APPENDIX A8
Compaction Requirements

A8.1 Granular, Cohesive and Cement Bound Materials

All graded granular, granular, cohesive/granular, cohesive and cement bound materials laid above the surround to apparatus shall be compacted in accordance with Table A8.1.

Table A8.1 Compaction Requirements for Granular, Cohesive and Cement Bound Materials

Compaction Plant and Weight Category	Cohesive Material (less than 20% granular content)			Granular Material (20% or more granular content including cement bound material)		
	Minimum Passes/Lift for compacted lift thickness up to			Minimum Passes/Lift for compacted lift thickness up to		
	100 mm	150 mm	200 mm	100 mm	150 mm	200 mm
Vibrotamper						
50 kg minimum	4	8 #	NP	4	8	NP
Vibrating Roller Single Drum						
1000-2000 kg/m	8	NP	NP	6	NP	NP
2000-3500 kg/m	3	6	NP	3	5	7
Over 3500 kg/m	3	4	6 #	3	4	6
Twin Drum						
600-1000 kg/m	NP	NP	NP	6	NP	NP
1000-2000 kg/m	4	8	NP	3	6	NP
Over 2000 kg/m	2	3	5 #	2	3	4
Vibrating Plate						
1400-1800 kg/m^2	NP	NP	NP	5	NP	NP
Over 1800 kg/m^2	3	6	NP	3	5	7
All Above Plant	For Maximum and Minimum compacted lift thickness See Appendix A2.6, Table A2.3					
Alternative Compaction Plant for Areas of Restricted Access (including small excavations and trenches less than 200 mm width)						
Vibrotamper 25 kg minimum **Percussive Rammer 10 kg minimum**	Minimum of 6 compaction passes Maximum of 100 mm compacted lift thickness					

Notes:

1 **NP** = Not Permitted

2 # = Not permitted on wholly cohesive material i.e. clay and/or silt with no particles > 75 micron (μm)

3 Single drum vibrating rollers are vibrating rollers providing vibration on only one drum

4 Twin drum vibrating rollers are vibrating rollers providing vibration on two separate drums

A8.2 Chalk Materials

All chalk materials, including medium and high-density chalks shall be compacted in accordance with Table A8.2. However, if the chalk is unstable after compaction, the unstable material shall be removed and replaced with fresh material. Fresh chalk shall be compacted in accordance with Table A8.2, except that the specified number of compaction passes shall be reduced by one pass. If the chalk is still unstable after compaction, it shall be deemed to be unsuitable for use as backfill and replaced with suitable material.

Table A8.2 **Compaction Requirements for Chalk Materials**

Compaction Plant and Weight Category	Chalk Material Minimum Passes/Lift for compacted lift thickness up to 100 mm	150 mm	200 mm
Vibrotamper			
50 kg minimum	3	6	**NP**
Vibrating Roller			
Single Drum			
1000–2000 kg/m	6	8	**NP**
2000–3500 kg/m	**NP**	4	6
Over 3500 kg/m	**NP**	**NP**	4
Twin Drum			
600–1000 kg/m	6	8	**NP**
1000–2000 kg/m	2	4	6
Over 2000 kg/m	**NP**	3	4
Vibrating Plate			
1400–1800 kg/sq.m	6	8	**NP**
Over 1800 kg/sq.m	**NP**	6	8
Alternative Compaction Plant for Areas of Restricted Access (including small excavations and trenches less than 200 mm width)			
Vibrotamper 25 kg minimum **Percussive Rammer** 10 kg minimum	Minimum of 6 compaction passes Maximum of 100 mm compacted lift thickness		

Notes:

1 **NP** = Not Permitted

2 Single drum vibrating rollers are vibrating rollers providing vibration on only one drum

3 Twin drum vibrating rollers are vibrating rollers providing vibration on two separate drums

A8.3 Bituminous Mixtures

All bituminous mixtures permitted in Appendix A2 shall be compacted to the following requirements:

1) Mixtures laid within any reinstatement as follows:

a) Reinstatement of 250 mm width or less;

b) Reinstatement within 250 mm of the edge of any other reinstatement; or

c) Reinstatement within 250 mm of a fixed feature within any reinstatement shall be compacted in accordance with Table A8.3.

2) Compaction should be discontinued if the mixture shows any signs of distress, regardless of whether the minimum number of passes required by Table A8.3 have been applied; see Section NG10.2.3.

3) Mixtures laid in all other locations shall be compacted to the in-situ air void requirements of Section S10.2.3. However, material requirements and laying conditions are unchanged and it will be necessary for compaction to be carried out to a procedure that is capable of achieving the in-situ air void content requirements.

Table A8.3 **Compaction Requirements for Bituminous Mixtures**

Compaction Plant and Weight Category	**Bituminous Mixtures**			
	Minimum Passes/Lift for compacted lift thickness up to			
	40 mm	**60 mm**	**80 mm**	**100 mm**
Vibrotamper				
50 kg minimum	5 #	7 #	**NP**	**NP**
Vibrating Roller				
Single Drum				
1000–2000 kg/m	6	**NP**	**NP**	**NP**
2000–3500 kg/m	5	7	8	**NP**
Over 3500 kg/m	4	6	7	**NP**
Twin Drum				
600–1000 kg/m	5	7	**NP**	**NP**
1000–2000 kg/m	4	5	6	8
Over 2000 kg/m	3	4	4	6
Vibrating Plate				
1400–1800 kg/m^2	6	**NP**	**NP**	**NP**
Over 1800 kg/m^2	3	5	6	8
All Above Plant	For Maximum and Minimum compacted lift thickness See Appendix A2.6, Table A2.2			

Alternative Compaction Plant for Areas of Restricted Access (including small excavations and trenches less than 200 mm width)	
Vibrotamper 25 kg minimum **Percussive Rammer** 10 kg minimum	Minimum of 6 compaction passes Maximum of 75 mm compacted lift thickness

Notes:

1 **NP** = Not Permitted

2 # = Vibrotamper not permitted on permanent surface course of trenches >500 mm width

3 Twin drum vibrating rollers are preferred for compaction of bituminous mixtures

4 Single drum vibrating rollers are vibrating rollers providing vibration on only one drum

5 Twin drum vibrating rollers are vibrating rollers providing vibration on two separate drums

APPENDIX A9
Alternative Reinstatement Materials (ARMs)

A9.1 Introduction

1) New or alternative materials have been, or may be, developed for use in highway construction and maintenance. These materials may allow more rapid, reliable and cost-effective reinstatements, with less dependence on the skill and physical effort of the operators. These materials may also offer significant environmental or practical advantages, and/or cost benefits, compared with conventional materials, including various combinations of the following:

a) Reduced usage of virgin materials, by including recycled or secondary materials

b) Lower energy requirements during manufacture and/or laying

c) Reduced landfill requirements during construction or reconstruction

d) Self-cementing properties to improve performance, reliability of laying and compaction

e) Self-levelling or flowable, to avoid or reduce the need for compaction

f) May be placed in fewer lifts

2) These materials are termed Alternative Reinstatement Materials (ARMs), and are categorised by this Specification into two generic groups:

a) **Structural Materials for Reinstatements (SMRs)**

This generic group is intended to include proprietary or alternative bound reinstatement materials that include a cementitious, chemical or hydraulic binder or are inherently self-cementing. SMRs are categorised as follows:

i) **Foamed Concretes for Reinstatements (FCRs)**

These are cement-bound materials that have been prepared off-site, generally as "prescribed" mixes, at an approved mixing plant and under appropriate quality control procedures. They are flowable in nature and should not require compaction when placed. Materials manufactured under these conditions, and any foamed concretes conforming to Clause 1043 of the SHW are deemed to be approved for use as ARMs. FCRs may not necessarily incorporate a coarse aggregate.

ii) **Flowable SMRs (FSMRs)**

These materials comprise any type and/or combination of aggregates and binders. They are flowable mixes that should not normally require compaction, and are capable of achieving strengths equivalent to FCRs. These materials may only be used on a trial basis by prior agreement.

iii) **Non-flowable SMRs (NFSMRs)**

These materials comprise any type and/or combination of aggregates and binders. They are non-flowable mixes that will normally require compaction on site, and are capable of achieving strengths equivalent to FCRs in their compacted state. These materials may only be used on a trial basis by prior agreement.

b) **Stabilised Materials for Fills (SMFs)**

This generic group is intended to include materials derived from excavated spoil, virgin, secondary or recycled materials, or any combination thereof, that have been improved by re-processing, re-grading and/or by the inclusion of a cementitious, chemical or hydraulic binder. SMFs are generally non-flowable and shall therefore normally require compaction.

These materials may only be used on a trial basis by prior agreement.

A9.2 General Requirements for ARMs

1) With the exception of FCRs as described in A9.1.2 (a) (i) above, (which are deemed to be approved for use), ARMs shall only be used with the prior agreement of the Undertaker and the Authority on an approved trial basis. An outline of a trial procedure scheme is described in A9.5.

2) ARMs shall be prepared and installed in accordance with the approved mix formulations and procedures proven by prior development and testing.

3) Alterations to the proven mix formulations, mix proportions, aggregate type, admixtures, etc. shall not be undertaken without confirmation of their suitability, obtained by further development and testing. The approval of the Authority is required prior to the use of any ARM whose formulation has been changed.

4) ARMs used within 450 mm of the road surface shall be non-frost susceptible subject to the exceptions referred to in S5.3.1.

5) Where the Authority is aware of areas with drainage or groundwater problems, it should notify the Undertaker. Following such notification the Undertaker shall provide, at backfill and sub-base levels within reinstatements, ARMs that are permeable to a degree not less than the surrounding ground. A backfill layer of single size aggregate 6 mm nominal size, of 100 mm minimum thickness and surrounded by a geotextile filter fabric where appropriate, may by considered to offer equivalent drainage potential.

6) Where the Authority is aware of any site where high sulphate levels are known to occur, it should notify the Undertaker. Following such notification, any Ordinary Portland Cement based binders in the ARMs shall be replaced with sulphate resistant Portland Cement based binders.

7) Surfacing materials shall not be reinstated until the ARM has attained sufficient strength to allow adequate compaction of bituminous materials and to sustain adequate traffic loading. A simple penetration or indentation test is recommended to allow confirmation of adequate strength prior to surfacing. Any appropriate standardised test procedure may be used and, with prior experience, will indicate the earliest time at which surfacing should be carried out.

8) Fluid ARMs may flow into damaged drainage or ducting within, or adjacent to, the excavation. Where required, plastic sheeting etc. may provide adequate protection during pouring and curing.

A9.3 Structural Materials for Reinstatements (SMRs)

A9.3.1 Permitted Uses of SMRs

1) SMRs may be used on a trial basis, by prior agreement, in any combination of the following, regardless of the nature of reinstatement materials used above and below:

a) At any position within the surround to apparatus and/or backfill as the entire layer or combined with any other permitted backfill materials, in any proportion, within any reinstatement.

b) As a sub-base within any reinstatement.

c) As a combined sub-base and base (roadbase) within any reinstatement in Road Types 1, 2, 3 & 4.

d) As a combined sub-base and binder course, within any reinstatement in footways, footpaths and cycle tracks.

2) SMRs shall not be used in place of surface course materials.

A9.3.2 General Requirements for SMRs

1) SMRs shall comply with the minimum layer thickness and compressive strength requirements shown in Table A9.1

Table A9.1 **SMR Minimum Layer Thickness and Compressive Strength Requirements**

Layer	Road Type					Footway Footpath or Cycle Track
	0	1	2	3	4	
Combined Binder Course & Sub–base	**NP**	**NP**	**NP**	**NP**	**NP**	150 mm C2
Base (Roadbase)	**NP**	**NP**	**NP** (see A9.2.1.1)	300 mm C2	200 mm C2	–
Base (Roadbase) & Sub–base	**NP** (see A9.2.1.1)	450 mm C4	450 mm C4	450 mm C2	350 mm C2	–
Sub–base &/or below	150 mm C2	150 mm C2	150 mm C2	150 mm C2	150 mm C2	100 mm C2
Crushing Strength at 90 days	C4 – 4 N/mm^2 Minimum to 10 N/mm^2 Maximum C2 – 2 N/mm^2 Minimum to 10 N/mm^2 Maximum					

Note to Table A9.1: NP = Not Permitted (see A9.3.1)

2) Where the total thickness of SMR laid exceeds 1000 mm, any minimum crushing strength requirement of 4 N/mm^2 shall apply to the top 1000 mm only and a minimum of 2 N/mm^2 below this depth.

A9.3.3 Particular Requirements for FCRs and FSMRs

1) The compressive strength shall be determined in accordance with the principles of BS1881: Part 116 or Part 120, with the following exceptions or options:

a) Test specimens may be prepared at the time of placement by casting within a test mould, or recovered from site after placement by the extraction of cores from the reinstatement.

b) Specimens may be cast in conventional steel test cubes with a nominal side length of 150 mm, or they may be cylindrical with a diameter in the range 150 - 300mm and an aspect ratio of 1.0. Moulds may also be manufactured from cellular foam (preferably polystyrene) and include a cellular foam lid. The samples shall not be compacted, except for minimal tamping to allow the mould to be filled without leaving excessive areas of voids.

c) Core test specimens shall be cylindrical, with a diameter in the range 150 - 300mm and an aspect ratio of 1.0. The top and bottom surfaces of the test specimen may be grouted to ensure flat, parallel loading surfaces.

d) Following preparation or recovery, the test samples shall be stored upright, at ambient temperature until 90 days have elapsed from the placement of the material on site. Accelerated curing at temperatures exceeding 25°C is not permitted.

2) Experience suggests that results obtained from 150 mm test cubes in moulds with cellular foam lids, stored at ambient temperature, are most representative of in-ground conditions.

3) FCRs and FSMRs should not normally be tamped or compacted.

4) FCRs and FSMRs of density less than 1000 kg/m^3 may not displace standing water. In excavations containing water, the minimum recommended density for foam concretes is 1050 kg/m^3. FCRs may flow into, and block, damaged drainage or ducting within, or adjacent to, the excavation. Where required, plastic sheeting etc. may provide adequate protection during pouring and curing.

5) FCRs and FSMRs are unlikely to provide significant load bearing capacity for several hours after placement, depending on the ambient temperature. During this time, unguarded reinstatements may be a hazard to children and animals etc and should be protected.

A9.3.4 Particular Requirements for NFSMRs

1) The compressive strength of NFSMRs shall be determined in accordance with the principles of BS1881: Part 116 or Part 120, with the following exceptions or options:

a) Test specimens may be prepared at the time of placement by compaction of a sample of material within a test mould or preferably recovered from site after placement by the extraction of cores from the reinstatement.

b) Specimens prepared on site may be placed in conventional steel test cube moulds with a nominal side length of 150 mm, or in cylindrical steel moulds with a diameter in the range 150 - 300 mm and an aspect ratio of 1.0. Compaction shall be applied in order to achieve a specimen density between 100% ± 5% of that achieved on site.

c) Core test specimens shall be cylindrical, with a diameter in the range 150 - 300 mm and an aspect ratio of 1.0. The top and bottom surfaces of the test specimen may be grouted to ensure flat, parallel loading surfaces.

d) Following preparation or recovery, the test samples shall be stored upright, at ambient temperature until 90 days have elapsed from the placement of the material on site. Accelerated curing at temperatures exceeding 25°C is not permitted.

2) NFSMRs shall normally require compaction to ensure adequate strength. The compaction regime (i.e. details of plant type, weight category, lift/layer thickness and number of passes) shall be specified before the NFSMR is used, and should be obtained by prior development and testing.

A9.3.5 SMR Material Production

A9.3.5.1 FCR Material Production

1) FCRs will generally be produced from virgin aggregates. Aggregates from other sources may be used with the written approval of the Authority (see S1.6 Alternative Options). Approval may require supporting information relating to the properties of the aggregate.

2) The wet density of the FCRs should be checked prior to placement. Depending on the method of manufacture, the quality of the foaming agent added at site should be checked prior to being incorporated in the mix. Any on-site addition of a foaming agent must be in accordance with the approved mix design.

A9.3.5.2 FSMR and NFSMR Material Production

1) FSMRs and NFSMRs shall be prepared in accordance with the procedures set out in the Approval Trial Agreement (see A9.5), to the approved mix formulation(s) (obtained by prior development and testing), in order to achieve the required compressive strength. Binders, additives and admixtures may be included based on prior development and testing.

2) FSMRs and NFSMRs may be delivered to site as ready-made materials or be prepared partly or wholly on site.

3) Mixing may be carried out using any equipment, adapted as necessary for the manufacture of FSMRs and NFSMRs in quantities appropriate to the intended use, provided the approved mixing procedure is used throughout. Mixing equipment should be maintained in accordance with the manufacturer's recommendations and checked regularly. All metering or weighing apparatus should be calibrated regularly.

4) All binders, additives and admixtures, including diluted solutions thereof, should be stored according to the manufacturer's recommendations and used within the recommended shelf life.

5) NFSMRs shall be compacted in accordance with the manufacturer's recommendations or an agreed compaction regime obtained by prior development and testing.

A9.4 Stabilised Materials for Fill (SMFs)

A9.4.1 Permitted Use of SMF Materials

1) SMFs may be used in place of other materials on a trial basis by prior agreement, in the layers appropriate to their strength classification as defined by Table A9.2, and regardless of the nature of reinstatement materials used above and below, in any combination of the following:

a) At any position within the surround to apparatus and/or backfill, as the entire layer or combined with any other permitted backfill materials, in any proportion, within any reinstatement.

b) As a sub-base within any reinstatement.

c) As a combined surround to apparatus and/or backfill and/or sub-base within any reinstatement.

2) SMFs shall not be used in place of the permanent binder course or surface course.

A9.4.2 Overall Requirements for SMFs

1) Each stabilisation method and formulation shall be classified as yielding SMF materials equivalent to one of the four defined classes of backfill material permitted in Appendix A1, as follows:

a) Class A SMF Material - equivalent to Class A Graded Granular Backfill Material

or b) Class B SMF Material - equivalent to Class B Granular Backfill Material

or c) Class C SMF Material - equivalent to Class C Cohesive/Granular Backfill Material

or d) Class D SMF Material - equivalent to Class D Cohesive Backfill Material.

2) Stabilised materials that achieve CBR values in excess of 30% are designated class 'S' SMF materials and may be used as a combined backfill and sub-base.

3) The SMF material classification shall be based on the "soaked" %CBR or equivalent value proven during the development and laboratory testing, in accordance with Table A9.2.

Table A9.2 **SMF Strength Requirements**

SMF Class	% CBR
S	Over 30
A	15 to 30
B	7 to 15
C	4 to 7
D	2 to 4

4) The %CBR value shall be determined by laboratory testing in accordance with the principles of BS1377, with the following requirements:

i) Conventional test moulds may be unsuitable for some SMF materials and in-situ testing may need to be considered. The preparation of SMF test samples is not restricted and may include test cores extracted from site, provided that the samples are not excessively damaged or disturbed during extraction. CBR samples prepared off site shall be compacted so as to yield a density in the range 100% ± 5% of the site density.

ii) Following preparation, the test samples shall be stored at ambient temperature until a period of 90 days has elapsed from the placement of the material on site.

iii) The laboratory CBR test shall be performed on samples in a soaked condition.

iv) A UKAS accredited laboratory shall verify the test results unless agreed otherwise.

v) When testing in-situ, a recognised appropriate direct or indirect test method shall be used.

A9.4.3 SMF Material Production

1) SMFs shall be prepared in accordance with the procedures set out in the Approval Trial Agreement (see A9.5), to the approved mix formulation(s) obtained by development and testing, to achieve the required strength classification. Binders, additives and admixtures may be included as agreed from prior development and testing.

2) SMFs will normally be prepared on site from basic constituents or delivered to site as a ready-mixed fill material. However, subject to experience gained by prior development testing, the SMF mix may, by prior agreement, be transported. SMF mixes may be prepared, wholly or partially, remote from the site.

3) Mixing may be carried out using any equipment, adapted as necessary for the manufacture of SMFs in quantities appropriate to the intended usage, providing the approved mixing procedure is used throughout. Mixing equipment should be maintained in accordance with the manufacturer's recommendations and checked regularly. All metering or weighing apparatus should be calibrated regularly.

4) All binders, additives and admixtures, including diluted solutions should be stored according to the manufacturer's recommendations and used within the recommended shelf life.

5) SMFs shall be compacted in accordance with the manufacturer's recommendations or an agreed compaction regime obtained by prior development and testing.

A9.5 Scheme for Approval Trials

A9.5.1 Introduction

An Undertaker or Authority may wish to undertake or permit Approval Trials of ARMs for the purposes of development and/or performance assessment. Trials may be carried out by formal agreement between an Undertaker and Authority, only under an Approval Trial Agreement. The requirements of a scheme, under which trials of ARMs should be carried out, are outlined in the following sections.

1) Section A9.5.2.1 gives general guidance relating to the organisation of an Approval Trial.

2) Section A9.5.2.2 describes conditions relating to the scale of an Approval Trial and its effect on organisational and reporting matters.

3) Section A9.5.2.3 outlines the intended duties of each party within the Approval Trial.

4) Section A9.5.3 comprises a list of headings that describe the key requirements and stages of an Approval Trial and which are considered to represent the minimum essential information required to ensure that an Approval Trial is carried out in a controlled and agreed manner. The additional information under each heading given in parentheses is for guidance only. The parties to an Approval Trial (normally an Undertaker and an Authority) may, by agreement with the other party, add, amend or omit any details that do not affect the legal standing of the Agreement.

A9.5.2 Requirements for Approval Trials

A9.5.2.1 General

1) No Approval Trial shall be undertaken within a Type 0 or 1 road or high amenity or high duty footway, footpath or cycle track, or a site of Special Engineering Difficulty.

2) Approval trials in carriageways should be conducted on a minimum of three separate sites, representing a range of traffic conditions. A range of positions within the carriageway (i.e. within and outside of a wheeltrack, longitudinal and transverse orientation (for reinstatements)) should also be considered.

3) The duration of all Approval Trials shall be two years - the final inspection shall be completed within one month following the end of the two-year test period. The Undertaker shall notify the Authority of the inspection date at least seven working days in advance. The Authority shall confirm their intention to attend, or otherwise, within seven working days of receipt of such notification. The inspection measures should be carried out on the notified date at an agreed time or an agreed alternative date. Where the Authority does not attend the final inspection, the Undertaker shall provide the Authority with a summary of the investigation within 28 days of the inspection. The Undertaker should keep a photographic record of the Approval Trial sites at the time of inspection and send copies to the Authority.

4) Core sampling and interim inspections of any type may be carried out on Approval Trial reinstatements at any time. Where required, as part of the Approval Trial Agreement, the Undertaker shall notify the Authority at least five working days in advance of such works. Any holes created during these activities should be reinstated in accordance with the relevant requirements of this Specification.

5) Approval Trial reinstatements may be accidentally damaged during the trial and rendered unsuitable for accurate assessment. It is therefore recommended that trials should include duplicate sites for each road type, category, position, orientation, etc.

6) Where an Approval Trial site requires remedial action, regardless of the reason, the Undertaker shall provide the Authority with details of the remedial measures within one month of completion. Where practicable, records of surface measurements, photographs etc taken before and after the remedial work should be kept by the Undertaker and copies provided to the Authority.

7) On completion of an Approval Trial, and by agreement between the parties involved, some or all of the details of the trials may be forwarded to Regional HAUC and/or National HAUC for information.

8) Further use of the ARMs under trial may be permitted on or before completion of the Approval Trial in accordance with S1.6 Alternative Options but only with written approval of the relevant Authority. Such approval shall apply to works carried out within the boundary of the Authority.

9) It is recognised that the scope, extent and duration of ARM Approval Trials may vary widely.

A9.5.2.2 Special Considerations

1) For small-scale Approval Trials intended to take place on a small number of sites and over a fixed time period (e.g. for specially prepared Approval Trial excavations), the Undertaker shall notify the Authority at least one month in advance of the start of the Trials. Specially prepared excavations should be of similar depth and plan dimensions to the Undertaker's routine excavations, and generally be not less than 500 mm by 500 mm in plan, or not less than 200 mm wide for trench excavations. The total combined surface area of all Approval Trial sites should not be less than 2 square metres. The location and position of the Approval Trial sites should represent as wide a range as possible (see A9.5.2.1 (2)). If specially prepared sites are to be used, the site locations may be jointly selected.

2) Approval Trials of a larger extent, (e.g. trials that use an Undertaker's routine excavation sites as Approval Trial sites) may take place over a longer time period and the Undertaker shall notify the Authority at least one month in advance of the start of a Trial. Arrangements for notification and attendance at these Approval Trials should be included in the Trial Agreement.

3) Any restrictions as to the size, location and position, total number of Approval Trial sites and/or the period, during which the Approval Trials may be carried out, should also be included in the Approval Trial Agreement.

4) A two-year Approval Trial period shall apply to each Approval Trial site, commencing on its date of installation. An interim report on the Approval Trial should be provided within six months of the start date of the Trial. The final review or reporting need not be carried out until the final Approval Trial site has reached an age of two years.

A9.5.2.3 Duties of Parties

1) The initiator (usually the Undertaker) of an Approval Trial shall document the development work to ensure a high level of confidence in the proposed process before the commencement of any Approval Trial.

2) The Undertaker shall provide details of the Approval Trial operation(s) (e.g. location, road category, date/time, excavation, mixing, reinstatement, sampling, post-construction activities etc) as far, as is practicable, in accordance with the requirements of A9.5.3.1 of the Approval Trial Agreement.

3) The Undertaker shall not unreasonably withhold information relating to any aspect of the Approval Trial from the Authority.

4) The Authority shall not unreasonably obstruct the commencement, progress, or cause the termination of an Approval Trial provided it is carried out in accordance with the terms of the Approval Trial Agreement.

5) Each party shall have the right to request confidentiality on any matter relating to the Approval Trial.

A9.5.3 Information for inclusion in an Approval Trial Agreement
Prior to the commencement of an Approval Trial, all parties should consider the details of the general, procedural and technical aspects for inclusion in an Approval Trial Agreement.

A9.5.3.1 General
The following information should be recorded and copies kept by all parties to the Approval Trial.

1) **Parties to trial** – names of the Undertaker and Authority agreeing to Approval Trial

2) **Confidentiality** - parties (if any) to whom trial information may be divulged

3) **Geographical extent of trial** - county or district border, utility region or area boundary

4) **Scope of trial** - total number of trial reinstatements or maximum number of sites

5) **Time limit for trial** – agreed start/end dates

6) **Termination criteria** - conditions under which an Approval Trial Agreement may be terminated and notice period of termination

7) **Signatories/witnesses** - approved officers of appropriate seniority who are permitted to commit their organisation to the execution of an Approval Trial and who can approve the terms and conditions of the trial.

A9.5.3.2 Procedural
1) **Contemporary records** – agreement to the details of records required, the responsibility for record-keeping and the sharing of information

2) **Notification details** - notice periods, arrangements for contacting relevant parties to an Approval Trial

3) **Attendance at trials** - parties who may attend an Approval Trial

4) **Review periods/meetings** - dates, attendees, procedures for calling ad hoc meetings

5) **Post-construction assessment** – test methods to be employed and arrangements for periodic surveying, sampling, etc

A9.5.3.3 Technical
1) **Type of trial site** - routine utility excavations or specially excavated Approval Trial sites

2) **Location of trial site** – non high-amenity or non high-duty footway, cycle track, (including road classification Type 2 to 4) etc.

3) **Positioning of trial site** - "as excavated", within wheeltrack, etc

4) **ARMs to be trialled** - SMR or SMF materials

5) **ARMs details** - Mix design, binder details, additives, dependencies on site conditions or excavated/base material type and condition, details of prior development work.

6) **ARMs preparation** - batching, mixing and placement procedures.

7) **Quality control on site** - any tests to be applied in order to ensure that an ARM has been prepared to the required design

8) **Compaction regime** - NFSMRs and SMFs only

9) **Sampling requirements** - types of samples and sampling frequency

10) **Testing laboratories** - contact details of accredited laboratories or otherwise

11) **Remedial measures for "failed" sites** – agree replacement of failed material with an alternative SMR or SMF material or other approved material or remove site from the Approval Trial Agreement

12) **Future of trial sites** - remove after trial completion or leave in place, future monitoring and/or testing

APPENDIX A10

Permanent Cold-lay Surfacing Materials – (PCSMs)

A10.1 Introduction

Conventional hot–lay bituminous materials generally require heated and/or insulated transport and are especially difficult to lay when the required quantity is small or the site is remote from the nearest coating plant. Cold–lay surfacing materials can be formulated to give a performance equivalent to hot–laid materials, yet remain workable for several days, at least, without degradation during storage and transport. Such materials may allow a higher degree of immediate permanent reinstatement in small or remote excavations that represent much of an Undertaker's workload. Such materials are termed Permanent Cold–lay Surfacing Materials (PCSMs).

A10.2 Permitted Usage of Approved PCSM Materials

1) The overall PCSM formulation, manufacture and placement are limited only by the need to comply with the BBA/HAPAS guideline for approval and certification of Permanent Cold–lay Surfacing Materials (PCSM's) December 1999 which includes procedures for the testing of potential PCSMs within the public highway and formal approval procedures for their use within England and Wales.

2) Approved PCSMs, laid and compacted in accordance with Appendix A8, may be used in substitution for any permitted bituminous material, at the discretion of the Undertaker, as follows:

a) Deferred Set Material (DSM), at any position, in all reinstatements.

b) Permanent Cold–lay Surfacing Material (PCSM), at any position, in all reinstatements in footways, footpaths and cycle tracks.

c) Permanent Cold–lay Binder Course (PCBC) in all reinstatements in Type 3 & 4 roads.

d) Permanent Cold–lay Surface Course (PCSC) in all reinstatements in Types 2, 3 & 4 roads.

3) Whenever a potential PCSM binder has begun a PCSM Approval Trial, regardless of aggregate or material formulation under trial, then any material manufactured using that binder shall be considered to be an approved Deferred Set Material to BS 4987 (DSM), for interim use only, with immediate effect.

A10.3 Unsuccessful PCSM Approval Trials

1) Where any PCSM fails to meet the requirements for BBA/HAPAS approval at the conclusion of a carriageway trial, the following remedial actions shall be carried out:

a) Where a PCSM fails to meet the specified NAT test requirements, then the Undertaker, at the discretion of the Authority, shall normally be required to replace all failed PCSMs with hot mixtures, in accordance with the Specification requirements. However, the Authority is recommended to consider the acceptance, within locations subject to light traffic only, of approval trial reinstatements that otherwise comply with the specified surface profile criteria.

b) Where PCSMs meet the specified NAT test requirements, then only trial reinstatements failing to comply with the specified surface profile criteria are liable to be replaced.

2) Where a PCSM fails to meet approval requirements at the conclusion of a footway trial, then only individual trial reinstatements failing to comply with the specified surface profile criteria are liable to be replaced.

3) Where a PCSM fails to meet approval requirements at the conclusion of an Approval Trial, BBA/HAPAS shall notify HAUC accordingly. HAUC shall then inform regional HAUC committees.

APPENDIX A11
Bitumen Binder Equivalence

A11.1 Introduction
In some road types, particular binder grades are not permitted or are not permitted for machine–lay. In general, hand laying is not recommended where the material is likely to be difficult to compact adequately, especially in cold conditions.

A11.2 Base (Roadbase) and Binder Course Materials
Binder grades permitted for base (roadbase) and binder course materials are shown in Table A11.1, provided that the layer thickness is amended to that shown in the table.

Table A11.1 **Permitted Base (Roadbase)/Binder Course Binder Grades and Layer Thickness**

Material	Bitumen Pen Grade	Combined Base (Roadbase)/Binder Course (mm)					Binder Course Only (mm)	
		Road Type					Road Type	
		0	1	2	3	4	3	4
20 mm DBC	50 (40/60)	305	260	200	120	100	60	60
	125 (100/150)	375 **H**	315	245	150	110	60	60
	190 (160/220)	**NP**	**NP**	**NP**	**NP**	155 **H**	**NP**	85 **H**
50/20 HRABC	50 (40/60)	350	295	230	150	110	60	60
	125 (100/150)	**NP**	**NP**	275 **H**	215 **H**	155 **H**	85 **H**	85 **H**

Notes:

1 **NP** = Not Permitted

2 **H** = Hand-lay only – not recommended for hot weather & not permitted for machine-lay

A11.3 Surface Course Materials
Binder grades permitted for surface course materials are shown in Table A11.2. No alteration in the layer thickness is permitted.

Table A11.2 **Permitted Surface Course Binder Grades**

Material	Bitumen Pen Grade	Road Type				
		0	1	2	3	4
10 mm CGSC	50 (40/60)	NP	NP	NP	✔	✔
	125 (100/150)	NP	NP	NP	✔	✔
	190 (160/220)	NP	NP	NP	✔ H	✔ H
30/14 HRASC	50 (40/60)	✔	✔	✔	✔	✔
	125 (100/150)	NP	NP	NP	✔ H	✔ H
10 & 14 mm SMA	50 (40/60)	✔	✔	✔	✔	✔
	125 (100/150)	H	H	H	H	H

Notes:

1 **NP** = Not Permitted
2 ✔ = Permitted
3 **H** = Hand-lay only – not recommended for hot weather & not permitted for machine-lay

APPENDIX A12
Reinstatement of Modular Surface Layer

A12.1 Interim Reinstatement
Where an interim reinstatement is required, the existing modules should be reused, including the use of broken modules. Where damage has resulted in fragmentation or widespread breakage of modules, then bituminous mixtures may be used for interim reinstatement, provided they meet the performance requirements of Section S2 and that compaction of such mixtures do not result in further damage to adjacent modules.

A12.2 Permanent Reinstatement
1) Permanent reinstatement of modular surface layers should be generally carried out in accordance with BS 7533.

2) Permanent reinstatement of modules shall include all modules which are situated within or extend beyond the effective width of the reinstatement (W) described in S2.1.4 and shall also include any other modules which are disturbed in the course of carrying out the excavation or reinstatement.

3) Clean undamaged modules shall be re-used for permanent reinstatement; broken modules shall not be used for permanent reinstatement and shall be replaced.

4) Bedding material shall be sand or mortar, to match the characteristics of the existing type and thickness. Sand, mortar or other grouting, to match the performance of the existing, shall be applied to gaps between individual modules at the time of permanent reinstatement.

A12.3 Provision of Replacement Modules
1) Where insufficient modules remain for reinstatement use and identical replacement modules are no longer available, then a reasonably similar colour, shape and size shall be the preferred order of criteria in the choice of acceptable replacements.

2) Where replacement modules are required due to breakage at some time prior to the Undertaker's works, the Authority may provide suitable replacements to the Undertaker, free of charge.

3) Where replacements modules are required due to breakages caused during the course of the Undertaker's works, the Undertaker shall reinstate using modules purchased at the Undertaker's expense or purchased from the Authority at reasonable cost.

4) Authorities are recommended to retain stocks of modules used within their areas to enable them to provide replacements when required. Where no stocks of suitable replacements are available, Authorities should assist Undertakers in locating a source of suitable replacement modules.

A12.4 Pre-existing Surface Damage Outside Limits of Undertaker's Works

1) Some modular surfaces outside of the limits of the Undertaker's works may be broken or have settled or deformed. Where the existing profiles are near or exceed the current intervention and construction tolerances specified in S2, it will be difficult for the Undertaker to construct a complying reinstatement. Subject to the Authority agreeing to meet the costs of the works necessary to reinstate the surfaces outside the limits of its works, the Undertaker shall extend its reinstatement works to include such surfaces. In the absence of agreement, the Undertaker shall be under no obligation whatsoever to extend its reinstatement works but shall use its best endeavours to ensure that the interface between its reinstatement and the adjoining surfaces avoid creating hazardous trips. In such situations, it must be recognised that it may be necessary to install different sized modules or fillets to minimise surface irregularities at the interfaces. The Undertaker shall use its best endeavours to match existing materials and profiles and meet the tolerances specified in S2.

2) Where the area of permanent reinstatement needs to be substantially extended, to include an existing area of broken or settled modular surfacing, the Undertaker shall notify the Authority prior to the commencement of works.

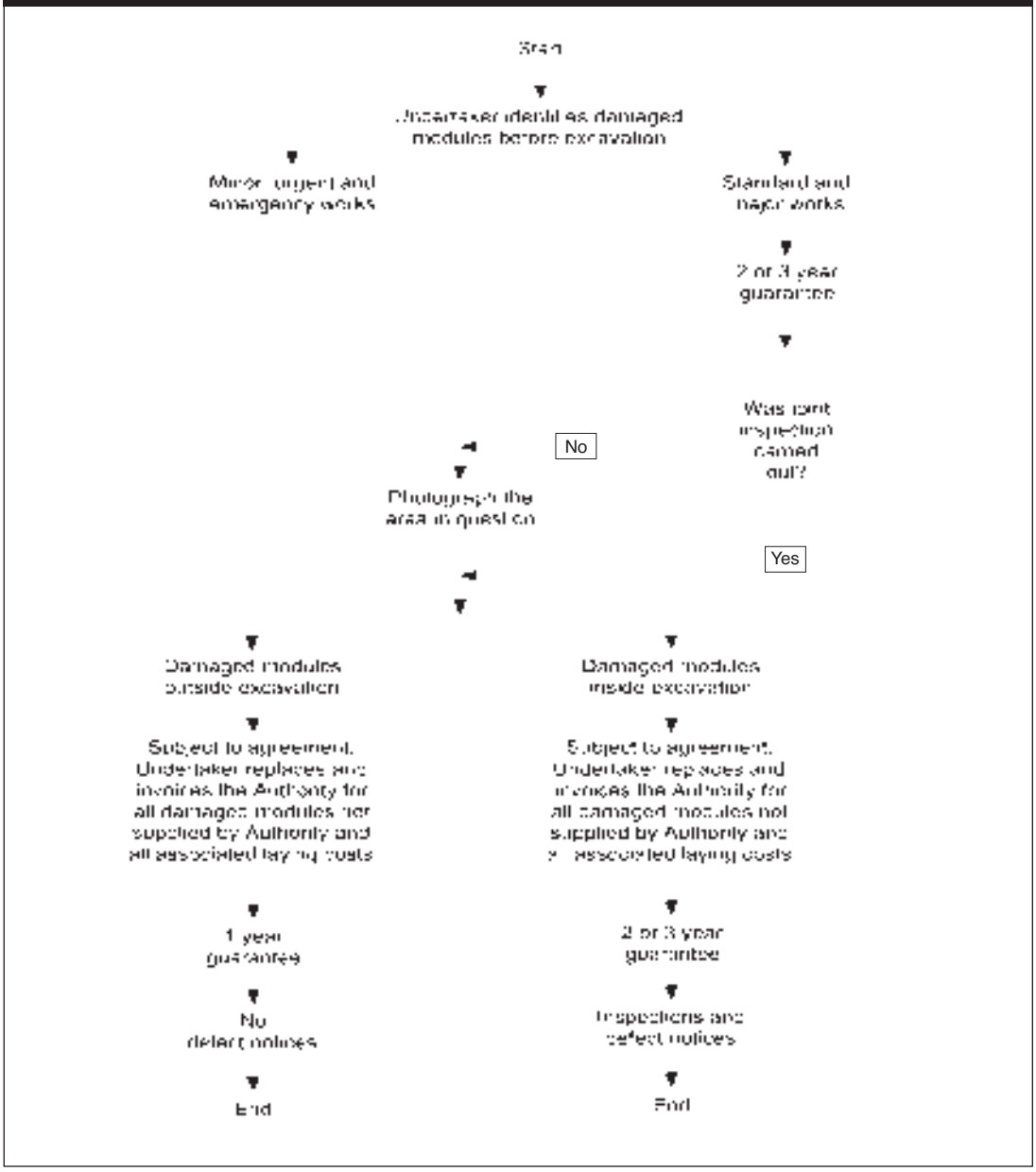
A12.5 Joint Inspections and Recovery of Costs

1) Within Limits of Undertaker's Works – Following notification from the Undertaker, a joint inspection shall be arranged prior to the commencement of all standard or major works to agree the extent of damaged, settled or deformed surfacing within the limits of the works. Where the Authority does not provide suitable replacements to the Undertaker in accordance with paragraph A12.3 (2) above, it may contribute to the Undertaker the sum notified by the Undertaker as the cost of replacing the same.

2) Outside Limits of Undertaker's Works – Following notification from the Undertaker, a joint inspection shall be arranged to agree the need and extent of any remedial measures outside of the limits of the Undertaker's works. An apportionment of the additional costs, based on the relative areas of permanent reinstatement, shall be agreed. In the event of an Authority failing to agree to meet a proportion of the costs of reinstating modules, the Undertaker shall proceed in accordance with paragraph A12.4 (1).

3) Prior joint inspections will usually be impractical for minor, emergency and urgent works. However, such works are usually small individual excavations and a proportion of such works will be inspected by the Authority, within the sample inspection regime. On completion of all minor, emergency and urgent works, the Undertaker shall be free, at its discretion subject to paragraphs A12.3 (2) and A12.4 (1), to recover all reasonable costs from the Authority, according to the procedure illustrated in Figure A12.1.

Figure A12.1 **Procedure for Pre-existing Damage to Modular Surfaces**



NOTES FOR GUIDANCE

NG1 Introduction

NG1.1 General

1) The primary objectives of this Specification are to ensure that all Undertakers' reinstatements, within highways, are completed to a permanent standard, as soon as is practicable and of a consistent high quality. Undertakers and Authority personnel should work together, in close co-operation, in order to achieve these objectives.

2) This Specification may require a joint inspection of any reinstatement site, depending on the existing site conditions, before the commencement of works. Such joint pre-inspections may be of an informal nature, by agreement, and should be carried out at the earliest convenience of both parties. Where either party fails to attend any agreed pre-inspection, or where existing site conditions warrant concern, it is recommended that the Undertaker retains a photographic record of the existing surfaces, prior to the commencement of works.

3) This Specification may require a formal notification of circumstances or other requirements, depending on the existing conditions of any reinstatement site, prior to the commencement of works. Such pre-notifications should be issued at the earliest possible opportunity. Undertakers shall comply with such notification issued at the street works notice stage, and should make reasonable efforts to comply with any notification issued thereafter.

4) Where this Specification allows several options, it is recommended, wherever practicable, to agree a preferred option from the alternatives available. This principle should be applied to all sections where alternatives are provided.

NG1.2 Guarantee Period

1) Where an Authority intends to resurface or reconstruct a section of road, the Undertaker may complete any reinstatement to an alternative interim standard, by agreement. The guarantee period shall thereafter be waived, unless the Undertaker's reinstatement can be shown to be grossly substandard. It is expected that agreement to this procedure will be conditional upon all savings in costs made by not carrying out a permanent reinstatement being shared, equally, between the Undertaker and the Authority.

2) Where site circumstances are considered to militate against a successful permanent reinstatement, an additional interim period of up to a further 6 months may be adopted, before it is necessary to complete the permanent reinstatement.

NG1.3 Road Categories

1) Road categories 0 to 4 are based on the number of millions of standard axles (msa) carried by the road over a 20-year period. Reinstatements are designed on this basis. The traffic loading is calculated in accordance with the following:

a) Roads Type 0 & 1 – HD 24/96

b) Roads Type 2 – Intermediate between HD 24/96 & LR1132

c) Roads Type 3 & 4 – TRL Reports LR1132 or RR 87

Some roads that have been constructed in recent years (particularly new housing estate roads constructed under the auspices of Section 38 of the Highways Act 1980) may have been designed and constructed to HD/24/96 standards. In these cases the Authority shall notify the Undertaker, in advance of the works, and the Undertaker shall reinstate the excavation to match the existing construction thickness.

2) For any road, its msa rating gives the number of standard axle loads which it is expected to carry over a defined period of time. This msa rating is calculated using the following input data:

a) 24 hour annual average daily flow (AADF) of commercial vehicles in one direction. The use of AADF data in one direction, averaged from data in each direction, is recommended.

b) Average vehicle axle factor over a 20-year service life.

c) Actual sustained annual growth rate of commercial vehicles, averaged over several years, from valid census data.

These data, processed in accordance with HD 24/96 procedures, provide the maximum number of commercial vehicles per day, in each direction, for all road types. Table NG1.1 has been prepared in accordance with HD 24/96, showing the maximum annual average daily flow (AADF) in one direction, in commercial vehicles per day (cvd), for a single carriageway road, or for both lanes of a dual carriageway, for all road types, from 2002 onwards, for all likely traffic growth rates. Appropriate AADF rates for all Intermediate years within each five-year period can be calculated by interpolation, pro rata.

Table NG1.1 **Maximum Commercial Vehicle Traffic per Road Type**

Year of Traffic Count	Daily Traffic Flow – Commercial Vehicles/Day One Direction – Single or Dual Carriageway					Average Growth Rate %
	Type 4	Type 3	Type 2	Type 1	Type 0	
2002	66	240	638	1383	4499	
2006	66	240	638	1383	4499	
2011	66	240	638	1383	4499	**0**
2016	66	240	638	1383	4499	
2021	66	240	638	1383	4499	
2002	60	217	578	1253	4079	
2006	62	226	601	1304	4245	
2011	65	237	632	1370	4461	**1**
2016	68	249	664	1440	4689	
2021	72	262	698	1514	4928	
2002	54	196	521	1132	3690	
2006	58	212	564	1225	3994	
2011	64	234	623	1353	4410	**2**
2016	71	259	687	1494	4869	
2021	78	286	759	1649	5376	
2002	49	176	469	1020	3333	
2006	55	198	528	1148	3751	
2011	64	230	612	1331	4349	**3**
2016	74	266	709	1543	5041	
2021	86	309	822	1789	5844	
2002	43	157	420	916	3005	
2006	50	184	491	1072	3515	
2011	61	223	598	1304	4277	**4**
2016	74	272	727	1586	5204	
2021	91	331	885	1930	6331	
2002	39	140	375	821	2704	
2006	47	170	456	998	3287	
2011	61	217	582	1274	4195	**5**
2016	77	277	742	1626	5354	
2021	99	354	948	2075	6833	
2002	35	125	334	734	2430	
2006	44	158	422	927	3068	
2011	59	211	564	1240	4105	**6**
2016	79	283	755	1660	5494	
2021	106	378	1011	2221	7352	
2002	31	111	297	655	2180	
2006	41	145	389	859	2858	
2011	57	204	546	1204	4008	**7**
2016	80	286	766	1689	5621	
2021	112	401	1074	2369	7884	
2002	27	98	263	584	1953	
2006	37	133	358	795	2657	
2011	54	196	526	1167	3904	**8**
2016	79	288	772	1715	5736	
2021	117	423	1135	2520	8429	

3) Where the actual AADF rates for any road are significantly different for each direction and Table NG1.1 indicates different road types in each direction, the highest traffic category shall be applied in each direction.

4) Where one-way traffic systems and/or other traffic management schemes result in multi-lane traffic, standard growth rate predictions and lane correction procedures may result in an inaccurate road classification overall. In such cases, whenever reasonably practical, the flow of commercial vehicles should be monitored separately, and traffic calculations completed, for each traffic lane.

5) Where an existing road is near, or beyond, its service life, and is expected to be re-constructed within the foreseeable future, a temporary re-classification of the road will usually be appropriate, pending its re-construction. Such temporary re-classifications should be undertaken by agreement between the parties involved. Similarly, where roads are expected to be re-constructed within the guarantee period of the reinstatement, it will usually be appropriate to amend methods, materials or performance requirements for those reinstatements, by agreement.

6) The national network of roads carrying, up to 125 msa within a 20-year period, and classified as Types 0 to 4 roads according to the requirements of this Specification, will yield a distribution similar to that shown in Table NG1.2.

Table NG1.2 **Estimated Highway Classification**

Road Type	% of Total
0	< 1
1	< 1
2	< 5
3	< 9
4	< 84

7) It is expected that the roads in any Authority area will show a distribution similar to that shown in Table NG1.2, although there will be some local variations. In future years, there may be cases where traffic flows change, to such a degree, that re-classification will be necessary.

NG1.4 – NG1.5 There are no Notes for Guidance

NG1.6 Alternative Options

1) New Materials

Research into new or improved reinstatement materials is often undertaken by various organisations and such work may produce materials that perform as well as, or better, than those given in this Specification. In order to allow such materials to be proven, by development testing, the materials and relevant layer thickness quoted in this Specification may be amended or supplemented, subject to prior agreement.

2) Local Materials

Materials may be available locally that have not been defined in any national Specification, but which, by experience, are known to give acceptable performance in service. In order to allow the use of such local materials, the materials and relevant layer thickness quoted in this Specification may be amended or supplemented, subject to prior agreement.

3) Alternative compaction equipment

Alternative compaction equipment, including any compaction device not specifically permitted within Section S10 and Appendix A8, may be permitted, provided it has been proven to be capable of achieving the performance requirements permitted in Section S10, Appendix A2 and/or Appendix A8.

a) For all compaction plant not shown in Appendix A8, an approved operating procedure should be established, by development testing, in an appropriate trench environment with the relevant material options to meet the performance requirements permitted in Section S10, Appendix A2 and/or Appendix A8. The development testing shall be verified by an independent, accredited laboratory.

b) Where alternative compaction plant is intended to be used on more than one type of material, as defined in Appendix A8, an approved compaction procedure shall be established, as defined in section NG1.6(3) a) above, for each intended category of material.

NG1.7 Immediate Works

The minimum thickness of bituminous surfacing material, required by Section S1.7.1 for the reinstatement of all immediate works, is 40 mm. A greater thickness may be required, in areas subject to frequent or heavy traffic, if further remedial works, during the 10 days permitted duration of immediate works, are to be avoided.

NG1.8 Apparatus within the Road Structure

1) Some apparatus may already be present at shallow depth, within many existing road structures and special requirements may apply to their reinstatement. Both the Undertaker and the Authority are likely to have particular criteria and this Specification may be altered, or supplemented, subject to prior agreement, to accommodate any such requirements.

2) Not all new apparatus will need to be installed to the full depth or width expected by this Specification; an example is small diameter cabling and/or ducting for telecommunications, traffic controls, etc. This Specification may be altered, or supplemented, subject to prior agreement, to accommodate these applications.

NG1.9 – NG1.11 There are no Notes for Guidance

NG2 Performance Requirements

NG2.1 There are no Notes for Guidance

NG2.2 Surface Profile

NG2.2.1 There are no Notes for Guidance

NG2.2.2 Edge Depression – Intervention
Freedom from excessive edge depressions, or 'trips', for all pedestrians and two wheeled vehicles, is considered to be one of the most important performance requirements. Given that pedestrians and various two wheeled vehicles are likely to use or cross any roads, footways and cycle tracks, it is considered necessary to set a single limit for all edge depressions.

NG2.2.3 Surface Depression – Intervention
Excessive surface depressions will reduce ride quality and give rise to noise and vibration. The maximum depth of surface depression within the area of a reinstatement is limited to approximately 2.5% of the width of reinstatement, which represents a mean slope of 1 in 20 (5% gradient). In order to prevent excessive areas of standing water, it is considered necessary to limit the maximum depth of a surface depression to 25 mm, regardless of the reinstatement width.

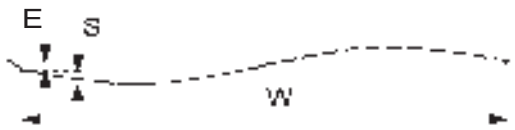
NG2.2.4 Surface Crowning – Intervention
Excessive surface crowning will reduce ride quality and give rise to noise and vibration. The maximum height of crowning within the area of a reinstatement is limited to approximately 2.5% of the width of the reinstatement, which represents a mean slope of 1 in 20 (5% gradient). In order to prevent excessive surface irregularity, it is considered necessary to limit the maximum height of crowning to 25 mm, regardless of the reinstatement width.

NG2.2.5 Combined Defect – Intervention
The intervention limits specified for surface depressions and surface crowning include a reduction in the intervention limit, to 80% of the tabulated value, subject to a minimum of 10 mm, where surface depressions and/or crowning and/or edge depressions abut. The individual features shall be measured, and the reduction applied, as follows:

1) Combination Depressions

Where an edge depression abuts an area of surface depression, then the area of abutting depression should be measured as shown in Figure NG2.2. Any surface crowning also abutting the area of combined depressions should be measured separately, as shown in Figure NG2.3. The permitted depth of a combination depression is further limited if the depression results in standing water.

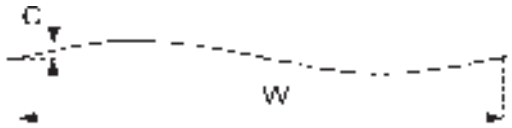
Figure NG2.2 **Combination Depression**



E = Edge Depression Contribution = 10 mm
S = Surface Depression Contribution = 10 mm or 80% of tabulated value } whichever is the greater

2) Combination Crowning
Where an area of surface crowning abuts an edge depression, or a surface depression, or any combination thereof, then the area of abutting crowning should be measured as shown in Figure NG2.3. The area of abutting depression should be measured separately, as shown in Figure NG2.2. The maximum height of combination crowning is further limited if the crowning results in standing water.

Figure NG2.3 **Combination Crowning**



C = Surface crowning contribution = 10 mm or 80% of tabulated value } whichever is the greater

NG2.2.6 There are no Notes for Guidance

NG2.3 Fixed Features
Fixed features, e.g. kerbstones and related precast concrete products, channel blocks and drainage fixtures, surface boxes and ironware, should be bedded on a sound foundation, in accordance with the owner's requirements. In order to prevent excessive areas of standing water, it is considered necessary to set separate intervention limits for channel blocks, drainage fixtures, surface boxes and ironware.

NG2.4 Surface Regularity
Where the use of a rolling straightedge is not permitted, the surface regularity shall be assessed on an agreed basis. One method could be the use of a two metre or three metre straightedge.

NG2.5 Structural Integrity

1) Reinstatement materials and compaction requirements have been specified in order to safeguard the pavement structure, both within and adjacent to the reinstatement. Any substantial or rapid settlement within a reinstatement may therefore indicate a potential reduction in the stability of the adjacent pavement structure, as well as potential defects within the reinstatement.

2) There will be cases, in adverse circumstances, where the correct application of this Specification, in all respects, will still result in levels of settlement within the reinstatement that do not meet the requirements of Section S2.5, Structural Integrity. For example, the type and condition of the adjacent ground and/or pavement structure may limit the degree of compaction that can be achieved, so influencing the amount of settlement that could occur.

3) Any engineering investigation is intended only to determine the likelihood and extent of any further settlement, and the most cost-effective and convenient method of restoring the structural stability and surface performance of failed sections of a reinstatement, to a satisfactory condition.

4) In the case of large or deep excavations, it may be appropriate for an Authority and an Undertaker to agree an extended interim guarantee period, with additional interim surfacing materials laid to restore the running surface. When no further consolidation or settlement is considered likely, a permanent binder course and surface course may be laid, and the permanent guarantee period initiated. In any event, the location and extent of any re-excavation should be mutually agreed, taking full advantage of any bound materials already in place.

NG2.6 Skid Resistance

1) An adequate skid resistance of the reinstated running surface must be maintained, by selection of the polished stone value (PSV), aggregate abrasion value (AAV) and texture depth of the aggregate exposed at the road surface. The exposed aggregate may be precoated chippings rolled into the surface (HRA), coarse aggregate within the surface course, coated material to BS 4987 or any chippings or other aggregate applied in any form of surface dressing or slurry sealing treatment.

2) Smaller reinstatements constitute a much lower degree of skidding risk, but the measurement of skid resistance, texture depth and surface regularity become progressively more difficult as the reinstatement width reduces. However, material requirements and laying conditions remain unchanged and it is expected that the skid resistance of smaller reinstatements will not be significantly different.

3) For the purposes of identifying reinstatement sites where the risk of skidding is potentially high (Site A), sections of carriageway of greater than 10% gradient should be identified from existing steep hill warning signs or by notification from the Authority. Similarly, bends of less than 100 metres radius in roads where the speed limit is greater than 40 mph (65 kph) should be identified from existing bend, double bend or chevron warning signs or by notification from the Authority.

4) Given good site conditions, it is possible to obtain reasonably representative measurements of skid resistance and surface regularity on narrower reinstatements but amended test procedures and/or extra care are required. The TRL Mini Texture Meter and TRL Rolling Straightedge should always be fully contained within the limits of the reinstatement. The actual minimum practicable width for these instruments will depend on the trench alignment and radius of curvature. Measurements can be particularly difficult when testing on tight radius bends.

NG2.7 There are no Notes for Guidance

NG3 Excavation

NG3.1 There are no Notes for Guidance

NG3.2 Excavation
1) HSG 185 "Health and Safety in Excavations" gives guidance to those carrying out excavations.

2) Where possible, all excavations should be planned before commencement of works on site.

3) Work must be undertaken and supervised by properly qualified personnel.

NG3.3 There are no Notes for Guidance

NG3.4 Side Support
1) Where required, there must be sufficient quantities of appropriate materials available to provide safe trench support.

NG3.5 – NG3.7 There are no Notes for Guidance

NG4 Surround to Apparatus

NG4.1 General

1) It is often necessary for an Undertaker to require a specific type or quality of material, and/or special protective components, to be laid within the immediate vicinity of certain types of underground apparatus. This material is usually referred to as the surround to the apparatus, and may include fine unbound granular materials (usually termed 'finefill'), bound materials, tiles, covers, tubular shields, etc., or any combination thereof. The resulting surround may be required for a variety of reasons, including structural support, low corrosion potential, protection for non-metallic materials or special coatings, etc.

2) The nature of the Undertaker's apparatus, and/or the protective features of the surround, especially any fine unbound granular materials used within the surround, may impose additional restrictions on the type of compaction equipment that can be used and the necessary operating procedures. However, the entire surround will effectively form a foundation structure for the remainder of the reinstatement and must be capable of providing adequate support for all loading imposed on the reinstatement surface, as well as the weight of the reinstatement structure.

3) In selecting a material for the surround to apparatus, Undertakers should be mindful of the potential for the migration of fines from the adjacent ground, and/or the overlying backfill, into any surround material that is open-textured. Such migration will normally result in settlement of the adjacent ground, and/or the backfill. Migration of fines can be prevented by using a close textured surround or, if this is undesirable, by enclosing the surround within a suitable filter membrane.

NG5 Backfill

NG5.1 Backfill Material Classification
The assumed limiting performance of the five classes of backfill material defined in Appendix A1 is shown in Table NG5.1.

Table NG5.1 **Blackfill Material Performance**

Blackfill Material Class	Material Performance % CBR
A	Over 15
B	7 to 15
C	4 to 7
D	2 to 4
E	Less than 2

NG5.2 There are no Notes for Guidance

NG5.3 Additional Requirements
1) Frost Heave Susceptibility

The frost heave test described in BS 812: Part 124 is costly and time consuming and is not suitable for routine on-site control checks. The test is primarily intended as a method to establish whether an aggregate from a particular source is likely to be frost susceptible when used in road pavement construction. Material for the frost heave test must be representative of the source or sub-grade encountered. Authorities usually maintain a list of "Approved Suppliers of Non-frost Susceptible Materials" and should have knowledge of frost susceptible sub-grades in their locality.

The following notes on identification of potentially frost heave susceptible material are for guidance but are not, in themselves, exhaustive:

a) Clay materials can be regarded as non-frost susceptible, particularly when the plasticity index is greater than 15%. Clay/silt mixtures are more difficult to assess and are likely to be of marginal frost susceptibility.

b) Silts, particularly those with more than 10% passing a 75 micron (μm) BS sieve size, are likely to be frost susceptible.

c) Cohesive/granular materials will often be frost susceptible; the quantity and type of granular aggregate and, to a lesser degree the silt fraction are the controlling factors. If the aggregate is a frost susceptible type, then it is very probable that the mixture will also be frost susceptible.

d) Granular materials with more than 10% passing a 75 micron (μm) BS sieve size have a high potential for frost susceptibility and granular materials with more than 12% passing 75 micron (μm) are likely to be frost susceptible.

e) All crushed chalks are frost susceptible and the magnitude of the frost heave will increase with the saturation moisture content of the chalk.

f) Oolitic and magnesium limestones are likely to be frost susceptible, particularly those where the aggregate saturation moisture content exceeds 3.5%.

g) Hard carboniferous limestones are unlikely to be frost susceptible unless they have been contaminated with clay or have more than 12% passing 75 micron (μm).

h) Crushed granites will only be frost susceptible if the percentage passing 75 micron (μm) exceeds 12% and is partially plastic.

i) 'As dug' sands and gravels are frequently frost susceptible especially if the percentage passing 75 micron (μm) BS sieve size is greater than 12% or if it is plastic. Sands and gravels won by "wet working" techniques are unlikely to be frost susceptible unless contaminated by a clay or a high silt fraction.

j) Burnt colliery shales, slags, PFAs, etc. are secondary materials, and it is not possible to give general guidance to their potential for frost heave resistance. Each source is different and will need to be assessed by the frost heave test. The exception to this is graded bottom furnace ash produced by modern power stations, which has been found to be non-frost susceptible.

k) Foamed concretes can generally be regarded as non-frost susceptible.

NG6 Flexible and Composite Roads

NG6.1 There are no Notes for Guidance

NG6.2 Sub-base Reinstatement
1) It may be reasonable to expect that an adequately compacted sub-base should achieve an in-situ CBR value in excess of 30%.

2) It is expected that a bituminous sub-base will only be selected where the base (roadbase) is also bituminous.

3) When placing bituminous material directly on to the backfill it is important to ensure that the exposed surface of the backfill has been compacted. This operation is essential to minimise the risk of a build up of pore water pressure causing the subgrade to become spongy. It is also imperative that construction is phased such that excavated areas are covered, on the same day, with the first layer of bituminous material, to prevent the ingress of water. Care should be taken in the compaction of this first layer. If pore water pressure builds up in the backfill at this stage, then rolling should cease and the material left overnight, or longer if necessary, prior to the placement of any further layers.

NG6.3 Base (Roadbase) Reinstatement
Overlaid Modular Layers

1) This Specification permits the re-use of cobbles and setts for the reinstatement of the relevant layer. However, it is often extremely difficult to achieve a performance from such reinstatements that is similar to that of the original, well interlocked and 'stress hardened' layer. Failure to achieve this structural stiffness could result in failure of the reinstatement and particularly any surfacing materials laid thereon.

2) The Specification does not permit the re-use of penning, in which the layer of modules is laid upright, in an interlocking manner, exhibiting a greater stiffness than an equivalent layer of cobbles/setts.

NG6.4 Surface Reinstatement

NG6.4.1 Hot Rolled Asphalt Surfaces
1) HRA design mixtures give better resistance to deformation where queuing of heavy traffic is likely to occur and may be more economical to lay.

2) Type C mixtures use fine aggregates of a coarser grading than Type F mixtures, usually associated with the use of crushed rock fines. Such mixtures tend to be stiffer and less well suited to the reinstatement of small excavations.

3) Type R mixtures have better fatigue and durability characteristics than Type F or Type C mixtures but can be expected to have less resistance to deformation.

NG6.4.2 – NG6.4.5 There are no Notes for Guidance

NG6.4.5.2 High Friction Surfacings
Special friction surfacings are likely to be bauxite epoxy resin systems, special textured slurry seals or premium surface dressing applications. They will usually have been laid for safety reasons and their early reinstatement will be important to maintain adequate skid resistance.

NG6.4.5.3 Porous Asphalt
Edge sealing requirements specified in Section S6.5.2.2 may not be appropriate with porous asphalts because the free-flow characteristics of the material may be impeded.

NG6.4.5.4 Coloured Surfacings
1) Coloured surfacings are sometimes used for marking bus lanes, accident prevention measures, traffic prioritisation schemes, etc. The use of warning signs, e.g. "Temporary Road Surface", should be considered until the special surface can be restored.

2) It may not be possible to obtain coloured surfacings in a wide selection of colours and Authorities may have to accept limitations in colour matching. In addition, all coloured surfacings fade or undergo other changes in colour as the materials age.

NG6.4.5.5 Other Specialist Surfacing Materials
Texture depth requirements specified in Section S2.6.2 may not be appropriate for the increasing number of specialist surfacing materials currently being used by some Authorities.

NG6.4.6 Surface Treatments
In all roads, where the overall quality of existing surface dressings or surface treatments are to a high standard, it may be difficult to produce small excavations or narrow trenches with surface dressings or other surface treatments that closely and uniformly match the existing adjacent surfaces. Under such circumstances, some localised variation in surface quality may be acceptable to the Authority.

NG6.4.7 – NG6.4.10 There are no Notes for Guidance

NG6.5 Base and Edge Preparation

NG6.5.1 Base Preparation
Tack coating materials are generally based on rapid curing anionic or cationic bitumen emulsions to BS 434, with approximately 40% bitumen content. New tack coating materials are becoming available, and the trial use of more modern variants is recommended.

NG6.5.2 Edge Preparation
1) Edge regularity requirements are intended to provide a shape that will not hinder the compaction of material adjacent to the reinstatement edge. The final shape, when viewed from above, should be governed by the following general principles rather than by aesthetic considerations:

a) There is no requirement to trim the sides of trench excavations solely to provide a uniform width, provided that individual projections are not less than 250 mm length, measured parallel to the nominal centreline of the trench.

b) There is no requirement to trim a small excavation solely in order to provide a square or rectangular shape. Any shape, with included angles not less than 90° and with no projection less than 250 mm length, may be considered to be regular.

c) Where the existing surfacing material is sound at the corners of an excavation, there is no necessity to cut out to a corner; a regular chamfer may be preferable.

d) Where a 90° corner is to be cut out, overlapping cross cuts should be minimal and all cuts extending into the existing surface should be filled with sealant.

2) Edge sealant materials are generally based on rapid curing anionic or cationic bitumen emulsions to BS 434, typically 50 or 70 pen and approximately 70% bitumen content, or hot bitumens to BS 3690, typically 50 or 70 pen. An increasing number of high build and rubberised edge sealants are becoming available and, in general, are preferred. The use of high-build liquid sealants, sprays or solid sealing strips etc, is recommended, on a trial basis at least.

NG6.6 There are no Notes for Guidance

NG7 Rigid and Modular Roads

NG7.1 Reinstatement Methods

1) The requirements of this Specification shall apply to all rigid roads up to 125 msa traffic flow. All rigid roads with existing traffic flows exceeding 30 msa must be identified by the Authority, prior to the commencement of works, so that reinstatement requirements can be agreed.

2) Some modern concrete roads, constructed in accordance with current Government standards and specifications, may incorporate special design philosophies that are beyond the scope of this Specification. Similarly, there may be other existing rigid road designs that will also require the use of particular reinstatement methods. Such roads must also be identified by the Authority, prior to the commencement of works, so that reinstatement requirements can be agreed.

NG7.2 – NG7.6 There are no Notes for Guidance

NG7.7 Modular Roads

1) When excavating in modular roads, the existing modules shall be lifted carefully and stored for re-use.

2) It is particularly important to ensure that bedding and jointing sands should meet the performance demands in areas subject to heavy vehicular traffic.

NG7.8 There are no Notes for Guidance

NG8 Footways, Footpaths and Cycle Tracks

NG8.1 There are no Notes for Guidance

NG8.2 Sub-base and Binder Course Reinstatement

NG8.2.1 – NG8.2.3 There are no Notes for Guidance

NG8.2.4 Excavations Adjacent to Roads
The most heavily stressed area of a road is usually the inside wheel track adjacent to the road edge. Depending on ground conditions, it is often necessary to support the road edge by providing lateral restraint within the adjoining footway, footpath, cycle track or verge. The most common form of edge support is a section of unbound or cement bound granular materials. This construction will most commonly be encountered when the horizontal distance, between the edge of the Undertakers' excavation and the edge of the road surface, is less than the expected depth of cover of the Undertakers' apparatus.

NG8.3 Surface Reinstatement

NG8.3.1 There are no Notes for Guidance

NG8.3.2 High Duty and High Amenity Areas
1) In high duty footways, the durability of the wearing surface is of prime importance and simple cosmetic matching of materials may not be adequate. Specific grades of material such as York stone modules, or specific types of construction such as asphalt sand carpet/mastic, may have been laid in order to give an acceptable performance under extreme conditions. In these cases, similar or equivalent grades of materials will need to be reinstated.

2) In high amenity footways, the cosmetic matching of materials at the wearing surface may be of primary importance with durability of secondary importance.

NG8.3.3 Areas Surfaced with Material BS4987
A wide range of surface treatments exist and commonly these are less than 6 mm aggregate size. Where available, a similar surface finish will be reinstated. The surface course material may be reinstated using any of the allowed binder course or surface course materials, with a final surface treatment applied as soon as practicable following the laying of the permanent surface course.

NG8.3.4 There are no Notes for Guidance

NG8.3.5 Concrete Material Areas
1) In general, reinstatements in a concrete footway, footpath or cycle track should match the existing surfacing as closely as is practicable.

2) Generally, the use of all flexible permanent reinstatements in overlaid concrete, mastic asphalt, asphalt carpet, sand carpet or other derivative surfaces etc., has proven to be entirely adequate in practice.

NG8.3.6 – NG8.3.8 There are no Notes for Guidance

NG8.4 – NG8.5 There are no Notes for Guidance

NG9 Verges and Unmade Ground

NG9.1 – NG9.4 There are no Notes for Guidance

NG10 Compaction Requirements

NG10.1 Introduction
1) Research has shown that failure to operate and maintain compaction equipment in accordance with manufacturer's schedules and recommended practices is likely to result in inadequate compaction with serious implications for the short term performance of individual structural layers and the long term integrity of the entire reinstatement.

2) All compaction equipment covered by this Specification must be frequently checked, adjusted and maintained, as necessary, in accordance with the manufacturer's recommended practices, in order to ensure that the manufacturer's recommended operating frequency is maintained throughout each compaction operation.

3) All compaction equipment covered by this Specification must be used in accordance with the manufacturer's recommended operating procedures.

NG10.2 Reinstatement Materials

NG10.2.1 Unbound Granular and Cohesive Materials
For granular or cohesive materials, a vibrating roller may be unsuitable in small excavations because of the restricted manoeuvrability of large heavy rollers required to achieve adequate levels of compaction with an acceptable number of passes.

NG10.2.2 There are no Notes for Guidance

NG10.2.3 Bituminous Mixtures
With some combinations of compaction plant and certain types of bituminous mixtures if compaction is continued as the material approaches its maximum density the following may result:

a) The migration of fines or binder to the surface.

b) The development of shear surfaces and or crushing of aggregates.

Provided that the material has been laid and compacted within the appropriate temperature range, fewer passes will be required when any signs of distress become apparent.

NG10.2.4 There are no Notes for Guidance

NG10.2.5 Modular Surfacing Materials
Depending on the size and type of paving module to be laid, and/or the extent of the area to be surfaced etc., the use of additional mechanical compaction may become necessary.

NG10.3 Equipment Operation and Restrictions

NG10.3.1 Hand Rammers
1) Hand rammers may be used for initial tamping of fine fill material or immediately adjacent to street furniture, reinstatement edges etc.

2) In all cases, full machine compaction complying with Appendix A8 will normally be applied immediately after the required thickness of material has been built-up. However, hand ramming alone may be necessary around standpipes and other isolated fixed features.

NG10.3.2 Percussive Rammer

1) A percussive rammer is deemed to be a hand-held and/or pedestrian guided machine in which an electric, pneumatic or hydraulically operated reciprocating mechanism acts on a plate or 'foot'.

2) Percussive rammers may only be used to provide full machine compaction in areas where restricted access prevents the effective use of conventional compaction equipment.

NG10.3.3 Vibrotamper

1) A vibrotamper is deemed to be a free-standing, pedestrian guided machine in which a reciprocating mechanism, driven by an integral engine or motor, acts on a spring system through which oscillations are set up in a base plate or 'foot'.

2) Vibrotampers may be operated at reduced speed, for the first pass only, with cohesive materials.

3) Vibrotampers are not preferred for any permanent surface course application or any other application involving a layer thickness of less than 50 mm.

NG10.3.4 Vibrating Roller

1) A vibrating roller is deemed to be a self-propelled, pedestrian steered machine with a means of applying mechanical vibration to one or more rolls.

2) Vibrating rollers should be operated in the lowest available gear, except for the first pass, which should be at maximum forward speed.

3) All compaction passes should be carried out with full vibration, except for the first pass, which should be carried out without vibration in order to nip in the material adjacent to the reinstatement edges and to prevent uneven displacement of material within the remainder of the reinstatement area.

4) Vibrating rollers are the preferred method of compaction for all permanent surface courses.

5) The use of twin drum rollers is preferred to single drum for the compaction of bituminous mixtures and will improve the quality of the permanent surface course. However, single drum vibrating rollers are permitted, as detailed in Appendix A8.

NG10.3.5 Vibrating Plate Compactor

1) A vibrating plate compactor is deemed to be a pedestrian guided plate equipped with a source of vibration consisting of one or more rotating, eccentrically weighted shafts.

2) Vibrating plate compactors should be operated in the lowest available gear, except for the first pass, which should be at maximum forward speed.

NG10.3.6 Other Compaction Equipment

Compaction plant not referenced in Appendix A8, including machine-mounted, modified and other alternative compaction equipment, may be permitted for the compaction of reinstatement materials, in accordance with the following relevant requirements:

1) Machine-Mounted Compactors

A machine-mounted compactor is deemed to be any compaction equipment that is mounted, as an attachment or accessory, to the chassis or front or rear booms of an excavator, tractor, skid-steer vehicle or other proprietary vehicle, for the purposes of compaction.

All machine-mounted compactors, whether integral to the vehicle design or special attachments for front or rear mounting to the chassis or booms of any excavator, tractor or skid-steer vehicle etc. should be operated in accordance with the recommendations of the compactor or attachment manufacturer, to the relevant compaction procedure required by Appendix A 8. However, other operational variables should also be considered prior to the operation of such plant as follows:

a) Compactor Downforce

The total downforce will vary depending upon the weight of the vehicle chassis or compactor frame, and any additional downforce applied by hydraulic rams etc. However, changes in the configuration of any vehicle, by the addition or removal of other accessories etc, changes in the width of the vibrating foot, roll or plate etc, movement of any boom resulting in a significant change of loading geometry or outreach etc, attaching of the compactor to other vehicles of differing types or weights etc, can all result in a significant reduction of compactive performance that is seldom apparent. All operators should be aware of the potential reduction in compactive performance resulting from such changes in configuration.

b) Applied Downforce

The mounting of compaction equipment to the front loader arms of an excavator, where the downforce is sensibly limited by the lifting of the front wheels, is preferred. All compactors mounted to the backhoe of an excavator should be fitted with a downforce-limiting device, correctly set, or with a simple indicating device allowing the amplitude to be estimated.

c) Compactor Set-up

Where vibration frequency or amplitude, or any other parameter affecting the dynamic output of a compactor, is expected to be adjusted on a routine basis, all parameters should be set in accordance with the manufacturer's recommendations unless specific testing, meeting the requirements of Section NG1.6.3, has shown other settings to be at least as effective.

2) Modified Compaction Equipment

Modified compaction equipment shall include any proprietary vibrotamper, vibrating roller, vibrating plate compactor, percussive rammer or other compaction plant which has been adapted, converted, revised or otherwise changed from the original manufacturer's Specification, resulting in a significant change to the original configuration, dimensions, operational weight or power output.

Modified compaction equipment shall be permitted, provided it is operated in accordance with compaction procedures meeting the following requirements:

a) The original manufacturer shall provide written confirmation that the modified compaction equipment, operated in accordance with the original compaction procedure, is capable of achieving the same degree of compaction as any other option permitted in Appendix A8. or

b) A revised compaction procedure is developed in accordance with the requirements of Section NG1.6.

3) Alternative Compaction Equipment

Alternative compaction equipment shall include all other compaction devices not specifically permitted within Section NG10.3. Alternative compaction equipment may be permitted, provided it is operated in accordance with compaction procedures developed in accordance with the requirements of Section NG1.6 (3).

NG10.3.7 Compaction Procedure (Note: There is no equivalent S10.3.7 for this section)

1) A single pass of any compaction plant is deemed to be completed when the foot, roll or plate of the compactor has impacted the entire surface area of the layer.

2) Where the excavation width is more than 50 mm greater than the foot, roll or plate width (i.e. side clearances between the compacting surface and the wall of the excavation exceed 25 mm per side), two or more traverses of the compaction device will be required to ensure coverage of the entire surface and all will be deemed to constitute a single compactive pass.

3) Compaction plant should be steered along a line offset from that steered on the previous pass so that alternate passes are run close in to each side wall of the excavation.

4) Small items of compaction plant will frequently be required and additional provisions must be considered for use in trenches of less than 200 mm width, small excavations and other areas of restricted access. In general, lightweight vibrotampers and poletampers are capable of achieving the same degree of compaction as the heavier items of plant specified in Appendix A8. However, small plant is usually not self-advancing and therefore more difficult to operate effectively. Currently there is no alternative equipment available for this application and the provisions included in Appendix A8 are proven in practice.

NG11 Ancillary Activities

NG11.1 Traffic Signs, Road Markings, Studs and Verge Markers
In the interests of safety generally and particularly in the interests of the disabled, all traffic signs, road markings, studs and verge markers removed during the course of the works should be replaced immediately following completion of works.

NG11.2 Street Furniture and Special Features
In the interests of safety generally, and particularly in the interests of the disabled, all street furniture, tactile paving and any other special features removed during the course of works should be replaced immediately following the completion of works.

NG11.3 Traffic Sensors
1) Examples of sensors include ice warning sensors, buried queue and traffic detectors, other electronic detectors and various data collection devices.

2) The replacement of some traffic sensors may require the use of specialist contractors.

NG11.4 – NG11.5 There are no Notes for Guidance

NG12 Remedial Works

NG12.1 – NG12.5 There are no Notes for Guidance

NGA2 Key to materials

NG A2.1

1) HRA design mixtures give better resistance to deformation where queuing of heavy traffic is likely to occur and may also be more economical to lay.

2) Type C mixtures use fine aggregate of a coarser grading than Type F mixtures – usually associated with the use of crushed rock fines. Such mixtures tend to be stiffer and are less well suited to the reinstatement of small excavations.

3) Type R mixtures have better fatigue and durability than Type F or Type C but can be expected to have less resistance to deformation.