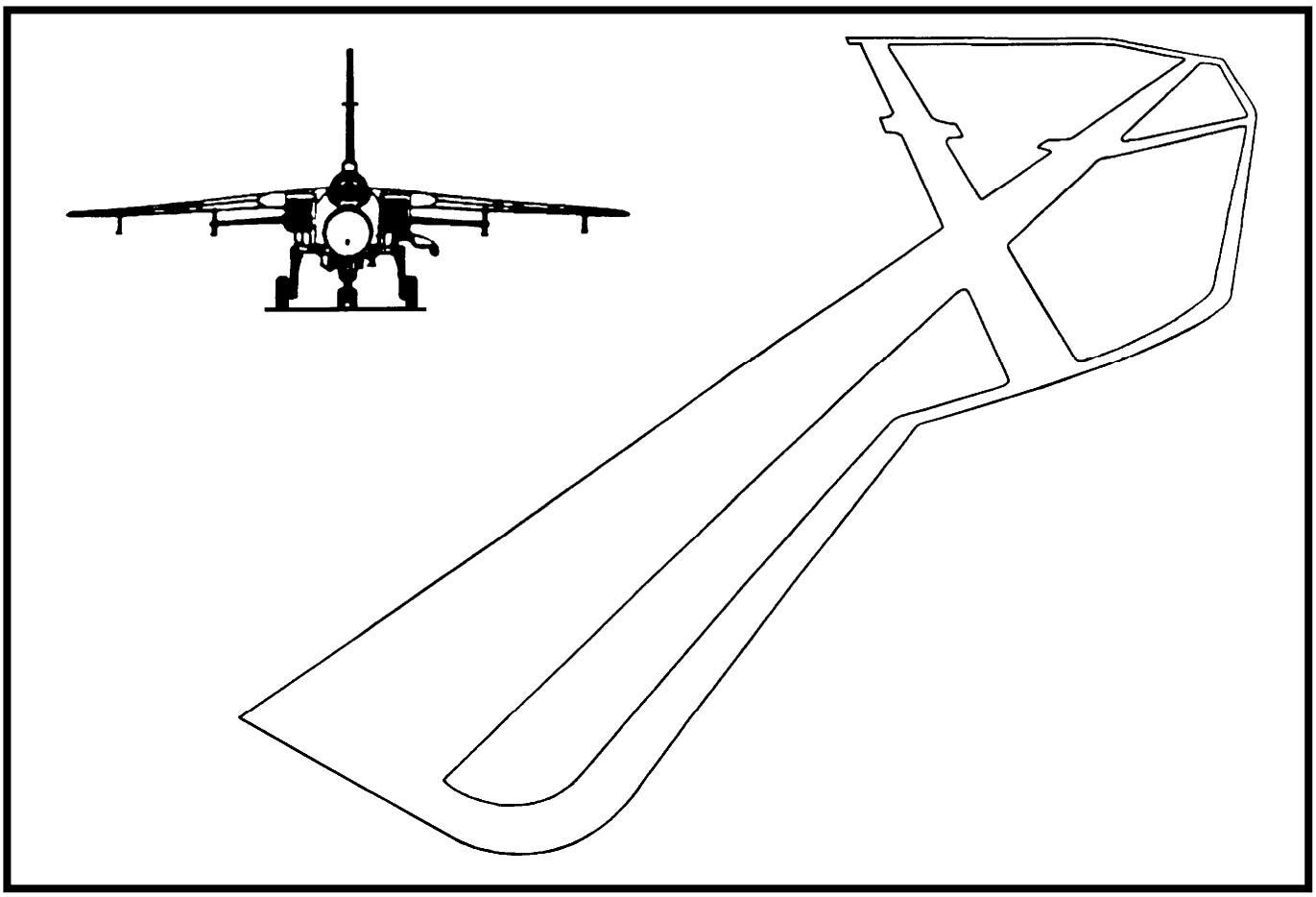
Specification 045



Slurry Surfacing (including Slurry Seal and Microsurfacing) for Airfields

DEFENCE ESTATES

MINISTRY OF DEFENCE

Specification 045

Slurry Surfacing (including Slurry Seal and Microsurfacing) for Airfields

May 2009

CONSTRUCTION SUPPORT TEAM
DEFENCE ESTATES

Ministry of Defence

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Foreword

This document is for the use of Top Level Budget Holders (TLBHs) for application by Project Sponsors and their Project Managers, Property Managers (PROMs), Establishment Works Consultants (EWCs), Works Service Managers (WSMs) and other parties involved with airfield pavement works on the MOD estate.

This revision of the Functional Standard supersedes the 1999 edition.

The application and limitations of the specification requirements in this Functional Standard are outlined in Section 1. Further technical assistance regarding the contents of this document can be obtained from Defence Estates (DE). Approaches may be made through local DE offices or directly to the airfield pavement Technical Authority (DE TA):

Head of Airfield Pavements
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Kingston Road
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This Specification, "*Slurry Surfacing (including Slurry Seal and Microsurfacing) for Airfields"*, has been devised for use of the Crown and of its Contractors in the execution of contracts for the Crown and, subject to the Unfair Contracts Terms Action 1977, the Crown will not be liable in any way whatever (including but without limitation negligence on the part of the Crown its servants or agents) where the Standard is used for other purposes.

Glossary of Technical Terms

Added Filler	Filler aggregate that is additional to that inherent in the course and fine aggregate
Asphalt	A mixture of coarse and fine aggregate, filler aggregate and bituminous binder used in the construction of flexible pavements for roads and airfields.
Asphalt Concrete	An asphalt mixture consisting of continuous graded aggregate, filler aggregate and bituminous binder proportioned to produce a dense and impermeable surfacing.
Asphalt Surfacing	A porous friction course, surface course, or a combination of these, and a binder course.
Asphaltic Concrete	Alternative name for 'Asphalt Concrete'.
Aggregate / Cement Ratio	The ratio between the total mass of aggregate, including the mass of any absorbed water, in a concrete mix and the mass of cement in the mix.
Base	Structural layer(s) of a pavement immediately below the Binder Course that are bound.
Basecourse	Previous name for 'Binder Course'.
Bay (of Concrete)	The area of slab bounded by adjacent pairs of longitudinal and transverse joints or grooves.
Bay Layout	The pattern of joints and grooves on a concrete pavement.
Bond Coat	Proprietary polymer modified bituminous emulsion that provides a strong adhesive and cohesive bond between pavement layers. This is used to produce a monolithic structure and is also used to protect the lower layers from water ingress. The rate of application is recommended by the proprietor for the particular situation. (Replaces a tack coat).
Binder	A material used for the purpose of holding solid particles together as a coherent mass.
Binder Course	The layer or layers of the asphalt surfacing immediately below the surface course. (Previously called 'Basecourse').

Bitumen	Binder obtained from crude oil by refinery processes.
Bitumen Emulsion	An emulsion in which bitumen is dispersed in water or in aqueous solution with the aid of suitable emulsifying agents.
Bitumen Macadam	See 'Macadam'.
Bituminous	Containing bitumen and additives. (Previously included road tar, pitch or mixtures thereof).
Bituminous Surfacing	Alternative name for 'Asphalt Surfacing'.
Bond Coat	A polymer modified bituminous emulsion often a proprietary emulsion designed to enhance adhesion between Asphalt layers or between Microsurfacing and substrates.
Coarse Aggregate	For asphalt, aggregate mainly retained on a 2.0 mm test sieve and containing no more finer material than is permitted for the various sizes in BS EN 13043. For concrete and block making, aggregate mainly retained on a 4.0 mm test sieve and containing no more finer material than is permitted for the various sizes in BS EN 12620.
Construction Joint	A joint separating areas of a concrete pavement slab placed during different pours, usually on different days. May be a longitudinal, or lane, joint or a transverse joint across a lane.
Construction Trial	Section of airfield or road pavement where the installation of the product may be made prior to commencement of the works so that the product may be assessed
Contraction Groove	A groove formed in the surface of a concrete slab, either during or soon after laying, in order to induce shrinkage cracking to occur in a controlled manner. Usually formed transversely at regular intervals along a lane of concrete by saw cutting so as to subdivide it into approximately square bays.
Crushed Aggregate	Aggregate produced by crushing rock or gravel.
Cut-back Bitumen	Bitumen whose viscosity has been reduced by the addition of a suitable volatile diluent.
Dense Bitumen Macadam (DBM)	See 'Macadam'.

Drylean concrete	A cement bound granular material with low water content suitable for use as a Base or subbase. Unlike conventional concrete, it is usually compacted by rolling.
Edge Restraint	Device that serves to prevent sideways movement of paving units and prevents loss of material from the laying course, base or subbase.
End Performance Specification	Specification of characteristics of performance for the installed product. For example: skid resistance or visual assessment. Durability is assumed by the use of a TAIT and component tests (aggregate and binder properties).
Expansion Joint	Joint provided in a concrete pavement to accommodate the expansion which occurs when the temperature of the pavement rises.
Fines	Any solid material passing a 0.063 mm test sieve.
(Sieved) Fraction	Previous name for 'Particle Size Fraction'.
Filler Aggregate	For asphalt, aggregate, most of which passes a 0.063 mm sieve as permitted in BS EN 13043, which can be added to construction materials to provide certain properties. For concrete and block making, aggregate, most of which passes a 0.063 mm sieve as permitted in BS EN 12620, which can be added to construction materials to provide certain properties.
Fine Aggregate	For asphalt, aggregate mainly passing a 2.0 mm test sieve and containing no more coarse material than is permitted for the various gradings in BS EN 13043. For concrete and block making, aggregate mainly passing a 4.0 mm test sieve and containing no more coarser material than is permitted for the various gradings in BS EN 12620.
Foreign Object Damage (FOD)	Damage sustained by aircraft as a result of foreign objects striking the aircraft or being ingested into jet engines. Potential sources of damage are generally referred to as FOD hazards.
Friction Course	See 'Porous Friction Course'.
Grading	Particle size distribution of an aggregate.
Heavy Duty Macadam (HDM)	See 'Macadam'.

Hot Rolled Asphalt (HRA)	An asphalt mixture of gap-graded aggregate, filler aggregate and bitumen binder proportioned to a design or recipe to produce a dense and impermeable surfacing material.
Intermediate Restraint	Device that is used to provide restraint of concrete block paving units at intervals in the paved surface.
Interlock	Effect of frictional forces between concrete blocks that prevent them moving vertically in relation to each other.
Laitance	On a concrete pavement, a thin layer with poor durability formed of fine aggregate, cement and water brought to the surface, usually by overworking.
Lane	A longitudinal strip of a pavement layer produced by one pass of a set of paving equipment.
Lane Joint	A construction joint between adjacent lanes.
Laying Course Material	Layer of material on which concrete blocks are bedded. Often referred to as the 'bedding sand' or 'laying course sand'.
Laying Face	Working edge of the wearing surface when concrete blocks are being laid out.
Laying Pattern	An arrangement of concrete blocks to form specific patterns for structural requirements.
Joint Filling Material	Material used to fill the joints between concrete blocks. Often referred to as 'joint filling sand'.
Joint Width	The distance between adjacent concrete blocks or concrete blocks and restraint.
Macadam	An asphalt mixture (nominally an Asphalt Concrete) consisting of graded aggregate coated with bitumen. a. Dense Bitumen Macadam (DBM): A dense, relatively impermeable, Macadam coated with a bitumen binder and with a filler aggregate content of between 2 % and 9 %. b. Heavy Duty Macadam (HDM): A dense bitumen Macadam with 40/60 pen grade bitumen binder and a high filler aggregate content of 7 % to 11 %. c. Pervious Macadam: A layer of 0/32 mm Porous Asphalt which acts as a topping to protect whilst allowing free penetration of the surface water to French drains.

Marshall Asphalt	An Asphalt Concrete designed to achieve specified stability, flow, voids and density characteristics.
Microsurfacing	A Slurry Surfacing where the coarse aggregate maximum size is often greater than 4mm and which is a proprietary material containing polymer modified binder and sometimes polymer fibres. When applied on airfields a polymer modified bituminous emulsion bond coat is used.
Particle Size Fraction	That portion of aggregate which passes one sieve but is retained on the adjacent smaller sized sieve in the sequence of sieves used to specify that grading.
Pavement	A structure consisting of a layer or superimposed layers of selected materials, whose primary purpose is to distribute the applied load to the Subgrade.
Pavement Quality Concrete (PQC)	A cement concrete of a suitable quality for use as the surfacing on airfield pavements.
Pervious Macadam	See 'Macadam'.
Petroleum Bitumen	See 'Bitumen'.
Polymer Modified	The modification of binder (bitumen or bituminous emulsion) in Slurry Surfacing or an Asphalt mixture to provide enhanced performance properties
Porous Asphalt	An asphalt mixture consisting of gap-graded aggregate and binder with a relatively open structure that is pervious to air and water.
Porous Friction Course	A relatively thin layer of 2/10 mm aggregate sized Porous Asphalt that allows free penetration of the surface water to the underlying impervious surface course.
Ramp	A section of pavement, usually laid at a gradient near the maximum permissible, which accommodates differences in level between adjacent pavements. (Note that, in US terminology, 'Ramp' may also be used to indicate an aircraft parking area).
Regulating Material	Asphalt of variable thickness applied to an existing pavement to adjust the shape preparatory to resurfacing.
Roadbase	Previous name for 'Base'.
Road Tar	A viscous liquid derived from crude tar obtained by the destructive distillation of coal which was, but is no longer, used as a component in asphalt.

Sand (for making concrete)	Now called 'Fine Aggregate'.
Slurry Seal	A fine close textured slurry surfacing. When specified by recipe, using unmodified bitumen emulsion, slurry seal is not able to withstand high stresses and temperatures and its sealing ability and durability is poor.
Slurry Surfacing	A surface treatment, consisting of a mixture of mineral aggregates, water, bitumen emulsions and additives, which is mixed and laid in place. (See also Microsurfacing). NOTE: for small areas the material may be premixed and transported to site. For example for repairs.
Stone Mastic Asphalt (SMA)	Dense gap-graded asphalt with aggregate-to-aggregate interlock that includes fibres as a stabilising additive to carry the binder without drainage.
Subgrade	Upper part of the soil, natural or constructed, that supports the loads transmitted by the overlying pavement.
Surface Course	The layer of the asphalt surfacing immediately below the porous friction course or which directly supports the traffic. (Previously called 'Wearing Course').
Tack Coat	A thin film of conventional bitumen emulsion to improve the adhesion between two courses of asphalt or between an existing surface and a new asphalt layer. (See also Bond Coats for enhanced performance).
TAIT (Type Approval Installation Trial)	TAIT consists of a defined section where slurry surfacing or microsurfacing has been installed using Factory Production Control (FPC) and which has been submitted to performance tests after a period of between 11 and 13 months. TAIT is synonymous with Initial Type Testing (ITT, CEN nomenclature).
Torque Test Method for shear strength and bond	Test method for the measurement of the performance of Slurry Surfacing and Microsurfacing in terms of bond to substrate and shear strength of the material.
Thin (Asphalt) Surfacing System	A proprietary asphalt product with suitable properties to provide a surface course that is laid at a nominal depth of less than 50 mm (previously limited to 40 mm).
Uncrushed Aggregate	Aggregate resulting from the natural disintegration of rock.

(Free) Water/Cement Ratio	The ratio between the mass of water, less any water absorbed by the aggregates, in a concrete mixture and the mass of cement in the mixture.
Wearing Course	Previous name for 'Surface Course'.

(NOTE. This glossary is common to all DE Functional Standards for asphalt and concrete pavement materials and the Project Manager should delete any terms not applicable to a particular project and should add any terms necessary due to the particular nature of that project.)

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1 Introduction

1.1 BACKGROUND

1.1.1 The unique characteristics of military aircraft, in terms of speed, weight, tyre pressures, and problems with FOD, fuel, de-icing fluids, etc., create special requirements for the surfacing of MoD airfields. Performance specifications are required to meet these needs.

1.1.2 Slurry Seal has been a standard maintenance treatment for weathered/worn asphalt on MOD airfields for over 40 years. Recent experience has shown that the Slurry Seal recipe specification using unmodified bitumen emulsion may not meet the functional requirements particularly in areas subject to severe loading conditions. For this reason the Standard has been revised with the incorporation of additional performance/test criteria and the use of modified binders.

1.1.3 This Standard for Slurry Surfacing, which includes Microsurfacing, is one of a series being produced by DE to provide performance specification requirements for airfield pavement works. The following clauses are intended to set out the applications of Slurry Surfacing including Microsurfacing in the construction and refurbishment of airfield pavements.

1.1.4 The use of this Standard does not absolve a Project Manager from any responsibility for his designs; neither does its existence constrain him from using alternatives, provided such alternatives can be demonstrated to provide a result of equal quality.

1.2 DEFINITION OF SLURRY SURFACING AND MICROSURFACING

1.2.1 Slurry Surfacing is the general European term (BS EN 12273 - see references) applied to the product and includes both Slurry Seal and Microsurfacing. Microsurfacing is normally a proprietary system with slightly larger coarse aggregate maximum size with a polymer modified bituminous emulsion binder. Microsurfacing for airfields can contain other additives such as polymer fibres and in application for airfields uses a polymer modified bituminous emulsion bond coat.

1.2.2 For the purposes of this Specification, the term “slurry seal” shall be used to refer to a material with maximum aggregate size less than 4mm and incorporating a modified or unmodified binder, and the term “microsurfacing” shall be used to refer to a material with a maximum aggregate size greater than 4mm and incorporating a modified binder and laid with a bond coat.

1.3 FUNCTIONAL REQUIREMENTS OF AIRFIELD PAVEMENTS

1.3.1 The pavements must facilitate safe aircraft ground operations. In order to do this, they must meet certain specialist performance requirements. The following sets out the main requirements, the relative importance of which will be dependent on the function of the pavements and the nature and type of aircraft operations:

a. Good rideability.
b. Good friction characteristics.
c. High strengths and stability to withstand the shear stresses induced by heavy wheel loads and high tyre pressures.
d. A durable, hard-wearing weatherproof surface free from loose material and sharp edges which might endanger aircraft.
e. Resistance to fuel spillage and jet blast. Depending on the nature and type of aircraft operations, these requirements are likely to be too onerous for asphalt surfacings in certain areas of the airfield.
f. Facilitate economic maintenance.

1.3.2 To aid proper control and make sure that the performance criteria will be met, Slurry Surfacing and Microsurfacing shall always be mixed on site even for very small quantities.

1.4 USE OF SLURRY SURFACING FOR THE MAINTENANCE OF ASPHALT

1.4.1 Many of the runways (see Para 1.4.3) and taxiways on military airfields in the UK are surfaced with asphalt, often Marshall asphalt (or asphaltic

concrete). As the bitumen binder in such surfacing becomes oxidised, traffic (and sweeper) wear causes erosion of the bitumen/filler/ fine aggregate matrix so that coarse aggregate particles begin to stand proud. The protruding coarse aggregate would eventually become loose if no preventive measures were taken; this would be unacceptable since, when loose, these larger particles present potential foreign object damage (FOD) hazards, being capable of causing expensive damage to aircraft if ingested into their jet engines or striking propeller blades.

1.4.2 Slurry Surfacing should be applied to the ageing asphalt before any significant loss of coarse aggregate occurs. Slurry Surfacing can be effective in sealing some of the fine embrittlement cracks that may be present in the asphalt, provided it has not aged significantly. Prominent cracks that are accommodating thermal or load-induced movement will generally reappear through the Slurry Surfacing quickly. Slurry Seals and Microsurfacing are treatments for surface weathering and wear of asphalt and not for the sealing of cracks, as the name “slurry seal” might imply. (Cracks require a separate maintenance operation, usually consisting either of repair by patching before the Slurry Surfacing is applied or sealing later by overbanding with an elastomeric material).

1.4.3 Slurry Surfacing should **NOT BE USED ON RUNWAYS ON MOD AIRFIELDS** unless agreed with Construction Support Team of Defence Estates.

1.4.4 This Performance Standard includes for three grades of slurry seal: 'standard texture' slurry seal and 'coarse texture' slurry seal (these two have gradings similar to the previous slurry seal recipe specification but using CEN specifications), and the third described as “microsurfacing” which has a coarser grading specified by the producer (contractor) and incorporates a modified bituminous binder. For taxiways, standard texture slurry seal has normally been used, because traditional coarse textured unmodified slurry surfacing can cause significantly increased tyre wear, especially in turning areas. Also the coarse textured slurry seal was likely to be more prone to abrasion by turning aircraft or vehicles. Polymer modified microsurfacing can be used upon asphalt surfaces which have weathered and abraded to the extent that use of the standard texture grade slurry surfacing is not viable. As a general guide the limiting asphalt texture depth for the application of the standard grade slurry seal is about 1.5mm.

1.4.5 The life of the Slurry Surfacing is very much dependent on the frequency and nature of the trafficking. The life of polymer modified slurry surfacing is being evaluated, but is expected to be in excess of five years. Regular trafficking by aircraft with high pressure tyres in turning areas (e.g. taxiway intersections) will result in a very much reduced life. When Slurry Seal or Microsurfacing wears away it is often feasible to replace them with a second application.

1.4.6 Unmodified bitumen emulsion slurry surfacings are more susceptible to damage by scuffing, heavy wheel loads, spilled aviation fuel, de-icing fluids or by jet engine exhaust efflux than are the bitumen bound surface courses to which they are applied, particularly during their early life. Experience has also shown that long term adhesion to concrete surfaces, even after the application of a tack coat or bond coat, is poor and delamination occurs. Consequently, on MOD airfields slurry surfacings incorporating unmodified bitumen binder should only be used on areas trafficked by light aircraft and subject to agreement with the Construction Support Team of Defence Estates.

1.5 USE OF SLURRY SURFACING AS A FRICTION TREATMENT FOR RUNWAYS

1.5.1 In addition to providing a maintenance treatment for weathered and worn asphalt surfaces, coarse texture slurry surfacings have also been applied to new asphalt surfaces on the main lengths of some MOD runways to improve friction characteristics. However, until the proprietary polymer modified Microsurfacings have consistently demonstrated enhanced performance, they should be regarded as a less favoured option compared with the application of a porous friction course or the provision of a grooved Marshall asphalt wearing course; Joint Services Publication 554 - *Military aerodrome construction and safeguarding criteria* sets out the policy on the use of surfacing materials on MOD runways. New asphalt surfaces should be allowed to cure (for a period of about one month) before a slurry surfacing is applied.

1.6 WORKS OF SMALL SCOPE

1.6.1 For works of limited scope, it may be necessary to modify the Specification in order to achieve a realistic balance between cost and quality requirements. Such modifications may apply to aggregate grading, provision of on-site mixing, mechanised laying and rolling, and test requirements. Some guidance is given in Appendix Z to this Standard and also in DE Defence Works Functional Standard 06 - *Guide to Maintenance of Airfield Pavements*.

1.7 SPECIFICATION CLAUSES FOR SLURRY SURFACING (INCLUDING MICROSURFACING)

1.7.1 Specification clauses are contained in Sections 2 to 7 of this Standard. Guidance Notes for the Project Manager on Quality Systems are given in Appendix Y and for the preparation of job specifications in Appendix Z.

1.8 ADVICE FROM CONSTRUCTION SUPPORT TEAM - DE

1.8.1 Clauses **Error! Reference source not found.** to 1.6 provide general advice on the application of this Standard. However, having regard to the various design parameters affecting the choice of construction and specifications, including scope of work, aircraft type and frequency of usage, location of pavement on an airfield, design life, timescale constraints and existing pavement constructions, the guidance notes cannot be exhaustive. Further advice on a project/works specific basis can be obtained from the Construction Support Team/DE.

2 General

2.1 REFERENCES

2.1.1 All references to British Standards and other documents given in this Specification refer to the editions as listed in the References at the end of this document unless otherwise stated.

2.2 OVERALL REQUIREMENTS

2.2.1 Slurry Surfacing shall be specified, mixed, transported and laid to the requirements of the following clauses in this Specification. The requirements of this Specification are arranged in the following parts:

General	Section 2
Constituent Materials	Section 3
Composition & Performance Requirements	Section 4
Plant & Workmanship	Section 5
Trials	Section **Error! Reference source not found.**
Summary of Tests	Section 7
Bituminous Binders	Appendix A
Magnesium Sulfate Test	Appendix B
Binder Recovery and Ageing Test	Appendix C
Visual Assessment	Appendix D
Shear Bond Strength Test	Appendix E
Type Approval Installation Trial	Appendix F

2.2.2 Slurry Seal and Microsurfacing mixtures shall be designed by the Contractor in his laboratory in accordance with this specification, and a TAIT shall have been carried out in accordance with Clause 2.5 and Appendix F. The material shall be either standard or coarse textured slurry seal (defined in terms of grading), or Microsurfacing (which shall be a grading to the design proposal of the contractor) as stated in the contract. The contractor shall provide the Project Manager with his design proposal and method statement before the start of the main works.

2.3 USE OF SLURRY SURFACING

2.3.1 Slurry Seal or Microsurfacing shall be used in the locations indicated on the project drawings.

2.4 QUALITY ASSURANCE FOR THE SUPPLY OF MATERIALS

2.4.1 Component materials shall either be CE marked in accordance with a harmonised European Standard or European Technical Approval or shall be procured from a supplier with Quality Assurance accreditation to the BS EN ISO 9000 series and approved by Construction Support Team/DE. All operations in the supply of materials shall be carried out by a Contractor (or Supplier on his behalf) who has a Quality Assurance accreditation to the BS EN ISO 9000 series for those operations.

(NOTE. Advice for the Project Manager on Quality Systems is given in Appendix Y.)

2.4.2 Each production unit or depot involved in the work shall be registered under a Quality Management scheme to the BS EN ISO 9000 series and under “Sector Scheme 13B”, for the supply and application of Slurry Surfacing/Microsurfacing. The CE mark documentation or the Quality System documentation for the supply of component materials, slurry surfacing production and installation, together with other relevant records and certificates, are to be submitted at Tender Stage.

(NOTE. The Project Manager should provide a questionnaire requesting the details of information that is required; advice is given in Sub-Clauses Y.5.2 and Y.6.4 of Appendix Y.)

2.4.3 The Contractor shall be responsible for having all testing for the supply of materials carried out in accordance with the requirements of Section 7 and shall provide the Project Manager with a written copy of the results in accordance with Clause 7.1.

2.4.4 All documentation relevant to the work, including records of mixing and test results, shall

also be available at the plant or the depot for inspection. The documentation, including worksheets, shall be stored in an easily retrievable form for a minimum of 3 years.

2.5 TYPE APPROVAL (TAIT)

2.5.1 The Contractor shall submit, with his tender proposals or quotation, evidence of an appropriate Type Approval Installation Test (TAIT) and CE marking specific to the use of the proposed product on airfields. The TAIT shall have been carried out and documented under a Quality System accredited to BS EN ISO 9000.

Where a TAIT has been produced for a slurry seal with unmodified binder, that TAIT may be accepted where the binder is replaced by a modified binder but all other properties of the material remain unchanged, subject to approval by the Project Manager.
(**NOTE**. Advice must be sought from Defence Estates Construction Support Team in all cases where this is to be considered.)

2.5.2 As an interim measure pending implementation of the relevant harmonised European Standard, a TAIT or CE marking applicable to highway works **MAY** be accepted by the Project Manager subject to:

- The proposed works are of **SMALL SCALE** and in **NON-CRITICAL** areas;
- the material complying with all other requirements of this specification;
- satisfactory mixing and laying trials; and
- review and approval of the TAIT by the DE Construction Support Team.

(**NOTE**. It is anticipated that this interim measure may apply until 1st January 2011. Advice must be sought from Defence Estates Construction Support Team in all cases where this measure is to be applied.)

3 Constituent Materials

3.1 AGGREGATES, GENERAL

3.1.1 The Contractor shall inform the Project Manager of the source and aggregate properties for each aggregate. The aggregate shall be crushed granite, gabbro, porphyry, hornfels, basalt, quartzite or gritstone blended if necessary to achieve the overall grading requirements.

3.1.2 Initial approval of aggregates shall be obtained from the Project Manager before mixing starts; approval shall be based on results supplied to the Project Manager of those tests listed in Clause 7.2 and carried out by the Contractor.

3.1.3 All aggregates used in the Slurry Surfacing shall be CE marked.

3.1.4 Aggregates shall conform to BS EN 13043 Categories for fines content, physical properties and durability as defined in Clauses 3.2 and 3.3. Aggregates shall not contain deleterious materials in such a form or in sufficient quantity to adversely affect the strength at any age or the durability of the slurry surfacing, including resistance to frost.

3.1.5 The resistance to freezing and thawing of each source shall be categorised over all fractions using a modification of the Magnesium Sulfate Test in accordance with BS EN 1367-2 as outlined in Appendix B.

OR

The aggregates do not have to be categorised for resistance to freezing and thawing over all fractions using the Magnesium Sulfate Test in accordance with BS EN 1367-2 provided there is local evidence that the aggregate is sound.

3.2 COARSE AGGREGATES

3.2.1 The properties of the coarse aggregate shall conform to the BS EN 13043 Categories shown in Table 3.1 (only applicable to coarse textured slurry seal and microsurfacing).

Table 3.1 Required properties for coarse aggregates

Property	Situation	Category
Resistance to freezing and thawing	Each source ‡ Each fraction ‡	MS_{18} MS_{30}
Resistance to fragmentation	All	LA_{30}*
Water absorption	All	$WA_{24}2$*
Resistance to Polishing	Runway surface course	PSV_{50}*
	Taxiway surface course	PSV_{50}*
Maximum aggregate size	All	*See Clause 4.1*

* These data are obtained from the CE mark for the aggregate concerned. The tests should be carried out on the aggregate size appropriate to the test from the same source

‡ BS EN 1367-2: 1998 is restricted to the 10/14 mm fraction but, for this purpose, the same techniques shall also be used for other fractions of the coarse aggregate. Advice on the use of the test with non-standard aggregate fractions is given in Appendix B.

(NOTE: Advice for small works is given in Appendix Z.)

3.3 FINE AGGREGATES

3.3.1 Fine aggregates shall be crushed rock; and shall be free from loosely bonded aggregations and other foreign matter. Natural or sea-dredged sand shall not be permitted.

3.3.2 Crushed rock fines shall be washed.

3.3.3 The properties of the fine aggregate shall conform to the BS EN 13043 Categories shown in Table 3.2.

Table 3.2 Required properties for fine aggregates

Property	Aggregate type	Limit
Resistance to freezing and thawing	Each source ‡ Each fraction ‡	MS_{18} MS_{30}
Fines quality	All	MB_FNR*
Water absorption	All	WA_{24}2*

* These data are obtained from the CE mark for the aggregate concerned.

‡ BS EN 1367-2: 1998 is restricted to the 10/14 mm fraction but, for this purpose, the same techniques shall also be used for other fractions of the coarse aggregate. Advice on the use of the test with non-standard aggregate fractions is given in Appendix B.

3.4 ADDED FILLER

3.4.1 All filler aggregate used in the Slurry Surfacing shall be CE marked.

3.4.2 The type of filler aggregate to be used for a particular material shall be selected from cement (to BS EN 197-1) or hydrated lime (to BS EN 459-1).

3.4.3 Filler shall be stored in dry conditions.

3.4.4 A copy of all filler aggregate delivery tickets shall be passed to the Project Manager on a regular basis during production, for his retention.

3.5 BINDER

3.5.1 For microsurfacing and for slurry seal incorporating a modified binder, the Contractor shall provide, with his Design Proposal, a Binder Data Sheet giving details of the properties of each binder proposed, including rheology (graphs of complex shear modulus and phase angle against temperature), cohesion (graph of Vialit pendulum cohesion against temperature) on binder recovered from the emulsion and aged in accordance with Appendix C.

3.5.2 For slurry seal incorporating an unmodified bitumen emulsion binder the Contractor shall submit confirmation of the proposed binder class. The emulsion shall be selected from the applicable classes defined in BS EN 13808 to ensure that the finished product will meet the required shear bond strength after 48 hours (see Clause 4.3).

3.5.3 Each delivery of emulsion to the contract works shall be accompanied by a delivery ticket giving the following details:

- Delivery ticket number;
- Customer name and delivery site reference;
- Date loaded;
- Date delivered;
- Vehicle registration number;
- Emulsion type and grade; and
- Quantity.

3.5.4 Copies of delivery tickets for the binder shall be passed to the Project Manager for his retention.

3.6 TACK COATS

3.6.1 Tack coats shall not be used with microsurfacing or for slurry seal incorporating a modified binder.

3.6.2 Tack coat for use with standard or coarse texture slurry seal shall be Class C40 B4 to BS EN 13808.

3.7 BOND COATS

3.7.1 A bond coat shall be used for all microsurfacing and slurry seal incorpoprating a modified binder.

3.7.2 The rate of spread shall provide a residual binder film of not less than 0.2kg per square metre unless otherwise approved and demonstrated through the TAIT and construction trial.
(NOTE: “residual binder” is the binder remaining after evaporation of the water from an emulsion)

3.7.3 Bond coats shall be premium grade polymer modified bituminous emulsions.
(NOTE: a premium grade polymer modified binder has a minimum cohesion value when tested in accordance Appendix A of 1.2 J/m^2.)

3.8 COURSE THICKNESS

3.8.1 The thickness of each course of slurry seal or microsurfacing shall be as shown on the drawings. It shall be the thickness of the course at any point after compaction.

4 Composition and Performance Requirements

4.1 GRADING ENVELOPES

4.1.1 The target grading of the slurry surfacing shall comply with table 4.1 using standard texture, coarse texture, or microsurfacing as specified in the contract.

Table 4.1 Slurry surfacing gradings

Sieve size	Percentage by mass passing		
mm	Standard texture slurry seal	Coarse texture slurry seal	Micro-Surfacing
4.0		100	See Clause 4.1.2
2.8	100	76-100	
2.0	86-100	60-85	
1.0	60-90	41-60	
0.5	40-64	27-41	
0.25	23-40	17-27	
0.125	10-25	9-19	
0.063	6-15	7-14	

4.1.2 The proposed grading envelope of Microsurfacing shall be declared by the Contractor in his Design Proposal and shall have been assessed by a TAIT (Type Approval Installation Trial) as Clause 2.5 and Appendix F.

4.2 MINIMUM BINDER CONTENT

4.2.1 For slurry seal (incorporating a modified or unmodified bitumen binder) the proportion of bitumen emulsion within the mixture (as % of dry aggregate by mass) shall be not less that 22% for standard texture or 18% for coarse texture.

4.2.2 For microsurfacing (incorporating a polymer modified bitumen binder) the target binder content and acceptable tolerances shall be declared by the Contractor and shall comply with the binder content demonstrated by the approved TAIT and/or CE marking.

4.3 SHEAR BOND STRENGTH

4.3.1 The shear bond strength (SBS) test shall be carried out in accordamce with Appendix E to measure the strength of the slurry surfacing and the bond to the substrate. The shear bond strength shall comply with the requirements in Table 4.2.

Table 4.2 Required Shear Bond Strength

Requirement (As Appendix E)	Compliance Level
Initial Shear Bond Strength in situ at 48hrs (corrected to 20°C)	≥ 200 KPa
Laboratory Shear Bond Strength of aged sample (tested at 35°C)	≥ 400 KPa
Ratio of retained Shear Bond Strength after ageing and moisture conditioning to value after ageing only (tested at 35°C)	≥ 0.8

4.3.2 Compliance with this requirement shall be demonstrated by the appropriate TAIT, and shall be verified on site through a site Trial Run and by routine testing during production.

4.4 MACROTEXTURE

4.4.1 The texture depth of the completed slurry surfacing or microsurfacing shall be determined by sand patch test in accordance with BS EN 13036-1, each test comprising ten measurements equally spaced across a diagonal over a 50 m length of laid surfacing.

4.4.2 The average texture depth for each 1,000 m length of paving, or for the complete length where this is less than 1,000 m, and the individual test measurements shall be within the ranges given in Table 4.3.

Table 4.3 Texture depth ranges

Surfacing type	1000 m Mean	Individual test
Standard texture	(0.5 ± 0.2) mm	(0.5 ± 0.3) mm
Coarse texture	(1.0 ± 0.2) mm	(1.0 ± 0.4) mm
Microsurfacing	In accordance with standard detailed in the relevant TAIT	

4.5 VISUAL ASSESSMENT OF DEFECTS

4.5.1 A visual assessment of defects shall be carried out on completion of the works and again at the end of the maintenance period (ie: between eleven and thirteen months after application). In addition to assessing compliance this enables the durability of the material to be assessed.

(NOTE : In general most defects occur during the first twelve months after the construction of a slurry surfacing.)

4.5.2 Visual defects shall be assessed in five groups as defined in Appendix D. They are:

a. P_1 bleeding, fatting up and tracking
b. P_2 delamination, loss of aggregate, wearing, lane joint gaps, rutting and slippage
c. P_3 corrugation, bumps and ridges
d. P_4 Groups of small and small repetitive defects
e. Longitudinal grooves or score marks

The percentage of defects by area shall be determined as Appendix D, and shall not exceed the limits stated in Table 4.4 at completion and after 12 months.

Table 4.4 Visual defects compliance requirements

Requirements	Immediately upon completion	After 12 months
P_1 – fatting etc	0%	≤0.2%
P_2 aggregate loss etc	0%	≤0.2%
P_3 corrugation etc	≤0.05%	≤0.2%
P_4 groups of small defects	≤0.05% in not more than 1 rectangle	≤0.2% in not more than 1 rectangle
Longitudinal grooves / score marks	0 m	≤2 m

4.5.3 Notwithstanding Clause 4.5.2 and Table 4.4, there shall be no delamination evident on inspection after 12 months.

4.6 DURABILITY

4.6.1 Current experience of the durability of Slurry Surfacing indicates that it is likely to have a reasonable economic working life if the product complies with the requirements of this specification. The producer shall provide an estimate of the expected life for Microsurfacing based upon the historic performance of similar products in similar end use conditions.

4.6.2 The durability of the binder shall be demonstrated by a plot of G* (0.4Hz; 25°C) as described in Appendix C 'ageing profile test'.

4.6.3 The resistance to abrasion of the slurry surfacing shall be determined by testing in accordance with BS EN 12274-5. The mass loss after testing shall not exceed 250g/m^2.

5 Plant and Workmanship

5.1 GENERAL

5.1.1 The standard of workmanship and finish of all slurry surfacing included in this Contract shall be equivalent in all respects to that of the Approved Area established in the Trials in accordance with Section 6.

5.1.2 The production of slurry surfacing shall be carried out by the Contractor working to a Quality Assurance scheme to the BS EN ISO 9000 series incorporating “Sector Scheme 13B”, Supply and Application of Slurry Surfacing /Microsurfacing, with an appropriate scope of application for those operations.

(**NOTE**. Advice for the Project Manager on Quality Systems is given in Appendix Y.)

5.1.3 Airfield lighting units, gratings, covers and similar fittings shall be adequately masked with an approved protection during application. Care shall be taken to prevent the spraying of porous surfacing of the french drains and, if the Project Manager considers it to be necessary, these shall also be protected.

5.1.4 *Either:*
Airfield markings shall be masked, using approved, self-adhesive, masking material cut to the correct size, and the Contractor shall demonstrate, at the time of the trial runs, his proposed method of masking for approval by the Project Manager.

Or:

Airfield markings shall be removed prior to bond coating by grit or sand blasting or mechanical flail. The Contractor shall demonstrate to the Project Manager's satisfaction at the time of the trial runs that the removal method proposed does not cause unacceptable damage to the existing surface. Methods that do not satisfy the Project Manager in this respect shall not be used.

5.1.5 At junctions with surfaces not to be treated with slurry surfacing, straight clean lines shall be defined by masking with waterproof building paper or other impervious strips. The contractor may propose alternative methods but the approval of the Project Manager shall be obtained before use and shall be subject to a satisfactory demonstration.

5.2 PREPARATION OF EXISTING ASPHALT SURFACES

(**NOTE:** Slurry surfacing is not normally to be used on concrete surfaces.)

5.2.1 It shall be the Contractor's responsibility to ensure that the surfaces to be treated are prepared to such a condition that the finished slurry surfacing film is uniform and fully bonded to the pavement.

5.2.2 All overband sealant which is loose or peeling and any areas where tar or bitumen bleeding is evident on the surface shall be removed by approved hand or mechanical means. Where other existing overband sealant is proud of the surrounding surface the excess shall be removed, by heated shovel or other approved means. The Contractor shall demonstrate to the Project Manager the methods he proposes to use and shall carry out no more than demonstration areas until the Project Manager's approval for general work is given.

5.2.3 All vegetable growth, including lichen, shall be removed from the surface and from cracks in the existing bituminous surfacing before the bond coat is applied.

5.2.4 Loose aggregate and other particles along the edges of cracks in the existing surfacing shall be removed by vigorous sweeping with wire hand brooms. The surfaces shall be swept until free water, mud, grit and all other extraneous matter has been removed. Immediately prior to the application of the bond coat, all dust shall be removed by means of mechanical vacuum sweeping supplemented by hand sweeping as necessary.

(NOTE 1. Cleaning machines applying high pressure water and vacuum extraction are very effective in removing debris and cleaning the surface. Water pressures about 50 Bar are adequate for general

cleaning, but higher pressures may be used subject to the Project Manager's discretion. At very high pressures, damage to the surfacing may result.)

(NOTE 2. Vacuum extraction after high pressure cleaning generally results in a sufficiently dry surface for application of the bond coat.)

5.3 FILLING RAVELLED LANE JOINTS, RAVELLED CRACKS AND POTHOLES IN EXISTING ASPHALT SURFACING

5.3.1 Ravelled joints, ravelled cracks and potholes in the existing bituminous surfacing are to be made good before application of the tack or bond coat and slurry surfacing. The repairs shall be effected by one of the following two methods:

Either: a proprietary process employing infra-red heating and in situ recycling of the existing surfacing material, with addition of new ingredients as necessary, and subsequent rolling to produce thoroughly compacted patches, monolithic with the adjacent existing surfacing. The surface of each patch shall be finished flush to the general surface level after rolling. Overheating (i.e. burning of the bitumen) in the existing surfacing shall be avoided. Advice shall be obtained from the Construction Support Team of DE before using this option.

Or by patching, adopting the following procedure:

i) Form trenches by carefully saw cutting and removing the existing bituminous surfacing on either side of the joints, cracks or potholes for the full depth of the wearing course and, if directed, the base course, to expose the underlying asphalt, concrete or pavement base. The side walls shall be clean vertical cuts and shall be stepped back a minimum of 50mm on each side at a convenient plane of separation between any two courses of the existing surfacing. The minimum width of trenches, measured at the surface, shall be 200mm. All loose and crumbling fractions shall be removed from the bottom and sides of the trench. The bottom shall be painted with a generous application of bond coat and the sides by bond coat or an approved jointing emulsion.

ii) The defective surfacing shall be replaced with hot asphalt 'HRA 30/14 F surf', complying with BS EN 13108-4 and containing crushed rock aggregate and 100/150 grade bitumen binder. The asphalt shall be placed in lifts of 30 to 40mm, each separately compacted with approved mechanical tampers. At the time of compaction, the temperature of the mixture shall not be less than 80°C. The final layer shall be laid flush to the general surface level after thorough compaction by rolling.

iii) Sufficient time shall elapse following the laying of the asphalt to ensure that volatiles in the binder evaporate, thereby ensuring that the tack coat and slurry surfacing will properly bond to the surface of the repair.

5.3.2 Unravelled cracks open to widths in excess of 2mm shall either be packed with fine-graded bitumen macadam surface course 'AC 4 fine surf', complying with BS EN 13108-1, after widening by approved means where necessary, or shall be sealed by other approved means.

5.4 WEATHER AND SURFACE CONDITIONS

5.4.1 Sealing shall not be carried out during periods of rain, snow or sleet; when free water, frost, ice or snow is present on the surface; when the air/shade temperature is below 8°C or below 10°C on a falling thermometer or when the pavement surface temperature is below 8°C.

5.4.2 When rain is forecast, the final decision on proceeding with the work shall remain with the Contractor on the understanding that any slurry surfacing damaged by rain is to be removed and the area retreated entirely at the Contractor's expense.

5.4.3 If the surface of the pavement is not already damp, it shall be slightly dampened with a mist-spray of water applied uniformly by approved mechanical equipment immediately ahead of the slurry surfacing spreader.

5.5 SAMPLING AND TESTING MIXED MATERIALS

5.5.1 Duplicate bulk samples of the mixed materials shall be taken by the Contractor. One sample shall be analysed as required by the Contractor's Factory Production Control procedures and by Clause 7.3, and the other retained for reference in the case of a dispute.

5.5.2 Samples shall be labelled and details shall include material type, date of delivery, vehicle registration number, location and time of laying and other relevant information deemed necessary by the Project Manager.

5.6 TACK COAT APPLICATION

5.6.1 Tack coat shall be used only with slurry seal incorporating unmodified bitumen binder.

5.6.2 Tack coat complying with Clause 3.6 shall be applied at least 2 hours and not more than 24 hours in advance of application of the slurry seal. It shall be applied at a rate of spread of 0.25 to 0.35 litres/m^2 (or between 0.20 and 0.30 l/m^2 where the existing surfacing is less than 4 weeks old), unless the contractor's proposal based on a TAIT is different and an alternative is accepted by the Project Manager. Tack coats may be applied to damp surfaces but ponded or standing water shall be removed as specified in Clauses 5.2 and 5.4

5.6.3 The tack coat shall be applied by mobile mechanical tank spraying units complying with BS 3136. Before commencing work on site, the Contractor shall provide a certificate of test not more than three months old, from an independent test authority, showing that the uniformity of distribution from each spray bar of each spraying unit meets the requirements of Clause 3.2.2 of BS 3136.

5.6.4 The tack coat shall be uniformly free of streaks and blobs. When the spraying unit is stationary, care should be taken to prevent dripping or other spillage.

5.6.5 After application, no traffic of any kind shall be allowed to run over the tack coat until the slurry seal is installed and arrangements shall be made to cordon off the sprayed areas until the surfacing is completed. When surfacing starts, only the minimum amount of traffic essential to the surfacing operations shall be permitted.

5.7 BOND COAT APPLICATION

5.7.1 The type of bond coat to be used for the particular material being laid is specified in Clause 3.7.

5.7.2 Bond coats shall be applied not more than 24 h in advance of surfacing at a target rate of application in accordance with BS 594987 unless the contractor's proposal based on a TAIT is different, but not lower than the minimum rate specified in Clause 3.7. Bond coats may be applied to damp surfaces but ponded or standing water shall be removed as specified in Clauses 5.2 and 5.4.

5.7.3 Bond coats shall be applied uniformly, free of streaks and blobs in accordance with BS 594987 by mobile mechanical tank-spraying units complying with BS 3136-2. The accuracy of spraying shall be tested in accordance with BS EN 12272-1 and the coefficient of variation shall not exceed 10% and the rate of spread shall not be less than 10 % of that that specified or proposed in the TAIT or construction trial. The tack coat or bond coat shall be allowed to 'break' completely before laying proceeds. Where the size or shape of an area to be sprayed precludes mobile operation, pressure spraying equipment or hand-spraying complying in accordance with BS 434-2 will be permitted with the approval of the Project Manager.

5.7.4 The bond coat shall be uniformly free of streaks and blobs. When the spraying unit is stationary, care should be taken to prevent dripping or other spillage.

5.7.5 After application, no traffic of any kind shall be allowed to run over the bond coat until the slurry surfacing is installed and arrangements shall be made to cordon off the sprayed areas until the surfacing is completed. When surfacing starts, only the minimum amount of traffic essential to the surfacing operations shall be permitted.

5.8 HANDLING AND BLENDING OF AGGREGATES

5.8.1 For blended aggregate, the constituents shall be intimately blended together in a dry condition in a mixer suitable for the purpose. The required quantity of each of the aggregates determined to comply with Clause 3.1.6 and approved as detailed in Clause 6.2 shall be proportioned into the dry mixer separately by mass to within a tolerance of ±2 per cent of the approved proportions, allowance being made for the weight of moisture in the aggregate.

5.8.2 Before manufacture of the slurry surfacing starts, the uncoated aggregate shall be passed through a mechanical oscillating screen. For standard texture slurry surfacing the screen shall be of 3.0mm mesh and for coarse texture it shall be 4.0mm mesh. The screen shall be effectively protected against the wind to ensure that the fines are retained in the dry aggregate.

(NOTE: The mesh sizes are indicative and may vary from system to system but should be such as to remove the oversize material from the aggregate)

5.8.3 The Contractor shall take all necessary measures to prevent segregation of the aggregates during screening, handling or loading. Should the slurry surfacing film show signs of segregation the Contractor shall turn over the sieved aggregate by mechanical shovel to counter segregation immediately prior to the aggregate being loaded into the hopper of the slurry surfacing mixing machine. When in the opinion of the Project Manager the blended material has been adversely affected by handling, transportation or weather (whilst stockpiled before wet mixing takes place) the materials shall be subjected to re-blending in the dry-mixer and re-screening.

5.9 SLURRY SURFACING MIXING

5.9.1 The slurry surfacing/microsurfacing shall be mixed in an approved proprietary mobile combined mixing and spreading unit. The unit shall be so designed that aggregate, emulsion, filler, water and control additive are fed and mixed together in a continuous process. The rate of feed of each shall be separately controlled and monitored to ensure that a uniform mixture of the approved proportions is produced. Meters or other gauges showing the rate of feed of each constituent of the mix shall be readily visible and shall be kept clean. They shall be calibrated before work starts and shall be checked in accordance with table 7.2 throughout the work, before work starts that day, and at such other times as the Project Manager may require. The Contractor shall satisfy the Project Manager of the accuracy of the meters after each check.

5.9.2 On completion of the mixing process, all particles of the aggregate shall be completely and uniformly coated and the mixture shall be of a creamy consistency which will flow slowly and evenly over the surface being treated but which will not develop random breakaways or runs from the edges of the finished lanes after the spreader has passed. The finished surface shall at all times match the selected trial area marked 'Approved' as specified in Clause 6.2.12.

5.9.3 If the time which elapses between mixing and spreading prevents the mixture from flowing smoothly or if for any other reason the mixture shows visible segregation as it emerges from the spreading unit, it shall be condemned and shall be removed from the site. Laying operations shall then cease until the reasons for the defective work have been established and the Project/ Works Services Manager is satisfied that the necessary corrective actions have been taken.

5.9.4 All mixing units shall be maintained in good working order and shall be flushed out with clean water after each day's work.

5.10 THICKNESS OF SLURRY SURFACING

5.10.1 For standard or coarse texture slurry seal the nominal thickness to be provided generally, after rolling, shall be 1.5mm for standard texture slurry seal and 2.5mm for coarse texture slurry seal. Variations in slurry surfacing thickness, to take account of existing pavement conditions, will be permitted within the limits of 1.2mm and 3.0mm for standard texture and of 2.4mm and 5.0mm for coarse texture.

5.10.2 Microsurfacing thickness shall be as declared in the Contractor's Proposal and TAIT.

5.11 APPLICATION OF THE SLURRY SURFACING MIXTURE

5.11.1 The rate of spread of the slurry surfacing, expressed in kgs of dry aggregate/m^2, shall be agreed by the Project Manager as a result of the trial runs specified in Clause 6.3. The mixture shall be applied to the surface with an approved spreader-box not less than 3m wide, at the agreed rate of spread.

5.11.2 The spreader-box shall be rectangular or trapezoidal in plan with a screeding blade, adjustable for height above the surfacing, fitted across the full width of the rear of the box. A squeegee of neoprene rubber or similar approved material shall be fixed to the screeding blade with means of ready adjustment and replacement. The squeegee shall be kept clean of encrusted material during the spreading of the slurry surfacing. Similar squeegees shall be fitted to the front and, if necessary, the sides of the box to prevent leakage. The spreader-box shall be towed behind the mixing unit and be equipped with a side shift mechanism permitting lateral movement of the box.

5.11.3 Mechanical augers shall be used to distribute the slurry surfacing evenly against the screeding blade. The mixture shall be fed into the spreader-box at an even rate so that it appears to roll for about 300mm against the full width of the

screeding blade and emerges free from segregation or other irregularities.

5.11.4 Only where the shape of an area precludes spreading with mechanical units may spreading with hand boxes and hand squeegees be employed.

5.11.5 Longitudinal lane joints shall be straight lines which are continuous for the full length of the pavement or smooth curves around bends. Transverse joints shall be straight across the lane and at right angles to the longitudinal joints. All joints shall be so formed as to leave no gaps and with the least practicable overlap. Increase in the thickness of the slurry surfacing film at the overlap shall be minimised by 'wiping off' or similar technique such that no obstruction is offered to the free flow of water across the joint. Any agglomerations standing above the general level of the joint lines after rolling shall be removed by wire brushing.

5.11.6 During the application of the slurry surfacing, airfield lighting units shall be removed; gratings, covers and other metal fittings shall be either removed or adequately masked by approved protective measures to prevent coating of the fittings. The apertures formed when fittings are removed shall be similarly masked against coating. The slurry surfacing shall be finished neatly around all fittings. Care shall be taken to ensure that the material does not cover french drain surfacing. If the measures taken by the Contractor are considered by the Project Manager to be inadequate, the Project Manager may instruct provision of protective covers to the french drains at the Contractor's expense.

5.11.7 Unless they have already been removed to comply with the requirements of Clause 5.1.4, airfield markings shall be masked and the Contractor is to demonstrate at the time of the trial runs his proposed method of masking for approval by the Project Manager.

5.11.8 At junctions with surfaces not to be treated and at the start and end of all runs, straight clean lines shall be defined by masking with waterproof building paper or other impervious strips.

5.11.9 After the slurry surfacing has been laid, the areas shall be cordoned off, barricaded and lighted to exclude all traffic and prevent damage to the unstabilised slurry surfacing. The cordoned areas shall remain closed until the Project Manager is satisfied that the material will not be marked under trafficking. (See also the requirements of the Specification Preliminaries).

(**NOTE**: General advice for the Project Manager on Specification Preliminaries is contained in DEO Functional Standard - *Guidance Notes for Preparation of Specification Preliminaries for Airfield Pavement Works*.)

5.12 ROLLING AND FINISHING

5.12.1 Rolling of the slurry surfacing shall be carried out as soon as the material has set sufficiently to ensure that rutting or shoving will not occur.

5.12.2 For standard or coarse texture slurry seal, all points on the surface shall receive six passes of an approved multi-wheeled smooth tread pneumatic tyred self propelled roller, ballasted to at least 9 tonnes. Tyre pressures are to be adjusted to ensure that the tyre profile in contact with the surface is plane. The tracks of the front and rear tyres are to overlap slightly.

5.12.3 For microsurfacing, the rolling shall be in accordance with the procedures defined by the contractor in his method statement and in accordance with the TAIT where applicable.

5.12.4 After rolling, the slurry surfacing shall be of uniform texture throughout the work. Surfaces showing variations of texture within the lane, or from lane to lane, due to segregation of the aggregates or to any other cause shall be condemned. Whenever this occurs the work shall be stopped and corrections shall be made to overcome the defects, to the satisfaction of the Project Manager.

5.12.5 The thickness of the slurry surfacing after rolling shall be checked at least once for each 1000m^2 of slurry surfacing laid. Each check shall consist of 16 measurements made on a 3m square grid of points 1m apart. If more than 12 of the 16 measurements are outside the limits specified at Clause 5.10, the result shall be considered unsatisfactory. In this case, further checks shall be made in the same manner to determine the extent of the unsatisfactory area, which shall then be condemned. For microsurfacing, the thickness of the surfacing shall be within the limits proposed by the Contractor and agreed by the Project Manager. The results of the thickness checks shall be recorded and reported to the Project Manager daily.

5.12.6 The finished surface shall be entirely free from surface irregularities due to scraping, scabbing, dragging, droppings, excessive overlapping, faulty lane or transverse junctions, damage by rain or frost or other defects and shall be left clean and tidy to the satisfaction of the Project Manager.

5.13 CONDEMNED WORK

5.13.1 Work, which fails to comply with the requirements of this Specification shall be condemned and shall be replaced at the Contractor's expense. The faulty or damaged work shall be removed for the full width of the lane by approved mechanical means and carted away. When the exposed surface has been cleaned to the satisfaction of the Project Manager, a run of new slurry surfacing shall be laid in accordance with this Specification in replacement of the faulty lane. Depending on whether any damage is caused to the underlying surface in the process of removing defective slurry surfacing, the Project Manager may require more substantial remedial works than simple reprovision of a new film of slurry surfacing.

5.14 FINISHED LEVELS

5.14.1 Where applicable, the finished surface levels shall conform with the levels, profiles and contours shown on the drawings and the finished levels of the underlying courses are to be such that at no point will the thickness of any overlying courses be less than the thickness specified.

5.14.2 The Contractor shall be responsible for maintaining the finished surfacing in good and clean condition. He shall make good any defects, damage or defacement which occurs during the Contract by the means, and to the standards, described in this Specification.

5.15 FILLING CORE HOLES

5.15.1 The walls and base of all holes from which core samples have been cut are to be painted with bitumen and filled with hot asphalt complying with BS EN 13108-4 type ‘HRA 30/14 F surf’, and containing crushed rock aggregate and 100/150 grade bitumen binder, well rammed in lifts not exceeding 50 mm.

6 Trials

6.1 TRIAL MIXTURES

6.1.1 For standard and coarse texture slurry seals, trial mixtures shall be made at maximum, mid-way and minimum binder percentages of the range permitted in Clause 4.2, with water added as necessary to produce a slurry surfacing/microsurfacing of creamy consistency.

6.1.2 Two samples shall be taken from each mixture for the preparation of laboratory specimens for:

- Abrasion testing in accordance with Appendix A of BS EN 12274-5 and
- Analysis in accordance with BS EN 12274-2 to establish binder content.
- Shaking abrasion test in accordance with BS EN 12274-7 (this is to provide DE with information to determine what the limits should be for specification purposes.

6.1.3 The samples and specimens shall be carefully identified to match the particular mixtures to which they relate.

6.1.4 Trial mixtures are not required in the case of microsurfacing, or where the proposed mixture or product is in accordance with an approved TAIT or CE marking.

6.2 PRE-TRIAL RUNS

6.2.1 For standard and coarse texture slurry seals only, separate pre-trial runs shall be made with each of the three trial mixtures specified in Clause 6.1.1, care being taken to mark individual runs in such a way that they can be readily distinguished later.

6.2.2 Each pre-trial shall be carried out on an area of disused pavement approved by the Project Manager and shall have a minimum length of 10m. Its purpose shall be to show that the maximum proportion of control additive proposed for the mixture does not inhibit the break of the emulsion nor render the slurry surfacing/microsurfacing non-cohesive after the emulsion has broken. No full trial run shall commence until the emulsion in the corresponding pre-trial has broken and the slurry surfacing film has been found acceptable by the Project Manager.

6.3 TRIAL RUNS

6.3.1 Trial runs shall be carried out for all slurry surfacing.

6.3.2 The trial runs shall be made in the presence of the Project Manager prior to the start of the laying generally. The trial runs shall be made along outside edges of the pavements to be surfaced, in positions approved by the Project Manager. The purpose of the trial runs shall be:

- to demonstrate that mixture proportions are satisfactory, and are in accordance with the TAIT
- to demonstrate the method of operation and efficiency of the mobile plant and operatives as a prerequisite to approval of its use
- (for slurry seal only) to enable a suitable emulsion content and rate of spread to be confirmed
- (for slurry seal only) to demonstrate the ability of the product to carry traffic when installed on a sound substrate.
- to provide a sample area of satisfactory workmanship and material with which the rest of the work may be compared.

6.3.3 The surface texture on the area of pavement selected for the trial runs shall be typical of the texture of the whole area to be treated. It shall be prepared, cleaned and tack or bond-coated (as applicable) to comply in all respects with the requirements of this Specification. Each run shall not be less than 60m long by two lanes wide and shall include not less than 60m of continuous longitudinal lane joint and a transverse joint of at least one lane width. Each run shall be rolled as required by this Specification or in accordance with the TAIT.

6.3.4 During each trial run, the Contractor shall demonstrate to the Project Manager the settings of

the feed controls on the mobile plant for each ingredient of the mix.

6.3.5 If necessary, further runs shall be made with the mixtures modified by controlled and recorded variations of the filler, bitumen emulsion and water content, until a mixture of the required laying consistency has been achieved which will flow smoothly without difficulty over the pavement and which will produce a continuous film of uniform thickness over the entire surface free from massed pinholes, breaches or irregularities. The Contractor shall demonstrate that the emerging slurry surfacing film is free from segregation or other irregularities, including dragging imperfections resulting from failure to eliminate oversize aggregate particles or lumpy conglomerates. The mixture shall be so designed that blow holes in excess of 2 mm diameter do not occur.

6.3.6 Additional trial runs shall be made with each mixture for each mobile plant and/or spreader box.

6.3.7 Twenty-four hours after the laying of the trial runs, the Contractor shall attend for examination of the trial areas by the Project Manager, who will decide, on the basis of adhesion, uniformity of surface finish and film thickness, which, if any, of the trial areas appears acceptable. The area selected will be given 'Provisional Approval'. If no area is acceptable, additional trial mixes and trial runs shall be carried out until an acceptable standard is achieved.

6.3.8 The twin specimens of the mixture used for the selected run, made previously in compliance with Clause 6.1, shall be tested for abrasion resistance in accordance with BS EN 12274-5. The result of the test on each specimen must meet the requirement specified at Clause 4.6.3 as a prerequisite to the mixture being accepted. The Contractor shall confirm to the Project Manager in writing the rate of spread and the proportions of aggregate, bitumen emulsion, filler, control additive and water used in the trial run of the mixture.

6.3.9 The residual binder contents from samples of the selected mixtures shall be determined by BS EN 12274-2. These shall also be reported in writing to the Project Manager, together with the equivalent proportion of bitumen emulsion in the mix (expressed in terms of mass per 100 parts of dry aggregate). If the Project Manager is satisfied that the values demonstrate compliance with Clause 4.1.1 and with the mix proportions reported in accordance with Clause 6.2.9, then the proportions will be approved as a basis for all subsequent work.

6.3.10 A representative section of the trial area shall be selected by the Project Manager and shall be tested by the Contractor for Initial Shear Bond Strength within 48 hours of laying, in accordance with the procedure in Appendix E, Clause E.5.1. Six cores shall be cut from the trial area, in locations agreed by the Project Manager, for laboratory ageing, conditioning and testing in accordance with the procedure in Appendix E, Clause E.5.2. The results of both initial in-situ and laboratory shear bond strength tests shall meet or exceed the minimum requirements stated in Clause 4.3.

6.3.11 A representative section of the trial area shall be selected by the Project Manager and shall be tested by the Contractor for macrotexture in accordance with Clause 4.4.

6.3.12 Providing the Project Manager is satisfied with the standard of work on the selected run and the materials used, the shear bond strength test and macrotexture results are satisfactory, and providing the slurry surfacing thickness complies with the requirements of Clause 3.8, the selected area shall be marked 'Approved' and dated. The approved longitudinal and transverse joints shall also be permanently identified. Until approval has been given, the general application of the slurry surfacing shall not commence.

6.3.13 The standard of workmanship and finish of the slurry surfacing in all subsequent work shall be equal in all respects to that of the 'Approved' area. The proportions of aggregate, filler, bitumen emulsion and water, the rate of spread, the methods of spreading and compacting and the items of equipment and number of personnel engaged in the work shall all remain unchanged unless the approval of the Project Manager to a change is given in writing, and then only after new trials. The proportion of control additive may be reduced to suit ambient conditions as work proceeds but shall not be increased above the proportion used in the 'Approved' area without further successful pre-trials.

7 Summary of Tests

7.1 TEST RESULTS

7.1.1 The Contractor shall be responsible for having all testing carried out in accordance with the requirements of this Section and provide the Project Manager with a written copy of all results at the first reasonable opportunity but not later than 24 hours after completion of each test. Testing shall be started on specimens within 2 working days of sampling (or sooner if required by the test procedure) and shall be carried out in an expeditious manner.

7.2 TESTS FOR INITIAL APPROVAL OF MATERIALS

7.2.1 Before mixing starts the Contractor (or his materials supplier(s) on his behalf) shall provide current CE mark certificates for all aggregates showing conformity with all requirements of Section 3.

7.2.2 In addition to 7.2.1, the Contractor (or his materials supplier(s) on his behalf) shall have carried out the aggregate tests in Table 7.1 for comparison with the relevant specification clauses

Table 7.1 Additional aggregate tests for initial approval

Component material	Clause No.	Test	
		Title	Reference
Coarse Aggregate	3.2	Magnesium Sulfate Val.	Appendix B
Fine Aggregate	3.3	Magnesium Sulfate Val.	Appendix B

7.2.3 In addition, the Contractor shall submit the appropriate certificates for:

- the binder;
- other constituents, including bond coat;
- bond coat spray-bar equipment;
- results of testing of trial runs.

7.3 ROUTINE TESTS

7.3.1 Abrasion Tests

Duplicate specimens shall be made from samples of the wet mixture and shall be prepared for the Abrasion Test as detailed in BS EN 12274-5. Two samples shall be taken for each 10,000m^2 of slurry surfacing laid. The samples shall be taken from the point of discharge into the spreader box.

7.3.2 One of the four specimens shall be tested by the method described in BS EN 12274-5. If the mass loss exceeds that specified at Clause 4.6.3, then the remaining three specimens shall be tested. If any of these specimens also show a mass loss in excess of that specified at Clause 4.6.3, then the material represented by the samples shall be deemed to have failed and the 10,000m^2 to which the samples relate shall be condemned.

7.3.3 Analysis

One sample of the slurry surfacing mixture for each 5000m^2 of slurry surfacing laid shall be taken for determination of the residual bitumen content. The sample shall be taken in accordance with BS EN 12274-1 except that the mixer shall have been operating for at least 30 m. After drying the sample shall be analysed by one of the extraction methods detailed in BS EN 12274-2.

7.3.4 The Contractor shall report to the Project Manager the proportion by weight of soluble bitumen in the dried mixture and its equivalent proportion as emulsion in the mixture. If the results from any sample reveal that the bitumen emulsion content differs from the target value agreed in accordance with Clause 6.2.12 by more than 2 per cent, the work shall cease immediately and shall not restart until the reasons for non-compliance have been established and corrective measures taken. The area of slurry surfacing to which the non-compliant sample relates shall be condemned.

7.3.5 Shear Bond Strength
The Contractor shall carry out in-situ and laboratory shear bond tests on the trial runs as specified at Clause 6.3.10 in locations agreed with the Project Manager.

7.3.6 The Contractor shall carry out routine in-situ Initial Shear Bond Strength tests in accordance with Appendix E, Clause E.5.1, within 48 hours of laying. In-situ tests shall be carried out at a frequency of one set per 1,000m^2 of surfacing laid or once for each day's production, whichever is greater. If any of these tests fails to meet the required standard, then the material represented by the samples shall be deemed to have failed and the section to which the test relates shall be condemned.

7.3.7 Macrotexture
The Contractor shall determine the macrotexture of the trial runs as specified at Clause 6.3.11 in locations agreed with the Project Manager.

7.3.8 The Contractor shall carry out routine in-situ macrotexture tests in accordance with Clause 4.4 within 48 hours of laying. One test shall be carried out for every 500m of length paved, or a minimum of once for each day's production, whichever is greater.

7.3.9 If any of the tests fails to meet the required standard, then the material represented by the samples shall be deemed to have failed and the section to which the test relates shall be condemned.

7.4 FACTORY PRODUCTION CONTROL

7.4.1 The producer shall establish, document and maintain a Factory Production Control (FPC) system to ensure that the slurry surfacing conforms with the stated performance characteristics. The FPC system shall consist of procedures, regular inspections and tests and/or assessments and the use of the results to control incoming materials, equipment, the production process and the product. The FPC procedures shall comply with BS EN 12273, Annex A, or with the requirements of Sector Scheme 13B where applicable (see Clause 2.4). Alternative tests to those referred to in this document may be used for Factory Production Control if a correlation can be identified with the test used for TAIT.

7.4.2 Where the producer purchases constituent materials or has the slurry surfacing designed, or parts of the production or testing carried out by sub-contracting, the FPC of the supplier or sub-contractor may be taken into account. However, where this occurs, the producer shall retain the overall control of the slurry surfacing and ensure that he receives all the information that is necessary to fulfil the requirements according to the relevant European Standard. The producer who sub-contracts all of his activities may in no circumstances discharge himself of his responsibilities to a sub-contractor.

7.4.3 All the elements, requirements and provisions adopted by the producer shall be documented in a systematic manner in the form of written policies and procedures. This production control system documentation shall ensure a common understanding of conformity evaluation and enable the achievement of the required component characteristics and the effective operation of the production control system to be checked.

7.4.4 Factory Production Control therefore brings together operational techniques and all measures allowing maintenance and control of the conformity of the slurry surfacing with its technical requirements. Its implementation may be achieved by controls and tests on measuring equipment, constituents, processes, machines and manufacturing equipment and finished components, including material properties of components, and by making use of the results thus obtained.

7.4.5 A producer who has a Factory Production Control system which complies with BS EN ISO 9000 and is made specific to this specification shall be deemed to satisfy the requirements of this Clause.

7.4.6 The minimum test frequencies for factory production control are set out in tables 7.2 to 7.8.

Table 7.2 — Equipment calibration: Specification of the calibration of the machine

Machine components	Control/test	Purpose	Minimum frequency
Metering Equipment	Visual control	Check the proper operation of the machine	Once on each production day
Flow meters for liquids	Comparison of the quantity delivered by the pump with the quantity consumed by time unit. Control done on different flows relevant to the range of uses. Tests are done for extreme contents and tests for the middle one. Graph plotting.	Check the accuracy of the contents in accordance to the quality plan	— at the installation[a] — every year — when apparatus does not appear to be functioning correctly
Solids measured by volume	Determination of the flow of the machine as a function of the speed of the conveyor or the screw. Control done at different speeds of the range of use. tests are carried out at the highest and lowest flow and one flow rate approximately mid way between Graph plotting	Check the accuracy of the contents in accordance to the quality plan	— at the installation[a] — every year — when apparatus does not appear to be functioning correctly
Solids measured by mass	Comparison of the mass delivered by the control instrument with the actual mass. Control based on contents linked to the range of use. Tests are carried out at the highest and lowest flow and one flow rate approximately mid way between Graph plotting.	Check the accuracy of the contents in accordance to the quality plan	— at the installation[a] — every year — when apparatus does not appear to be functioning correctly
Levels in the tanks and storage hoppers	Visual control	Check the proper operation	— Continual

[a] Or following a complete repair; the term installation includes the changing type of the components.

Table 7.3 — Control of aggregates

Control/test	Purpose	Normative references	Minimum Frequency
Control tests usually carried out by aggregate supplier under FPC to EN 13043			
— Controls of the intrinsic properties of the components : — Flakiness index* — Los Angeles* — Micro Deval with water* — Polished stone value* — Crushing index — Methylene Blue test — Sieve analysis of the combined aggregates	Check the characteristics to the final use. Tests are carried out only where required by the slurry surfacing producer or the parameter is specified by the purchaser of the slurry surfacing	BS EN 13043 BS EN 933-3 BS EN 1097-2 BS EN 1097-1 BS EN 1097-8 BS EN 933-5 BS EN 933-9 BS EN 933-1[a]	Initial approval of the source Once the year and per quarry In case of doubt following a perceptible properties check
Control tests that shall be carried out by the slurry surfacing producer			
Check the delivery ticket	Check the conformity of the aggregates received with the order	As described in the quality plan	At each delivery
Visual check perceptible properties	Realise a comparison with the normal aspect in matter of source, gradation Flakiness and impurities		At each delivery
Control on stock	Check that the material has not changed since delivery into stock		
Sieve analysis	Tests are carried out only where required by the slurry surfacing producer	BS EN 933-1	Every 1000 t per type In case of doubt following a perceptible properties check
Moisture of the aggregates		BS EN1097-5	In case of doubt following a perceptible properties check
Sand equivalent (10 %) or Methylene Blue test		BS EN 933-9	In case of doubt following a perceptible properties check

[a] Not necessary in case of delivery from plant owned by the slurry surfacing producer (sample already taken at the plant).

* Test performed on 6/10 aggregate from the same source as any aggregate larger than 2 mm in the slurry surfacing

Table 7.4 — Frequencies of control and test on bituminous emulsions

Control/test	Purpose	Normative reference	Frequency
Control tests usually carried out by binder supplier under FPC to prEN 14733			
Intrinsic properties of the bituminous emulsion	Confirm the characteristics of the product and the conformity to the appropriate specification	BS EN 13808	Source approval before initial use. One test per 250 t per type of emulsion In case of doubt following a perceptible properties check
Sieve retained	Tests are carried out only where required by the slurry surfacing producer or the parameter is specified by the purchaser of the slurry surfacing	BS EN 1429	
Water content		BS EN 1428	
Efflux time		BS EN 12846	
Breaking index		BS EN 13075-1 and -2	
pH		BS EN 12850	
Residue on sieving (7 days storage)		BS EN 1429	
Settling tendency (7 days storage)		BS EN 12847	
Adhesivity by water immersion		BS EN 13614	
Properties of recovered binder		As appropriate	
Control tests that shall be carried out by the slurry surfacing producer			
Check the delivery ticket	Check the conformity of the binder received with the order.	As described in the quality plan	At every delivery
Perceptible properties check (control of the sample or the tank)	Do a comparison with the normal characteristics		At every delivery or each production day
Take a reference sample			1 per load[a]
[a] Not necessary in case of delivery from plant owned by the slurry surfacing producer (sample already taken at the plant).			

Table 7.5 — Control of the water

Control/test	Purpose	Normative reference	Frequency
Intrinsic properties	Confirm the water is suitable for use (not needed for potable water from public supply)		Source approval before initial use.
Perceptible properties	Do a comparison with the normal characteristics		On each production day

Table 7.6 — Control of the additives

Control/test	Purpose	Normative reference	Frequency
Intrinsic properties		As described in the quality plan	Source approval before initial use.
Control of the delivery ticket	Check that the delivery is in conformity to the order and comes from the right plant	As described in the quality plan	At each delivery
Perceptible properties check of the delivery	Compare with the normal aspect		At each delivery

Table 7.7 — Controls during the application of the slurry surfacing.

Control/test	Purpose	Normative reference	Frequency
Control of the storage areas	Check that the storage areas correspond to the criteria described in the quality plan	As described in the quality plan	For every site
Check the cleanness of the tanks	Avoid contamination	As described in the quality plan	— every production day prior to production — if constituents are changed
Control the quantities of the components (bituminous emulsion, aggregates...)	Check that sufficient of the correct materials are available to carry out production	As described in the quality plan	For every site
Weather conditions	Check that the weather conditions are suitable.	As described in the quality plan	For every application
Preparation	Check that the substrate conforms to the criteria described in the quality plan	As described in the quality plan	For every application
Application of the slurry surfacing	Check that all the settings described in the quality plan are achieved	As described in the quality plan	For every application
Determination of residual binder content		BS EN 12274-2	1 per 1000 tonnes
Determination of rate of application		BS EN 12274-6	Each work site
Perceptible properties	Check that material conforms to normal appearance etc		Continuously during application

Table 7.8 Inspection and test frequencies measured between 11 months and 13 months after production

Inspection/test	Purpose	Minimum frequency
Visual assessment as Appendix D	To ensure slurry surfacing conforms to specification	All
Macrotexture	To ensure slurry surfacing conforms to specification	All with laser device, or 1 per 5000m^2 for sand patch test

APPENDIX A - Bituminous Binders

A.1 BINDER SPECIFICATION

A.1.1 Binders shall be tested in accordance with BS EN 12591 for Paving Grade Bitumen, BS EN 14023 for polymer modified binders and BS EN 13808 for Bituminous Emulsion Binders. In addition the rheological properties defined in Highways Agency "Manual of Contract Documents for Highway Works" – Vol 1: Specification for Highway Works, Clause 928, or the British Board of Agrément (BBA) HAPAS SG4 Guidelines document for modified binders, shall be reported.

A.2 DETERMINATION OF COHESION OF BINDER

A.2.1 For modified binders intended for use in slurry surfacing and/or bond coat the value of cohesion shall be determined by using the (Vialit) Pendulum Cohesion test method in accordance with BS EN 13588.

A.2.2 The binder sample for test shall be prepared from the bituminous emulsion used for the bond coat or microsurfacing unless otherwise specified.

A.2.3 A test report shall be prepared in accordance with BS EN 13588 and shall submitted with the mix proposals prior to commencement of work on site.

- Name of Organisation
- Name of Project / Site
- Details of Material Tested
- Test Method
- Date of Test
- Test Results
- Additional Comments (as required)

Appendix B – Use of Magnesium Sulfate Test with Non-Standard Aggregate Fractions

B.1 SCOPE

B.1.1 This Appendix specifies a procedure extending the method in BS EN 1367-2 for assessing how an aggregate behaves when subjected to the cyclic action of immersion in magnesium sulfate, followed by oven drying, to all fractions.

B.2 APPARATUS AND REAGENTS

B.2.1 Apparatus and reagents as detailed in BS EN 1367-2, Clauses 7 and 8, (except that the balance for coarse aggregate, Sub-Clause 6.2, to be accurate to 1 g) together with:

- 20 mm and 6.3 mm sized square hole perforated plate test sieves and 2 mm, 1 mm, 0.5 mm and 0.25 mm sized woven wire test sieves; the additional test sieves shall comply with BS EN 933-2; and
- at least two brass or stainless steel mesh baskets for immersing aggregate specimens for fractions other than 10 to 14 mm with the maximum dimension of the apertures not more than half the maximum aperture of the sieve on which the specimen is retained, but not less than 0.125 mm.

B.3 PREPARATION OF TEST PORTIONS

B.3.1 Bulk samples from each nominal size of aggregate being delivered from each source of supply to be used shall be tested separately and the procedure described hereafter shall be applied to each separate sample.

B.3.2 Prepare two test portions from the bulk samples of each aggregate supplied as in BS EN 1367-2, Clauses 8.1 and 8.2, replacing "*minimum mass of 500 g of the 10 mm to 14 mm size*" in Clause 8.1 by the relevant masses from Table B.1.

B.4 PREPARATION OF AGGREGATE TEST SPECIMENS FOR EACH FRACTION

B.4.1 The particle size distribution of the test portion shall be determined by the dry sieving method described in Clause 8.3 of BS EN 1367-2 using the 20 mm, 10 mm, 6.3 mm, 2 mm, 1 mm, 0.5 mm and 0.25 mm sieves. For coarse aggregate test specimens, the fractions retained on the 20 mm sieve and passing the 1 mm sieve shall be discarded and not taken into account in the calculation of the test result. The remainder of the reduced sample shall be considered as the test portion. The particle size distribution shall be recorded giving the percentage of the mass of the test portion retained between each pair of sieves, together with that passing the 0.25 mm sieve for fine aggregate test specimens, to the nearest whole number.

B.4.2 Those fractions retained whose proportions are less than 5 % by mass of the test portion shall be discarded. Nevertheless, the proportions that the discarded fractions represent shall be taken into account in the calculation of the test result.

B.4.3 One test specimen, of mass in accordance with Table B.1, shall be taken out of each fraction retained after completion of sub-Clause B.4.2. If there is insufficient material in any of these fractions to provide a test specimen of the required size, the procedure shall be repeated starting from sub-Clause B.3.2. The particle size distribution recorded shall be that obtained from all the material sieved out.

Table B.1 - Required mass of coarse aggregate test specimens

Sieves		Mass of specimen before test (g)
Passing	Retained	
20 mm	10 mm	1000 ± 10
10 mm	6.3 mm	300 +10 / –0
6.3 mm	2 mm	100 +10 / –0
2 mm	1 mm	100 +10 / –0
1 mm	0.5 mm	100 +10 / –0
0.5 mm	0.25 mm	100 +10 / –0

B.5 PROCEDURE

B.5.1 The procedure for each test specimen shall be as in BS EN 1367-2, Clause 9, replacing "*10 mm sieve*" in Clause 9.6 by the sieve relevant to the lower size of the aggregate fraction.

B.6 CALCULATION AND EXPRESSION OF TEST RESULTS

B.6.1 Calculate the magnesium sulfate value of each test specimen as in BS EN 1367-2, Clause 10.1, replacing "*10 mm sieve*" by the sieve relevant to the lower size of the aggregate fraction.

B.6.2 Fractions not tested because they represent less than 5 % by mass of the test portion shall be assumed to have a magnesium sulfate value equivalent to:

a) the mean of the magnesium sulfate value found by the tests on specimens of the two fractions immediately adjacent to it in size; or
b) the magnesium sulfate value found by the test on a specimen of the fraction, either larger or smaller, immediately adjacent to it if only one of these fractions were tested; or
c) the mean magnesium sulfate value found by the tests on specimens of the two fractions next but one adjacent to it if both these fractions were tested and the adjacent fractions were not; or
d) the magnesium sulfate value found by the test on a specimen of the fraction, either larger or smaller, in this order of priority, most nearly adjacent to it.

B.6.3 For samples of fine aggregate, the material passing the 0.25 mm sieve shall not be tested but shall be taken as having a magnesium sulfate value equivalent to that of the specimen passing the 0.5 mm sieve but retained on the 0.25 mm sieve.

B.6.4 The magnesium sulfate value of each test portion of aggregate shall be the sum of the magnesium sulfate values found for each aggregate fraction times the proportion by mass of that fraction in the test portion.

B.6.5 The magnesium sulfate value for the aggregate shall be the mean of the two results for the test portions to the nearest whole number. The magnesium sulfate value for each fraction of the aggregate shall be the mean of the magnesium sulfate values for the two results for the test specimens to one decimal place.

(NOTE. A suitable worksheet (with two examples, one fine aggregate and one coarse aggregate) is shown on the following pages.)

B.7 PRECISION

B.7.1 As BS EN 1367-2, Annex A.

B.8 TEST REPORT

B.8.1 As in BS EN 1367-2, Clause 11, together with:

- The magnesium sulfate value and the individual magnesium sulfate values of the two specimens for each aggregate fraction tested.

EXAMPLE B.1

Blackstone Quarry, 6 mm nominal single size. Tested 8-25 August 2003						
Sieve Size		Grading of Test Portion (% of total mass)	Mass of Test Specimen		Magnesium Sulfate Value (% of original mass)	Weighted Mag. Sulfate value (%)
Passing (mm)	Retained (mm)		Before Test (g)	After Test (g)		
First Test Portion						
37.5	20	*0*	–	–	–	*0*
20	10	*0*	–	–	–	*0*
10	6.3	*26.4*	*303.2*	*278.2*	*8.2*	*2.18*
6.3	2	*69.4*	*104.9*	*98.6*	*6.0*	*4.17*
2	1	*4.2* †	–	–	*6.0* ‡	*0.25*
Total		*100*			Total	*6.60*
Second Test Portion						
37.5	20	*0*	–	–	–	*0*
20	10	*0*	–	–	–	*0*
10	6.3	*28.7*	*296.1*	*272.3*	*8.0*	*2.31*
6.3	2	*66.2*	*98.4*	*92.5*	*6.0*	*3.97*
2	1	*5.1*	*104.1*	*98.2*	*5.7*	*0.29*
Total		*100*			Total	*6.57*
					Mean	7

† Less than 5 % by mass of total sample, no test specimen.
‡ Taken as equivalent to that for 6.3 mm to 2 mm size under Sub-Clause B.6.2, indent (b).

EXAMPLE B.2

Sandy Heath Pit, Coarse Sand. Tested 8-12 August 2003						
Sieve Size		Grading of Test Portion (% of total mass)	Mass of Test Specimen		Magnesium Sulfate Value (% of original mass)	Weighted Mag. Sulfate value (%)
Passing (mm)	Retained (mm)		Before Test (g)	After Test (g)		
First Test Portion						
10	6.3	*4.6* †	–	–	*11.9* ‡	*0.55*
6.3	2	*10.8*	*97.2*	*85.6*	*11.9*	*1.29*
2	1	*17.0*	*101.8*	*94.2*	*7.5*	*1.27*
1	0.5	*25.2*	*92.9*	*89.0*	*4.2*	*1.06*
0.5	0.25	*26.2*	*104.1*	*99.3*	*4.6*	*1.21*
0.25	–	*16.2*	–	–	*4.6* *	*0.75*
Total		*100*			Total	*6.12*
Second Test Portion						
10	6.3	*4.4* †	–	–	*11.2* ‡	*0.49*
6.3	2	*10.9*	*104.1*	*92.4*	*11.2*	*1.23*
2	1	*17.3*	*106.8*	*98.3*	*8.0*	*1.38*
1	0.5	*25.1*	*101.7*	*96.8*	*4.8*	*1.21*
0.5	0.25	*26.1*	*100.3*	*96.1*	*4.2*	*1.09*
0.25	–	*16.2*	–	–	*4.2* *	*0.68*
Total		*100*			Total	*6.08*
					Mean	6

† Less than 5 % by mass of total sample, no test specimen.
‡ Taken as equivalent to that for 6.3 mm to 2 mm size under Sub-Clause B.6.2, indent (b).
* No test but mass loss taken as equivalent to that for 0.5 mm to 0.25 mm size under Sub-Clause B.6.3.

Appendix C – Binder Recovery and Ageing: The Ageing Profile Test.

C.1 TEST METHODS

C.1.1 The test methods and reporting requirements shall be as described in the Highways Agency Manual of Contract Documents for Highway Works, Vol 1: Specification for Highway Works, Clause 923.

Appendix D– Visual Assessment of slurry surfacing

D.1 SCOPE

D.1.1 This appendix specifies qualitative and quantitative test methods of the visual assessment of defects of slurry surfacing.

D.1.2 This document is applicable to all slurry surfacing.

D.1.3 The visual assessment reports for both methods have identical records and thus both may be used to check the specification for visual assessment of defects in section 4.2.

D.1.4 Defects emanating from the substrate (existing surface) shall not be taken into consideration.

NOTE 1 The qualitative and quantitative tests may be used separately or sequentially. The qualitative test is carried out first as much slurry surfacing is either definitely good or definitely bad. The quantitative test is only used on those areas where the outcome is in doubt.

D.2 TERMS, DEFINITIONS AND SYMBOLS

D.2.1 For the purposes of this test method, the following terms, definitions and symbols apply.

D.2.2 *Defect* - state of a slurry surfacing where the material is affected by one or more of the effects defined in this Appendix

D.2.3 *Bleeding, fatting up and tracking* appearance of free binder at the surface

NOTE: This may be due to the binder migrating to the surface (bleeding) or to coarse aggregate migrating downwards(fatting up) or a combination of the two, it is often difficult to visually separate the two causes. Tracking is evident as shiny areas caused by traffic resulting in loss of macrotexture normally in the wheel tracks.

D.2.4 *Delamination* detachment of the slurry surfacing from the underlying road or from a lower layer of a multi-layer slurry surfacing

D.2.5 *Wearing and loss of slurry surfacing* loss of mass of material

D.2.6 *Loss of coarse aggregate* loss of chippings due to the action of traffic before the slurry surfacing has gained sufficient strength or by stripping of the binder from the aggregate

D.2.7 *Lane joint gaps* incomplete layer of slurry surfacing between adjacent lanes

D.2.8 *Rutting* permanent deformation, by flow, of the slurry surfacing layer, which occurs in the wheel tracks

D.2.9 *Slippage* horizontal deformation by flow of the slurry surfacing over the layer beneath or the underlying road due to the action of traffic

D.2.10 *Corrugation* transverse undulations at more or less regular spacing (the area encompassing the corrugation is measured)

D.2.11 *Bump (ridge)* transverse or longitudinal raised area

NOTE This may be caused by overlap during installation.

D.2.12 *Small repetitive defects or groups of small defects*. Defects less than 1 m^2 and greater than 10 D^2 where D is the upper aggregate size as defined in BS EN 13043 for the slurry surfacing being visually assessed. They include blisters or domes where small areas have lifted from the substrate and blow holes where the blisters have burst (see D.2.13).

NOTE They may be grouped together for evaluation.

D.2.13 *Blow Holes* are small, usually round, holes caused by bubbles in the newly laid slurry which have burst. They are considered to be a defect when their diameter exceeds 2 mm.

D.2.14 *Other defects.* Defects caused by operations on the surface since the slurry surfacing was laid, for example damage caused by winter maintenance or accident. These are not considered as a defect in this specification.

D.2.15 *Longitudinal grooves (score marks).* Marks parallel to the laying direction below the general finished level of the slurry surfacing

NOTE: Longitudinal grooves are often produced by larger aggregate particles or broken and hardened mix dragged by the spreader box.

D.3 SYMBOLS

A_1 is the sum of the areas of bleeding fatting up and tracking in the section being considered, in square metres (m_2);

A_2 is the sum of the areas of delamination, loss of aggregate, wearing, lane joint gaps, rutting and slippage in the section being considered, in square metres (m_2);

A_3 is the sum of the areas of corrugation, bumps and ridges in the section being considered, in square metres (m_2);

A_4 is the sum of the areas of the rectangle or rectangles containing small repetitive defects or group of small defects in the section being considered, in square metres (m_2);

D is the upper aggregate sieve size of the slurry surfacing (as in BS EN 13043);

L is the total length of longitudinal grooves in the section, in metres (m);

P_1 is the proportion of area of bleeding, fatting up and tracking in the section being considered, expressed as a percentage (%), of the area of the section;

P_2 is the proportion of area of delamination, loss of aggregate, wearing, lane joint gaps, rutting and slippage in the section being considered, expressed as a percentage (%), of the area of the section;

P_3 is the proportion of area of corrugation, bumps and ridges in the section being considered, expressed as a percentage (%), of the area of the section;

P_4 is the proportion of area of the rectangle or rectangles containing a group of small defects or small repetitive defects, in the section being considered, expressed as a percentage (%), of the area of the section plus the number of rectangles (in the form area + number);

S is the area of section of slurry surfacing, in square metres (m^2) (generally between 300 and 500 m^2);

W is the mean width of lane, in metres (m).

D.4 GENERAL

D.4.1 An area of slurry surfacing is chosen for visual assessment. The section should consist of an area of between 300 and 500 m^2. The section reference shall be recorded in the relevant table.

D.4.2 Sections may be located anywhere along or across the surface except that they shall not overlap.

D.4.3 The remainder of the site that is not chosen for test or the area between sections is deemed to be without defects at the time of carrying out the test.

NOTE 1: The sections should be chosen in order to maximise the number of defects in each section.

NOTE 2: If the defects are localised there may be only one section chosen in one section for the entire length of treatment.

NOTE 3: Where the whole site has defects to be evaluated, it may be convenient to divide it up into (300 ± 1) m sections that are contiguous.

D.5 QUALITATIVE PROCEDURE

D.5.1 The qualitative assessment uses the visual assessment report as given in Table D.1.

D.5.2 Determine the section where the visual assessment is to be made (see D.4). For the defect being considered, if there is none detected by this qualitative visual assessment then “none” should be reported according to Table D.1.

D.5.3 *Area defects* Estimate the area S of the section. Area defects shall be assessed individually if they are larger than 1 m_2. Where they are smaller than this see D.5.7.

D.5.4 *Bleeding, fatting up and tracking* The areas of bleeding, fatting up and tracking shall be estimated and recorded if the individual area of a defect is more than 1 m². A_1 is the sum of these defects. P_1 is A_1 divided by S as a percentage (see equation D.1). P_1 shall be recorded according to Annex A.

D.5.5 *Delamination, loss of aggregate, wearing, lane joint gaps, rutting and slippage* The areas of these defects shall be estimated and recorded if the individual area of a defect is more than 1 m². A_2 is the sum of these defects. P_2 is A_2 divided by S as a percentage (see equation D.2). P_2 shall be recorded according to Annex A.

NOTE Care should be taken to ensure that a lane joint gap is only included in one section.

D.5.6 *Corrugation, bumps and ridges* Bumps and ridges can be considered as defects if their height above the surrounding material is equal to or greater than 3 mm. The total area encompassing the corrugation is assessed. The areas of these defects shall be estimated and recorded if the individual area of the defect is more than 1 m². A_3 is the sum of the areas of these defects. P_3 is A_3 divided by S as a percentage (see equation D.3). P_3 shall be recorded according to Annex A.

NOTE Corrugations can be considered as defects if the amplitude (peak to trough) measured by laying an approximately 1 m long straightedge is greater than 5 mm and the distance between the two adjacent wave peaks is between approximately 50 mm and 200 mm.

D.5.7 *Groups of small defects or small repetitive defects* Any defects with dimensions larger than 10 D^2 (except blowholes where the lower size limit is 2 mm diameter) but smaller than 1 m^2 shall be estimated and grouped together if they are less than 5 m apart. The area to be recorded is that of the smallest rectangle that encompasses the group or repetitive defect.

NOTE It is possible to have more than one rectangle in a section. A_4 is the sum of the areas of these rectangles. P_4 is A_4 divided by S as a percentage (see equation D.4). P_4 shall be recorded according to Annex A. The number of rectangles in the section shall also be recorded.

D.5.8 *All other area defects* The area of these may be recorded for information but shall not be included in the overall assessment of the slurry surfacing.

D.5.9 *Longitudinal grooves (score marks)* These defects are assessed by length, they are taken into account if the length of an individual defect is equal to or more than 1 m and where the width is equal to or greater than 1,5 D and the depth is equal to or greater than 1,5 D. In case of repetitive longitudinal grooves in the same line having an individual length greater than 10 D and separated by less than 5 m the total length from start to finish shall be included in the assessment of L. The length L shall be visually estimated as the total length in metres of all the longitudinal grooves in a section and reported according to Table D.1.

D.6 QUANTITATIVE PROCEDURE

D.6.1 The quantitative assessment uses the table of results as given in Table D.2.

D.6.2 Determine the section where measurement is to be made (see D.4).

D.6.3 Measure the width of the section in metres to 0,1 m at 6 positions along the section at approximately 20 m intervals to obtain a mean value W for determining the area of section S.

D.6.4 Measure the length of each defect to the nearest 0,1 m and its width to the nearest 0,05 m.

D.6.5 Area defects shall be assessed individually if they are larger than 1 m_2. Where they are smaller than this see D.6.11.

D.6.6 *Rectangular shape* Calculate the surface area of a rectangular shaped defect by multiplying the length by the width.

D.6.7 *Non-rectangular shape* Calculate the surface area of a non-rectangular shaped defect by multiplying the maximum length by 0,8 times the maximum width.

D.6.8 *Bleeding, fatting up and tracking*. The areas of bleeding, fatting up and tracking shall be measured and recorded if the individual area of a defect is more than 1 m². A_1 is the sum of these defects. P_1 is A_1 divided by S as a percentage (see equation D.1). P_1 shall be recorded in according to Table D.2.

D.6.9 *Delamination, loss of aggregate, wearing, lane joint gaps, rutting and slippage*. The areas of these defects shall be measured and recorded if the individual area of a defect is more than 1 m². A_2 is the sum of these defects. P_2 is A_2 divided by S as a percentage (see equation D.2). P_2 shall be recorded in according to Table D.2.

NOTE Care should be taken to ensure that a lane joint gap is only included in one section.

D.6.10 *Corrugation, bumps and ridges*. Bumps can be considered as defects if their height above the surrounding material is equal to or greater than 20 mm. The total area encompassing the corrugation is measured. The areas of these defects shall be measured and recorded if the individual area of a defect is more than 1 m². A_3 is the sum of the areas of these defects. P_3 is A_3 divided by S as a percentage (see equation D.3). P_3 shall be recorded in according to Table D.2.

NOTE Corrugations can be considered as defects if the amplitude (peak to trough) measured by laying an approximately 1 m long straightedge is greater than 5 mm, and the distance between the two adjacent wave peaks is between 50 mm and 200 mm.

D.6.11 *Groups of small defects and small repetitive defects*. Any defects with dimensions larger than 10 D^2 but smaller than 1 m^2 shall be grouped together if they are less than 5 m apart. The area to be measured and recorded is that of the smallest rectangle that encompasses the group or repetitive defect. A_4 is the sum of the areas of these rectangles. P_4 is A_4 divided by S as a percentage (see Equation D.4). P_4 shall be recorded according to Table D.2. The number of rectangles in the section shall also be recorded.

NOTE It is possible to have more than one rectangle in a section.

D.6.12 *All other area defects*. The area of these may be recorded for information but shall not be included in the overall assessment of the slurry surfacing.

D.6.13 *Longitudinal grooves (score marks)*. These defects are measured by length, they are taken into account if the length of an individual defect is equal to or more than 1 m and where the width is equal to or greater than 1,5 D and the depth is equal to or greater than 1,5 D. In case of repetitive longitudinal grooves in the same line having an individual length greater than 10 D and separated by less than 5 m the total length from start to finish shall be used to calculate the total length L. The length L shall be the total length in metres of all the longitudinal grooves in a section and reported according to Table D.2.

D.7 EXPRESSION OF RESULTS

Values

D.7.1 The visual assessment of defects for slurry surfacing has five values:

- P_1 is the proportion of area of bleeding, fatting up and tracking in the section being considered expressed as a percentage of the area of the section;
- P_2 is the proportion of area of delamination, loss of aggregate, wearing, lane joint gaps, rutting and slippage in the section being considered expressed as a percentage of the area of the section;
- P_3 is the proportion of area of corrugation, bumps and ridges in the section being considered expressed as a percentage of the area of the section;
- P_4 is the proportion of area of the rectangle or rectangles containing a group of small defects, sometimes repetitive, in the section being considered expressed as a percentage of the area of the section;
- L is the total length of longitudinal grooves in the section, in metres (m).

Qualitative assessment

D.7.2 The visual assessment (drive over) report is completed and estimates of P_1, P_2, P_3, P_4 and L are reported (see Table D1).

Quantitative assessment

D.7.3 The table of results is completed with measurements of P_1, P_2, P_3, P_4 and L (see Table D2).

D.7.4 *Bleeding, fatting up and tracking.* Calculate the total area of bleeding fatting up and tracking in the section expressed as a percentage, from equation (D.1):

$$P_1 = 100 \cdot A_1 / S \qquad \text{(D.1)}$$

where

P_1 is the proportion of area of bleeding, fatting up and tracking in the section being considered, expressed as a percentage (%), of the area of the section;

A_1 is the sum of the areas of bleeding fatting up and tracking in the section being considered, in square metres (m^2);

S is the area of section of slurry surfacing, in square metres (m^2).

D.7.5 *Delamination, loss of aggregate, wearing, lane joint gaps, rutting and slippage*. Calculate the total area of delamination, loss of aggregate, wearing, lane joint gaps, rutting and slippage in the section expressed as a percentage, from equation (D.2):

$$P_2 = 100 \cdot A_2 / S \qquad \text{(D.2)}$$

where

P_2 is the proportion of area of delamination, loss of aggregate, wearing, lane joint gaps, rutting and slippage in the section being considered, expressed as a percentage (%), of the area of the section;

A_2 is the sum of the areas of delamination, loss of aggregate, wearing, lane joint gaps, rutting and slippage in the section being considered, in square metres (m^2);

S is the area of section of slurry surfacing, in square metres (m^2).

D.7.6 *Corrugation, bumps and ridges*. Calculate the total area of corrugation, bumps and ridges in the section expressed as a percentage, from equation (3):

$$P_3 = 100 \cdot A_3 / S \qquad \text{(3)}$$

where

P_3 is the proportion of area of corrugation, bumps and ridges in the section being considered,
expressed as a percentage (%), of the area of the section;

A_3 is the sum of the areas of corrugation, bumps and ridges in the section being considered, in square metres (m^2);

S is the area of section of slurry surfacing, in square metres (m^2) (generally between 300 and 500 m^2).

D.7.7 *Groups of small defects or small repetitive defects* Calculate the total area of rectangles containing the groups of small defects and repetitive small defects in the section expressed as a percentage, from equation (4):

$$P_4 = 100 \cdot A_4 / S \qquad \text{(4)}$$

where

P_4 is the proportion of area of the rectangle or rectangles containing a group of small defects or small repetitive defects, in the section being considered, expressed as a percentage (%), of the area of the section plus the number of rectangles (in the form area + number);

A_4 is the sum of the areas of the rectangle or rectangles containing small repetitive defects or group of small defects in the section being considered, in square metres (m^2);

S is the area of section of slurry surfacing, in square metres (m^2).

D.7.8 *Longitudinal grooves* Report the total length in metres as L.

D.8 TEST REPORT

D.8.1 The test report shall refer to this document and for the qualitative test shall contain the information detailed in Tables D1 and when the quantitative test is carried out the information detailed in Table D2

NOTE The report may include other useful information about the defect such as the amplitude and wavelength of any corrugations or depth of groove or macrotexture of fatting up areas in order to indicate the severity of the defect.

TABLE D.1 QUALITATIVE ASSESSMENT – Estimated "drive-over" method

Visual Assessment Report

The Report below is an example of a suitable layout. Other data may be included.

Qualitative Visual Assessment Report – estimated

Client: .....…….. Contractor: .....……

Reference of the site…….. Total surface area of site: ..... m^2

Reference of the part covered with the slurry surfacing and date of installation: ……..

Type of slurry surfacing: .....……

Reference of the section					
Exact place of inspection					
Estimated Area of section S	m^2	S			
Defects –visual estimate of areas and lengths:					
Bleeding, fatting up and tracking (D.5.4)	m^2	A_1			
$P_1 = 100 \times A_1 / S$	%	P_1			
Delamination, loss of aggregate, wearing, lane joint gaps, rutting and slippage (D.5.5)	m^2	A_2			
$P_2 = 100 \times A_2 / S$	%	P_2			
Corrugation, bumps and ridges (D.5.6)	m^2	A_3			
$P_3 = 100 \times A_3 / S$	%	P_1			
Small repetitive defects (D.5.7)	m^2	A_4			
Number of rectangles containing defects	no.				
$P_4 = 100 \times A_4 / S$	%	P_4			
Longitudinal grooves (score marks) (D.5.9)	m	L			

Remarks:

Date of assessment : ……

Name of the person responsible for assessment ……

Signature .....……

TABLE D.2 QUANTITATIVE ASSESSMENT – Measured method

The Table below is an example of a suitable layout of results. Other data may be included.

Quantitative visual assessment Table of Results – measured

Client: .....…….. Contractor: .....……

Reference of the site …… Total surface area of site: ..... m^2

Reference of the part covered with the slurry surfacing and date of installation: …….

Type of slurry surfacing: .....…….

Reference of the section					
Exact place of inspection					
Estimated Area of section S	m^2	S			
Defects – Measured areas and lengths:					
Bleeding, fatting up and tracking (D.6.8)	m^2	A_1			
$P_1 = 100 \times A_1 / S$	%	P_1			
Delamination, loss of aggregate, wearing, lane joint gaps, rutting and slippage (D.6.9)	m^2	A_2			
$P_2 = 100 \times A_2 / S$	%	P_2			
Corrugation, bumps and ridges (D.6.10)	m^2	A_3			
$P_3 = 100 \times A_3 / S$	%	P_3			
Small repetitive defects (D.6.11)	m^2	A_4			
Number of rectangles containing defects	no.				
$P_4 = 100 \times A_4 / S$	%	P_4			
Longitudinal grooves (score marks) (D.6.13)	m	L			

Remarks:

Date of test: ……..……...

Name of the person responsible for test .....……..

Signature .....……

Appendix E – Shear Bond Strength Test

SHEAR BOND STRENGTH TEST METHOD FOR SLURRY SURFACING

E.1 PRINCIPLE

E.1.1 The shear and bond strength (SBS) test method is carried out either in situ or in the laboratory using a nominally 200 mm diameter core which may be subjected to certain curing condition. A 100 mm diameter metal plate is bonded to the top surface and rotated using a torque meter to determine the rotational shear strength between layers. In situ testing is done without the necessity to core into the substrate. A curing protocol can be used to assess the effect of temperature and moisture to the development of strength with time.

E.2 APPARATUS

E.2.1 Equipment

- *Core cutting apparatus:* suitable for cutting 200mm diameter cores in bituminous and cementitious materials (for laboratory testing).
- *Torque meter*: fitted with a reading gauge that indicates the maximum torque obtained. The device shall be calibrated over a range of 0-400 N m with a scale accurate and readable to at least 10 N m. The device shall be fitted with socket-fitting allowing steel plates to be fitted and removed.
- *Metal Plate*: having a diameter of (95±5) mm and a thickness of (14±2) mm (mild steel has been found to be suitable). The plate shall incorporate a fitting enabling it to be coupled to the torque meter.
  (Note: Fittings of 12.7 mm and 19.05 mm have been found to be suitable.)
- *Thermometer*: readable to 0.1°C and accurate to 0.5°C.
- *Steel Rule* readable to 1 mm.
- *Callipers*: for measurement of metal plate diameters, if necessary.
- *Watch or Timer*: readable and accurate to 1 second.
- *Mould*: for confining laboratory test specimens.
- *Spirit Level*: for checking laboratory test specimens.
- *Oven* or refrigerated incubator.

E.2.2 Materials

- *Adhesive*: (a stiff adhesive, such as rapid setting epoxy resin, with sufficient strength to avoid failure within the adhesive or at the interface between the adhesive and slurry surfacing/ microsurfacing).
- *Mounting material (for laboratory tests)*: e.g. rapid hardening mortar, concrete or grout.

E.3 DEFINITIONS

- SBS : shear bond strength in kilopascals (kPa),
- M : peak value of applied shearing torque in Newton metres (N m),
- D : diameter of metal plate in millimetres (mm)

E.4 SITE

E.4.1 The location to be tested, either in situ or where cores are to be taken for laboratory testing, should be generally free of detritus, oil deposits and visually uniform in texture, if this is not the case the visual appearance should be reported.

E.5 TEST METHOD

E.5.1 In situ test method

E.5.1.1 Use the adhesive agent to secure the metal plate to the surface, taking care to ensure that the plate is parallel to the surface. Three metal plates placed within 1 m of each other (at least 100 mm apart) shall be tested at each location of testing.

(NOTE 1: The section area for testing and the number of tests within each section should be defined in the contract, this will depend on importance of the site in terms of traffic and use.)

(NOTE 2: The tests may be carried out on a separate trial section or previous results may be acceptable as a type test.)

E.5.1.2 When the adhesive agent has developed sufficient strength, (i.e. failure should not occur within the adhesive), fit the torque meter to the metal plate, using adapters and extension rods as appropriate.

E.5.1.3 Record the temperature (to an accuracy of ± 0.5 °C) at approximately the interface position of the slurry surfacing and microsurfacing by making a hole (e.g. 10 mm deep) at the location of testing. The minimum temperature for carrying out the test shall be 20 °C.

E.5.1.4 Apply torque to the metal plate at a steady rate so that the torque wrench sweeps an angle of 90° within (30±15) s. Care must be taken to ensure that the torque is applied parallel to the core surface (within ± 10°). Torque is applied to the plate until failure occurs or a torque of 400 N m is exceeded.

E.5.1.5 Record the value of torque at failure, M, in Newton metres. Any interface that comes apart during preparation shall be noted.

E.5.1.6 Examine the material adhering to the metal plate and the substrate and record the condition of the bond interface (e.g. smooth, planar, rough or irregular) and the extent of failure in the material surrounding the metal plate. Record the substrate type (e.g. bituminous or cementitious surface)

and details if known (eg. friction course, grooved Marshall Asphalt Surface course, base course, age, etc.). Record the age of the slurry surfacing and microsurfacing.

(NOTE: The failure at the surface sometimes occurs outside the area of the metal plate and should not be of concern as the effect is minimal. See photographs in section 6.)

E.5.1.7 Assess the depth, from the surface, of the interface revealed.

E.5.1.8 Calculate the shear bond strength in accordance with section E.5.4.

E.5.2 Laboratory test method

E.5.2.1 Cut six cores from the location to be tested. A 200 mm diameter core barrel shall be used to core a sample of at least 50 mm in total depth (thickness of core). The coring machine and core cutter shall be such that there is minimal vibration. The location for testing shall be preferably dry and air cooling used. Wet conditions and the use of water cooling are permitted and shall be recorded. The core shall be removed carefully. If the core is damaged during removal then providing the centre 100 mm area to be tested is not affected and the edge is damaged by less than 6 mm then the core may be used for testing. The condition of the core shall be reported.

(NOTE 1: The section area for testing and the number of cores taken within each section should be defined in the contract, this will depend on importance of the site in terms of traffic and use.)

(NOTE 2: The tests may be carried out on a separate trial section or previous results may be acceptable as a type test.)

(NOTE 3: The core holes should be reinstated as detailed in the contract.)

E.5.2.2 The cores shall be transferred as quickly as possible to storage (maximum period of 48 hours after placing) and stored at a temperature between 0 °C and 5 °C (generally 5 °C is used).

E.5.2.3 Divide these cores into two sets of three (i.e. dry and wet subsets) and condition each set using the protocol in section 5.3. The slurry surfacing and microsurfacing may have aged in situ, after application and before storage and testing, therefore the date of application should be recorded. If the age of the slurry surfacing and microsurfacing is greater than 2 years then there is no requirement to condition the cores prior to testing and the six cores can be used to provide a single mean value for an “in situ aged” (e.g. 3-year) shear bond strength.

E.5.2.4 Trim a core to a length suitable for mounting if appropriate.

E.5.2.5 Place the core in the mould, using mortar or grout as a bedding layer if appropriate, so that the upper layer and the bond interface to be tested is (20±10) mm above the rim of the mould. Fill the mould with the mortar/grout and trim flush with the mould rim, ensuring that the core is perpendicular to, and the upper surface parallel with, the mould surface. Check this using the spirit level.

E.5.2.6 Use the adhesive agent to secure the metal plate to the surface of the core at approximately its centre (assess this visually), taking care to ensure that the plate is parallel to the surface. Leave at ambient temperature until the adhesive agent has developed sufficient strength, (i.e. failure should not occur within the adhesive during the test).

E.5.2.7 Condition the mounted core by storing at the selected test temperature i.e. (35 ± 2) °C for a minimum of 4 hours and for not more than a total of 16 hours between removal from storage and shear bond strength test, or between the end of the curing protocol (described in section 5.3) and the shear bond strength test. Record the conditioning time and temperature of test. (20± 2) °C testing is used for determining early life shear bond strength, when in situ testing within the first 48 hours is not possible.

E.5.2.8 Fix or clamp the mould containing the mounted core to a suitably rigid horizontal surface. Fit the torque meter to the metal plate, using adapters and extension rods as appropriate. Apply torque to the core at a steady rate so that the torque wrench sweeps an angle of 90° within (30±15) s. Care must be taken to ensure that the torque is applied parallel to the core surface (within ± 10°). Torque is applied to the plate until failure of the bond or material occurs or a torque of 400 N m is exceeded. The test shall be completed within 5 minutes of removal from the conditioning environment.

E.5.2.9 Record the value of torque at failure, M, in Newton metres. Measure and record the bond interface temperature immediately after failure. Any interface that comes apart during preparation shall be noted.

E.5.2.10 Examine the material adhering to the metal plate and the substrate and record the condition of the bond interface (e.g. smooth, planar, rough or irregular) and the extent of failure in the material surrounding the metal plate. Record the substrate type (e.g. bituminous or cementitious surface) and details if known (eg. friction course, grooved Marshall Asphalt Surface Course, base course, age, etc.). Record the age of the slurry surfacing and microsurfacing if known. Record whether the core has been conditioned by the protocol in section 5.3.

(NOTE: The failure at the surface sometimes occurs outside the area of the metal plate and should not be of concern as the effect is minimal. See photographs in section 6.)

E.5.2.11 Measure and record the depth, from the surface, of the interface being tested to an accuracy of 1mm.

E.5.2.12 Calculate the shear bond strength in accordance with section 5.4.

E.5.3 Conditioning protocol for new ('unaged') material

E.5.3.1 Apparatus

- *Water bath* - of suitable size to accommodate at least one specimen and thermostatically controlled such that temperature of (20± 0.5) ℃ can be maintained
- *Oven* or refrigerated incubator
- *Thermometer* - capable of measuring temperatures from room temperature to 100°C and having an accuracy of ±2°C or better.

E.5.3.2 Procedure A (Conditioning in air)

- Store the prepared specimens (both dry and wet subsets) in an oven or refrigerated incubator at (20±0.5) ℃ for (168 ± 2) hours.
- For the dry subset, determine the shear bond strength at the test temperature i.e. (35±0.5) ℃ after the conditioning time has elapsed.
- For the wet subset, carry out further conditioning as detailed in section 5.3.3.

E.5.3.3 Procedure B (Moisture conditioning)

- Fully submerged the wet subset specimens in a water bath previously conditioned at 20 °C. After (168 ± 2 hours), remove the specimens from the water bath, surface dry and determine the shear bond strength at the test temperature i.e. (35±0.5) ℃.

E.5.4 Calculation of Bond and Shear Strength and expression of results

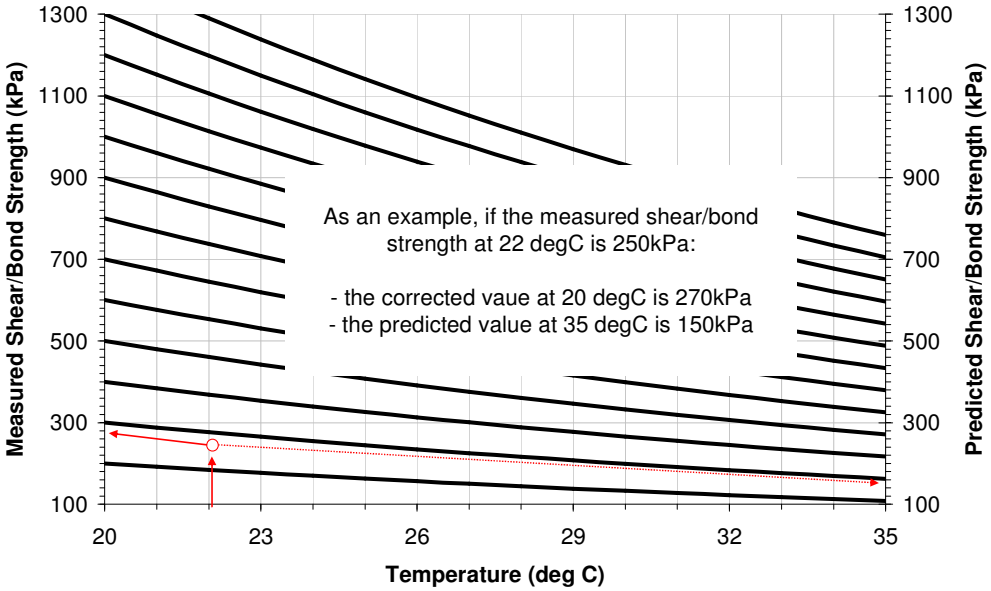
E.5.4.1 Calculate the shear bond strength for each specimen using the following formula:

$$SBS = \frac{12M \times 10^6}{\pi D^3}$$

E.5.4.2 Calculate the arithmetic mean of the shear bond strength, SBS, for the three dry subset specimens and separately the other three wet subset specimens.

E.5.4.3 For in situ values of standard slurry surfacing, the following graph can be used to correct the measured value to that at 20°C and to predict the value at 35 °C.

(NOTE: Shear bond strength vs temperature relationship from 20 to 35 °C shall be developed for non standard materials. This can be done on samples produced in laboratory or recovered from a trial section.)



E.5.5 Shear Bond Strength Test Report

The test report shall include the following information:

i) Name of organisation carrying out the test

ii) Identification of Site or Scheme

iii) Core or in situ test location

iv) Date of test

v) Age of the installation / specimen at the time of test

vi) Method of test used (in situ or laboratory)

vii) Description and age of materials (slurry surfacing and microsurfacing and substrate, if possible)

viii) Peak torque at failure (N m) for individual cores or in situ

ix) Shear bond strength (kPa), (individual and mean values):

- 48 hours in situ (corrected to 20°C) or laboratory at 20°C
- After laboratory conditioning to Procedure A and tested at 35 °C
- After laboratory conditioning to Procedures A + B and tested at 35 °C

x) Time to failure (seconds)

xi) Depths of bond interface for cores (mm)

xii) Temperature of the bond interface at test (°C)

xiii) Conditioning details (duration and temperature)

xiv) Mode of Failure

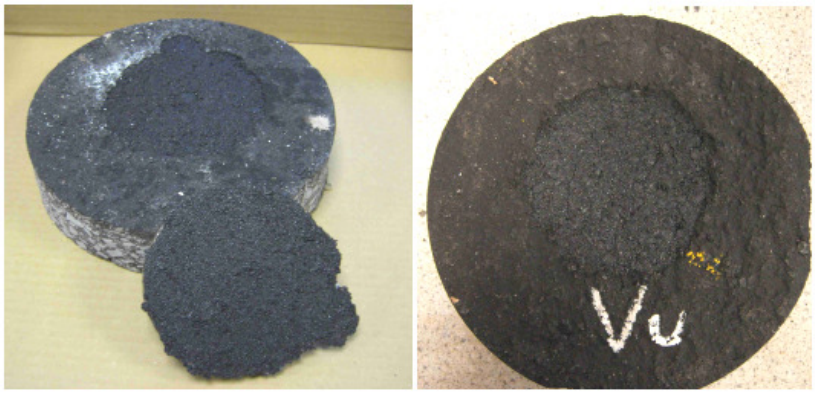
E.5.6 Precision

The precision for this test method has not been determined.

E.6 PHOTOGRAPHS

These photographs illustrate typical failure modes under the metal plate at the bond interface of laboratory tested 200 mm cores at 35 °C for two different slurry surfacing and microsurfacings (microsufacings).

NOTE: Although the failure sometimes occurs at the surface outside of the plate, the effect is minimal, it is the torque measurement that is the important parameter.



Appendix F – TAIT (Type Approval Installation Trial)

F.1 GENERAL

F.1.1 A TAIT consists of a defined section where slurry surfacing has been installed using Factory Production Control (FPC) and which has been submitted to performance tests after a period of one year. Detailed information is recorded to clearly identify the product, its performance and the intended uses. The producer carries out one Type Approval Installation Trial (TAIT) to cover each product family he wishes to place on the market. The TAIT is synonymous with Initial Type Test (ITT) which demonstrates that the characteristics of the slurry surfacing comply with the requirements of the technical specification.

F.1.2 A TAIT of microsurfacing for a motorway would cover the use on lightly trafficked road but not vice versa as it demonstrates the ability of the producer. A product family is performance based and therefore permits a variation of components in accordance with the producer's FPC.

(NOTE: A TAIT is used by the producer to demonstrate that his product complies with the requirements of this European Standard.)

F.2 REQUIREMENTS

F.2.1 A TAIT shall comprise a full set of test results as required by the relevant European Standard or Specification demonstrating the performance characteristics of a defined section or sections of slurry surfacing constructed in accordance with the requirements of this Appendix.

F.2.2 The minimum length of a section shall be 200 m and the width shall be the full width of road on single carriageway roads or one lane width on dual carriageways or motorways, or twice the width of the paving machine (but not less than 8m) where laid on an airfield.

F.2.3 A TAIT shall be carried out on one section of work that shall be representative of a slurry surfacing/microsurfacing type.

F.2.4 The TAIT is completed by carrying out additional performance tests on the slurry surfacing, on site, after one year of completion of the installation.

F.2.5 The producer shall design and install the slurry surfacing, of which the TAIT is a representative section, in accordance with his documented Factory Production Control System. He shall record all the data required by the FPC and any additional data required by the applicable Standard or Specification.

F.3 RECORDS

F.3.1 The data recorded for a TAIT shall include the following information:

- Producer (name, address, phone number, etc.);
- Date of TAIT;

- Location of TAIT (location/site, start and end points);
- Description of type of slurry surfacing system, including tack/bond coat;
- Intended use;
- Mix design (constituent materials and proportions);
- Design office: name, address, phone number, etc. (where different from 'producer');
- Relevant test results of materials used;
  NOTE: The TAIT can include further information, for example: Rate of Application BS EN 12274-6, Residual Binder Content BS EN 12274-2, Shaking Abrasion Test BS EN 12274-7, bond test results, target grading and tolerances, macrotexture, etc.
- Visual assessment to BS EN 12274-8 and macrotexture to BS EN 13036-1 or to BS EN ISO 13473-1 after one year shall be recorded;
- Shear Bond Strength;
- Name of producer's representative responsible for TAIT.

F.4 INFORMATION AVAILABILITY

F.4.1 The information from a TAIT shall be kept and stored securely and made available for inspection upon request. If the data is lost the TAIT shall no longer be valid.

Appendix Y – Guidance Notes on Quality Systems for Project Managers

Y.1 INTRODUCTION

These Guidance Notes are intended to assist Project Managers in assessing Suppliers' Quality Assurance (QA) systems for the supply of component and mixed materials as required by Clause 2.4. In particular, guidance is given on:

- how to appraise and evaluate different Quality Systems offered by Suppliers when tendering for jobs (Clauses Y.5 and Y.6); and
- how to monitor work undertaken (Clause Y.7).

Separate clauses are devoted to each aspect.

Y.2 GENERAL

Y.2.1 These Guidance Notes are not intended to replace the BS EN ISO 9000 series and associated documentation.

Y.2.2 The generic term "Client" or "Purchaser" in these Guidance Notes is to include the person or organisation that is acting for, or on behalf of, the Property Manager or the Project Sponsor in the role of either a Project Manager or a Works Services Manager.

Y.2.3 The generic term "Supplier" is used to cover any person or organisation that has, or is tendering for, a Contract with the Client to supply a product or service, and includes those traditionally referred to as the (main) Contractor.

Y.2.4 Products which are specified by means of a Harmonised European Standard under the Construction Products Directive are subject to CE marking. It is not permitted to require additional quality assurance or testing requirements over and above those required for Attestation of Conformity within the European Standard. The CE mark certificate should be taken as sufficient evidence of product conformity.

Y.3 QUALITY SYSTEMS

Y.3.1 It is now the accepted practice that all suppliers of goods and services should:

- install and maintain a Quality Management System; and
- become registered to a United Kingdom Accreditation Service (UKAS) accredited third party certification scheme as a Supplier of assessed capability. For slurry surfacing many contractors are certified to the Highways Sector Scheme 13B which covers all the requirements of this specification and often goes beyond them.

Y.3.2 It is general practice that, once a Quality Management Scheme has been set up within an organisation, application for registration to a second or third party certification scheme will be made.

Y.3.3 Second party assessment is carried out by the purchasing organisation; this is very expensive because the resource requirements for systematic and continuous auditing and the management of an assessment scheme are extremely high. Consequently, this form of registration is now in decline and organisations which previously carried out second party assessment, such as British Telecom, British Gas, what used to be the National Coal Board and the MoD, are beginning to insist that their suppliers obtain third party assessment and, hence, pay the costs of quality assurance.

Y.3.4 Certification of a Supplier's Quality Management System by a third party should provide the Purchaser with the confidence that the Supplier is:

- operating and maintaining a fully documented Quality Management System that addresses consistent requirements; and
- operating within the scope of registration.

This avoids the need for the Purchaser to undertake his own structured regime of second party assessments to ascertain the adequacy and focus of the Supplier's Quality Management Systems.

Y.3.5 However, this does not absolve the Project Manager of his responsibilities on behalf of the Client to ensure that the Quality System of the Supplier addresses all the requirements and needs. This is because the Quality Standards are interpreted differently by individual organisations.

Y.3.6 In principal, the more independent the assessment and audit regime, the more confident the Purchaser can be as to the value of a Supplier's Quality Management System. Once registered under a certifying bodies scheme, there is still a need to audit, by both the Supplier and the third party certification body, that procedures and standards are being maintained.

Y.3.7 Assessments and audits can be carried out by:
- the Supplier's management - Under his own audit and monitoring regime;
- the Client (Project Manager) - Second party assessment scheme; or
- an independent body - Third party assessment scheme.

Y.4 PROCESSES COVERED UNDER THE QUALITY SYSTEM

Y.4.1 For a Quality Management System to be effective, it must cover all the operations and processes that are relevant to the business conducted by the Supplier.

Y.4.2 Dependent upon the type of work being tendered for, but as a minimum for the purpose of this Specification, the following areas should normally be addressed:
- procurement, inspection and safe storage of constituent materials;
- training of plant operatives;
- setting up on-site plants and the mixing and spreading of slurry surfacing;
- inspection and test regimes and records at appropriate stages;
- sub-contractor/supplier assessment and control;
- calibration of equipment; and
- statistical techniques to be used for trend analysis, statistical process control and inspection.

Y.4.3 Quality Management Systems should include provisions for planned and systematic audits, inspections and tests by participating organisations. The Project Manager has the responsibility to evaluate and audit the system being operated by the Supplier to ensure adequacy. This should include checking records to substantiate that the procedures are being followed and that the Supplier has evidence that the materials and works are conforming to the specified standard.

Y.4.4 A Quality Plan in accordance with Defence Standard 05-67 should be stipulated in the Contract as a deliverable, but may be included in the *Invitation to Tender* if required. The activities described within the Quality Plan shall be stated unambiguously and concisely so that their intent is clear and that, upon implementation, they can be conducted, assessed, audited, demonstrated, measured or verified.

Y.4.5 The Quality Plan must state or contain definitions as to the levels of quality assurance and control to be applied throughout the Contract, which should include:
- traceability of materials;
- frequency and stages of inspections and tests;
- process controls; and
- records (including the retention periods and reviews).

Y.4.6 As quality standards are not extensively defined in relation to the process control, it is the responsibility of the Project Manager to ensure that all processes and methods proposed in Quality Plans are clearly defined and understood with regard to how the Supplier will deal with these aspects of the operation, and that all anomalies, shortfalls, errors and omissions are documented and resolved.

Y.5 ASSESSMENT OF QUALITY MANAGEMENT SYSTEMS

Y.5.1 The assessment of Quality Management Systems is a logical and progressive multi-stage process that encompasses good management precepts.

Y.5.2 A list and records should be maintained of acceptable suppliers and only suppliers on this list should be chosen. Therefore, any solicited or unsolicited suppliers should, as the first stage in the selection process, be required to complete a supplier questionnaire and must, as a minimum, include the following elements:
- verification/proof that the Supplier's Quality Management System is registered by a Certification Body accredited by UKAS;
- that the registration certificate is current;

- that the offices/sites from which the works or services are to be provided are covered by the registration certificate;
- that the scope of registration is appropriate for the works/services to be provided;
- experience or references of other users of the Supplier's services;
- the Supplier's past performance, covering experience and results with similar work/projects;
- financial information;
- insurance information; and
- Health and Safety information.

Y.5.3 If the responses to the above are satisfactory, an assessment of the Supplier's Quality Management System can be undertaken.

Y.5.4 The extent of the assessment can range from a visit to the Supplier's premises to overview the Quality Management System in operation on a similar project, to a full formal audit conducted against the BS EN ISO 9000 series and in accordance with BS EN 30011 by the Project Manager's own QA staff.

Y.5.5 It is the responsibility of the Project Manager to decide if an assessment is necessary. The decision for, and the scope of, such an assessment should be taken on the basis of the size, complexity, cost and length/duration of the Contract in conjunction with the level of confidence that can be established from other sources.

Y.6 ASPECTS TO ASSESS TENDER ACCEPTABILITY

Y.6.1 The requirements for the purchasing of goods and services should, as a minimum, be those set down in the BS EN ISO 9000 series. In order to ensure successful procurement, it is a prerequisite that the purchaser (the Project Manager) provides a clear definition of requirements in the form of contractual conditions and specifications. This aspect applies equally to Quality Management System requirements.

Y.6.2 All *Invitations to Tender* must contain elements outlining the quality requirements. These should be in the form of asking tenderers to provide:

- proof of registration to BS EN ISO 9001 with an appropriate scope of registration for that particular Contract;
- method statements for all processes to be carried out;
- inspection/test schedules; and
- other information relevant to the Contract.

Y.6.3 When the Supplier returns a tender, his submission must be scrutinised to assess whether his Quality Management System covers all the areas that are relevant to the processes necessary for him to carry out the work to the required standard. Where only part of the required elements is covered in the Quality Management System, it may be acceptable for the tenderer to address these areas in his Quality Plan and to compile site-specific procedures for unique elements of the Contract.

Y.6.4 The returned tenders must provide precise details against the information requested in the *Invitation to Tender*, which is to include the following:

- the Quality System that will be enforced throughout the duration of the Contract;
- the method and procedures to be used to ensure the positive identification and issue status of specifications, drawings, inspection instructions and other data including the requirements for the approval of operational procedures, equipment, staff, operative training and outputs;
- the method and procedures to be used to ensure conformity to the Specification by processes, inspection and test criteria; and
- methods for the procurement of raw materials, services, etc.

Y.6.5 It is the responsibility of the Project Manager to select those suppliers that they consider will provide the level of confidence that they require to meet the Specification and fulfil their obligations under the Contract.

Y.6.6 Information, in the form of Inspection Records, Test Certificates and Certificates of Conformity, from the Supplier will not normally be supplied automatically unless particularly requested or made a contractual requirement. To make sure that the Supplier understands these requirements, a Quality Plan can be required as part of the tender response. The Quality Plan must be evaluated as part of the tender selection process.

Y.6.7 Where the Supplier proposes that some of the work is carried out by sub-contractors, it does not absolve the Supplier of any of his responsibilities to ensure that the work is carried out to the contracted specification and quality.

Y.6.8 The Supplier is to ensure that, where sub-contractors have their own Quality Management System, it is found by scrutiny to be acceptable and they work to it. Where a sub-contractor does not

have his own Quality Management System, the Supplier is to extend his own to include the sub-contractor. The Project Manager has a responsibility to audit both the Supplier and any sub-contractors to ensure compliance to the tender proposal.

Y.7 MONITORING THE QUALITY MANAGEMENT SYSTEM AND PROCESSES

Y.7.1 Whilst the Supplier may have registration to BS EN ISO 900, it does not necessarily mean that his system is fully focused on the specific requirements of the Contract, nor does any second party scheme run by another purchaser. Monitoring of the system should take place irrespective of whether the Supplier has, or has not, achieved registration.

Y.7.2 The Supplier should have procedures in place for the auditing, monitoring, recording and rectifying of all his activities. The Project Manager should ensure, by conducting surveillance audits of the Supplier's system, that:

- these are being carried out;
- the system is effective; and
- the system is focused on the Contract requirements and deliverables.

Y.7.3 Within the Contract, there will be requirements for the Supplier to carry out tests on the materials, etc. The Supplier may not have his own test laboratory, in which case he will send samples out to a test house. Any test laboratory, whether part of the Supplier's organisation or an independent test house, conducting the tests for initial approval of materials and design of mixtures should be a United Kingdom Accreditation System (UKAS) accredited test house with an appropriate test schedule. Site laboratories used to carry out routine tests on bulk supplies and mixtures throughout plant mixing shall be either UKAS accredited or, subject to the Project Manager's approval, work to a Quality Assurance scheme.

Y.7.4 Where non-compliances are found, whether within the system being operated or the goods or services provided, they can be either random instances when the value is outside the specified range or an indication of a trend. If the running mean of the last, say, twenty results has remained reasonably consistent with a standard deviation that also has not fluctuated, then it is likely to be a random instance. Preferably, the running means and standard deviations should be monitored to allow corrective action before non-compliances occur. All actions taken to deal with non-compliances are to be documented.

Y.7.5 Rates of sampling and testing must be appropriate to the Contract and stated clearly in the Quality Plan. Where rates are stipulated in the Contract (see Section 7), these will take preference unless the frequency of testing in the quality plan is higher..

Y.7.6 The procedures for sampling and testing slurry surfacing materials are to be in accordance with the appropriate parts of the latest editions of relevant British Standards, and also with the latest edition of the appropriate Appendices to this Standard. All samples and testing should be carried out by suitably trained personnel. The results are to be supported by valid Test or Sample Certificates.

Y.7.7 The use of a Quality System should minimise the need for the Project Manager to carry out his own tests. Therefore, they can:

- do nothing because the Supplier is carrying out sufficient inspections and tests, and assessing the results and implications;
- [preferred option] assess the inspection and test results for the material provided for the Contract to ensure that checks are being made and that the results indicate compliance to the Contract and Quality Plan is being achieved; or
- conduct a separate inspection and test regime of his own to check for compliance.

Y.8 RECORDS

Y.8.1 The training records of all operatives, sampling and testing personnel are to be maintained by the Supplier and are to be made available for inspection.

Y.8.2 The results of all inspections, tests, etc. for the Contract should be obtained and retained for record purposes. All documentation (including work-sheets, Inspection and Test Certificates and Certificates of Conformity) that are relevant to the Contract should be:

- available at the place of work (usually the plant or depot) for inspection by the Project Manager for the duration of the Contract; and
- handed over to the Project Manager on completion of the Contract.

Appendix Z – Guidance Notes on the Preparation of Job Specifications

Z.1 VARIATIONS FOR SMALL WORKS

Z.1.1 For small works, the magnesium sulfate test on all fractions can be omitted provided there is local evidence that the aggregate has adequate resistance to freezing and thawing. In such cases, the standard BS EN 1367-2 magnesium sulfate test conducted on the 10/14 mm size fraction may be considered satisfactory and it is unnecessary to require testing in accordance with Appendix B.

Z.1.2 Off site mixing of slurry surfacing is not permitted. If very small quantities are required, eg for patching, then a small concrete type mixer shall be used on site using the same ingredients as have been proven elsewhere on site (or on another airfield surfaced by the same contractor)

Z.1.3 Laboratory facilities and the requisite level of expertise must be available to carry out the full range of test procedures but for small areas these may be off site.

(NOTE. Advice on equipment needed and, where possible, inspection services, will be provided by Defence Estates upon request.)

Z.2 METEOROLOGICAL DATA

Z.2.1 In deciding whether to offer meteorological data about the site, the ease of availability of the data and the possible usefulness of the data (in terms of the expected season when the work is to be carried out and the size of the works) need to be considered.

References

Defence Estate, Ministry of Defence

FS 06	1994	Specification 06, Guide to Maintenance of Airfield Pavements
FS 12	2007	Specification 012, Hot Rolled Asphalt and Macadam for Airfields
FS 13	2007	Specification 013, Marshall Asphalt for Airfields
FS 33	2005	Specification 033, Pavement Quality Concrete for Airfields
FS 35	2005	Specification 035, Concrete Block Paving for Airfields
FS 40	2007	Specification 040, Porous Friction Course for Airfields
FS 49	2007	Specification 049, Stone Mastic Asphalt for Airfields
DMG 27	2006	A guide to airfield pavement design and evaluation

British Standards Institution

BS 434			Bitumen road emulsions (anionic and cationic)
	Part 1	1984	Specification for bitumen road emulsions
	Part 2	2006	Code of practice for use of bitumen road emulsions
BS 598			Sampling and examination of bituminous mixtures for roads and other paved areas
	Part 100	2004	Methods for sampling and analysis
	Part 102	2003	Analytical test methods
	Part 107	2004	Method of test for the determination of the composition of design course rolled asphalt
BS 2000			Methods of test for petroleum and its products
	Part 49	2007	Determination of needle penetration
BS 3136			Specification for cold emulsion spraying machines for roads
	Part 2	1972	Metric units
BS 8420		2003	Methods of measuring irregularities on surfaces of roads, footways and other paved areas using straightedges and wedges
BS 594987		2007	Asphalt for roads and other paved areas - Specification for transport, laying and compaction and type testing protocols
BS EN 58		2004	Bitumen and bituminous binders – Sampling bituminous binders
BS EN 197			Cement
	Part 1	2000	Composition, specifications and conformity criteria for common cements
BS EN 459			Building lime
	Part 1	2001	Definitions, specifications and conformity criteria
BS EN 932			Tests for general properties of aggregates
	Part 1	1997	Methods for sampling
	Part 2	1999	Methods for reducing laboratory samples
BS EN 933			Tests for geometrical properties of aggregates
	Part 1	1997	Determination of particle size distribution – Sieving method
	Part 2	1996	Determination of particle size – Test sieves, nominal size of apertures
	Part 5	1998	Determination of percentage of crushed and broken surfaces in coarse aggregate particles
	Part 6	2001	Assessment of surface characteristics. Flow coefficient of aggregates
	Part 9	1999	Assessment of fines – Methylene blue test
	Part 10	2001	Assessment of fines – Grading of fillers (air-jet sieving)

BS EN 1097			Test for mechanical and physical properties of aggregates
	Part 1	1996	Determination of the resistance to wear (micro-Deval)
	Part 2	1998	Methods for the determination of resistance to fragmentation (Los Angeles Test)
	Part 3	1998	Determination of loose bulk density and voids
	Part 4	1999	Determination of the voids of dry compacted filler
	Part 5	1999	Tests for mechanical and physical properties of aggregates. Determination of the water content by drying in a ventilated oven
	Part 6	2000	Determination of particle density and water absorption
	Part 7	2008	Determination of the particle density of filler – Pyknometer method
	Part 8	2000	Determination of the polished stone value
BS EN 1367			Test for thermal and weathering properties of aggregates
	Part 2	1998	Magnesium sulfate test
BS EN 1428		2000	Methods of test for petroleum and its products. Bitumen and bituminous binders. Determination of water content in bitumen emulsions. Azeotropic distillation method
BS EN 1429		2000	Methods of test for petroleum and its products. Bitumen and bituminous binders. Determination of residue on sieving of bitumen emulsions and determination of storage stability by sieving
BS EN 12272			Surface Dressing Test Methods
	Part 1	2002	Rate of spread and accuracy of spread of binder and chippings
BS EN 12273		2008	Slurry surfacing. Requirements
BS EN 12274			Slurry Surfacing. Test Methods
	Part 1	2002	Sampling for binder extraction
	Part 2	2003	Determination of residual binder content.
	Part 3	2002	Consistency
	Part 4	2003	Determination of cohesion of the mix
	Part 5	2003	Determination of wearing.
	Part 6	2002	Rate of application
	Part 7	2005	Shaking abrasion test
	Part 8	2005	Visual assessment of defects
BS EN 12591		2000	Bitumen and bituminous binders – Specifications for paving-grade bitumens
BS EN 12620		2002	Aggregates for concrete
BS EN 12697			Bituminous mixtures – Test methods for hot mix asphalt
	Part 3	2005	Bitumen recovery: rotary evaporator
	Part 4	2005	Bitumen recovery: fractionating column
	Part 5	2002	Determination of the maximum density
	Part 6	2003	Determination of bulk density of bituminous specimens
	Part 8	2003	Determination of void characteristics of bituminous specimens
	Part 11	2005	Determination of affinity between aggregates and binder
	Part 13	2000	Temperature measurement
	Part 28	2001	Preparation of samples for determining binder content, water content and grading
	Part 36	2003	Determination of the thickness of a bituminous pavement
BS EN 12846		2002	Methods of test for petroleum and its products. Bitumen and bituminous binders. Determination of efflux time of bitumen emulsions by the efflux viscometer method
BS EN 12847		2002	Methods of test for petroleum and its products. Bitumen and bituminous binders. Determination of settling tendency of bitumen emulsions
BS EN 12850		2002	Methods of test for petroleum and its products. Bitumen and bituminous binders. Determination of the pH value of bitumen emulsions
BS EN 13036			Road & Airfield Characteristics – Test methods
	Part 7	2003	Irregularity measurement of pavement courses. The straightedge test
BS EN 13043		2002	Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas
BS EN 13075			Methods of test for petroleum and its products.
	Part 1	2002	Determination of breaking value of cationic bitumen emulsions, mineral filler method
	Part 2	2002	Determination of fines mixing time of cationic bitumen emulsions

BS EN 13108			Bituminous mixtures – Material specifications
	Part 1	2006	Asphalt concrete
	Part 4	2006	Hot rolled asphalt
BS EN 13588		2008	Determination of cohesion of bituminous binders with pendulum test
BS EN 13614		2004	Methods of test for petroleum and its products. BS 2000-521: Bitumen and bituminous binders. Determination of adhesivity of bitumen emulsions by water immersion test. Aggregate method
BS EN 13808		2005	Bitumen and bituminous binders. Framework for specifying cationic bituminous emulsions
BS EN 14023		2005	Bitumen and bituminous binders. Framework specification for polymer modified bitumens
BS EN 30011			Guidelines for auditing quality systems
	Part 1	1993	Auditing
	Part 2	1993	Qualification criteria for quality systems auditors
	Part 3	1993	Management of audit programmes
BS EN ISO 3838		2004	Methods of test for petroleum and its products. BS 2000-189/190. Crude petroleum and liquid or solid petroleum products. Determination of density or relative density. Capillary-stoppered pyknometer and graduated bicapillary pyknometer methods
BS EN ISO 9000		2000	Quality management and quality assurance standards
BS EN ISO 13473			Characterization of pavement texture by use of surface profiles
	Part 1	2004	Determination of mean profile depth

Her Majesty's Stationery Office

DS 05-67		1980	Defence Standard 05-67, Guidance to Quality Assurance in Design
		1990	Environmental Protection Act 1990

British Board of Agrément

HAPAS	SG3	2002	Guideline document for the assessment and certification of thin surfacing systems for highways

American Society for Testing and Materials

ASTM D 2041 - 91		1991	Standard test method for theoretical maximum specific gravity and density of bituminous paving mixtures

Civil Aviation Authority

CAP 168			Licensing of Aerodromes

International Civil Aviation Organization (Quebec)

Annex 14			International Standards and Recommended Practices, Aerodromes: Annex 14 to the Convention on International Civil Aviation
	Volume 1	1990	Aerodrome design and operations
9137-AN/898			Airport Services Manual
	Part 2	1994	Pavement surface conditions