 2014[1], the key condition characteristics of existing VRS which need to be considered are:

- The **presence of damage** (which affects VRS durability and performance in the event of a collision);
- **Ground conditions**, i.e. the ability of the ground to support the VRS posts (which affects the structural performance of the VRS and if the post/system will deflect/deform as intended);
- **Mounting height** (which affects the performance of the VRS and influences how the errant vehicle behaves upon impact);
- The **inclination of a system's posts** should be vertical. Leaning posts, and particular those leaning out towards approaching traffic, can be detrimental to performance;
- **Connections and fixings** e.g. bolts, washers, brackets, torque, etc. (which affect the structural performance of the VRS);
- The **presence of corrosion / rust** (which affects system durability);
- **Availability of clear space** in front of and behind the system to allow the system to perform as intended during impact (e.g. no obstacles and hazards in front of the system or within its working width).

2.4 Identifying Issues

Issues relating to existing VRS and which may or may not require intervention can be identified and highlighted by a variety of stakeholders, such as Road Authority personnel, VRS or other maintenance contractors, An Garda Siochána or other emergency services, VRS Designers or Installers, or members of the public.

Regardless of how notification arises, all issues which have been (or which need to be) identified, should be subject to a VRS inspection.

[1] CEDR 2014 Publication (details to be added)

2.4.1 VRS Inspections

There are 3 main types of VRS inspections:

Table 2.2 - VRS Inspection Types

Safety Patrol	• Planned • To identify urgent defects	Ideally carried out every 4 weeks
Detailed Inspections	• Planned • To update inventory • To programme routine maintenance • To identify non-urgent defects	Ideally carried out every 2 years or 5 years (depending on the age of the system)
Safety Inspections	• Unplanned • To visit new collision sites or investigate complaints or damage reports	Carried out as required

It is important that as part of any inspection, the damage or fault on any given system is identified so that it can be given the appropriate priority and ultimately maintained to the ensure road safety for all users[2].

A higher frequency of inspections, cleaning or treatment may be necessary in some locations (e.g. where ground subsidence is common, in areas with known higher incidence of vandalism, etc).

Whenever possible, inspections (and particularly safety inspections) should be carried out by trained maintenance personnel. In this way any defects encountered which constitute an immediate hazard to the public can be identified and then either corrected, made safe, or otherwise protected at the time of discovery. As a minimum, the aim should be to warn motorists of the hazard, make safe if possible, and then report to head office at the earliest opportunity with a request for immediate action.

Detailed inspections will include checking of tensioned systems and torque.

Figure 2.4 - VRS Inspection

[2] W-Beam Guardrail Repair, A Guide for Highway and Street Maintenance Personnel (2008).

2.4.2 Pre-Inspection Collision Data

Where possible records of any known collisions involving VRS should be sourced from An Garda Siochána / Emergency Services in order to identify vehicle details.

This information may also be used by the Local Authority in recouping costs from motorist insurance policies where appropriate.

2.5 Design Considerations

2.5.1 Where Designer Input is Required

Before a damaged VRS is repaired or replaced, the requirement for the VRS should always be interrogated. In some situations, there may be an opportunity to remove, relocate or mitigate the hazard in some way and remove the barrier installation altogether i.e. create a more forgiving roadside.

Where the existing damaged barrier cannot be removed, an assessment should be made of the hazard(s) being protected to ensure that the VRS when repaired or replaced, covers the full extent of that hazard(s). This may lead to extending (or in some cases shortening) the length of need.

Where design related decisions need to be made which may affect VRS provision, it is essential that the input of a suitably trained and competent VRS designer is sought and that the resulting repair, replacement, modification or removal is in accordance with the current design standards.

2.5.2 Design to Reduce Future Risk

In terms of design input to VRS maintenance works, designers should consider two main threads in order to reduce future risk to operatives where maintenance cannot be avoided[3]:

a) Design so that future maintenance interventions are minimised; and

b) Design so that when maintenance is required it can be carried out safely.

2.5.3 Departures from Standard

For national roads, if a proposed repair solution contradicts or does not comply with current TII design standards, the designer should either apply for a Departure from Standard or generate a VRS Preliminary Design Report at design stage or at least in advance of any works. Retrospective departures will not be considered and therefore it is important that design or standards related decisions are agreed before site works commence.

Where the VRS related design standards do not cover certain aspects of repair or maintenance works, an agreement can be made with TII at design stage of the scheme as to how to proceed. This will help avoid the need for multiple departures for similar issues.

2.6 VRS Repair and Maintenance Technical Policies

2.6.1 Policy on Pre and Post EN1317 VRS Repairs

Like for Like

'Like for like' is the current TII policy when carrying out repairs to EN1317 compliant systems. The existing system should be identified and the correct components sourced to carry out the repairs correctly.

[3] Interim Advice Note 69/15: Designing For Maintenance

When addressing damage to pre-EN1317 barrier systems, including TCB, OBB and UCB, like for like components are also required. Such components are available on the open market and therefore non-availability cannot be argued.

Contractor prices should cover the cost of sourcing and installing the required system and components (and any specialist plant/equipment which may be required) to achieve a like for like repair. The nearest alternative components should not be used.

Repairs to pre-EN1317 barrier systems should be carried out in accordance with BS 7669-3: 1994 Vehicle Restraint Systems[4].

Different barrier profiles or systems should not be introduced or used in repairing a continuous length of barrier.

When a barrier system has gone out of production and the manufacturer can no longer supply components, the system should be scheduled for replacement as it cannot be properly maintained. In the event of a high priority repair being required on such a system, the repair can be carried out using a system with matching performance criteria and profile as a temporary measure until a full replacement of the barrier can be carried out.

2.6.2 Repair or Replace?

When a pre-EN1317 system has been scheduled for replacement, it must be replaced with an EN1317 compliant system.

Any beams or posts that have permanent structural damage (distortion, deformation, splitting, buckling) must be replaced. Damaged components must not be straightened and re-used.

Any fasteners (bolts, nuts, washers, connecting plates) that are removed during a repair must not be re-used and should be replaced.

Beam lap connection bolt holes on either side of the damaged section should be inspected for signs of splitting or stretching of the hole.

Any beams with signs of deformation at the lap connection bolt holes should be replaced[5].

[4] BS 7669-3:1994 Vehicle restraint systems. Guide to the installation, inspection, and repair of safety fences
[5] Guidelines for the Installation, Inspection, Maintenance and Repair of New and In-Service FlexBeam, FlexBeam PLUS, TranZFlex, Bri-Flex & FlexGuard EN 1317 Vehicle Restraint Systems (2010) & EasyRail XS Installation Manual (2014).

Figure 2.5 - Structurally damaged post should be replaced

2.6.3 When the Hazard is Removed

When a hazard which is protected by a VRS is removed (e.g. a large traffic sign is relocated, removed or mounted on passively safe supports) consideration should be given to removing the VRS i.e. if the only purpose for the VRS was to protect that hazard which is now removed.

2.6.4 Repairing Radius Beams

The performance of radius VRS (or VRS installed on a radius) is largely unknown as VRS systems are not tested in radius situations. Therefore, such installations are outside of EN1317.

When an existing radius barrier (using radius beams) is scheduled for repair or replacement, an assessment should be carried out to ascertain if the radius section could be removed and the hazard mitigated in some other way.

Where convex or concave radius beams are used and have been damaged (but cannot be removed), they should be repaired with the appropriate radius beams.

Figure 2.6 - Example of curved corrugated beams

The performance criteria of the existing radius VRS should be reviewed and if warranted should be increased (e.g. use a section of higher containment or lower working width VRS along the radius which will typically have closer posts centres and additional anchorage) in order to compensate for the reduced performance which is likely to arise with radius installations.

Where radius beams have to be used, care should be taken to source the correct radius beams for each location. (Some manufacturers mark their components with the radius value). Forcing the wrong beams into place which are not the correct radius is likely to strain the connections which results in in-built tension. This can be dangerous for operatives and can cause unacceptable structural damage to the beam when tightened. System performance may also be compromised if bolts are over tightened in order to align the beam correctly.

Figure 2.7 - Incorrect radius beam used in a repair

The VRS industry is constantly evolving and innovating, therefore the availability of a tested radius VRS solution should be checked from time to time in case a suitable solution becomes available.

2.6.5 Re-Tensioning

Re-tensioning of VRS which rely on tension for their performance (e.g. wire rope) should be carried out as a cyclic maintenance activity, ensuring the manufacturer's re-tensioning frequencies are met in full.

At a minimum, tensioning devices (e.g. tension buckles for wire rope systems) should be checked and reset to the correct level every two years (part of detailed inspections as described in Table 2.2 above).

Re-tensioning of proprietary systems shall be undertaken in accordance with the manufacturer's instructions. Tension in a wire rope system should be measured with a calibrated rope tension indicator in accordance with BS 7669-3: 1994 Vehicle Restraint Systems.

Tension in wire ropes should be checked after collisions. During these checks all ropes and fittings should be checked for any sign of damage.

In general, VRS shall be re-tensioned in sections. The re-tensioning of a section shall be completed by the end of each working period and in any event before the removal of any traffic management.

Note that when working on a tensioned wire rope VRS (which is installed on a horizontal curve), no maintenance personnel should be positioned on the inside of the system.

2.6.6 Torque

When a new section of VRS is being installed, or where replacement components are being installed to repair an existing VRS, the torque for all bolted connections should be set to the correct values as indicated in the manufacturer's installation manuals.

This should be done using a calibrated torque wrench in accordance with BS 7669-3: 1994 Vehicle Restraint Systems.

It should be noted that torque values measured on installation day may differ from the torque value measured on a subsequent day. This is partly due to the gradual deformation of the metals and their zinc coatings, expansion/contraction due to different temperatures, etc.

Figure 2.8 - Typical Torque Wrench

2.6.7 System Progression

Changes to working widths along a run of barrier require a gradual and even progression in order to avoid the risk of pocketing if a collision occurs. It is only permitted to connect two barriers where the difference in working width is no more than one class. Therefore, system progression is required to connect barriers which have a difference of two or more working width classes.

A minimum of 8m (typically two beam lengths) per working width should be provided to achieve system progression between barriers of different performance criteria. For example, in order to go from a W2 system to a W4 system, an 8m section (or two beams) of W3 should be installed between them.

For similar reasons, transitions are required between barriers and terminals, between barriers and parapets, and between systems of different containment levels. Care should be taken during repairs and replacements to ensure that appropriate transitions are catered for and are provided where required.

Figure 2.9 - Example of system progression to connect new replacement terminal and W2 transition to existing W5 barrier

2.6.8 Reflectors / Anti Dazzle Vanes / Sign Attachments

End terminal chevron plates shall be orientated so that the lines of the chevron point down towards the direction of the carriageway which the approaching driver should be driving on. This is illustrated in **Figure 2-10**.

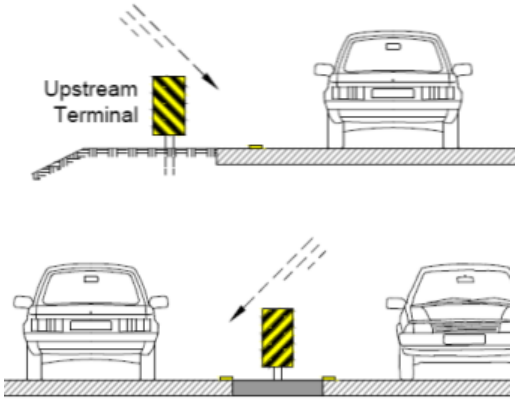


Figure 2.10 - (i) Orientation of chevrons on front face of terminal on nearside verge and (ii) on central reserve

Reflectors should be mounted on barriers at locations where additional delineation is considered necessary.

On single carriageways, VRS reflectors should be red on the left-hand (nearside) verge, and white on the right hand (offside) verge i.e. they should be double sided red and white, with red facing nearside traffic lane, and white facing the opposing lane as shown in **Figure 2-11**.

Figure 2.11 - Example of VRS reflector colours on a single carriageway: red on nearside, white on offside

Figure 2.12 - Incorrect reflector colour on nearside verge: should be red facing approaching traffic

Where installed on dual carriageway barriers, reflectors should be red on the left-hand (nearside) verge, and white on the central reserve barrier. Reflectors on dual carriageways should generally be single sided.

All reflectors should be installed in accordance with Chapter 6 of the Traffic Signs Manual and based on the following guidance:

- Reflectors on single carriageway roads should be installed at a maximum of 12m centres;
- On dual carriageways they should be installed at a maximum of 24m centres;
- Reflector centres can be reduced on narrower more sinuous sections of road where additional guidance/warning is required.

Manufacturer's installation manuals must always be consulted prior to installing any such attachments to ensure that they have no negative impact on system performance or CE certification.

2.6.9 Re-locating Traffic Signs / Lighting Columns

VRS installers should not in general relocate traffic signs or lighting columns or other road furniture that have been installed within a barrier's working width or in front of a barrier that affect the performance criteria of the barrier. Where sign relocation is required, this should be reported to the TII Signs Maintenance Manager or TII Regional Road Safety Engineer for the region or the relevant Road Authority.

In general, it is considered that the support(s) of a traffic sign present the primary hazard. Normal sign faces are not considered a significant hazard to the road user due to their mounting height and the lightweight nature of the sign plate.

Figure 2.13 - Sign support within working width of terminal

2.6.10 Tolerances

Dimensions and values specified by a Manufacturer in the system installation manual should be adhered to all times.

However, tolerances cannot be used to defend poor quality installation or repair works. The individual responsible for checking and certifying repair or other VRS works will determine whether tolerances have been achieved and where if any remedial works are required to address any shortcomings.

2.7 Certification, CE Marking and Traceability

2.7.1 General

Key to managing the certification and traceability of VRS is fully and correctly identifying the system. This ensures that the relevant documentation is at hand.

2.7.2 Pre-Installation Certification

Before barriers are repaired, replaced or installed, the following documentation relating to the proposed system is required to be submitted by the installer (for each type being used in the works) and reviewed by the Client or his/her Representative:

- System installation manual
- System drawings
- CE Certs (if EN1317 VRS)
- Declarations of Performance (if EN1317 VRS)

2.7.3 Post-Installation Certification

All barrier installation, repair and replacement work should be certified and signed off upon satisfactory completion by the appropriate persons (listed below) using templates similar to those provided in Appendix A. This certificate confirms that the system was installed in accordance with the manufacturer's installation manual and in accordance with the design/specification. Certificates should be signed by:

- Client PM
- Designer Team Lead (where design input was needed)
- Installer Team Lead

Certificates should be retained as part of the VRS asset database for future reference.

2.7.4 Identification Labels

Where pre EN1317 like-for-like repairs are carried out, identification labels are not required e.g. OBB or TCB repair.

Where EN1317 systems or components are used in repairs, replacements or any VRS works, identification labels should be attached in accordance with CC-SPW-00400 and CC-SCD-00416.

All new VRS installed shall have identification labels attached at the start and end of the system and at any changes in performance within the system length in accordance with CC-SPW-00400 and CC-SCD-00416.

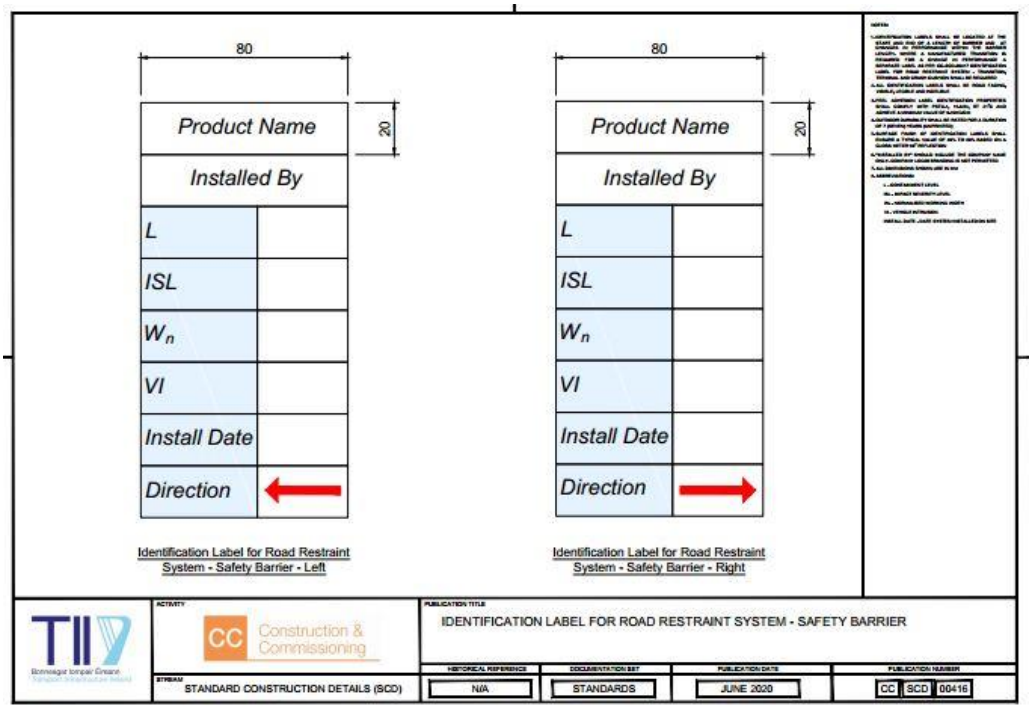


Figure 2.14 - VRS identification label from CC-SCD-00416

2.7.5 Traceability

Traceability markings are physical markings on VRS components and usually indicate where and by whom the system has been manufactured. The type and location of these markings varies from system to system.

Where possible all systems / components used should have traceability markings which will assist in identifying the system and sourcing replacement components etc.

Parts and components should have the correct manufacturer's markings. Spare parts etc should be from the original system if the CE mark is to remain valid for the repaired VRS.

Figure 2.15 - Example of Traceability Marking on VRS beam ('v' stands for Volkmann & Rossbach, Germany)

Figure 2.16 - Example of Traceability Marking on VRS post

2.7.6 Underground Services

VRS contractors/installers should always scan before they dig regardless of what level of utility information has been provided.

Driven posts should not be used where services are present in the verge and close to the line of the VRS is being installed.

Where concrete foundations are being used, excavations should be dug carefully, and foundation depths should be kept to a minimum. Consideration should be given to employing precast foundation systems where available.

If underground services are encountered upon excavation for post foundations and are required to be encased in the post foundation or will remain immediately adjacent, the VRS post when installed should be marked by the contractor with a services sticker to warn future repair crews of the possible dangers.

Figure 2.17 - Sample of warning sticker which should be used where services are located immediately under or beside a VRS support post

2.8 Health and Safety

2.8.1 General

The investigation and implementation of VRS interventions, including inspections and repair works, require personnel to work adjacent to or on live roads. All personnel involved in the works, including those carrying out the design and supervision functions, should seek to ensure that safe working practices can be achieved and are adopted at all times. No operation should cause danger to the employer, employee, contractor, subcontractor or any road user or other member of the public. Inconvenience should be kept to a minimum by careful pre-planning of the works.

All design and installation work should be carried out in accordance with the Safety, Health and Welfare at Work (Construction) Regulations (2013) or any subsequent revisions.

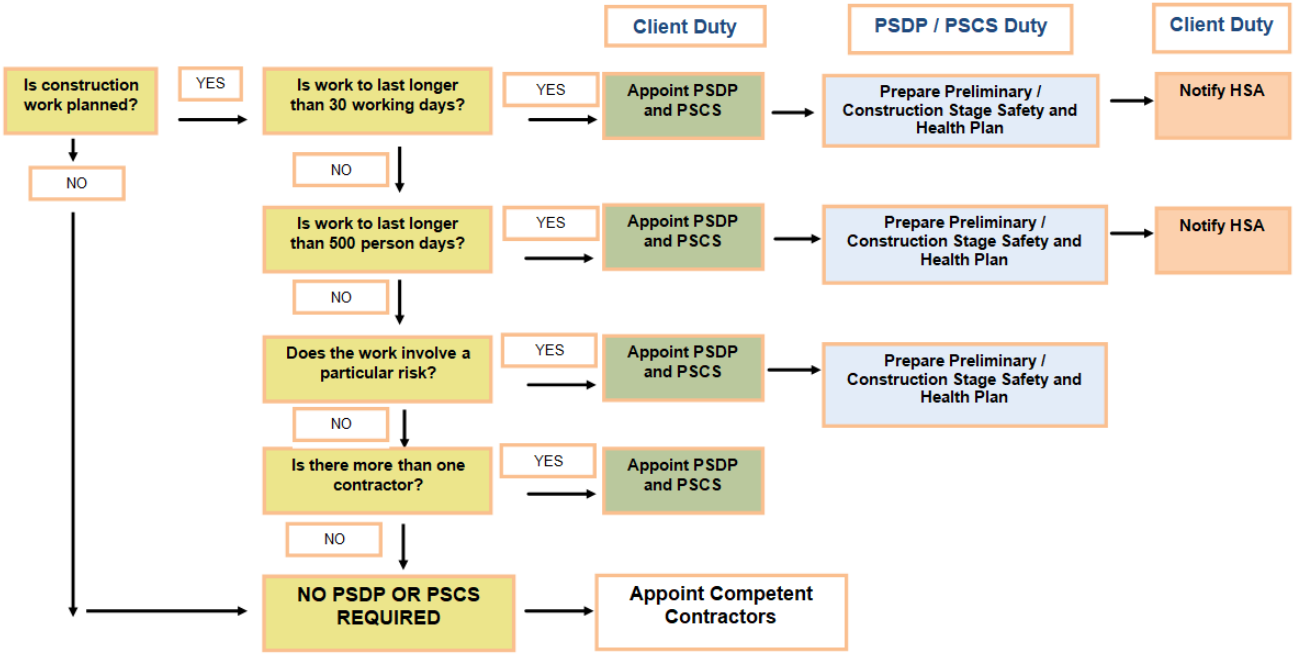


Figure 2.18 - PSDP/PSCS Legislative Requirements

2.8.2 Design VRS Interventions to Reduce Health & Safety Risks

Increase design life of VRS assets – Choose a design life taking account of both whole-life costs and the safety issues associated with in-service maintenance of the VRS system.

Ease of erection, placement and subsequent maintenance of VRS - Use socketed posts for safety barriers that are likely to be damaged frequently or could be difficult to access to repair e.g. where safety barriers are founded in concrete or driven through hardened surfaces, a sleeve or retention socket could assist speed of repair. Repair databases should be used to assist identification of high risk / high attrition locations. (Note that rigs to install safety barrier posts can be large and may require traffic management for long periods. Therefore, this concept has most merit where lane closures would be difficult).

Reduce Proximity of Operatives to Hazards - Increase verge and central reserve widths (including modest increase to safety barrier setbacks and working widths).

Improve Access to features which require maintenance Provide overlap in safety barriers to allow access to features (e.g. ITS equipment) to be maintained.

2.9 Disposal of Damaged or Obsolete VRS Components

All waste concrete or contaminated soil from damaged VRS must be disposed of in licensed construction and demolition waste facilities for recycling.

All waste metal components from damaged VRS must be disposed of in a licensed metal recycling facility.

Evidence of correct disposal methods should be provided by VRS contractors / installers to the client following completion of repair and maintenance works.

3. Repairs After Collision

3.1 Process Overview

The typical process for executing repairs to VRS after a collision is summarised as follows:

3.2 Reporting Damage

3.2.1 General

Reports of damage to a VRS resulting from a collision may come from a number of sources, such as An Garda Siochána, other emergency services, Road Authority personnel, maintenance patrols, or members of the public.

In cases where An Garda Siochána or other emergency services attend the scene of a collision, and damage has occurred to a VRS, they should immediately contact the relevant Road Authority (e.g. Area Engineer/Overseer) who can arrange to make the location safe, report the damage, and schedule an immediate Safety Inspection to be carried out.

Figure 3.1 - Photos from a collision attended by emergency services

3.2.2 TII Geo App

While any issues with an existing VRS on national roads should be picked up by VRS term maintenance contracts, VRS damage reports may also be uploaded onto the TII VRS defects portal via the TII GeoApp. Details to be recorded / reported include:

- Location (incl. co-ordinates)
- Length/extent of damage
- VRS type / manufacturer
- Height of system
- Post type / centres

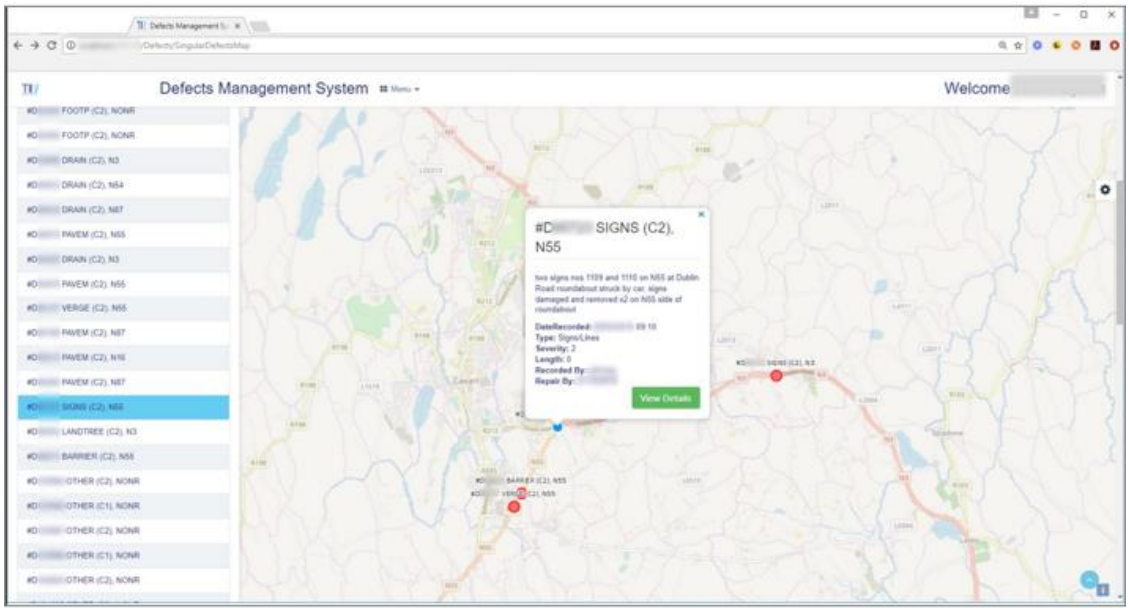


Figure 3.2 - Screen shot from TII GeoApp for reporting defects

3.2.3 Cost Recovery Information

Where practicable, efforts should be made to recover all costs incurred in repairing damaged sections VRS arising from a collision. These costs include the provision of traffic management, making safe, administration and ultimately repair. Information will be required from An Garda Siochána and insurance companies.

An Garda Siochána and/or the Road Authority should record details of all vehicles involved in collisions to enable the Road Authority to pursue insurance policies where appropriate to recoup VRS repair costs.

3.3 Making Safe a Damaged VRS

There are two scenarios to consider when making safe a damaged VRS:

(1) VRS impacted but can still perform:

If a VRS has been impacted but it is assessed as representing minor damage and should be capable of containing a subsequent impact, all debris from the collision should be cleared from the traffic lanes and placed behind the barrier outside the working width until a full assessment is carried out and all debris can be removed safely.

(2) VRS impacted and has suffered major damage:

If a VRS is assessed as being beyond function following a collision, measures should be put in place to warn drivers and protect the hazard if necessary until repair works can be carried out. Warnings to road users should be communicated through a combination of some or all of the following measures (and will depend on location, road type, traffic volumes, traffic speeds, etc.):

- Temporary warning signs
- Traffic cones
- Warning tape
- Flashing beacons

The damaged VRS / hazard location should be made safe by:

- **Removing** any loose or damaged components (e.g. beams, posts);
- **Treating** the ends of any exposed / unconnected beams to reduce the risk of spearing (e.g. protect or ramp down the last beam to the ground);
- **Using temporary safety barriers** (e.g. concrete, steel, plastic, all tested to EN1317-2 and provided with minimum length and appropriate end treatments) to ensure that the damaged barrier and the hazard behind it, are adequately protected. The choice to use concrete, steel or plastic temporary barriers should reflect the site-specific circumstances (e.g. the type and likely speed of vehicles using the road, the type and proximity of any hazards, the length of need, etc.). The minimum containment level of a temporary barrier system is T2. This may need to be increased in accordance with the hazard and location. (Refer to TII Publication DN-REQ-03034);
- **Using temporary wire rope hangers** to ensure that wire ropes are at the correct height until the posts are replaced;
- **Temporary traffic management** where required and appropriate should also be put in place before leaving site[6].

Figure 3.3 - Example of VRS damaged beyond function, but has not been made safe

[6] W-Beam Guardrail Repair, A Guide for Highway and Street Maintenance Personnel (2008).

Figure 3.4 - Example of damaged VRS protected by temporary barrier

Figure 3.5 - Example of damaged VRS at low risk location treated with temporary ramped beam and end plate to reduce risk of spearing

3.4 Safety Inspections

3.4.1 Requirements

Safety Inspections may be required in response to patrols, reports of new collisions or complaints/issues from the emergency services, other authorities and organisations, or as a result of other collisions, major incidents or extreme weather events.

Safety Inspections should provide sufficient detail to determine the actions required to repair the damaged barrier.

3.4.2 Records

The information captured by Safety Inspections should include all those items included on the Safety Inspection Record Form which is included in Appendix B. Reports should also include a record of any action taken during the inspection (e.g. making safe, dropping beams, removals, etc).

Safety Inspection Report Forms should be completed as far as possible at the time of the inspection.

Reference Name	Content	Image Required
Asset ID [VRS-Route ID-Four Digit Sequential No.] (i.e. VRS-RN-N05-0001)	County abbreviation; route number and four digit unique number (e.g. VRS-RN-N05-0001)	
Safety Inspection Date	Insert inspection date	
VRS Inspector	Contractors VRS Inspector	
Positional Accuracy (cm)		
GPS/GNSS Receiver		
Route (i.e. N05)		
County	Mayo (MO) / Leitrim (LM) / Roscommon (RN) / Sligo (SO)	
Route ID (i.e. RN_N05)	County abbreviation & route number	
Road Type	Motorway / Type 1 Dual Carriageway / Type 2 Dual Carriageway / Standard Single Carriageway / Non-Standard Single Carriageway / Single Carriageway	
Speed Limit	50 km/h / 60 km/h / 80 km/h / 100 km/h / 120 km/h	
Upstream Terminal Damage		
Upstream Terminal Damaged [*]	Yes / No	Yes
Upstream Terminal Transition Damaged [*]	Yes / No	Yes
Damage Description		
Repair Priority	High / Medium / Low	

Figure 3.6 - Example of Safety Inspection Report Form Template

Where a VRS is encountered and its type cannot be identified, an identification request should be made to an industry expert or to the Irish Barrier Association (IBA) which will endeavour to provide an appropriate determination (www.irishbarrierassociation.ie).

Once Safety Inspection Report Forms are completed and submitted with recommendations for any further action, any action required shall generally be subject to an Employer Instructed Works Order.

3.5 Prioritising Repair

As budgets are limited, not all repair works can be carried out immediately and not all systems can be maintained in an ideal as-built condition. Instead, road authorities should focus on prioritising repair work, based on high-risk locations and damage which is considered to have a detrimental effect on the safety performance of the VRS.

The distinction between minor damage and more severe performance-altering damage, however, is not always clear. In the case of a high severity collision involving beam breaks, the need for VRS repair is obvious. Much more common, though, is minor damage, e.g. a shallow dent which occurs in a low-speed collision or a sideswipe impact. Minor damage to VRS may also result from routine road maintenance operations (e.g. grass cutting, hedge trimming, pavement overlay works, etc.) or exposure to the environment, which may lead to corrosion.

3.5.1 Damage Assessment

Once identified, all VRS defects and damage should be assessed and the required action prioritised as HIGH, MEDIUM or LOW based on the severity of damage and the continued functionality of the barrier. This prioritisation will dictate how quickly the necessary repair work needs to be carried out.

- **HIGH** – VRS is no longer reasonably functional. Defects should be addressed promptly as they pose an immediate risk.
- **MEDIUM** – VRS should function adequately under a majority of impacts. Defects should be addressed within 6 months of inspection.[7]
- **LOW** – Damage should not affect the VRS's ability to perform[8]. Defects identified should be addressed within 9 months of inspection (or as otherwise determined by the inspection team with justification).

[7] BS 7669-3 Vehicle Restraint Systems (1994).
[8] W-Beam Guardrail Repair, A Guide for Highway and Street Maintenance Personnel (2008).

Figure 3.7 - Example of 'traffic light' risk priority mapping of VRS based on High, Medium, Low assessments

3.5.2 High Priority – Examples of Damage

- Beam sections are not continuous and have broken or lap joints have separated;
- Three or more posts are broken or have separated from the beam;
- Single bent post if facing oncoming traffic;
- Leaning posts facing oncoming traffic;
- Deflection of the beam by more than 450mm;
- Steel beam encroaching into carriageway or footway;
- Considerable displacement of concrete safety barrier, greater than 60mm;
- Steel beam section torn (horizontally or vertically);
- Low mounting height;
- Wire ropes lying on the ground or broken;
- Terminals/anchors damaged;
- Significant corrosion likely to affect structural integrity or performance;
- Clearly visible damage to concrete VRS such as cracks, concrete breakings, and clearly visible deformation of the soil anchors and/or coupling elements of precast concrete systems.

Figure 3.8 - Example of 'High Priority' Damage (beams detached from posts)

Figure 3.9 - Example of 'High Priority' Damage to precast concrete VRS (significant displacement > 60mm)

3.5.3 Medium Priority – Examples of Damage

- Beam sections are continuous and lap joints have not separated (can be bent or partially flattened);
- 2 or fewer posts are broken or have separated from the beam;
- Deflection of the steel beam is less than 300mm;
- Deflection of concrete barrier is less than 60mm;
- Soil anchorages and coupling elements of precast concrete units are not affected by deformation;
- Corrosion likely to affect the structural integrity[9].

Figure 3.10 - Example of 'Medium Priority' Damage (single post damaged, beam slightly bent, deflection < 300mm)

3.5.4 Low Priority – Examples of Damage

- Beam sections are continuous and lap joints have not separated (can be partially crushed or flattened);
- No posts are broken or separated from the beam;

[9] NCHRP Report 656 Criteria for Restoration of Longitudinal Barriers (2010).

- Deflection of the steel beam is less than 150mm;
- Superficial damage with no loss of integrity or no negative effect on system performance;[10]
- No displacement of concrete barrier, tyre abrasion or scratch marks are the only signs. No visible cracks or spalling;
- No deformation of the soil anchorages or coupling elements of precast concrete units.

Figure 3.11 - Example of 'Low Priority' Damage (no posts broken or detached, deflection < 150mm)

3.5.5 Length of Damage vs Length of Repair

As a general rule of thumb, if more than 50% of a length of barrier is damaged or out of specification the entire length of barrier should be replaced. If the damage is less than 50% a repair should be carried out.

If a VRS is impacted within 50m of a terminal the assessor should inspect the terminal for any signs of damage, movement of anchor posts, slack in tension components, etc.[11]

On National Roads, following assessment and prioritisation of defects TII will schedule repair Call-Offs based on available budgets. Medium and low priority repairs will be scheduled following completion of high priority repairs.

3.6 Repair Works

3.6.1 Procurement

There are a number of avenues for procuring VRS repair works following a collision. The following summarises those available for repair on the National Road Network, but some may also be applicable to non-national roads also.

- **TII Motorway Maintenance and Renewals Contracts (MMaRC):** MMaRC contractors are under a term contract to carry out any repairs to VRS on their section of the motorway or dual carriageway network. Any collisions are reported immediately to the Operating Company who arranges for the appropriate category of response to be actioned.

[10] NCHRP Report 656 Criteria for Restoration of Longitudinal Barriers (2010).
[11] Guidelines for the Installation, Inspection, Maintenance and Repair of New and In-Service FlexBeam, FlexBeam PLUS, TranZFlex, Bri-Flex & FlexGuard EN 1317 Vehicle Restraint Systems (2010) & Guidelines for the Installation, Maintenance and Repair of Tata Steel Vetex Road Safety Fence Systems (2010).

- **Regionalised VRS Maintenance Contracts:** Similar to the MMaRC contracts, regions of the country have been allocated to specialist VRS contractors to maintain and repair all VRSs within that region. Therefore, any collisions and resulting VRS repair works arising should be reported to this VRS contractor who will arrange for the appropriate category of repair to be carried out.
- **VRS Maintenance Contracts - Emergency Call-Out:** Under the TII VRS Maintenance Contracts, a Road Authority can seek to get emergency VRS repair works carried out by the specialist VRS contractor in the region. The Contractor should be available to respond to call outs and make the site safe within 24 hours of being notified.
- **TII VRS Framework – Emergency Call-Off:** Under the TII VRS Framework Contract, a Road Authority can seek to get direct emergency VRS repair works carried out up to a prescribed maximum value (e.g. €15,000) by one of the TII Framework Contractors. This generally only applies if there is no design input required. (Note the current TII VRS Framework Contract should be checked to ascertain current maximum value)
- **TII VRS Framework – Designed Call-Off:** TII's VRS Framework for VRS repair and replacement can be used by Local Authorities to procure a contractor for VRS repairs after collisions. The design for such a Call-Off can be carried out by the Local Authority or by a consultant on their behalf, once the designers involved have completed the 2-day TII VRS Designers Training Course.
- **Isolated Repair Contract:** Local Authorities can also use their in-house public procurement procedures to appoint a contractor for VRS repairs after a collision.

Figure 3.12 - VRS repair works underway

3.6.2 Standard of Works

All VRS repair works must be carried out in accordance with CC-SPW-00400 Specification for Road Restraint Systems and the installation manuals of the VRS systems and types being used in the repair works.

3.6.3 Supervision

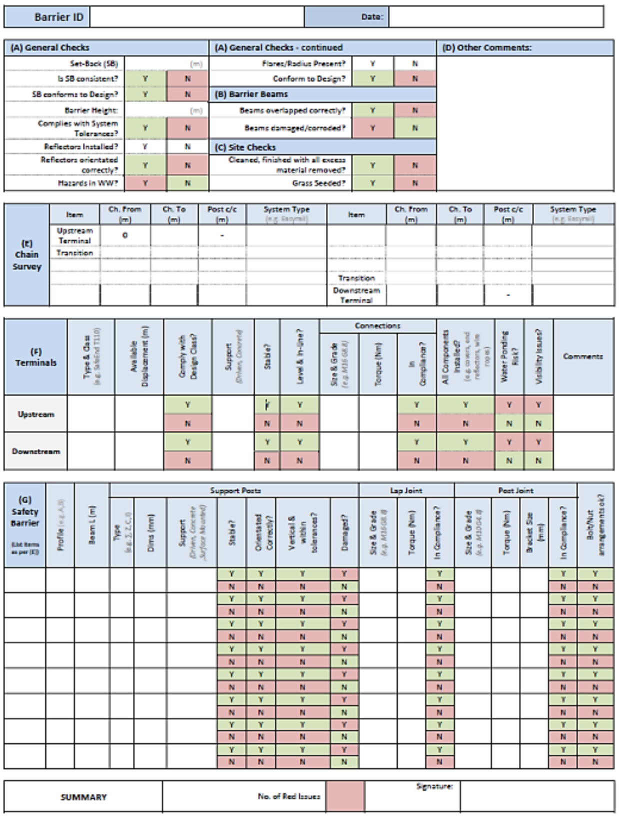
It is the responsibility of the Contracting Authority to ensure that the VRS works are executed in accordance with the Works Requirements and Specifications. To this end monitoring and supervision of the works is a key activity, and those involved should be trained and experienced.

Regular site visits should be carried out at all stages of installation. Key issues to monitor, check and inspect on site during the construction works include:

- Check installation training for installers;
- Ensure all drawings, repairs schedules, installation manuals are on site;
- Carry out Quality checks;
- Enforce any specified ‘hold points’ e.g. inspection of foundation excavations where concrete footings are required;
- Carry out a detailed snag of all works at the end of the project (using a snag list template to ensure a full and methodical snag process) and insist that all snags are rectified.

Figure 3.13 - Example of hold point, where dug foundations must be inspected prior to pouring concrete

Figure 3.14 - VRS snagging underway



Barrier ID		Date:	

(A) General Checks			(A) General Checks - continued			(D) Other Comments:
Set-Back (SB)		(m)	Flares/Radius Present?	Y	N	
Is SB consistent?	Y	N	Conform to Design?	Y	N	
SB conforms to Design?	Y	N	(B) Barrier Beams			
Barrier Height:		(m)	Beams overlapped correctly?	Y	N	
Complies with System Tolerances?	Y	N	Beams damaged/corroded?	Y	N	
Reflectors Installed?	Y	N	(C) Site Checks			
Reflectors orientated correctly?	Y	N	Cleaned, finished with all excess material removed?	Y	N	
Hazards in WW?	Y	N	Grass Seeded?	Y	N	

(E) Chain Survey	Item	Ch. From (m)	Ch. To (m)	Post c/c (m)	System Type (e.g. Easyrail)	Item	Ch. From (m)	Ch. To (m)	Post c/c (m)	System Type (e.g. Easyrail)
	Upstream Terminal	0		-						
	Transition									
						Transition				
						Downstream Terminal			-	

(F) Terminals	Type & Class (e.g. SafeEnd T110)	Available Displacement (m)	Comply with Design Class?	Support (Driven, Concrete)	Stable?	Level & In-line?	Connections: Size & Grade (e.g. M16 G8.8)	Connections: Torque (Nm)	Connections: In Compliance?	All Components Installed? (e.g. covers, end reflectors, w/e ropes)	Water Ponding Risk?	Visibility Issues?	Comments
Upstream			Y		Y	Y			Y	Y	Y	Y	
			N		N	N			N	N	N	N	
Downstream			Y		Y	Y			Y	Y	Y	Y	
			N		N	N			N	N	N	N	

(G) Safety Barrier (List items as per (E))	Profile (e.g. A,B)	Beam L (m)	Support Posts: Type (e.g. Σ, Z, C, I)	Support Posts: Dims (mm)	Support Posts: Support (Driven, Concrete Surface Mounted)	Support Posts: Stable?	Support Posts: Orientated Correctly?	Support Posts: Vertical & within tolerances?	Support Posts: Damaged?	Lap Joint: Size & Grade (e.g. M16 G8.8)	Lap Joint: Torque (Nm)	Lap Joint: In Compliance?	Post Joint: Size & Grade (e.g. M10 G4.6)	Post Joint: Torque (Nm)	Post Joint: Bracket Size (mm)	Post Joint: In Compliance?	Bolt/Nut arrangements ok?
						Y	Y	Y	Y			Y				Y	Y
						N	N	N	N			N				N	N
						Y	Y	Y	Y			Y				Y	Y
						N	N	N	N			N				N	N
						Y	Y	Y	Y			Y				Y	Y
						N	N	N	N			N				N	N
						Y	Y	Y	Y			Y				Y	Y
						N	N	N	N			N				N	N
						Y	Y	Y	Y			Y				Y	Y
						N	N	N	N			N				N	N
						Y	Y	Y	Y			Y				Y	Y
						N	N	N	N			N				N	N
						Y	Y	Y	Y			Y				Y	Y
						N	N	N	N			N				N	N
						Y	Y	Y	Y			Y				Y	Y
						N	N	N	N			N				N	N

SUMMARY	No. of Red Issues		Signature:	

Figure 3.15 - Sample VRS Installation Snag List Form

3.7 Record and Certify

Upon completion of the installation works for any VRS repair, the following information is to be provided to the Employer's Representative by the VRS contractor. These details shall be provided for each system type including barriers, terminals, transitions and crash cushions.

- Installation Log – including details of where each system was installed, and details of the supplier/source of each system;
- Details of services encountered during installation (note services may not be encountered on a like for like repair);
- Maintenance manuals/requirements;
- Completed Installation Certificate

Figure 3.16 - Example of a VRS Installation Certificate

All new VRS installed shall have identification labels attached at the start and end of the system and at any changes in performance within the system length in accordance with CC-SPW-00400 and CC-SCD-00416. Separate identification labels are required on barriers, terminals, transitions and crash cushions.

Using the information provided by the VRS contractor, as constructed record drawings of the completed installation should be prepared for future reference.

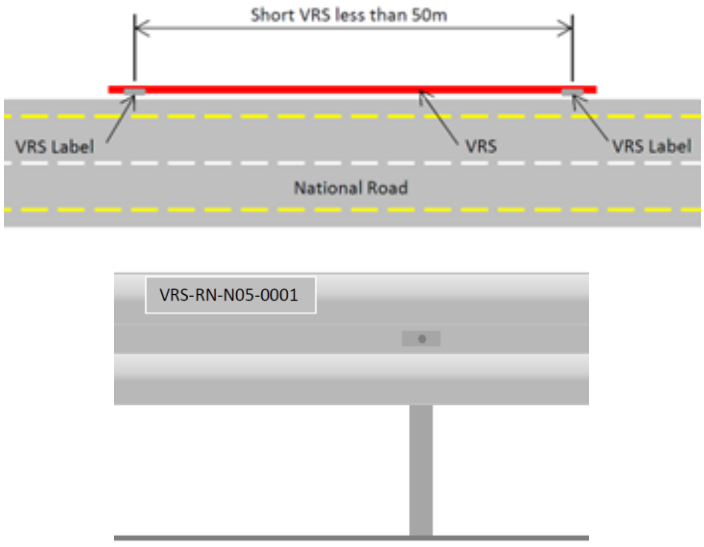


Figure 3.17 - Example of labelling on short VRS (plan & elevation)

3.8 Repair Issues & Rules of Thumb

3.8.1 Terminals/Transitions

Terminals that have been damaged and are scheduled for repair should be replaced with prEN1317-7 tested and approved terminals.

Terminal performance class should be in accordance with TII Publication DN-REQ-03034. Only terminals that have been approved by TII through the Terminal Assessment Procedure DN-REQ-03080 and appear on TII's Compliant Terminal Systems List can currently be installed on the National Road Network.

When installing a new prEN1317-7 terminal at a repair location, only the tested and approved transition to the safety barrier can be installed. This may require the removal of a section of undamaged existing barrier in order to accommodate the terminal and its approved transition.

Figure 3.18 - Examples of prEN1317-7 terminal and transition installed as part of a VRS repair

3.8.2 System Progression

When repairing/replacing terminals, adequate system progression is required to achieve a gradual transition from the terminal to the original safety barrier.

If a barrier adjacent to a terminal is being inspected and the Assessor notes that an approved transition has not been provided between the terminal and the barrier system, it should become part of the repair works to install an approved transition to the terminal.

Figure 3.19 - System progression between replaced terminal/ transition and existing VRS

3.8.3 Cutting Beams

In accordance with TII Publication CC-SPW-00400 Section 3.1.8, no drilling, cutting (including flame cutting) or welding of beams and posts shall be permitted on site to accommodate repairs or installation. Therefore, any non-standard or special closure pieces must be pre-ordered, fabricated before the application of any protective coating, and delivered to site.

While certain system installation manuals allow for cutting of components, national regulations take precedence.

Figure 3.20 - Short cut pieces are not permitted

3.8.4 Torque and Tension

Torque and tension must be checked on both new installations and repairs carried out to ensure that they are within the range specified in the system installation manual. Incorrect torque or tension may result in a system not performing as intended during an impact.

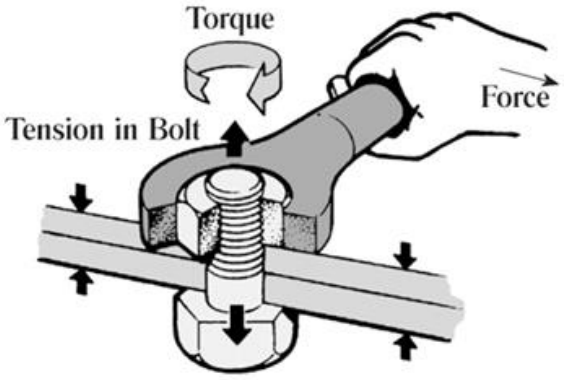


Figure 3.21 - Torque

3.8.5 Constrained Locations

In order to repair damaged VRS at constrained locations performance criteria may have to be compromised. If the repair is High Priority a temporary repair may be carried out promptly and then the barrier should be reported as a constrained location for upgrade. Any temporary repair should utilise a VRS which has equivalent containment level to the existing VRS and should overlap the damaged section by at least 8m (usually two beam lengths).

A condition survey of the existing VRS and a VRS risk assessment of the location must then be scheduled and carried out under TII publication DN-REQ-03079 - Design of Road Restraint Systems for Constrained Locations (Online Improvements, Retrofitting and Urban Settings) which provides a process for developing a risk-based solutions for VRS in constrained locations.

If the repair is Medium or Low Priority, it should be reported as a constrained location without carrying out any repair. The barrier as a whole can then be assessed under TII publication DN-REQ-03079 to provide an adequate solution.

Figure 3.22 - Example of constrained location with minimal/no working width available

3.8.6 Replacing Posts

When an existing driven post has moved out of position due to an impact, the new replacement post should not be driven into the same hole.

The enlarged postholes can be filled and packed with fine material to provide adequate stability to a new driven post[12]. Longer driven posts or additional posts are options to provide further stability[13] (subject to system installation manuals). If the above options for repairing a driven post fail, then a concrete foundation may be used[14].

Posts for any wire rope system which are leaning and are not vertical, and particularly those which are leaning towards on-coming traffic, should be removed and replaced as soon as possible.

[12] EasyRail XS Installation Manual (2014) & Heintzmann-Basic-Barrier Installation Manual.
[13] Heintzmann-Basic-Barrier Installation Manual.
[14] BS 7669-3: 1994 Vehicle Restraint Systems & Guidelines for the Installation, Inspection, Maintenance and Repair of New and In-Service FlexBeam, FlexBeam PLUS, TranZFlex, Bri-Flex & FlexGuard EN 1317 Vehicle Restraint Systems (2010).

Figure 3.23 - Example of driven post moving in the ground

3.8.7 Re-Using Posts

Where existing driven posts have moved less than 300mm resulting from an impact, and have not suffered any material or structural damage, they can be re-used.

When a post has moved in the ground due to an impact but has not buckled near ground level (i.e. no plastic hinge has formed) it may indicate that the ground was not suitable for driven posts. Ground testing should be carried out to determine the appropriate foundations for the repair[15].

If a post in a concrete foundation has moved following impact, and there are no signs of structural damage or buckling on the post, it is clear that the foundation has moved / failed. Therefore, the post and its foundation must be replaced[16].

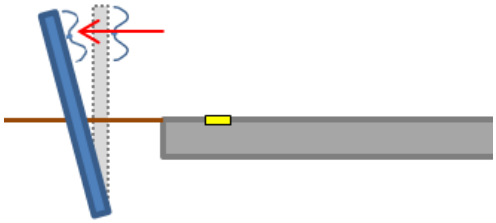


Figure 3.24 - Example of post which has moved but has not suffered structural damage

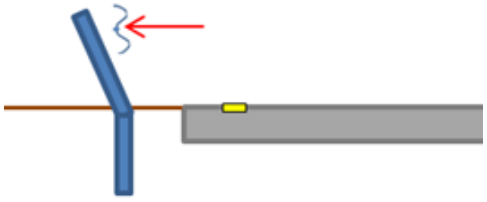


Figure 3.25 - Example of post which has developed a plastic hinge

[15] BS 7669-3: 1994 Vehicle Restraint Systems.
[16] Guidelines for the Installation, Inspection, Maintenance and Repair of New and In-Service FlexBeam, FlexBeam PLUS, TranZFlex, Bri-Flex & FlexGuard EN 1317 Vehicle Restraint Systems (2010).

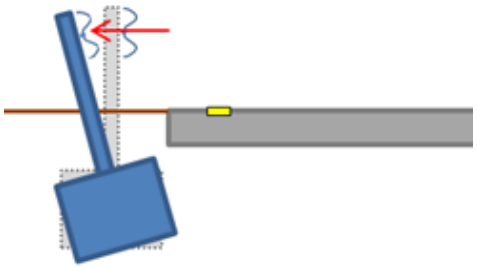


Figure 3.26 - Example of failed foundation

3.8.8 Post Driving

All post driving rigs should be fitted with the correct driving head/attachment to suit the posts being installed. Excessive damage to the post head is not acceptable and such posts will need to be replaced.

If ground conditions are too hard and driving is causing damage to the posts concrete foundations should be used[17].

Figure 3.27 - Unacceptable damage to post from driving rig

3.8.9 Concrete Foundations

Where a post in a concrete foundation has been damaged, both the post and the foundation should be removed and replaced with a new designed foundation.

Even where new concrete foundation positions do not coincide with the existing, the existing footings should be removed and the ground reinstated.

[17] Guidelines for the Installation, Maintenance and Repair of Tata Steel Vetex Road Safety Fence Systems (2010), EasyRail XS Installation Manual (2014), Heintzmann-Basic-Barrier Installation Manual, Guidelines for the Installation, Inspection, Maintenance and Repair of New and In-Service FlexBeam, FlexBeam PLUS, TranZFlex, Bri-Flex & FlexGuard EN 1317 Vehicle Restraint Systems (2010) & Specification for Road Works Series 400 – Road Restraint Systems (2015).

Figure 3.28 - Damaged posts with concrete footings removed, being replaced with new designed foundations

When carrying out an inspection of a damaged VRS with concrete foundations, the approximate size of the existing concrete foundation can be estimated by exposing the top of the foundation (for length and width) and using a probe (for depth). This information can be useful to estimate the volume of concrete required.

Care should be taken by the contractor to ensure that any new or replacement concrete foundations are of a regular shape. Domed 'Subbuteo' type footings are liable to rotate during impact, which prevents a plastic hinge being formed at ground level, and which in turn means the beam may not separate from the post as intended.

Figure 3.29 - Example of domed concrete foundation which has rotated in the ground, preventing plastic hinge from forming

Formwork can also be used for concrete foundations on level ground if the sides of the excavation are falling in[18].

Concrete foundations installed on sloped ground can be difficult to construct and may compromise the performance of the system. In some cases, foundations can be constructed on sloped ground using formwork to achieve the correct dimensions as per the foundation design. Verge works should then be carried out to backfill around the foundation as it is important that the foundation is adequately supported on all sides to achieve the required overturning resistance.

[18] Guidelines for the Installation, Inspection, Maintenance and Repair of New and In-Service FlexBeam, FlexBeam PLUS, TranZFlex, Bri-Flex & FlexGuard EN 1317 Vehicle Restraint Systems (2010).

Figure 3.30 - Example of concrete foundation breaking away from edge of embankment due to lack of ground support behind

Alternatives to traditional concrete foundations might involve using precast concrete foundations located in the verge or partially under the pavement, or the use of ground improvement VRS Pin or Screw anchors.

The top of concrete foundations should be installed at the correct level as set out in the system installation manual and design drawings. Foundations should be covered with topsoil to make up the ground level, to ensure the system is installed to the correct mounting height and to avoid the effects of freeze/thaw. (Note precast or concrete plinth solutions should be designed such that any exposed element is not adversely affected by weather conditions).

Figure 3.31 - Example of exposed concrete foundations

3.8.10 Ground Testing for Repairs

Ground testing for VRS repairs shall be carried out in accordance with TII Publication CC-SPW-00400 Specification for Road Restraint Systems and should also consider the barrier system's testing requirements.

Ground stability could be affected by an impact and therefore driven posts may not perform in this ground as they had previously[19]. The ground testing will determine the need for driven post, longer driven post or concrete foundation etc.

[19] Guidelines for the Installation, Inspection, Maintenance and Repair of New and In-Service FlexBeam, FlexBeam PLUS, TranZFlex, Bri-Flex & FlexGuard EN 1317 Vehicle Restraint Systems (2010) & Guidelines for the Installation, Maintenance and Repair of Tata Steel Vetex Road Safety Fence Systems (2010).

Figure 3.32 - Push testing in progress

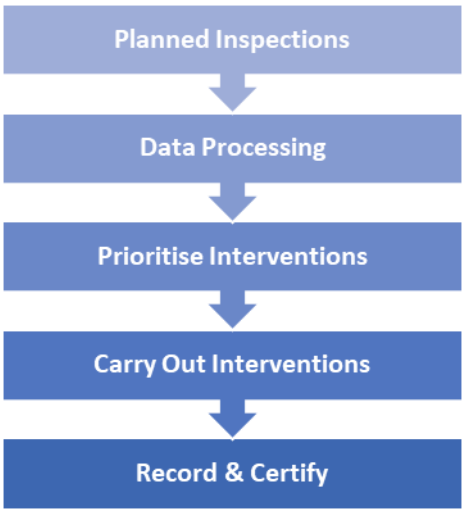
If there is evidence that the existing concrete foundation had moved during the impact, it may not have been sized correctly. Therefore, ground testing should be carried out on a larger foundation to ensure it is adequate.

4. Planned VRS Maintenance

4.1 Process Overview

A planned VRS maintenance regime is a periodically recurring activity under which VRS are inspected, and where necessary modified, to address defects or damage in order to maintain the 'target state' of the VRS system.

The typical process for implementing planned VRS maintenance is summarised as follows:



4.2 Planned Inspections and Patrols

4.2.1 Safety Patrols

Safety Patrols are necessary to identify new defects or damage which pose a hazard or serious inconvenience to the road user and which therefore require immediate or urgent attention. They are usually 'drive-by patrols' conducted from a slow-moving vehicle by someone competent of identifying and categorising damage.

When damage is encountered during a Safety Patrol, a Safety Inspection should be scheduled and carried out in accordance with Section 3.4 which will lead to a repair being prioritised.

Table 4.1 - Safety Patrol Frequency

Road Type	Inspection Frequency
All motorways & dual carriageways	monthly
Single carriageway National Primary Road	monthly
Single carriageway National Secondary roads	bi-monthly
Other roads	bi-annually

4.2.2 Detailed Inspections

Detailed Inspections are carried out at less frequent intervals than Safety Patrols and are designed to compile VRS inventories, detect any VRS defects or non-compliance issues that may affect the VRS's performance or pose a hazard to road users and establish a programme for routine maintenance tasks not requiring urgent attention.

The Detailed Inspection shall also record VRS which may be non-compliant with the current design standards DN-REQ-03034 and DN-REQ-03079 or system installation manuals which may render them obsolete.

Detailed Inspections should be carried out on-foot using a comprehensive Inspection Checklist.

Reference Name	Content	Image Required
VRS Inspector	Contractors VRS Inspector	
Positional Accuracy (cm)	Insert worst accuracy observed while recording data	
GPS/GNSS Receiver		
Route (i.e. N05)		
County	Mayo (MO) / Leitrim (LM) / Roscommon (RN) / Sligo (SO)	
Route ID (i.e. RN_N05)	County abbreviation & route number	
Road Type	Motorway / Type 1 Dual Carriageway / Type 2 Dual Carriageway / Standard Single Carriageway / Non-Standard Single Carriageway / Single Carriageway	
Speed Limit	50 km/h / 60 km/h / 80 km/h / 100 km/h / 120 km/h	
Lane Width [#]	Measured on site	
Hard Shoulder Width [#]	Measured on site	
Terminal Details		
Terminal Location [*]	Upstream / Downstream	Yes
Terminal Manufacturer	Manufacturer	
Terminal System	System Name	
Terminal Performance Class [*]	Short Ramp / P1 / T80 / T110 / Unknown	Yes
Available Displacement in Front of Terminal (x) [#] [*]	Measured on site	Yes
Available Displacement Behind Terminal (y) [#] [*]	Measured on site	Yes
Available Exit Box in Front of Terminal (Za) [#] [*]	Measured on site	Yes
Available Exit Box Behind Terminal (Zd) [#] [*]	Measured on site	Yes
Terminal Anchor Post Stability [*]	Ok / Minor Movement / Poor Stability	Yes
Terminal Anchor Post Foundation Type [*]	Driven / Concrete / Socketed / Unknown	Yes
Terminal Connection Bolts (Size & Grade) (i.e. M16 Grade 8.8) [#] [*]	Measured on site	Yes
Are Terminal Bolts Tightened to the Correct Torque [#]	Yes / No	
Terminal Bolts Torque Description		
Is the Terminal Retroreflective End Label Installed Correctly [*]	Yes / No	Yes
Has the Terminal Wire Rope been Installed Correctly [*]	Yes / No / N/A	Yes
Has the Correct Transition been Installed for the Terminal [*]	Yes / No	Yes
Terminal Length (m)	Automatically Calculated Field	

Figure 4.1 - Extract from a sample Detailed Inspection checklist

When damage is encountered during a Detailed Inspection a Safety Inspection should be carried out in accordance with Section 3.5 which will lead to a repair being prioritised.

4.2.3 Detailed Inspection Requirements

The information captured by Detailed Inspections should include all those items included on the relevant Inspection Record Forms (see Appendices B & C) including:

- system details
- corroded steel posts / beams / components
- corroded concrete
- missing sections / components
- deformation
- loose panels
- rotten timbers
- loose anchors
- loose posts
- inclined posts
- loose bolts
- incorrect torque (where torque is specified)
- incorrect tension
- incorrect system components
- height too high or too low
- erosion of ground

Detailed Inspections of steel barrier systems shall include a check of the actual height against the allowable height certified for that system i.e. a check to ensure the system is not out of spec due to pavement overlays or ground settlement.

Detailed Inspections of wire rope system shall check for any damage to the ropes, any damaged or missing spacers or other components, tension of the wire ropes, leaning posts and anchorage units.

Detailed Inspections of concrete barriers shall be carried out in respect of height and structural condition.

Detailed Inspections will include any tensioning devices of steel tensioned safety barriers including wire rope.

Table 4.2 - Detailed VRS Inspection Frequency

VRS Age	Inspection Frequency
Steel < 10 years Concrete < 15 years	Every 5 years
Steel > 10 years Concrete > 15 years	Every 2 years

4.2.4 Inspection Schedule

Detailed Inspection of a VRS can only be carried out using the specific installation/maintenance manual for that system, otherwise the requirements for system will not be known, and it will not be possible to identify what is correct and what is not.

Where a barrier type cannot be identified, an identification request should be made to an industry expert or to the Irish Barrier Association (IBA) which will endeavour to provide an appropriate determination. (Refer to www.irishbarrierassociation.ie).

Detailed Inspections should be arranged to minimise disruption to traffic, other road users and the public, while ensuring adequate access to allow proper inspection and provide a safe working environment for the inspection personnel involved.

Whenever practicable, Detailed Inspections which necessitate lane occupations should be carried out in conjunction with other Operations.

4.2.5 Inspection Schedule

On single carriageway roads the normal survey direction is that of increasing asset numbers. Where practical, on all roads, survey work should move in the same direction as traffic flow.

4.2.6 Records

The information captured during Detailed Inspections should include all those items included on the Inspection Record Form which are included in Appendix C. Reports should also include a record of any action taken during the inspection.

Inspection Report Forms should be completed as far as possible at the time of the inspection.

Where possible inspections should be carried out with hand-held data capture devices, using standard data capture applications that include checklists setting out the various defects to be noted.

Figure 4.2 - Example of data collector tablet with GPS receiver

Once Inspection Report Forms are completed and submitted with recommendations for any further action, any such action required shall be subject to an Employer Instructed Works Order.

4.2.7 Making Damaged VRS Safe

If during the course of an inspection a VRS is assessed as being beyond function, measures should be put in place to warn drivers and protect the hazard until maintenance works can be carried out.

Warning to road users should be communicated through a combination of some or all of the following measures (will depend on location, road type, traffic volumes, traffic speeds, etc.):

- Temporary warning signs
- Traffic cones
- Warning tape
- Flashing beacons

The damaged barrier should be made safe by:

- Removing any loose or damaged components (e.g. beams, posts).
- Treating the ends of any exposed / unconnected beams to reduce the risk of spearing (e.g. ramp down the last beam to the ground).
- Using temporary safety barriers of minimum containment level of T2 to ensure that the defective barrier and the hazard behind it, are adequately protected. The choice to use concrete, steel or plastic temporary barriers should reflect the site-specific circumstances (e.g. the type and likely speed of vehicles using the road, the type and proximity of any hazards, the length of need, etc.). The minimum length of temporary barrier provided should be that stated in the system installation manual and should overlap the damaged section by at least a minimum of 8m (typically 2 beam lengths).
- Ideally the appropriate traffic management should also be put in place before leaving site.[20]

4.3 Assessing and Prioritising Intervention Works

4.3.1 The Need for the VRS

When carrying out Safety Patrols, Safety Inspections or Detailed Inspections, the need for any existing VRS which is considered defective should always be reviewed. If the existing hazard no longer exists, or can be easily mitigated or removed, then the removal of the VRS will improve road safety and contribute to achieving a more forgiving roadside.

[20] W-Beam Guardrail Repair, A Guide for Highway and Street Maintenance Personnel (2008).

Figure 4.3 - Sign installed on passive posts to enable complete removal of defective VRS

If an Assessor considers it practical a new VRS Risk Assessment should be carried out in accordance with Chapter 5 of TII Publication DN-REQ-03079 Design of Road Restraint Systems for Constrained Locations (Online Improvements, Retrofitting and Urban Settings). A cost benefit analysis may also be required to determine whether mitigation measures are a preferable option to a safety barrier. If the barrier cannot be removed, the extent of damage and required repairs should be identified and detailed.

4.3.2 Defect Assessment & Prioritisation

As budgets are limited, not all defects can be remedied immediately and not all systems can be maintained in an ideal as-built condition. Instead, road authorities have to focus on prioritising repair work, based on high-risk locations and damage defects which is are considered to have a detrimental effect on the safety performance of the VRS.

The distinction between minor defects and more severe performance-altering defects, however, is not always clear. Minor defects may result from routine road maintenance operations (e.g. grass cutting, hedge trimming, etc.) or exposure to the environment, which may lead to corrosion etc. Major defects may arise due to significant ground subsidence, recent overlay works, etc.

Once identified, all defects and damage to existing VRS should be assessed and the required action prioritised as HIGH, MEDIUM or LOW based on severity of damage and the continued functionality of the barrier. This prioritisation will dictate how quickly the necessary repair work needs to be carried out:

HIGH – VRS is no longer reasonably functional. Defects should be addressed within 1 week as they pose an immediate risk.

MEDIUM – VRS should function adequately under a majority of impacts. Defects should be addressed within 6 months of inspection.[21]

LOW – Defect should not affect the barrier's ability to perform.[22] Defects should be addressed within 9 months of inspection.

[21] BS 7669-3 Vehicle Restraint Systems (1994).
[22] W-Beam Guardrail Repair, A Guide for Highway and Street Maintenance Personnel (2008).

4.3.3 High Priority – Examples of Defects

- Wire ropes detached from posts and lying on the ground;
- Beam sections are not continuous and have broken or lap joints have separated;
- Three or more posts are broken or have separated from the beam;
- Three or more missing post bolts;
- Single bent post if facing oncoming traffic;
- Leaning posts, and particularly if facing oncoming traffic;
- Deflection of the beam by more than 450mm;
- Steel beam encroaching into carriageway or footway;
- Considerable displacement of concrete safety barrier, greater than 60mm;
- Steel beam section torn (horizontally or vertically);
- Two or more missing lap connection bolts;
- Mounting height is too low in accordance with the manufacturer's system tolerances;
- Wire ropes lying on the ground or broken;
- Terminals/anchors damaged or incorrectly installed;
- Significant corrosion likely to affect structural integrity or performance;
- Incorrectly installed retroreflective terminal end sticker;
- Clearly visible damage to concrete VRS such as cracks, concrete breakings, and clearly visible deformation of the soil anchors and/or coupling elements of precast concrete systems.

Figure 4.4 - High priority defect: end of beam not tucked into terminal head, poses risk of spearing

Figure 4.5 - High priority defect: loose beams, poses risk of VRS failure and spearing

Figure 4.6 - High priority defect: beams detached from posts

4.3.4 Medium Priority – Examples of Defects

- Beam sections are continuous and lap joints have not separated (can be partially crushed or flattened);
- No posts are broken or separated from the beam;
- Deflection of the steel beam is less than 150mm;
- Superficial damage with no loss of integrity or no negative effect on system performance[23]
- No displacement of concrete barrier, tyre abrasion or scratch marks are the only signs. No visible cracks or spalling;
- No deformation of the soil anchorages or coupling elements of precast concrete units;
- Existing retroreflective terminal end sticker in poor condition and needs replacement.

Figure 4.7 - Medium priority defect: wire rope posts leaning due to tension

[23] NCHRP Report 656 Criteria for Restoration of Longitudinal Barriers (2010).

Figure 4.8 - Medium priority defect: single post damaged, beam slightly bent, deflection < 300mm

4.3.5 Low Priority – Examples of Defects

- Beam sections are continuous and lap joints have not separated (can be partially crushed or flattened);
- No posts are broken or separated from the beam;
- Deflection of the steel beam is less than 150mm;
- Superficial damage with no loss of integrity or no negative effect on system performance[23]
- No displacement of concrete barrier, tyre abrasion or scratch marks are the only signs. No visible cracks or spalling;
- No deformation of the soil anchorages or coupling elements of precast concrete units;
- Existing retroreflective terminal end sticker in poor condition and needs replacement.

On National Roads, following assessment and prioritisation of defects TII will schedule maintenance Call Offs based on available budgets. Medium and low priority maintenance works will be scheduled following completion of high priority works.

Figure 4.9 - Low priority defect: zinc coating damaged

Figure 4.10 - Low priority defect: no posts broken or detached, deflection < 150mm

4.3.6 Normal Service Life

The required lifespan for permanent and temporary VRS is as follows:

- steel barriers - not less than 20 years
- steel terminals / crash cushions – not less than 20 years
- concrete barriers - not less than 50 years
- timber clad barriers – not less than 10 years
- temporary safety barriers - not less than 10 years.[24]

The required lifespans set out above are the minimum duration a barrier should remain in a serviceable condition.

Detailed inspections should be carried out on steel barriers greater than 10 years old and concrete barriers greater than 15 years old every 2 years. These detailed inspections should be used to determine whether barriers which have reached their lifespan should be replaced or are in adequate condition to remain in place.

4.4 Maintenance Works

4.4.1 Procurement

The following summarises the main vehicles for procuring VRS maintenance services on the National Road Network.

- **TII Motorway Maintenance and Renewals Contracts (MMaRC):** MMaRC contractors are under a term contract to carry out VRS maintenance services (including inspections) on their section of the motorway or dual carriageway network. The contract sets out the required levels of maintenance required and the criteria for interventions to be carried out.
- **Regionalised VRS Maintenance Contract:** Similar to the MMaRC contracts, regions of the country have been allocated to specialist VRS contractors to maintain and repair all VRSs within that region. This includes patrols, inspections, interventions works, repairs, replacements, etc.

[24] Specification for Road Works Series 400 – Road Restraint Systems (2015).

- **Isolated Contract:** Local Authorities can also use their public procurement procedures to appoint a contractor for VRS maintenance services.

4.4.2 Standard of Works

All VRS maintenance works must be carried out in accordance with TII Publication CC-SPW-00400 Specification for Road Restraint Systems and the maintenance manuals of the VRS systems and types being used in the repair works.

4.4.3 Supervision & Monitoring

It is the responsibility of the Contracting Authority to ensure that VRS maintenance services and activities are executed. To this end monitoring and supervision of all activities is key, and those involved should be trained and experienced.

Regular checks including site visits should be carried out during the term of any maintenance contract. Key issues to monitor, check and inspect this term include:

- Training for all VRS maintenance installers;
- Carry out Quality checks;
- Target Response Times in the contract specification are being achieved;
- Planned Inspections are being carried out as per the contract specification;

Figure 4.11 - VRS inspection underway

4.5 Record and Certify

All maintenance works carried out should be fully recorded in accordance with the requirements of the maintenance contract in force.

Records of any interventions (repairs, replacements, modifications) to any VRS system should be provided to the Employers Representative by the VRS contractor. These records should include:

- Installation Log – including details of intervention to each system, details of that system and the supplier/source of components. This Log should then be used to update the VRS Asset Database;
- Details of any services encountered during the works;

- Maintenance manuals/requirements;
- Completed installation certificates where appropriate.

Figure 4.12 - Example of a VRS Installation Certificate

All new VRS or sections of new installation shall have identification labels attached at the start and end of the system and at any changes in performance within the system length in accordance with CC-SPW-00400 and CC-SCD-00416. Separate identification labels are required on barriers, terminals, transitions and crash cushions.

Using the information provided by the VRS contractor, as constructed record drawings of the completed installation should be prepared for future reference.

4.6 Routine VRS Maintenance Issues

4.6.1 Barrier Height

If an existing VRS has become too low due to pavement overlays or ground subsidence, it should be scheduled for replacement. Low barriers will not perform as designed when struck by an errant vehicle and untested post extensions are not permitted. A risk assessment should be carried out in accordance with TII Publication DN-REQ-03079 to determine the overall risk and prioritise the replacement works.

Figure 4.13 - VRS too low and out of spec due to pavement overlay

4.6.2 Adjusting for Pavement Overlay

When a section of road has been scheduled for pavement overlay all VRS on this section should be inspected at design stage. Ideally all barrier works including verge preparation should be carried out by a specialist VRS contractor as a separate contract which follow closely after the overlay works. However, it is possible that some civil engineering works (e.g. verge widening or re-profiling, tree felling, etc.) are required to be carried out in the overlay contract in order to allow the specialist VRS contractor install the barriers once the pavement works are complete.

There are three options for existing VRS on a pavement overlay scheme as follows:

- Remove the VRS and mitigate the existing hazard.
- If the condition of the VRS is acceptable for re-use remove the barrier and re-install following overlay works and verge preparation.
- Remove the VRS and install a new replacement system following overlay works and verge preparation.

VRS setback should also be taken into account when carrying out pavement overlays. Widening of the pavement may result in barrier setback being below the minimum allowable. VRS setback should be adjusted to correspond with the new pavement width on overlay schemes.

Figure 4.14 - Lighting column within barrier working width

Figure 4.15 - Inadequate setback following pavement overlay and verge works

4.6.3 Torque and Tension

As part of maintenance inspection surveys, torque and tension must be checked to ensure that they are within the range specified in the system installation manual. Incorrect torque or tension may result in a system not performing as intended during an impact.

4.6.4 Component Deformation

Any structural damage or deformation of a barrier beam around the slot for the beam to post connection bolt will render the beam unusable and it must be replaced.[25]

Figure 4.16 - Unacceptable deformation at beam to post connection slot

4.6.5 Replacing Moving or Loose Posts

When an existing driven post has moved out of position, this needs to be remedied. Any replacement post should not be driven into the same hole.

The enlarged postholes can be filled and packed with fine material to provide adequate stability to a replacement driven post.[26]

[25] Guidelines for the Installation, Maintenance and Repair of Tata Steel Vetex Road Safety Fence Systems (2010).
[26] EasyRail XS Installation Manual (2014) & Heintzmann-Basic-Barrier Installation Manual.

Longer driven posts or additional posts are options to provide further stability[27] (subject to system installation manuals). If the above options for repairing a driven post fail, then a concrete foundation should be used.[28]

Figure 4.17 - Example of driven post moving in the ground

4.6.6 Post Orientation & Size

When inspecting an existing barrier, the orientation and size of the posts should be noted. If there are abnormalities such as posts orientated in opposite directions or if a number of different post sizes have been used on a run of barrier, further investigation is warranted.

The installation manuals of the existing system must be checked to determine if the barrier has been correctly installed. Abnormalities with posts can affect the barriers performance and could potentially lead to snagging of a vehicle or pocketing of the barrier if struck, or could lead to more severe injuries for vulnerable road users e.g. motorcyclists.

Figure 4.18 - Example of posts orientated in opposite directions

4.6.7 Post Sockets

When posts are installed in post sockets an excluder must be fitted or the socket must be filled with a non-setting passive filler to avoid debris and water building up in the socket which could lead to corrosion.

[27] Heintzmann-Basic-Barrier Installation Manual.
[28] BS 7669-3: 1994 Vehicle Restraint Systems & Guidelines for the Installation, Inspection, Maintenance and Repair of New and In-Service FlexBeam, FlexBeam PLUS, TranZFlex, Bri-Flex & FlexGuard EN 1317 Vehicle Restraint Systems (2010).

4.6.8 Surface Mounted Posts

Surface mounted posts should only be used with a system that has provided details for surface mounted posts and where the system has been tested and CE marked for the use of surface mounted posts.

If surface mounted posts are out of spec due to pavement overlays and suitable replacement posts cannot be obtained, both the existing beam and post may have to be replaced to ensure the VRS complies with standards.

Figure 4.19 - Post socket excluder

4.6.9 Verge / Ground Profile

Where the ground immediately in front of or behind a VRS system is identified as being very uneven or sloping, ground re-profiling and verge levelling may be necessary to ensure the errant vehicle strikes the VRS as intended, and that the VRS can perform as designed and tested.

The maximum allowable fall on a verge with a safety barrier is 1:20 (5%). Ideally any fall should be away from the carriageway to avoid drainage issues.

While the ground profile within the setback and working width of any VRS should be generally level and free of hazards[29], care must be taken when re-profiling a verge to ensure that drainage of the road pavement is not negatively affected.

Figure 4.20 - Inappropriate fixing resulted in surface mounted post baseplate pulling away during impact

[29] Guidelines for the Installation, Inspection, Maintenance and Repair of New and In-Service FlexBeam, FlexBeam PLUS, TranZFlex, Bri-Flex & FlexGuard EN 1317 Vehicle Restraint Systems (2010) & Specification for Road Works Series 400 – Road Restraint Systems (2015).

Figure 4.21 - Verge profiling being checked during detailed inspection of an existing VRS

4.6.10 Damage due to Verge Maintenance

When carrying out inspections, superficial damage due to verge cutting or other maintenance activities should be identified. If the stability and durability of the system has not been affected, the minor damage can be repaired with zinc treatment. If posts have been structurally damaged or are moving in the ground, the posts should be replaced.

Figure 4.22 - Post structurally damaged due to verge maintenance activities

4.6.11 Leaning Posts

Single posts slightly out of vertical tolerance are generally acceptable. However research in Sweden has indicated that posts leaning at 9˚ or more to the vertical are detrimental to system performance and therefore should be replaced/re-installed. A number of posts together that are outside the vertical tolerances is an indication that ground conditions are not suitable for post driving and alternative foundations should be used.[30]

Figure 4.23 - Series of posts out vertical tolerance due to incorrect radius used on alignment

[30] EasyRail XS Installation Manual (2014) & Heintzmann-Basic-Barrier Installation Manual.

4.6.12 Cleaning

To ensure proper functioning, the fitted reflectors have to be regularly cleaned, depending on the environmental conditions at the site. This can be done with the aid of high-pressure cleaning equipment or mobile cleaning vehicles.

4.6.13 Issues Affecting Durability

Minor scratches to beams and posts can be repaired with zinc coating in accordance with EN ISO 1461:2009[31] and should not have any impact on the system's lifespan.

Care should be taken on installation not to damage the zinc coating of beams and posts. Any beams or posts which have deep scratches or evidence of corrosion pits cannot be repaired and must be replaced.[32]

Minor scratches to beams and posts should be cleaned and then repaired with a brush applied zinc-rich coating to achieve a minimum coating thickness of 100 µm in accordance with manufacturer's guidelines and EN ISO 1461:2009[33], such that the damage does not have any impact on the system's lifespan.

Proximity to the coast or areas with high industrial waste can have an impact on reducing the lifespan of VRS components due to the corrosive nature of the environments. Corrosion may be accelerated in these situations which must be taken into account when inspecting and making recommendations for barriers located in these environments.[34]

Any evidence of rusting discolouration on both steel and concrete barriers should be inspected further. Rusting colour on a concrete barrier may be an indication of corrosion of the reinforcement which will require remedial action. Both steel and concrete barriers are generally maintenance free and do not require cleaning.[35]

Figure 4.24 - Deep scratches with evidence of corrosion, beam should be replaced

[31] EN ISO 1461:2009 Hot Dip Galvanized Coatings in Fabricated Iron and Steel Articles – Specifications and Test Methods
[32] Guidelines for the Installation, Inspection, Maintenance and Repair of New and In-Service FlexBeam, FlexBeam PLUS, TranZFlex, Bri-Flex & FlexGuard EN 1317 Vehicle Restraint Systems (2010), EasyRail XS Installation Manual (2014) & MegaRail Installation Instruction (2015).
[33] https://galco.ie/repairing-galvanized-steel/
[34] MegaRail Installation Instruction (2015) & Hill & Smith Ltd. Guardrail Installation Manual (Issue B).
[35] MegaRail Installation Instruction (2015) & Britpave CSB Brochure.

4.6.14 Hedge Cutting/Invasive Weeds/Arrester Beds

All vegetation should be routinely cleared from the setback and working width of all safety barriers. This clearance ensures that all barriers can operate as designed without any obstruction and also allows access for inspections and maintenance.

Locations where non-native invasive vegetation such as Japanese Knotweed is growing around the safety barrier should not be interfered with until the vegetation can be treated and removed by specialist contractors. Temporary steel or plastic water filled barriers should be put in place to protect the hazard while treatment and removal of the vegetation can take place.

Where arrester beds exist in front of safety barriers, regular maintenance is required to avoid weeds growing which reduced the 'gravel-trap' effect.

Figure 4.25 - Barrier cannot be fully inspected due to vegetation

4.6.15 Re-locating Traffic Signs

Where inspections identify existing traffic signs within the working width of an existing VRS, this should be reported to the TII Signs Maintenance Manager for the region or the relevant Road Authority who will arrange for the sign to be relocated outside the working width.

5. Improvements

5.1 Designer's Inspection

5.1.1 Inspection Requirements

A designer's site inspection is required to carry out a VRS Risk Assessment in accordance with Chapter 5 of TII Publication DN-REQ-03079.

The risk assessment procedure determines the need for a VRS at a particular location. If a VRS is required, the designer will proceed with a detailed design solution.

The information captured by a designer's inspection should include all those items included on the Designers Inspection Record Form. There is a sample Designers Inspection Record Form included in Appendix D.

5.1.2 Records

The Inspection Report Form used shall follow the format of the form in Appendix D. This is to ensure the correct data is collected to facilitate full and consistent assessments. Reports should also include a record of any action taken during the inspection.

Inspection Report Forms should be completed as far as possible at the time of the inspection.

Where a safety barrier system is encountered and the barrier type cannot be identified, an identification application should be made to an industry expert or to the Irish Barrier Association (IBA) which will endeavour to provide an appropriate determination (www.irishbarrierassociation.ie). Once the barrier type is known, and the manual/drawings have been sourced, the system should be re-inspected.

Once Inspection Report Forms are completed and submitted with recommendations for any further action, any such action required shall be subject to an Employer Instructed Works Order.

5.2 Design Considerations

5.2.1 Need for VRS/Hazard Mitigation

When carrying out a site visit the need for a safety barrier should always be reviewed. If the existing hazard no longer exists, can be easily mitigated or removed the removal of the safety barrier will improve road safety and contribute to achieving a more forgiving roadside.

Figure 5.1 - Sign installed on passively safe posts to enable complete removal of a damaged VRS

If an Assessor considers it practical a new VRS Risk Assessment should be carried out in accordance with Chapter 5 of TII Publication DN-REQ-03079. A cost benefit analysis may also be required to determine whether mitigation measures are a preferable option to a safety barrier. If the barrier cannot be removed, the extent of damage and required repairs should be identified and detailed.[36]

5.2.2 Departure Requirements

If a proposed design solution contradicts or does not comply with current standards the designer should apply for a Departure from Standards at design stage. Retrospective departures will not be considered, and it is important that design/standard decisions are agreed before site works commence.[37]

Where the standard does not cover certain aspects of repair works an agreement can be made with TII at design stage of a Call-Off on how to proceed in these situations. This will avoid generating multiple departures for similar issues.[38]

5.2.3 Design & Schedule the Work

Designers should supply contractors with a detailed schedule of works outlining all repairs required as well as a specification to cover VRS works. Location maps and photographs of the damaged barriers should also be included for reference. Detailed drawings should be included for all full replacement barriers. The existing barrier system should be identified, and all relevant details provided to carry out a like for like repair.

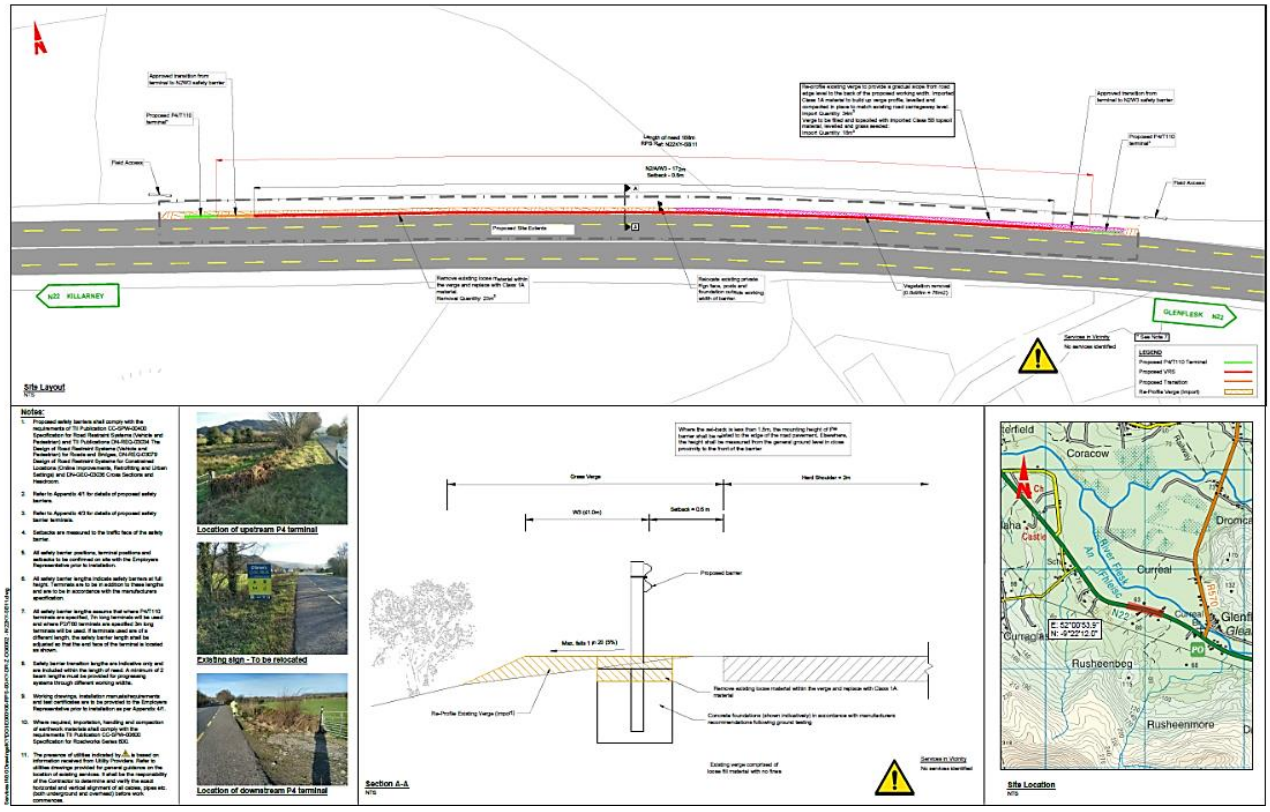


Figure 5.2 - Typical VRS Drawing

[36] W-Beam Guardrail Repair, A Guide for Highway and Street Maintenance Personnel (2008).
[37] Departures from Standards: Procedures for Local Highway Authorities (2011).
[38] Departures from Standards: Procedures for Local Highway Authorities (2011).

5.2.4 Design Requirements

Design is not required for Medium and Low priority repairs as they only involve replacing damaged components on a like for like basis. Design input is required for High priority damage locations as they require a much more detailed inspection by a trained and competent VRS designer.

The greater impact of collisions that cause High priority damage may cause damage to minor components which could have major implications if not identified and repaired correctly. Ground conditions at High priority damage locations may also require assessment to determine foundation types for the repairs.

Design input is required for all barrier replacements. Replacement locations should be assessed to determine whether hazard mitigation and barrier removal is an option. Length of need, setback, working width etc. should all be assessed and any design adjustments made to ensure the new barrier is installed in accordance with the current standards.

Figure 5.3 - Medium & Low Priority Damage: No design required

Figure 5.4 - Full Replacement Barrier: Design input required

5.2.5 Design Changes

All changes or modifications to VRS design such as changes to setback, working width, containment level, location of terminals etc. should not be carried out on site without prior approval from the designer. What might be considered minor adjustments may have a significant impact on the original design. Designers should be available to contractors to discuss site issues and any changes required due to site constraints.

Contractors that carry out modifications to original designs without consulting the designers are taking responsibility for the design of the barrier.

Systems that have not been installed as per the manufacturer's instructions or have been modified by the contractor onsite may not be covered by the manufacturer's warranty[39].

Figure 5.5 - Full Replacement Barrier: Design input required

Figure 5.6 - Grade 8.8 bolt used when grade 4.6 was specified – installation not covered by manufacturer's warranty

5.2.6 Posts and Filter Drains

VRS posts should never be driven into a filter drain.

Where a VRS must be located across a filter drain, careful excavation should be carried out for concrete foundations to ensure no damage occurs to the drainage pipes. Existing filter material should be saved for re-use where possible. Impermeable plastic sheeting 125 microns thick should be laid at the base of the foundation to ensure the filter drain is not contaminated with concrete. Adequate formwork should be used at post locations. The remainder of the trench should be backfilled with filter material. VRS installation manuals should also be consulted for additional guidance on foundations in filter drains.[40]

5.2.7 Adjusting Post Centres to Avoid Objects

Post centres may be adjusted to avoid objects such as manholes, access chambers, hydrant covers etc. The post centres indicated in the installation manuals are maximum values and must not be exceeded. Posts centres need to be modified to avoid the object and then must return to normal when clear of the object. Deviation of post spacing is not permitted to rectify incorrect setting out. VRS installation manuals should also be consulted for guidance on post spacing deviation.[41]

VRS beams running directly above manhole or utility chamber covers should be avoided.

[39] Hill & Smith Ltd. Guardrail Installation Manual (Issue B).
[40] Guidelines for the Installation, Inspection, Maintenance and Repair of New and In-Service FlexBeam, FlexBeam PLUS, TranZFlex, Bri-Flex & FlexGuard EN 1317 Vehicle Restraint Systems (2010), Guidelines for the Installation, Maintenance and Repair of Tata Steel
[41] Guidelines for the Installation, Maintenance and Repair of Tata Steel Vetex Road Safety Fence Systems (2010), EasyRail XS Installation Manual (2014) & Heintzmann-Basic-Barrier Installation Manual.

This forces untrained operatives to dismantle systems in order to gain access to manholes / chambers which could lead to incorrect assembly when the system is re-installed. The presence of manholes and chambers should be noted when inspecting VRS and where a barrier is scheduled for replacement the setback should be adjusted to avoid any manholes / chambers.

Figure 5.7 - Unacceptable post centres due to incorrect setting out

5.2.8 Post Orientation & Size

When inspecting or repairing an existing barrier, the orientation and size of the posts should be noted. If there are abnormalities such as posts orientated in opposite directions or if a number of different post sizes have been used on a run of barrier, further investigation is warranted.

The installation manuals of the existing system should be checked to determine if the barrier has been correctly installed. Abnormalities with posts can affect the barriers performance and could potentially lead to snagging of a vehicle or pocketing of the barrier if struck, or could lead to more severe injuries for vulnerable road users e.g. motorcyclists

Figure 5.8 - Example of posts orientated in opposite directions

5.2.9 Post Sockets

Post sockets should be considered for use in all new or replaced concrete foundations, and particularly at high attrition or high risk locations where frequent repairs are likely. Sockets will speed up repairs, increase the sustainability of the installation, reduce repair costs, and reduce exposure of site personnel to hazards e.g. live traffic etc.

Figure 5.9 - Example of post in socket

Where used, sockets should be installed as per manufacturer's installation instructions.

While sockets should perform for normal containment VRS systems, care should be taken when used with high containment systems as posts with a heavier steel section may be pull-out of the socket rather than deform.

When posts are installed in post sockets an excluder must be fitted or the socket must be filled with a non-setting passive filler to avoid debris and water building up in the socket which could lead to corrosion.

Figure 5.10 - Post socket excluder

Figure 5.11 - Inappropriate fixing resulted in surface mounted post baseplate pulling away during impact

5.2.10 Surface Mounted Posts

Surface mounted posts should only be used with a system that has provided details for surface mounted posts and where the system has been tested and CE marked for the use of surface mounted posts.

The VRS manufacturer's installation manual should be consulted for details of surface mounted posts.[42]

If surface mounted posts are out of spec due to pavement overlays and suitable replacement posts cannot be obtained, both the existing beam and post may have to be replaced to ensure the VRS complies with standards. Alternatively the verge pavement or support beam should be replaced or raised to enable compliant surface mounted posts be installed.

5.2.11 Verge / Ground Profile

When repairing existing VRS, do not assume the existing verge dimensions or slopes. Detailed surveys of the ground profile in front of and behind existing VRS are required to determine the extent (if any) of verge re-profiling required to install/repair compliant safety barriers and terminals.

Assessors should be aware that vegetation (particularly in the summer months) may disguise the embankment / ground profile and therefore any ground profile issues may not be immediately obvious without detailed inspections.

The maximum allowable fall on a verge with a safety barrier is 1:20 (5%). Installation manuals should also be referred to in this regard. Ideally any fall should be away from the carriageway to avoid drainage issues.

While the ground profile within the setback and working width of any VRS should be generally level and free of hazards[43], care must be taken when re-profiling a verge to ensure that drainage of the road pavement is not negatively affected.

VRS tolerances for mounting heights should not be exceeded and therefore ground re-profiling may be required to achieve this.

Any verge filling or re-profiling required should be carried out prior to VRS repair works being completed, and ideally when the damaged barrier has been dismantled.

If verge re-profiling works were unforeseen and urgent repairs are required for a high priority VRS, the VRS repair should be carried out without delay to protect the hazard, and the verge works should be scheduled.

Figure 5.12 - Verge profiling being checked during VRS safety inspection

[42] Guidelines for the Installation, Inspection, Maintenance and Repair of New and In-Service FlexBeam, FlexBeam PLUS, TranZFlex, Bri-Flex & FlexGuard EN 1317 Vehicle Restraint Systems (2010) & Guidelines for the Installation, Maintenance and Repair of Tata Steel Vetex Road Safety Fence Systems (2010).
[43] Guidelines for the Installation, Inspection, Maintenance and Repair of New and In-Service FlexBeam, FlexBeam PLUS, TranZFlex, Bri-Flex & FlexGuard EN 1317 Vehicle Restraint Systems (2010) & Specification for Road Works Series 400 – Road Restraint Systems (2015).

Figure 5.13 - Verge re-profiling works required at replacement terminal

Figure 5.14 - Verge re-profiling works carried out prior to VRS installation

5.2.12 Reinstatement

Reinstatement following VRS repair/replacement works should match the existing verge. If the existing verge is grassed then the area should be reinstated with topsoil and grass seeded. If the existing verge is gravel then gravel reinstatement is acceptable.

Any boulders, large stones and loose rough material should be removed from the reinstated area affected by the works so that it is safe and maintainable.

The carriageway adjacent to a barrier repair site should be swept down and any works materials and debris removed. All waste materials should be removed and disposed of off-site.

Where re-shaping or re-levelling of existing verges is required at VRS locations, existing topsoil should be stripped and stored for re-use. After re-shaping or re-levelling works have been completed, all areas should be harrowed to a depth of 50mm and then topsoil deposited to a thickness of between 50mm and 100mm.

Where existing verges are simply scraped back to allow for the installation of the barrier system, these areas shall also be grass seeded by the Contractor.

Figure 5.15 - Example of verge re-shaped and reinstated with existing topsoil

Figure 5.16 - Poorly reinstated following VRS repair works – uneven, large stones, not seeded

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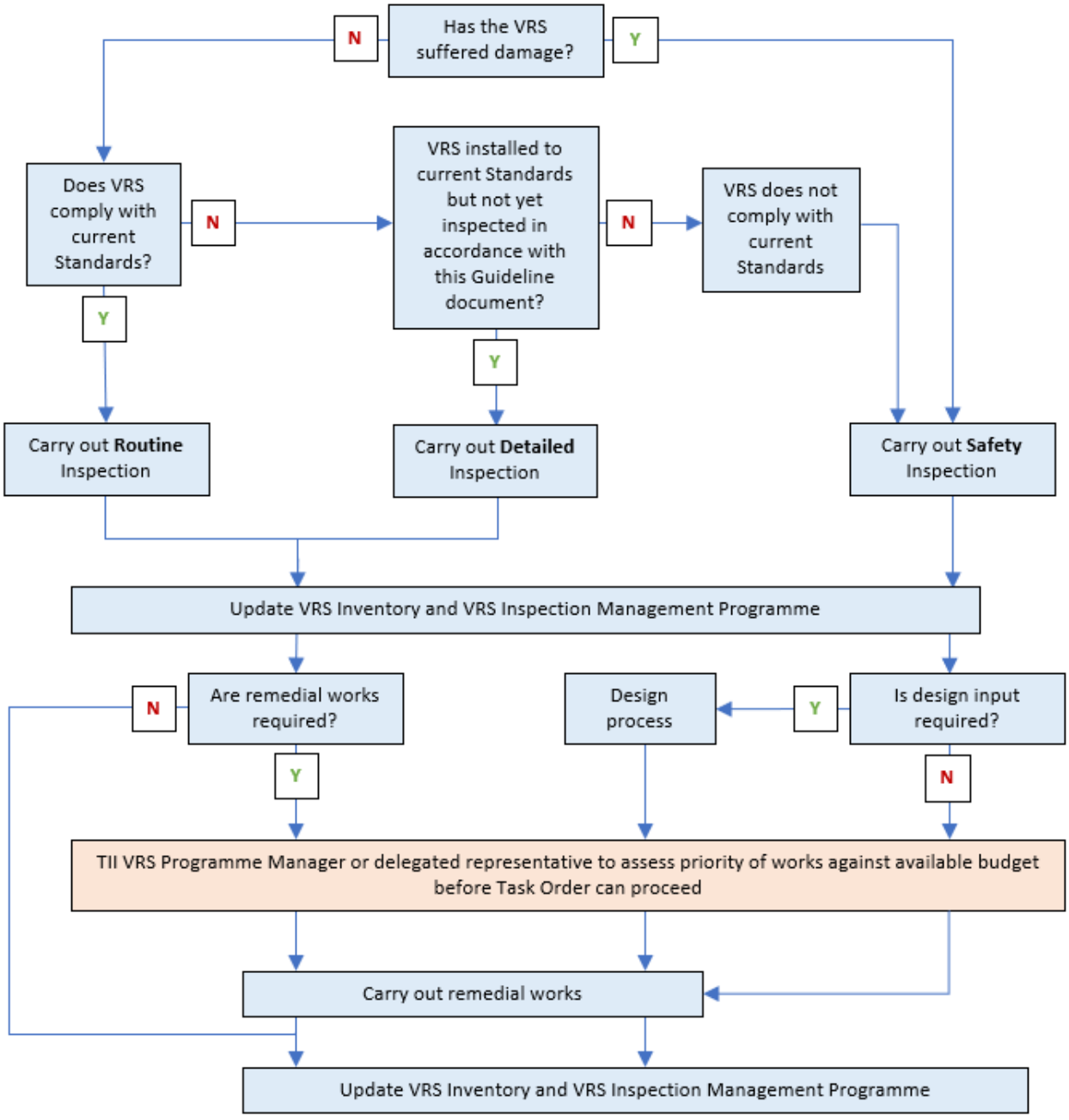
7. VRS Maintenance Flowchart



Appendix A - Post Installation Certificate

Post Installation Certificate – New Installations

Works Details	
Client	
Reference Number	
Job Number	
Works Location	

Installation Details

(A) General Checks			**(A) General Checks -** continued			**(D) Other Comments:**
Set-Back (SB)	(m)		Flares/Radius Present?	Y	N	
Is SB consistent?	Y	N	Conform to Design?	Y	N	
SB conforms to Design?	Y	N	**(B) Barrier Beams**			
Barrier Height:	(m)		Beams overlapped correctly?	Y	N	
Complies with System Tolerances?	Y	N	Beams damaged/corroded?	Y	N	
Reflectors Installed?	Y	N	**(C) Site Checks**			
Reflectors orientated correctly?	Y	N	Cleaned, finished with all excess material removed?	Y	N	
Hazards in WW?	Y	N	Grass Seeded?	Y	N	

(D) Terminals

	Type & Class	Available Displacement (m)	Comply with Design Class?	Support	Stable?	Level & In-Line?	Connections			All Components Installed?	Water Ponding Risk?	Visibility Issues?	Comments
							Size & Grade	Torque (Nm)	In Compliance				
Upstream			Y		Y	Y			Y	Y	Y	Y	
			N		N	N			N	N	N	N	
Downstream			Y		Y	Y			Y	Y	Y	Y	
			N		N	N			N	N	N	N	

(G) Safety Barrier																
		Support Pots							Lap Joint			Post Joint				
Profile (e.g. A,B)	Beam L (m)	Type	Dims (mm)	Support *(Driven, Concrete, Surface Mounted)*	Stable?	Orientated Correctly?	Vertical & within tolerances?	Damaged?	Size & Grade	Torque (Nm)	In Compliance?	Size & Grade *(e.g. M10 G4.8)*	Torque (Nm)	Bracket Size (mm)	In Compliance?	Bolt/Nut arrangements ok?
					Y	Y	Y	Y			Y				Y	Y
					N	N	N	N			N				N	N
					Y	Y	Y	Y			Y				Y	Y
					N	N	N	N			N				N	N
					Y	Y	Y	Y			Y				Y	Y
					N	N	N	N			N				N	N
					Y	Y	Y	Y			Y				Y	Y
					N	N	N	N			N				N	N
					Y	Y	Y	Y			Y				Y	Y
					N	N	N	N			N				N	N
					Y	Y	Y	Y			Y				Y	Y
					N	N	N	N			N				N	N

Comments

Photographs

Sign Off and Certification		
I can confirm that the above installation is complete and in accordance with System Requirements		
Signed by Lead Installer/ Installer	**Print Name**	**Date**

Signed by Designer	Print Name	Date
Signed on behalf of Client	**Print Name**	**Date**

Post Installation Certificate – Repairs

Works Details	
Client	
Reference Number	
Job Number	
Works Location	

Installation Details

(A) General Checks			(A) General Checks - continued			(D) Other Comments:
Set-Back (SB)	(m)		No. of repair sections undertaken?			
SB consistent with existing safety barrier?	Y	N	Hazards in WW?	Y	N	
Barrier Height:	(m)		**(B) Barrier Beams**			
Complies with System Tolerances?	Y	N	Beams overlapped correctly?	Y	N	
Height consistent with existing safety barrier?	Y	N	Beams damaged/corroded?	Y	N	
Overlap joints consistent?	Y	N	**(C) Site Checks**			
Beam profile consistent?	Y	N	Cleaned, finished with all excess material removed?	Y	N	
Post & Lap Fittings consistent?	Y	N	Grass Seeded?	Y	N	

(D) Terminals

	Type & Class	Available Displacement (m)	Comply with Design Class?	Support	Stable?	Level & In-Line?	Connections			All Components Installed?	Water Ponding Risk?	Visibility Issues?	Comments
							Size & Grade	Torque (Nm)	In Compliance				
Upstream			Y		Y	Y			Y	Y	Y	Y	
			N		N	N			N	N	N	N	
Downstream			Y		Y	Y			Y	Y	Y	Y	
			N		N	N			N	N	N	N	

(G) Safety Barrier

		Support Pots							Lap Joint			Post Joint				
Profile (e.g. A,B)	Beam L (m)	Type	Dims (mm)	Support *(Driven, Concreted, Surface Mounted)*	Stable?	Orientated Correctly?	Vertical & within tolerances?	Damaged?	Size & Grade	Torque (Nm)	In Compliance?	Size & Grade *(e.g. M10 G4.8)*	Torque (Nm)	Bracket Size (mm)	In Compliance?	Bolt/Nut arrangements ok?
					Y	Y	Y	Y			Y				Y	Y
					N	N	N	N			N				N	N
					Y	Y	Y	Y			Y				Y	Y
					N	N	N	N			N				N	N
					Y	Y	Y	Y			Y				Y	Y
					N	N	N	N			N				N	N
					Y	Y	Y	Y			Y				Y	Y
					N	N	N	N			N				N	N
					Y	Y	Y	Y			Y				Y	Y
					N	N	N	N			N				N	N
					Y	Y	Y	Y			Y				Y	Y
					N	N	N	N			N				N	N

Comments

Photographs

Sign Off and Certification

I can confirm that the above repair is complete and in accordance with System Requirements

Signed by Lead Installer/ Installer	Print Name	Date

Signed by Designer	Print Name	Date
Signed on behalf of Client	**Print Name**	**Date**

Appendix B - Safety Inspection Record Form

Reference Name	Content	Image Required
Asset ID [VRS-Route ID-Four Digit Sequential No.] (i.e. VRS-RN-N05-0001)	County abbreviation; route number and four digit unique number (e.g. VRS-RN-N05-0001)	
Safety Inspection Date	Insert inspection date	
VRS Inspector	Contractors VRS Inspector	
Positional Accuracy (cm)		
GPS/GNSS Receiver		
Route (i.e. N05)		
County	Mayo (MO) / Leitrim (LM) / Roscommon (RN) / Sligo (SO)	
Route ID (i.e. RN_N05)	County abbreviation & route number	
Road Type	Motorway / Type 1 Dual Carriageway / Type 2 Dual Carriageway / Standard Single Carriageway / Non-Standard Single Carriageway / Single Carriageway	
Speed Limit	50 km/h / 60 km/h / 80 km/h / 100 km/h / 120 km/h	
Upstream Terminal Damage		
Upstream Terminal Damaged [*]	Yes / No	Yes
Upstream Terminal Transition Damaged [*]	Yes / No	Yes
Damage Description		
Repair Priority	High / Medium / Low	
Materials Required for Repair	Terminal performance class; transition	
Barrier System Damage		
Barrier System Damaged [*]	Yes / No	Yes
Damage Description		
Damage Length	Automatically Calculated Field	
Repair Priority	High / Medium / Low	
Materials Required for Repair	Number of posts; number of beams	

Reference Name	Content	Image Required
Other Transition Damage		
Transition Damaged [*]	Yes / No	Yes
Damage Description		
Damage Length	Automatically Calculated Field	
Repair Priority	High / Medium / Low	
Materials Required for Repair	Number of posts; number of beams	
Downstream Terminal Damage		
Downstream Terminal Damaged [*]	Yes / No	Yes
Downstream Terminal Transition Damaged [*]	Yes / No	Yes
Damage Description		
Repair Priority	High / Medium / Low	
Materials Required for Repair	Terminal performance class; transition	
Repair Close Out Details		
Repair Date	Insert repair date	
Repaired By	Insert Lead Installer Name	
Upstream Terminal Repair Completed [*]	Yes / No / N/A	Yes
Barrier System Repair Completed [*]	Yes / No / N/A	Yes
Other Transition Repair Completed [*]	Yes / No / N/A	Yes
Downstream Terminal Repair Completed [*]	Yes / No / N/A	Yes
Were Services Encountered During the Installation? [*]	Yes / No	Yes
Were Services Cast in Concrete Foundations During the Installation? [*]	Yes / No	Yes
Repair Closed Out [*]	Yes / No (Default No)	Yes

Appendix C - Detailed Inspection Record Forms

Detailed Inspection Form for Terminals

Reference Name	Content	Image Required
Asset ID [VRS-Route ID-Four Digit Sequential No.] (i.e. VRS-RN-N05-0001)		
Detailed Inspection Date	Insert inspection date	
VRS Inspector	Contractors VRS Inspector	
Positional Accuracy (cm)	Insert worst accuracy observed while recording data	
GPS/GNSS Receiver		
Route (i.e. N05)		
County	Mayo (MO) / Leitrim (LM) / Roscommon (RN) / Sligo (SO)	
Route ID (i.e. RN_N05)	County abbreviation & route number	
Road Type	Motorway / Type 1 Dual Carriageway / Type 2 Dual Carriageway / Standard Single Carriageway / Non-Standard Single Carriageway / Single Carriageway	
Speed Limit	50 km/h / 60 km/h / 80 km/h / 100 km/h / 120 km/h	
Lane Width [#]	Measured on site	
Hard Shoulder Width [#]	Measured on site	
Terminal Details		
Terminal Location [*]	Upstream / Downstream	Yes
Terminal Manufacturer	Manufacturer	
Terminal System	System Name	
Terminal Performance Class [*]	Short Ramp / P1 / T80 / T110 / Unknown	Yes
Available Displacement in Front of Terminal (x) [#] [*]	Measured on site	Yes
Available Displacement Behind Terminal (y) [#] [*]	Measured on site	Yes
Available Exit Box in Front of Terminal (Za) [#] [*]	Measured on site	Yes
Available Exit Box Behind Terminal (Zd) [#] [*]	Measured on site	Yes

Reference Name	Content	Image Required
Terminal Anchor Post Stability [*]	Ok / Minor Movement / Poor Stability	Yes
Terminal Anchor Post Foundation Type [*]	Driven / Concrete / Socketed / Unknown	Yes
Terminal Connection Bolts (Size & Grade) (i.e. M16 Grade 8.8) [#] [*]	Measured on site	Yes
Are Terminal Bolts Tightened to the Correct Torque [#]	Yes / No	
Terminal Bolts Torque Description		
Is the Terminal Retroreflective End Label Installed Correctly [*]	Yes / No	Yes
Has the Terminal Wire Rope been Installed Correctly [*]	Yes / No / N/A	Yes
Has the Correct Transition been Installed for the Terminal [*]	Yes / No	Yes
Terminal Length (m)	Automatically Calculated Field	
For New Installations Complete the Following		
Has Ground Testing been Carried Out?	Yes / No	
Has Ground Testing Report been Issued to the Employer's Representative?	Yes / No	
Has the Certificate of Performance for the Terminal been Issued to the Employer's Representative?	Yes / No	
Has the Declaration of Performance for the Terminal been Issued to the Employer's Representative?	Yes / No	
Has the Installation Manual for the Terminal been Issued to the Employer's Representative?	Yes / No	

Reference Name	Content	Image Required
Were Services Encountered During the Installation? [*]	Yes / No	Yes
Were Services Cast in Concrete Foundations During the Installation? [*]	Yes / No	Yes

Detailed Inspection Form for Barrier Systems

Reference Name	Content	Image Required
Asset ID [VRS-Route ID-Four Digit Sequential No.] (i.e. VRS-RN-N05-0001)		
Detailed Inspection Date	Insert inspection date	
VRS Inspector	Contractors VRS Inspector	
Positional Accuracy (cm)	Inset worst accuracy observed while recording data	
GPS/GNSS Receiver		
Route (i.e. N05)		
County	Mayo (MO) / Leitrim (LM) / Roscommon (RN) / Sligo (SO)	
Route ID (i.e. RN_N05)	County abbreviation & route number	
Road Type	Motorway / Type 1 Dual Carriageway / Type 2 Dual Carriageway / Standard Single Carriageway / Non-Standard Single Carriageway / Single Carriageway	
Speed Limit	50 km/h / 60 km/h / 80 km/h / 100 km/h / 120 km/h	
Lane Width [#]	Measured on site	
Hard Shoulder Width [#]	Measured on site	
Barrier System Details		
Barrier Segment Type	Barrier System / Transition	
Barrier System Manufacturer	Manufacturer	
Barrier System Type	System Name	
Does the barrier system adopt the performance requirements of EN1317	Yes / No	
Barrier Post Type [*]	Z / C / Sigma / RHS / U	Yes
Barrier Post Material [*]	Steel / Timber / Concrete	Yes
Barrier Post Size [#] [*]	Measured on site	Yes
Barrier Post Stability [*]	Ok / Minor Movement / Poor Stability	Yes
Barrier Post Foundation Type [*]	Driven / Concrete / Socketed / Unknown	Yes

Reference Name	Content	Image Required
Barrier Post Spacing [*]	Distance between posts	Yes
Any Corrosion Present on Existing Barrier Posts [*]	Yes / No	Yes
Barrier Beam to Post Connection Bolts (Size & Grade) (i.e. M10 Grade 8.8) [#] [*]	Measured on site	Yes
Are Barrier Bolts Tightened to the Correct Torque? [#]	Yes / No	
Barrier Beam to Post Connection Bolts Torque Description		
Barrier Beam to Post Connection Bolt Attachments Type [*]	Circular Washer / Rectangular Plate / Other	Yes
Barrier Beam to Post Connection Bolt Attachments Size [#]	Measured on site	
Barrier Beam Length [#] [*]	Measured on site	Yes
Barrier Beam Face Height [#]	Measured on site	
Barrier Beam Cross-Sectional Profile [*]	A profile / B profile / Thrie Wave / OBB / Other	Yes
Barrier Beam Lap Connection Bolts (Size & Grade) (i.e. M16 Grade 4.6) [#] [*]	Measured on site	Yes
Are Barrier Beam Lap Connection Bolts Tightened to the Correct Torque [#]	Yes / No	
Barrier Beam Lap Connection Bolts Torque Description		
Barrier Beam Lap Connection Bolt Attachment Type [*]	Circular Washer / Rectangular Plate / Other	Yes
Barrier Beam Lap Connection Bolt Attachment Size [#]	Measured on site	

Reference Name	Content	Image Required
Any Corrosion Present on Existing Barrier Beams [*]	Yes / No	Yes
Barrier Set-Back (m) [#] [*]	Measured on site	Yes
Height above pavement (m) (if <1.5m set back) [#]	Measured on site	Yes
Height above ground (m) (if >1.5m set back) [#]	Measured on site	Yes
Are there Manufacturer / Traceability Markings on Barrier Beams or Posts? (EN1317 Compliant Systems Only) [*]	Yes / No	Yes
Barrier CE Mark (Only for systems which display CE Mark) [*]	Yes / No	Yes
Barrier Containment Level	N1 / N2 / H1 / L1 / H2 / L2 / H3 / L3 / H4a / H4b / L4a / L4b / Unknown	
Barrier Impact Severity	A (ASI < 1.0) / B (ASI < 1.4) / C (ASI < 1.9) / Unknown	
Barrier Working Width	W1 (< 0.6m) / W2 (< 0.8m) / W3 (< 1.0m) / W4 (< 1.3m) / W5 (< 1.7m) / W6 (< 2.1m) / W7 (< 2.5m) / W8 (< 3.5m) / Unknown	
Available Working Width [#] [*]	Measured on site	Yes
Has the Barrier System been Tensioned Correctly [#]	N/A / Yes / No	
Barrier Tension Description		
Taper Rate of the Barrier, if any [#] [*]		Yes
VRS Length	Automatically Calculated Field	
General Observations		
What Principal Hazard is the VRS protecting? [*]	Options as per DN-REQ-03034 Appendix D	Yes
What Additional Hazard is the VRS protecting? [*]	Options as per DN-REQ-03034 Appendix D	Yes
Hazard(s) Description		

Reference Name	Content	Image Required
Has the Approach to and Departure from the Hazards been Protected? [*]	Yes / No	Yes
Any hazards within vehicle intrusion zone? [*]	Yes / No	Yes
Is the VRS connected to a Parapet? [*]	Yes / No	Yes
Parapet type [*]	Masonry / reinforced concrete / steel or aluminium	Yes
Has the Correct Transition Between the Parapet and VRS been Installed [*]	Yes / No	Yes
Does the VRS Require Replacement	Yes / No	
General Remarks		
For New Installations Complete the Following		
Has Ground Testing been Carried Out?	Yes / No	
Has Ground Testing Report been Issued to the Employer's Representative?	Yes / No	
Have the Certificates of Performance for all Systems Installed been Issued to the Employer's Representative?	Yes / No	
Have the Declarations of Performance for all Systems Installed been Issued to the Employer's Representative?	Yes / No	
Have the Installation Manuals for all Systems Installed been Issued to the Employer's Representative?	Yes / No	
Were Services Encountered During the Installation? [*]	Yes / No	Yes
Were Services Cast in Concrete Foundations During the Installation? [*]	Yes / No	Yes

Appendix D - Designers Inspection Record From

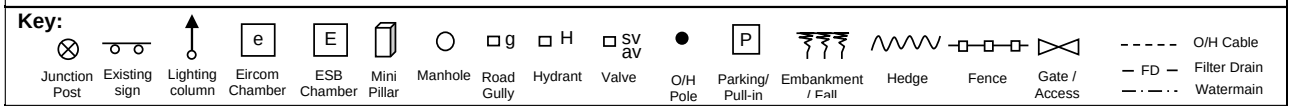
Route:	**County:**	**VRS ID / Description:**

VRS CONDITION SURVEY				
Hazards		Height above pavement (<1.5m set back)		
Has the approach to and departure from the hazards been covered/protected?		Height above ground (>1.5m set back)		
VRS type and profile (including EN1317 compliance status)		Size & Grade of bolts	Beam:	Post:
Post type		Bolt attachments		
Post stability		Taper rate, if any		
Post spacing		Parapet type – masonry, reinforced concrete, steel or aluminium		
Beam Length		Beam Face Height:		
Terminal Upstream		VRS connection to parapet, if any		
Terminal downstream		Any hazards within vehicle intrusion zone?		
Set back		Damage including description		
Available working width		Any traceability markings on the beams or posts?		
Observations:				

HAZARD IDENTIFICATION SURVEY			
Hazard	**Observed / Location / Notes / Control Measures**	**Hazard**	**Observed / Location / Notes / Control Measures**
ESB (O/H & U/G)		Speed limits	
Watermains		Traffic volumes	
Gas		Lane widths	
Telecoms		Hard shoulder widths	
SWS / FWS		Verge widths / workspace	
Observed traffic speed		Parking / pull in	
Road lighting		Adj. watercourse	
Road markings / studs / surface		Trees	
Road alignment		Junctions	
Overtaking permitted		Other (specify)	

+

Sketch



Survey By:	**Date:**

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