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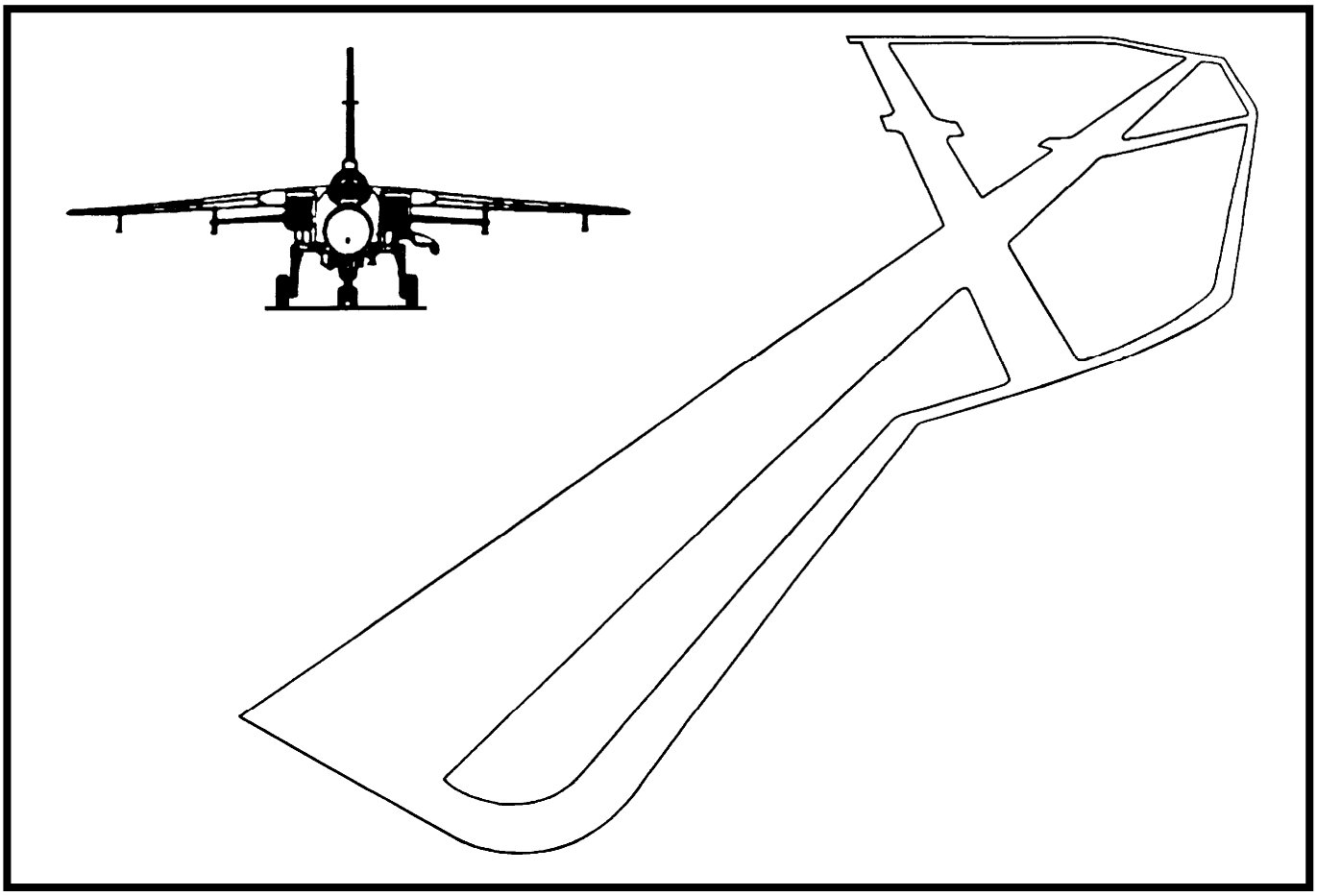

Porous Friction Course for Airfields

DEFENCE ESTATES
MINISTRY OF DEFENCE

Specification 40

Porous Friction Course for Airfields

August 2009

CONSTRUCTION SUPPORT TEAM
DEFENCE ESTATES

Ministry of Defence

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The specifications in this document have been prepared by TRL Limited in conjunction with and under commission to the Construction Support Team, Defence Estates, Ministry of Defence. It has, in part, evolved from standard specifications previously produced by former Government Departments: Air Ministry Works Department, Ministry of Public Buildings and Works and the Property Services Agency.

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.

This Defence Estates Specification supersedes the previous edition published in March 1998.

This DE Specification was prepared under the patronage of the Construction Support Team, Defence Estates, Ministry of Defence, for application to airfield pavement works on the MOD estate.

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

Head of Airfield Pavements
Construction Support Team
Defence Estates
Kingston Road
Sutton Coldfield
West Midlands
B75 7RL

Tel: 0121 311 2119 or Sutton Coldfield MI 2119

This Specification, "*Porous Friction Course 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
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.
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’.
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.
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. (Previously included road tar, pitch or mixtures thereof).
Bituminous Surfacing	Alternative name for ‘Asphalt Surfacing’.
Bond Coat	Proprietary bitumen spray that provides additional adhesion and imperviousness to that achieved with a Tack Coat and, therefore, improved bond between layers when applied at the rate of application recommended by the proprietor for the particular situation.
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.
Cold Recycled Bound Material (CRBM)	A material produced *ex situ* in a fixed or mobile mixing plant from recycling base and binder courses from existing pavements. The recycling process allows for the crushing, screening and grading of excavated material, blended if necessary with other aggregate, and bound with bituminous and hydraulic binder(s) including cement.
Construction Joint	A joint separating area 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.
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.
Cutback 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.
Expansion Joint	Joint provided in a concrete pavement to accommodate the expansion which occurs when the temperature of the pavement rises.
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.
Fines	Any solid material passing a 0.063 mm test sieve.
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.
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.
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.
Interlock	Effect of frictional forces between concrete blocks that prevent them moving vertically in relation to each other.
Intermediate Restraint	Device that is used to provide restraint of concrete block paving units at intervals in the paved surface.
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.
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.
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 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.
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'.
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.
Quick Visco-Elastic (QVE)	Type of CRBM in which the primary binder is bitumen but also includes a proportion of Portland Cement.
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.
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.
Roadbase	Previous name for 'Base'.
Sand (for making concrete)	Now called 'Fine Aggregate'.
Sieved Fraction	Previous name for 'Particle Size Fraction'.

Stone Mastic Asphalt (SMA)	A 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 bitumen emulsion to improve the adhesion between two courses of asphalt or between an existing surface and a new asphalt layer.
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.
Wearing Course	Previous name for 'Surface Course'.

(NOTE. This glossary is common to all DE Specifications 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.)

Contents

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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, etc., create specialist requirements in the surfacing of MOD airfields. As such, specialist materials specifications are required to meet these needs.

1.1.2 This Standard for Porous Friction Course is one of a series being produced by DE to lay down specification requirements for airfield pavement works. The following clauses are intended to set out the applications of Porous Friction Course in the construction and refurbishment of MOD airfield pavements.

1.1.3 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 results of equal quality.

1.2 FUNCTIONAL REQUIREMENTS OF AIRFIELD PAVEMENTS

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, including during wet conditions.
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 USE OF POROUS FRICTION COURSE

1.3.1 Porous Friction Course has been extensively used on runways at MOD airfields since the early 1960s. It is basically a high-performance open-textured macadam laid at a nominal thickness of 20 mm over a dense impervious surface. The open texture of Porous Friction Course, its composition of high quality aggregates and its free-draining characteristics improve the braking performance of aircraft and minimise the risks of skidding and aquaplaning. These properties make Porous Friction Course the first choice surfacing material for the main length of runways at MOD airfields used by high-performance aircraft, except as detailed at sub-Clause 1.3.2. Other asphalt surfacing materials currently used on MOD runways are as follows:

a. The provision of a grooved Marshall asphalt surface course with continuous grooves cut perpendicular to the centre-line of the runway; a separate DE Specification gives details.
b. The provision of a surface course of hot rolled asphalt with high stone content, which does not require grooving; a separate DE Specification gives details.
c. The provision of a coarse graded slurry seal over an asphalt; this is the least favoured option but does provide a useful method of extending the life of low-use runways.

1.3.2 Porous Friction Course is not resistant to fuel spillage or the heat and blast effects of jet engines. Therefore, its use is not recommended for pavements used by aircraft such as the Harrier, nor for pavements on which aircraft stand or move slowly or routinely make tight turns, such as runway ends and the adjoining taxiway junctions, hardstandings, aprons, aircraft parking platforms and arm/disarm pads. Porous Friction Course is

also not suitable for locations where wind blown sand can accumulate and block the voids.

1.3.3 The service life of Porous Friction Course on MOD airfields has ranged from 12 to 25 years. Discounting the lowest value, in which the circumstances were in any case unusual, and the two highest values, the range narrows to 15 to 20 years. Experience has shown that maintenance requirements of Porous Friction Course during its service life are minimal; a separate DE Specification gives further details.

1.3.4 In addition to the above, consideration should be given to the following matters concerning the use of Porous Friction Course:

a. It is normal to keep transverse construction joints to a minimum, especially when a runway has dominant longitudinal gradients. This is because the free draining characteristics of Porous Friction Course can sometimes be impaired at transverse joints. A measure of these characteristics will be given by hydraulic conductivity tests carried out during the Trials (Section 6 of this Standard). Therefore, for runway resurfacing work involving night time working, the provision of a Porous Friction Course may be unrealistic if it is necessary to lay it with a series of transverse joints.
b. Porous Friction Courses in their first year are susceptible to minor loss of stone until the bituminous binder has hardened. This loss is likely to be most noticeable during the first winter as a result of snow and ice clearance operations followed by runway brushing. If at all possible, runway sweeping/brushing regimes should avoid straddling the edges of Porous Friction Courses because this is likely to cause fretting. Also, aircraft executing U-turns are likely to scuff the surface of a new Porous Friction Course. Porous Friction Course should not be used in locations where aircraft routinely make tight turns.
c. When Friction Course Surfacing is laid in very hot weather, experience has shown that it can take several weeks to harden sufficiently to take aircraft movements. In such climactic conditions, it may be necessary to consider the use of a harder binder. However, this is likely to reduce the service life of the Porous Friction Course unless a modified binder is used.

1.4 SPECIFICATION CLAUSES FOR POROUS FRICTION COURSE

Specification clauses are contained in Sections 2 to 7 and Appendix A of this Standard with Guidance Notes given on suitable temperatures and wind speeds for laying in Appendix C and on recommended roller types and sequence in Appendix D. Guidance Notes for the Project Manager on Quality Systems are given in Appendix Y and for the preparation of job specifications in Appendix Z.

1.5 ADVICE FROM CONSTRUCTION SUPPORT TEAM, DE

Clause 1.3 provides 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

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

Porous Friction Course 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
Materials	Section 3
Design & Composition	Section 4
Plant & Workmanship	Section 5
Trials	Section 6
Summary of Tests	Section 7
Magnesium sulfate Test	Appendix A
Straightedge Test	Appendix B
Temperatures & Wind Speeds	Appendix C
Roller Types and Sequence	Appendix D

2.3 USE OF POROUS FRICTION COURSE

Porous Friction Course shall be used in the locations indicated on the project drawings.

2.4 QUALITY ASSURANCE FOR THE SUPPLY OF ASPHALT MATERIALS

2.4.1 Component materials shall either be CE marked or shall be procured from a supplier with Quality Assurance accreditation to the BS EN ISO 9000 series. All operations in the batching of asphalt materials shall be carried out by a Contractor (or Supplier on his behalf) that has a Quality Management accreditation to the BS EN ISO 9000 series, incorporating "Sector Scheme 14, Production of Asphalt Mixes, 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, incorporating "Sector Scheme 14, Production of Asphalt Mixes. The CE mark documentation or the Quality System documentation for the supply of component materials and batching of asphalt materials, 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 are required; advice is given in sub-Clauses Y.5.2 and Y.6.4 of Appendix Y)

2.4.3 Each laying unit involved in the work shall be registered under "Sector Scheme 16", The Laying of Asphalt Mixes.

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

2.4.5 All documentation relevant to the work, including records of temperature control during 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.

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 type of coarse and fine aggregate to be used shall be crushed rock.

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 Porous Friction Course shall be CE marked.

3.1.4 Aggregates shall conform to the 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 surfacing, including resistance to frost. Weathered rock shall not be permitted.

(NOTE. Examples of such deleterious materials include significant quantities of:

- clay, loam or chalk, particularly as an adherent coating;
- mica, shale and other laminated materials;
- coal and other organic or vegetable impurities;
- dust or other material preventing thorough coating with binder; and
- sulfates and chlorides or other reactive substances liable to break down during drying or subsequent exposure to weather or moisture.

This list does not include all possible deleterious materials.)

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 A.

3.2 COARSE AGGREGATES

The properties of the coarse aggregate shall conform to the BS EN 13043 Categories shown in Table 3.1.

3.3 FINE AGGREGATES

3.3.1 Fine aggregates shall be free from loosely bonded aggregations and other foreign matter.

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

3.4 ADDED FILLER

3.4.1 All filler aggregate used in the Porous Friction Course shall be CE marked.

3.4.2 Between 1.5 % and 2.0 % by mass of the combined aggregate/filler aggregate specified in sub-Clause 4.2.1 shall be CL 90-S lime to BS EN 459-1 which shall be added to the mixture as part of the fraction passing the 0.063 mm sieve. If additional material of this grading is required, it shall be crushed limestone

3.4.3 Filler shall be stored in dry conditions.

3.4.4 That part of the limestone filler (if any) which is retained on the 0.063 mm sieve shall be regarded as fine aggregate.

3.4.5 The loose bulk density in kerosene of added limestone filler aggregate shall be in accordance with Clause 5.5.5 of BS EN 13043.

3.4.6 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 All binder used in the Porous Friction Course shall be CE marked.

3.5.2 The binder to be used for Porous Friction Course shall be 160/220 paving grade bitumen meeting the requirements of BS EN 12591. The Contractor (or Supplier on his behalf) shall have Quality Assurance registration to the BS EN ISO 9000 series incorporating "Sector Scheme 15", Supply of Paving Grade Bitumen. A copy of the certificate shall be passed to the Project Manager at the commencement of the Contract.

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

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

- Delivery ticket number.
- Customer name and delivery site number.
- Date loaded.
- Date delivered.
- Vehicle registration number.
- Bitumen grade.
- Quantity.

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

3.6 ADDITIVES

3.6.1 Additives, including binder modifiers, polymer modified binders and mineral or cellulose fibres, may be used in the mixture in order to reduce binder drainage to below the permitted maximum specified in 4.3.2.

(NOTE. Polymers can be used to enhance certain properties, including minimising binder drainage and resistance to fuels and/or de-icing fluids. Fibres can minimise binder drainage.)

3.6.2 Binder modifiers or pre-blended modified binders shall have a British Board of Agrément HAPAS *Roads and Bridges Certificate*. In the event that no such Certificates have been issued, binder modifiers or pre-blended modified binders shall not be used without the approval of the Project Manager. When a binder modifier is added at the batching plant, the base bitumen shall be of a grade such that the penetration of the modified binder is in the range (190 ± 50) x 0.1 mm.

TABLE 3.1 REQUIRED PROPERTIES FOR COARSE AGGREGATES

Property	Test method	Situation	Category
Resistance to freezing and thawing	BS EN 1367-2/ Appendix A *	Each source Each fraction	MS_{18} MS_{30}
Shape	BS EN 933-3	All	FI_{20}
Resistance to fragmentation	BS EN 1097-2	All	LA_{15} †
Water absorption	BS EN 1097-6	All	$WA_{24}1$
Affinity between aggregate and bitumen	BS EN 12697-11 Part B	All	Not greater than 3 particles from a 150 particle test sample
Fines content	BS EN 933-1	All	f_1
Resistance to Polishing	BS EN 1097-8	All	$PSV_{declared}$ ‡

* BS EN 1367-2: 1998 is restricted to the 14/10 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 A.

† Values marginally greater than 15 within category LA_{20} can be used with prior approval of the Project Manager. Advice on when to grant approval is given in Clause Z.1 of Appendix Z.

‡ Project Manager to provide value for specific job specification; advice given in Clause Z.2 of Appendix Z.

(NOTE. Andesite, Basalt, Gabbro, Granite and Hornfels coarse aggregates, as classified in BS EN 932-3, have been found to be suitable in the past.)

TABLE 3.2 REQUIRED PROPERTIES FOR FINE AGGREGATES

Property	Test Method	Situation	Category
Resistance to freezing and thawing	BS EN 1367-2/ Appendix A ‡	Each source Each fraction	MS_{18} MS_{30}
Fines content	BS EN 933-1	All	f_5
Fines quality	BS EN 933-9	All	MB_FNR
Water absorption	BS EN 1097-6	All	$WA_{24}2$
Affinity between aggregate * and bitumen	BS EN 12697-11 Part B	All	Not greater than 3 particles from a 150 particle test sample

‡ BS EN 1367-2: 1998 is restricted to the 14/10 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 A.

* Parent rock

(NOTE. Andesite, Basalt, Gabbro, Granite and Hornfels fine aggregates, as classified in BS EN 932-3, have been found to be suitable in the past.)

(NOTE. The use of certain types of binder modifier/pre-blended modified binder may obviate the need for hydrated lime filler. Advice should be sought from Construction Support Team, DE.)

3.6.3 Adhesion agents may be used with the approval of the Project Manager when an aggregate does not comply with the Affinity between aggregate and bitumen test (BS EN 12697-11 Part B). The concentration of adhesion agent shall be such that the modified mixture complies with the Affinity between aggregate and bitumen test.

3.7 TACK AND BOND COATS

3.7.1 Bond coat shall be used.

OR

Tack or bond coat may be used.

(NOTE. Project Manager to select option for specific job specification)

3.7.2 Tack coat shall be bitumen emulsion complying with either C 40 B 1 or C 70 B 1 of BS EN 13808.

3.7.3 Bond coats shall have a British Board of Agrément HAPAS *Roads and Bridges Certificate*. In the event that no such certificates have been issued, they shall not be used without the approval of the Project Manager.

3.8 COURSE THICKNESS

The thickness of each course of surfacing shall be as shown on the drawings. It shall be the thickness of the course at any point after compaction.

3.9 AGGREGATE SIZE

The aggregate size for Porous Friction Course shall be 2/10 mm and the nominal layer thickness shall be 20 mm.

4 Design and Composition

4.1 GENERAL

4.1.1 All Porous Friction Course incorporated into the permanent works shall be CE Marked in accordance with BS EN 13108-7.

4.1.2 The production of Porous Friction Course shall be carried out by a Contractor (or Supplier on his behalf) who works to a Quality Assurance scheme to the BS EN ISO 9000 series incorporating "Sector Scheme 14", Production of Asphalt Mixes, with an appropriate scope of application for those operations.

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

4.2 COMPOSITION OF POROUS FRICTION COURSE

4.2.1 The target grading of the aggregates, determined in accordance with BS EN 933-1, shall comply with the limits of Table 4.1 and shall not vary from the low limit on one size of sieve to the high limit on an adjacent sieve, nor vice versa. When plotted, the target grading of the aggregates shall give a smooth curve within the specified aggregate grading.

TABLE 4.1 AGGREGATE GRADING

Sieve Size (mm)	Proportion Passing (% by mass)	Tolerance (%)
14	100	–
10	90 – 100	-8 / +5
6.3	40 – 55	±7
2	19 – 25	±3
0.063	3.0 – 6.0	±2.0

4.2.2 The mixture shall contain hydrated lime in accordance with Sub-Clause 3.4.2.

4.2.3 If additional material passing the 0.063 mm sieve is required, it shall be crushed limestone in accordance with Clause 3.4.

4.3 LABORATORY DESIGN MIXTURE

4.3.1 The Binder Drainage Test shall be carried out in accordance with BS EN 12697-18 Part B at the mid-point of the grading limits determined in accordance with Sub-Clause 4.2.1 using the same mixture proposed for use in the Works.

(NOTE 1. Aggregates vary in their shape and surface characteristics such as binder absorption. The Binder Drainage Test determines the maximum binder content that can be safely used without excessive binder drainage.)

(NOTE 2. Non-proprietary modifiers, such as natural rubber latex or powder, and proprietary modifiers or modified binders may be used subject to a satisfactory result in the Binder Drainage Test. The procedure for incorporating the modifier shall be according to the supplier's or manufacturer's instructions. Full details should be supplied to and advice sought from the Defence Estates prior to approval to use of a proprietary system being given.)

4.3.2 The target binder content shall be selected such that:

- The binder drainage of samples shall conform to BS EN 13108-7 Category D_0.
- The binder content shall not be less than 5.5 %.

(NOTE 1. If the maximum target binder content is less than 5.5 %, then the mixture as tested is not suitable and the binder, binder modifier and/or aggregate will need to be changed and the binder drainage test repeated with the revised mixture.)

(NOTE 2. The minimum binder contents limit is before applying any correction for aggregate density as for determining the BS EN 13108-7 Category B_{min}.)

4.3.3 The Binder Drainage Test shall be carried out with the mixture, manufactured at the target binder content plus 0.3 % and the target grading using the same coarse aggregates and filler aggregate and stabilising options proposed for use in the Works, at:

- (120 ± 3) °C when using 160/220 bitumen;
- (150 ± 3) °C when using bitumen modified with natural rubber latex or powder; and
- in accordance with the manufacturer's recommendations for other modifiers.

4.3.4 The Contractor shall provide full details of the Binder Drainage Test to the Project Manager.

4.4 JOB STANDARD MIXTURES

The 'Job Standard Mixture' shall be the 'Laboratory Standard Mixture', modified as necessary in accordance with Section 6 of this Specification. It shall be the standard for the routine production of Porous Friction Course for the works subject to the plant tolerances permitted in Clause 4.5.

4.5 VARIATION IN PLANT MIXTURES

On analysis in accordance with BS EN 12697-1, the series of mixtures turned out by the mixing plant during normal routine production shall comply with the approved job standard mixture within the limits of aggregate grading tolerances specified in Table 4.1. The actual binder content shall be within ± 0.3 % of the target binder content approved in Clause 4.3.2.

5 Plant and Workmanship

5.1 GENERAL

The standard of workmanship and finish of all surfacing included in this Contract shall be equivalent in all respects to that of the "Approved" areas established in the trials in accordance with Section 6.

5.2 STORING AND HANDLING AGGREGATES

5.2.1 Aggregates of different aggregate sizes shall be stockpiled separately as supplied and aggregates from different supply sources, though of similar grading, shall be stockpiled separately for each source of supply. Stockpiles shall be on a concrete or asphalt paved surface, laid to crossfalls to allow unrestricted drainage. The siting and preparation of the sites shall be approved by the Project Manager. Aggregates of different gradings and/or from different sources in close proximity shall be separated by sturdy bulkheads.

5.2.2 A description of the methods to be adopted to prevent 'overspill' between adjacent stockpiles, 'coning' or segregation of the aggregate grading in the stockpiles, particularly during tipping, shall be made available to the Project Manager if requested. At all times, the stockpiles shall be kept free from contact with deleterious matter.

5.2.3 Care shall be taken to avoid crushing by stockpiling equipment.

5.2.4 All aggregates produced or handled by hydraulic methods or which have been washed shall be stockpiled for at least 24 h before use in an area such that unrestricted drainage can occur.

5.3 TESTS ON COMPONENT MATERIALS IN STORAGE

5.3.1 The grading of a representative sample from each stockpile of each aggregate shall be determined once a daily on receipt for comparison with the grading of the initial samples. The samples shall be taken by methods described in BS EN 932-1 and the testing shall be by dry sieving as described in BS EN 933-1. The particle size grading shall be used for computation of the combined grading as an initial check on the production, and for comparison with the grading approved in accordance with sub-Clause 6.3.5 for the mixture being laid.

5.3.2 Daily on receipt of both the 10/14 mm and the 6/10 mm aggregate sizes, not less than six separate representative samples shall be obtained in accordance with BS EN 932-1. The samples shall be taken at intervals spaced evenly over the delivery period at random locations from the stock piles. The shape category to BS EN 13043 for each of the fractions shall be FI_{20}.

5.3.3 Daily on receipt of the 6/10 mm aggregate size, not less than six separate representative samples shall be obtained at the same intervals as in sub-Clause 5.3.2 in accordance with BS EN 932-1. If the Los Angeles coefficient, determined in accordance with BS EN 1097-2 but on the non-standard aggregate size, is 2 or more units higher than the declared Category as specified in Clause 3.2, a Los Angeles coefficient shall be determined by the standard method described in BS EN 1097-2 on samples from the same crushing as the rock in the stockpile sample. The Los Angeles Coefficient so determined shall comply with the Category required in Clause 3.2.

5.3.4 The grading of a representative sample from each silo of filler shall be determined once per delivery. The samples shall be taken by methods described in BS EN 932-1 and the testing shall be by wet sieving as described in BS EN 933-10.

5.3.5 The loose bulk density in kerosene of a representative sample from each silo of filler shall be determined once a week when mixing and laying are in progress. The samples shall be taken by methods described in BS EN 932-1 and the testing shall be as described in Clause 5.5.5 of BS EN 13043.

5.3.6 If the results of any tests indicate that the bulk deliveries are not of a grading or quality

consistent with the CE mark certificates and associated tests for the initial approval of materials at Clause 7.2, the Contractor shall, at his own expense, carry out further tests to establish the location and extent to which the materials already stockpiled fail to meet the specified requirements, and shall remove from the aerodrome all material condemned by the Project Manager for this reason. When all the material is mixed off site, any condemned material shall be carefully removed from the stockpiles to be used for the work.

5.4 PROPORTIONING COLD AGGREGATES

5.4.1 There shall be at least one cold hopper for each size of stockpiled aggregate from each source. When two or more fine aggregates are being incorporated in the mixture a separate hopper shall be provided for each. All cold hoppers shall be kept sufficiently charged to ensure a uniform rate of delivery.

5.4.2 The feed gates, vibrators and other devices provided for controlling the output from each hopper shall be capable of accurate adjustment to ensure a uniform rate of aggregate feed.

5.4.3 Overspill between cold hoppers shall be prevented.

5.5 STATIC PLANT

5.5.1 A weighbridge shall be provided on site if a regulating course is required, irrespective of whether the mixing is to be carried out on- or off-site.

5.5.2 * Porous Friction Course shall normally be mixed on site; proposals to mix off site should be submitted at tender stage.

OR

* Porous Friction Course shall be mixed on site.

(* NOTE. Project Manager to select option for specific job specification; advice given in Clause Z.2.1 of Appendix Z.)

5.5.3 Static plant shall be adequate for the purpose of producing fully-coated asphalt in accordance with this Specification. The Contractor shall submit his proposals in respect of static plant with his Tender. Proposals which include the use of continuous drum mixers shall contain details of the means of controlling the grading of aggregates throughout the mixing process, including that of filler/added filler in association with the control and extraction of dust.

5.5.4 The siting of all static plant shall be agreed with the Project Manager and the layout of the units shall be considered in relation to prevailing winds and the local population to minimise nuisance.

(NOTE. See the Guidance issued by the Department of the Environment for details of Local Authority requirements and authorisation of plant in respect of Part 1 of Environmental Protection Act as of 1 April 1991.)

5.5.5 The weighing, measuring and recording mechanism and temperature control gauges shall be checked by the manufacturer of the mechanism and gauges, or by an independent testing authority. The Contractor shall submit proofs certifying that each device is operating accurately or reporting deviation allowances required in respect of each indicator, to the Project Manager, for his retention. These checks shall be carried out before mixing starts, at the end of each month during mixing, and whenever the plant is re-sited or disturbed.

5.5.6 All plant shall be maintained in good working order, controlled by a trained and experienced operator, and shall be subject to inspection by the Project Manager. This applies equally to off-site mixing plants as well as for on-site mixing.

(NOTE. Approval for mixing outside the airfield should not be given if the distance between mixing plant and site is such that the specified mixing and laying temperatures cannot be routinely achieved.)

5.6 BINDER STORAGE

The binder shall be separately heated to the temperature(s) specified in Clause 5.8 in approved heating tanks. The temperature dials shall be readily accessible, shall be kept clean at all times, and their calibration checked at the start of the contract and thereafter at 6 monthly intervals.

5.7 DRYING AND HEATING AGGREGATES

Aggregates shall be thoroughly dried and heated. The Contractor shall carry out moisture tests at least once a week to check the effectiveness of the drying processes. Samples taken from the discharge of a

'dry batch' shall be tested for moisture by weighing, drying in a ventilated oven at a controlled temperature of (110 ± 5) °C for 24 h, and then weighing again. If at any time the difference in the weight of the sample before and after oven drying exceeds 0.5 %, mixing shall cease until the Contractor has improved his drying capability to the satisfaction of the Project Manager. All drying plant shall be equipped with efficient dust extractors.

5.8 MIXING, DELIVERY AND COMPACTION TEMPERATURES

5.8.1 Porous Friction Course shall be mixed, delivered, laid and compacted within the material temperature limits given in Table 5.1.

(NOTE. Compliance with the mixing temperature limits given in Clause 5.12 of BS EN 13108-71:2006 incorporating 2008 corrigendum will be achieved by these values.)

5.8.2 The Contractor shall check the temperature of the delivered load and the load in the hopper according to the method in BS EN 12697-13 at the following intervals:

- within 30 min of arrival on site;
- whilst discharging from the delivery lorry into the paver hopper;
- immediately before restarting the spreader following stoppage;
- immediately prior to the beginning of compaction; and
- at any time the Project Manager or his representative directs.

5.8.3 The prescribed compaction procedure shall have been substantially completed before the surfacing temperature has fallen to the minimum compaction temperature.

5.8.4 Mixtures which do not comply with the above requirements shall not be used. Reheating is prohibited.

5.8.5 The test results shall be recorded in an approved form linking the temperature taken with the location of the material tested and shall be submitted daily to the Project Manager.

5.9 MIXING

5.9.1 The proportion of filler shall be measured by weight. Where the Specification for the material being mixed requires a definite proportion of an added filler, extracted dust shall not be automatically fed back into the mixer.

5.9.2 The proportion of binder may be measured by either weight or volume.

5.9.3 All mixing plant shall incorporate means of access for samples of mixed material, bitumen and filler to be taken.

5.9.4 For batch mixers, the hot aggregates shall be screened and separated into the hot-bins after heating for batching by weight in at least three different sizes into the mixing unit. Means of enabling samples to be obtained from each hot-bin shall be provided. Batch-mixing plant which does not incorporate these requirements is prohibited. The hot aggregates and binder shall be mixed together in the correct proportions until the binder is evenly distributed. Filler may be added before or after the binder but mixing shall continue for at least 1 min after the addition of the filler. The total mixing time may only be reduced if the Project Manager is satisfied that thorough mixing can be achieved in less time. In such cases, the Contractor shall obtain the written authority of the Project Manager to reduce the mixing time to a specific period.

TABLE 5.1 MIXING, DELIVERY AND COMPACTION TEMPERATURES

Bitumen Grade	Temperature (°C)					
	Binder (Min)	Binder (Max)	Mixing (Max)	Delivery (Min)	Paver-out (Min) †	Compaction (Min) ‡
160/220	95	135	120	110	100	65
160/220 plus modifier	*	*	*	*	*	*

† These values are required in order to achieve the maximum available compaction time. They are useful for monitoring purposes to ensure that adequate compaction time is available.
‡ This is the mid-layer temperature at which completion of compaction should have been achieved.
* Value in accordance with the Supplier's recommendation.

5.9.5 For continuous drum mixers, the hot aggregate and binder shall be mixed together in the correct proportions until the binder is evenly distributed. Filler is to be added simultaneously with the binder to ensure full incorporation and distribution within the mix.

5.10 VARIATIONS IN PLANT MIXTURES

Any variations outside the limits specified in Clause 4.5 shall be investigated. If such variations continue for more than 24 h, all laying shall cease. All plant and processes shall then be checked and immediate arrangements shall be made by the Contractor to make the necessary modifications or corrections, until the Project Manager is satisfied that when laying restarts the mixtures will comply with these requirements. Before laying continues in the construction area, the Project Manager may instruct the Contractor to lay a further trial area of surfacing, as described in Clause 6.3, on disused pavements within the airfield boundary.

5.11 GENERAL WEATHER CONDITIONS FOR LAYING ASPHALT SURFACING

5.11.1 Laying of asphalt surfacing shall not proceed unless:

- the surface to be covered is unfrozen and free from ice, snow and de-icing agents;
- the temperature of the surface to be covered is 0 °C or more; and
- the air temperature is either:
  - above 1 °C or
  - between -1 °C and 1 °C and rising.

5.11.2 Laying of asphalt surfacing shall not proceed during precipitation unless:

- both the surface to be covered and the air temperature are above 0 °C;
- there is no free water on the surface; and
- the degree of moisture present on the surface is not detrimental to the finished product.

(NOTE. Guidance is given on suitable temperatures and wind speeds for laying in Appendix C.)

5.12 PREPARATION OF EXISTING ASPHALT SURFACES

Porous Friction Course shall not be laid on existing asphalt surfaces.

(NOTE. Porous Friction Course is normally only laid on new Marshall Asphalt. If consideration is being given to laying on existing surfaces, then advice on a project/works specific basis can be obtained from the Construction Support Team, DE.)

5.13 SAMPLING AND TESTING MIXED MATERIALS

5.13.1 Every 4 h during production, but not less than twice a day, bulk samples of the mixed materials after the completion of the mixing process shall be taken by the Contractor for each mixer in use and divided. One sample shall be analysed for grading and binder content; the other retained for reference in the case of a dispute. The results shall be plotted onto graphs in order to show comparison with the grading curve of the mixture approved in accordance with Clause 6.3 and the relevant binder content.

5.13.2 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.

5.13.3 The Contractor (or his materials supplier on his behalf) shall carry out the following additional tests when routine tests fail to establish the extent to which material already laid fails to meet the requirements specified for aggregate/filler aggregate grading or binder content. The additional tests for aggregate/filler aggregate binder content and binder content shall be made on four 300 mm square samples. The samples shall be cut from the compacted course, at positions selected by the Project Manager, within the lane width at a distance of not more than 5 m from the location in the pavement at which the mixture was laid which failed to satisfy the routine test requirements specified.

5.13.4 If any one of the additional test results specified in sub-Clause 5.13.3 also indicate failure to meet the specified requirement, further tests shall be made on 3 more samples. These samples shall be cut at further positions selected by the Project Manager, also within the lane width and at a distance of not more than 10 m further

along the lane from the location of the previous failure point. Should one of these additional samples also fail to meet the specified requirement, the above process shall be repeated until all samples or cores are satisfactory. The area represented by the failed core samples shall be cut out and replaced as detailed in Clauses 5.30.

5.14 TRANSPORTING PLANT MIXTURES

5.14.1 The plant mixtures shall be transported without delay to the laying sites from the mixing plant or from hot storage bins taking care to prevent segregation. The vehicles shall be double sheeted during transit and while waiting to prevent loss of heat, contamination and wetting. All vehicles shall be mechanically sound and roadworthy and shall be suitable for the spreading equipment in use and shall have insulated bodies.

5.14.2 The use of water or proprietary products on the surfaces of the transporting vehicles to facilitate discharge shall be strictly regulated to the absolute minimum. If the Project Manager considers that contamination of the mixtures is occurring, the vehicle shall be thoroughly cleaned out to his satisfaction before being used again. The use of diesel oil, dust, sand or other fine particles is prohibited.

5.14.3 The temperature of the load in every transporting vehicle shall be checked in accordance with sub-Clause 5.7.

5.14.4 Each delivery of mixed material to the contract works from an off-site mixing plant shall be accompanied by a delivery ticket giving the following details:

- Delivery ticket number.
- Customer name and delivery site number.
- Date and time loaded.
- Date and time delivered.
- Vehicle registration number.
- Source of supply.
- Material type and mix classification.
- Paving grade of bitumen used.
- Quantity.

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

5.15 TACK AND BOND COAT APPLICATION

5.15.1 The type of tack or bond coat to be used for Porous Friction Course is as specified in Clause 3.7.

5.15.2 A tack or bond coat shall be applied not more than 24 h in advance of surfacing. The rate of application shall be in accordance with BS 594987. Tack and bond coats may be applied to damp surfaces but ponded or standing water shall be removed by sweeping.

5.15.3 Tack and bond coat shall be applied uniformly, free of streaks and blobs in accordance with BS 434-2 by mobile mechanical tank-spraying units complying with BS 3136-2. The tack 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.

(NOTE. The use of paving machines that incorporate equipment to apply the tack or bond coat immediately before the mix is laid will not allow the opportunity to ensure that the tack coat has 'broken'. If the Contractor wishes to use such equipment, he shall seek prior written approval from the Project/Works Manager. Advice for Project/Works Manager is given in Clause Z.4 of Appendix Z.)

5.15.4 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.

5.15.5 After application, no traffic of any kind shall be allowed to run over the tack or bond coat until surfacing starts and arrangements shall be made to cordon off the sprayed areas until it does. When surfacing starts, only the minimum amount of traffic essential to the surfacing operations shall be permitted.

5.16 PERMITTED TOLERANCE OF COURSE THICKNESS

5.16.1 The total compacted thickness of Porous Friction Course at any point shall not be less than

the specified course thickness or exceed this thickness by more than +6 mm / - 0 mm.

5.16.2 Core samples shall be taken to determine course thickness:

- at minimum intervals of every 1000 m² laid or from every 2 h work, whichever is the more frequent; and
- at locations agreed with the Project Manager.

Cores shall be cut from the surfacing from areas as directed by the Project Manager.

5.16.3 The walls and base of all holes from which core samples have been cut are to be painted with hot bitumen and filled with:

- 0/10 Marshall Asphalt regulating course in accordance with DE Specification "Marshall Asphalt for Airfields"; or
- 0/10 Hot Rolled Asphalt regulating course in accordance with DE Specification "Hot Rolled Asphalt and Asphalt Concrete (Macadam) for Airfields"; or
- 0/6 Asphalt Concrete (Macadam) regulating course in accordance with DE Specification "Hot Rolled Asphalt and Asphalt Concrete (Macadam) for Airfields"; or
- 0/4, 0/6 or 0/10 Stone Mastic Asphalt regulating course in accordance with DE Specification "Stone Mastic Asphalt for Airfields".

The material shall be level with the rest of the surfacing after having been well rammed into the hole.

5.16.4 The Contractor (or his materials supplier on his behalf) shall carry out additional tests when routine tests fail to establish the extent to which material already laid fails to meet the requirements specified for course thickness. The additional tests shall be made on four 150 mm diameter cores. The cores shall be cut from the compacted course, at positions selected by the Project Manager, within the lane width at a distance of not more than 5 m from the location in the pavement at which the mixture was laid which failed to satisfy the routine test requirements specified.

5.16.5 If any one of the additional test results specified in sub-Clause 5.16.4 also indicate failure to meet the specified requirement, further tests shall be made on 3 more cores. These cores shall be cut at further positions selected by the Project Manager, also within the lane width and at a distance of not more than 10 m further along the lane from the location of the previous failure point. Should one of these additional cores also fail to meet the specified requirement, the above process shall be repeated until all samples or cores are satisfactory. The area covered by the failed samples of cores shall be cut out and replaced as detailed in Clauses 5.30.

5.17 REGULATION OF EXISTING SURFACES

Where the irregularities in the pavements to be surfaced are such that the permitted thickness tolerances for that course will be exceeded, the existing surfaces shall be regulated as a separate item in advance of general resurfacing.
Regulation shall be carried out in accordance with DE Specification "Marshall Asphalt for Airfields", DE Specification entitled "Hot Rolled Asphalt and Asphalt Concrete (Macadam) for Airfields" or DE Specification "Stone Mastic Asphalt for Airfields".

5.18 DRAINAGE CHANNELS AND CATCHPITS

5.18.1 Along the outer edges of the pavement(s) the Porous Friction Course shall terminate in a firm 20 mm step along the line of the inner edge of the drainage channel. Care shall be taken to lay the free edge of the lane neatly true to line. After completion of compaction any loose particles shall be removed by brushing.

5.18.2 Surface water catchpits shall be raised, as necessary, to be flush with the layer beneath the Porous Friction Course. The adjustment in the height of these fixtures shall be carried out as shown on the drawings, either in advance of laying the Porous Friction Course, or on completion of the new surfacing work. The fixtures shall be blanked out during laying.

5.19 LAYING REQUIREMENTS

5.19.1 A competent supervisor shall be in charge of all laying and finishing operations.

5.19.2 Porous Friction Course shall be laid on the surface course as soon as practicable, and shall be made to firmly adhere to the surface course.

5.19.3 Except in 'closing lanes', the mixture shall be laid in lanes not less than 3 m wide. The lanes shall be laid parallel to the pavement centre line. The first lane shall be placed on the low side, or

sides, with subsequent lanes working towards the high side or crown.

5.19.4 The laying shall be planned so that the number of transverse joints is kept to a minimum. Unless laying is interrupted by inclement weather or plant breakdown, transverse joints shall only be allowed at points of slack longitudinal fall when agreed by the Project Manager.

5.19.5 The mixture shall be spread initially to a depth which provides a generous surcharge proud of the required finished level so that, after compaction, the final thickness of the course shall be within the permitted tolerances given in Clause 5.16, but nowhere shall it be less than the nominal course thickness.

5.19.6 When the mixture is spread and finished by machine in accordance with Clause 5.20, the use of hand-rakes shall be prohibited except at joint edges and around manholes and pits, where their use shall be restricted to an absolute minimum.

5.19.7 After the spreading units have passed, hand-casting behind the spreader as a means of making-up irregularities or disguising blemishes left by the spreader shall not be permitted.

5.19.8 At all times, Porous Friction Course shall be kept free from all extraneous matter.

5.20 SPREADING BY MACHINE

5.20.1 Except where the conditions of Clause 5.22 apply, the mixture shall be spread, levelled and tamped by approved self-propelled spreading and finishing machines which are capable of continuously laying to the required widths, profile, camber or crossfall without causing segregation, dragging, burning or other surface defects or irregularities. They shall also be capable of operating at a speed consistent with the type and thickness of the Porous Friction Course being laid.

(NOTE. The method of control should be adequate to achieve the tolerances required and should not be limited by the length of the paving equipment if that is not sufficient. It may be necessary to use a wire guidance system or averaging beam to achieve the required accuracy in certain critical situations, such as at or in the vicinity of wandering crowns or for laying of regulating courses.)

5.20.2 Any extension beyond the basic width of the machine shall be strictly in accordance with the manufacturer's recommendations and shall give a level uniform surface over the full width of the lane to the satisfaction of the Project Manager.

5.20.3 Each spreader shall be maintained in good mechanical condition and shall be correctly adjusted for operation at the speed consistent with the properties and rate of delivery of the mixture and the thickness and agreed rolling procedures for Porous Friction Course, to produce a surface of uniform density and texture free from segregation, dragging, irregularities, or other unacceptable surface blemishes. If dragging or other faults should occur, laying shall cease until the mechanism and operation of the units have been checked and the defects have been rectified or modifications made.

5.20.4 As soon as possible after arrival at the laying site, the mixtures shall be discharged continuously to the spreader and shall be laid in accordance with the requirements of Clause 5.19 without delay. When discharging into the spreader, the lorry shall approach and gentle contact shall be made only between rollers on the spreader and the rear wheels of the lorry to avoid causing the paver screed to indent the mat.

5.20.5 Intermittent stopping of the spreader shall be avoided and the rate of delivery to the spreader shall be so regulated to enable spreading to be continuous.

5.21 COMPACTION

5.21.1 The surfacing shall be uniformly compacted in the manner approved during the laying of the trial area described in Clause 6.3, using the type of equipment and loads applied as agreed with the Project Manager.

5.21.2 Rollers shall be in good condition and fitted with smooth, rapid-acting reverse controls. They shall be equipped with roll scrapers, absorbent mats and tanks connected to spray pipes on both front and rear rolls to ensure a uniform minimal application of water or parting fluid. The rollers shall be operated by skilled and experienced drivers. The weight to which each roller shall be ballasted shall be agreed with the Project Manager during the laying of the trial(s).

5.21.3 Rolling shall proceed in the direction of laying with the rear wheel (3-point roller) or wheels (tandem roller) lapping the edge of any previously laid surfacing and shall progress gradually to the opposite edge of the lane. The lapping of the rolling shall be such that, on completion, all roller marks are obliterated. During rolling, the roller wheels shall be kept moist with sufficient water to avoid picking up material. A water bowser shall be provided alongside each spreading unit to ensure that rolling continues with the minimum interruption.

5.21.4 Rollers shall move at a slow but uniform speed which should not exceed 5 km/h and any pronounced change in direction of the roller shall be made on stable material. The line of rolling shall not be suddenly changed or the direction of rolling suddenly reversed, thereby displacing the mixture. Rollers shall not be left standing on the new surfacing within 24 h of laying.

5.21.5 The roller types and sequence shall be such as to provide the required standard of compaction and finish.

(NOTE. Guidance is given at Appendix D.)

5.22 SPREADING AND COMPACTING BY HAND

5.22.1 Spreading by hand shall only be permitted for areas of irregular shape. With the approval of the Project Manager, spreading by hand will also be permitted in areas where manholes or pits are concentrated and in areas which are inaccessible to the spreading and finishing machines specified in Clause 5.20.

5.22.2 The mixture shall be unloaded with care to avoid segregation onto an existing hard, clean surface on, or adjacent to, the area on which it is to be placed or, when this is not available, onto an approved metal sheet alongside the area; the mixture shall not be unloaded onto an area where Porous Friction Course has been laid. The mixture shall be spread portion by portion without break with hot shovels to a uniform thickness which, after compaction, shall not exceed the maximum thickness specified for the mixture. The material shall then be finished with hot hand-rakes by skilled rakers to the level required to give the correct shape and profile after compaction.

5.22.3 The exposed edges of manhole frames, lighting units and any fixtures in the pavement or the concrete surrounds against which the new surfacing abuts shall be scraped and thoroughly cleaned to the satisfaction of the Project Manager. An approved sealing system shall be applied around the fixture/surround in accordance with the manufacturer's instructions, or other treatment as recommended in BS 594987, within 2 h prior to laying the Porous Friction Course. The Porous Friction Course shall then be packed tightly around the fixture and firmly tamped into position.

5.22.4 On completion of compaction, the finished surface of the Porous Friction Course shall be level with the fixture to the accuracy specified in Clause 5.26.1. In places inaccessible to the rollers specified in Clause 5.21, compaction shall be achieved by suitable vibrating rollers or by tamping.

5.23 LONGITUDINAL LANE AND TRANSVERSE JOINTS

5.23.1 The cutting of edges shall be avoided but, where transverse edge cutting is essential, only sawing is permitted.

5.23.2 Longitudinal joints in surfacing materials shall be constructed in such a position that they are at least 600 mm horizontally away from any longitudinal joints in the underlying material. The longitudinal lane joints shall be vertical in straight lines which are continuous for the full length of the pavement, or in smooth curves around bends. Longitudinal joints shall be formed by butting-up to the adjacent Porous Friction Course to form a tight joint.

(NOTE. The procedure for the preparation and formation of longitudinal lane joints, including removal/brushing of loose fines from the exposed edges or the utilisation of spreading units operating in echelon, should be determined and agreed in the Trials described in Section 6.)

5.23.3 Transverse joints are required at the end of a day's work and following any interruption in laying which prevents continuity of rolling at, or above, the specified minimum temperature. Transverse joints shall be formed at right angles to the longitudinal joints and shall be vertical. Unless otherwise agreed with the Project Manager, the exposed vertical edges shall be cut back for at least 300 mm and trimmed. All loose material arising from this operation shall be

removed from the pavement and the underlying surface cleaned.

5.23.4 On completion, the joints shall present the same texture as the remainder of the surface and the accuracy of the surface across the joints shall meet the criteria specified in Clause 5.26.1.

5.24 JOINTS AND RAMPS BETWEEN NEW SURFACING AND EXISTING PAVEMENTS

Joints and ramps between the existing pavement and the new surfacing over which Porous Friction Course is to be laid shall be carried out in accordance with DE Specification "Marshall Asphalt for Airfields".

5.25 FINISHED LEVELS

5.25.1 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.

5.25.2 Where the Project Manager so directs, deviations from the required levels exceeding 6 mm shall be corrected by replacement with new surfacing at not less than the specified course thickness after total removal as detailed in Clause 5.3.1.

5.26 SURFACE ACCURACY

5.26.1 The surface accuracy of the surfacing material shall be measured as the gap between the bottom of a 3 m long test straightedge and the surface of the pavement when the straightedge is placed unsupported on the surface in accordance with Appendix B. The surface accuracy shall not exceed 3 mm for surface course nor 10 mm for binder course anywhere in any direction, other than across the crown of a camber or across a drainage channel.

5.26.2 Twenty surface accuracy tests shall be made for every 1000 m^3 laid, of which at least half shall be across lane joints. The location of all tests shall be selected by the Project Manager or his representative and shall be carried out in his presence. The Contractor shall mark with white paint all areas which fail to comply with the specified requirement.

5.26.3 Any non-complying area shall be removed for the full width of the lane and replaced by the Contractor, at his own expense, with material that shall satisfy the acceptance criteria, as specified in Clause 5.30.

5.26.4 Attempts to correct the surface accuracy with fine bituminous dressings, synthetic resin formulations, surface dressing applications, or emulsion slurry films shall not be allowed.

5.27 HYDRAULIC CONDUCTIVITY OF COMPACTED POROUS FRICTION COURSE

5.27.1 After the surfacing has cooled sufficiently, the relative hydraulic conductivity of the material shall be measured in accordance with BS EN 12697-40 in each lane, laid out such that the location of each determination is centred not closer than 500 mm to a free edge. The result from any area shall be not less than 0.015 s^{-1} and individual determinations shall be not less than 0.010 s^{-1}.

(NOTE: The limiting values are calculated as equivalent to those previous defined after allowing for the differences in the equipment in BS EN 12697-40 to that in BS DD 229, as listed in PD 6692. However, the calculations include assumptions and the values may need to be adjusted in the future. If there is evidence that material would have complied with the requirement using the BS DD 229 equipment but fails to comply with the requirement using the BS EN 12697-40 equipment, a request for a relaxation can be sent with the supporting evidence to the Construction Support Team, DE.)

5.27.2 The Contractor (or his materials supplier on his behalf) shall carry out additional tests when routine tests fail to establish the extent to which material already laid fails to meet the requirements specified for relative hydraulic conductivity. The area of the surfacing that is found to have insufficient hydraulic conductivity prior to trafficking shall be condemned. The condemned areas shall be removed and replaced by the Contractor, at his own expense, as specified in Clauses 5.30.

(NOTE. It is at the discretion of the Project Manager whether or not a failed area is replaced taking account of its location, its extent and its effect on the drainage

characteristics of the runway. A failed area that is replaced must be done so to the satisfaction of the Project/Works Manager.)

5.28 RECOVERED PENETRATION OF BINDER FROM COMPACTED MAT

The binder shall be recovered according to BS EN 12697-3 or BS EN 12697-4 from the first and then every tenth core taken as required by sub-Clause 5.16.2. Test results of recovered binder penetration in accordance with BS 2000-49 shall be submitted to the Project Manager for research purposes.

(NOTE. The Project Manager is requested to issue copies of recovered binder penetration to the Construction Support Team, DE.)

5.29 TRAFFIC ON FINISHED SURFACING

5.29.1 No trafficking of freshly laid surfacing is permitted until the surfacing has cooled to ambient temperature or has hardened off sufficiently. Traffic allowed on finished cold surfacing shall be restricted to the minimum required for the conveyance of mixed materials for the laying of the surfacing immediately adjacent to the area being laid.

5.29.2 If early trafficking of freshly laid material is required, the Contractor shall propose a method of measuring the temperature of the surfacing and validate it during the trials (Section 6). Trafficking shall not be permitted until the temperature throughout the surfacing has dropped below 45 °C.

(NOTE. Advice for the Project Manager on the assessment of the temperature of freshly laid surfacing is given in Clause Z.5 of Appendix Z.)

5.29.3 Notwithstanding the above, no vehicles liable to deposit detritus on the Porous Friction Course shall be allowed on the finished surfacing. 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.

5.30 CUTTING OUT AND REPLACING DEFECTIVE POROUS FRICTION COURSE

5.30.1 When Porous Friction Course is removed, for any reason, it shall be removed by planing with an approved planing machine. The machine shall be provided with control devices which enable the rapid adjustment of blades to fine depth-of-cut settings while the machine is operating. Porous Friction Course material shall be removed for its full depth. The area to be removed shall extend across the full width of the lane between the longitudinal joints in the course. The length of the lane to be removed shall be defined by two straight saw cuts, 25 mm deep, at right angles to the longitudinal joints.

5.30.2 The surface of the course exposed below the planed surfacing shall be cleaned of all loose fragments. The vertical edges of the Porous Friction Course, exposed by planing, along adjacent lanes, shall be trimmed, and all lightly adhering fractions shall be raked out and removed. The whole of the area from which the surfacing has been removed shall be swept with hand brooms and shall be left thoroughly clean. Replacement as specified in sub-Clause 5.30.3 shall not start until the Project Manager has approved the condition of the exposed surface and edges.

(NOTE. Guidance may be found in Specification 06, "*Guide to Maintenance of Airfield Pavements*" (Defence Estates, 1994).)

5.30.3 A coat of bitumen shall be applied at a rate of not more than 0.9 l/m² with a squeegee over the horizontal surface exposed by planing, and shall be thoroughly worked into the corners, angles and irregularities by vigorous hand brooming. New Porous Friction Course shall then be placed in the course thickness specified and not exceeding the permissible tolerance in Clause 5.16, and shall be spread and finished, by machine or by hand, to the standards detailed in this Specification.

6 Trials

6.1 GENERAL

Trials shall be carried out on all Porous Friction Course mixtures proposed for use in the works. For small works, the procedures and requirements for the trial may be modified at the discretion of the Project Manager.

6.2 LAYING TRIAL AREAS

6.2.1 For each Porous Friction Course mixture, after the 'Laboratory Design Mixture' has been approved by the Project Manager (see Clause 4.3), a trial area of surfacing not less than 60 m or more than 300 m by two lanes wide shall be laid. Duplicate areas shall be laid for each additional spreader. The trial areas shall be laid along the outside edges of the pavement in positions approved by the Project Manager.

6.2.2 Each trial mixture shall contain at least one 60 m continuous length of longitudinal joint and at least 4.5 m of transverse joint.

6.2.3 A trial mixture shall be made up in the mixers that the Contractor proposes to use at the appropriate mixing temperatures and with the aggregates proportioned from either:

- the various hot bins for a Batch Mixer; or
- the cold feed hoppers for a Continuous Drum Mixer

to produce the required aggregate grading with the binder content at the appropriate target binder content.

6.2.4 The trial mixtures shall be laid with the spreading and compacting equipment that the Contractor proposes to use. The materials shall be laid and compacted according to the requirements of this Specification.

(NOTE 1. Attention needs to be given to the material feed rate via the paver screws to the screed to avoid dragging and segregation.)

(NOTE 2. For planning purposes, the following equations will assist the Contractor to select paving and rolling rates to achieve the minimum specified number of roller passes before the surfacing has cooled to the minimum temperature for compaction:

Rolling length (m) = average paving speed (m/min) x 8 (min)

Roller passes = (Rolling rate/Paving Rate) x No of Rollers

where:
Rolling rate (m^2/min) = Roller width (m) x Roller speed (m/min)
Paver rate (m^2/min) = Paver width (m) x Paver speed (m/min))

6.3 ASSESSMENT OF TRIAL AREAS

6.3.1 For each trial area, the Contractor shall take, as described in BS EN 12697-27, at least three samples of the mixture after discharge from the mixer and before loading into the paver. He shall submit to the Project Manager the results from those three samples of analyses of the binder content and of the aggregate/filler aggregate grading in accordance with BS EN 12697-1 and BS EN 12697-2.

6.3.2 The rolling regime shall ensure that the surfacing is fully and uniformly compacted and that all roller marks are obliterated. The paving and rolling rates, demonstrated to be satisfactory during the laying of the trial mixture, shall be agreed with the Project Manager and shall be adhered to during the main works. The standard of finish, including that at joints, shall comply with the requirements of this Specification and be acceptable to the Project Manager as the standard to be achieved in future laying.

6.3.3 When the trial surfacing has cooled to ambient temperature, not less than five determinations of hydraulic conductivity shall be made along a diagonal across each lane in accordance with BS EN 12697-40. The relative hydraulic conductivity shall be in accordance with Sub-Clause 5.27.1.

6.3.4 Either a new design shall be carried out or the proportion of binder and aggregate grading shall be slightly modified within the limits of the specification if the trial indicates that the 'Laboratory Design Mixture' being trialled:

- is unsatisfactory for mechanical spreading and compacting,

- fails to produce the specified surface accuracy; or
- hydraulic conductivity or results in surface blemishes which are unacceptable.

New trials shall be laid until a satisfactory result is achieved. Unsatisfactory trials shall be removed and replaced in accordance with Clause 5.30.

6.3.5 As a result of the approved trials, the 'Job Standard Mixture' shall be confirmed and the Contractor shall report to the Project Manager in writing the following details for his approval and as a target for all future plant mixing:

- the precise grading for the combined aggregate/filler aggregate;
- the quantities for each aggregate size by dry weight; and
- the proportion of bitumen (and any binder modifier) by mass of the total mixture.

6.3.6 The approved 'Job Standard Mixture' shall be the successfully trialled 'Laboratory Design Mixture' and shall be within the limits for grading and binder content given in Clauses 4.2 and 4.3, respectively.

6.3.7 Until approval has been given, the general laying of Porous Friction Course required by the Contract shall not begin.

6.3.8 The standard of workmanship and finish of all Porous Friction Course included in the Contract shall be equal in all respects to that of the 'Approved' areas and shall not be changed afterwards without the specific approval of the Project Manager.

6.3.9 If for any reason the quality, grading or source of supply of aggregates is changed or if at any time the cause of variations outside the permissible limits specified in Clauses 4.2, 4.3 and 4.5 cannot be corrected for reasons beyond the control of the Contractor, the Project Manager may request a new 'Laboratory Design Mixture' or 'Job Standard Mixture', depending on the extent of change or variation.

6.3.10 Based on the trials, the rollers and rolling method shall be agreed with and approved by the Project Manager.

6.3.11 No change shall be made in the mixing and spreading plant or rolling methods without the approval of the Project Manager, and then only after new trials have been carried out and approved.

6.3.12 If early trafficking of freshly laid material is envisaged for the works, the temperature of the surfacing shall be measured to validate a suitable procedure.

7 Summary of Tests

7.1 TEST RESULTS

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 2 working days after completion of each test. Testing shall be started on specimens within 2 working days of sampling 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 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 A
		Affinity between ag. & bitumen	BS EN 12697-11 Part B
Fine Aggregate	3.3	Magnesium Sulfate Val.	Appendix A
		Affinity between ag. & bitumen *	BS EN 12697-11 Part B

* Test on particles of rock from the same source when crushed rock fines are used

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

- the binder;
- other constituents, including tack or bond coat;
- tack or bond coat spray-bar equipment; and
- calcium hydroxide content of hydrated lime.

7.3 TESTS FOR THE PROPORTIONING AND DESIGN OF MIXTURES

Before mixing starts the Contractor (or his materials supplier(s) on his behalf) shall provide current CE mark certificates for all Friction Course mixtures showing conformity with all requirements of Section 4 and the relevant specification clauses in Table 7.2.

7.4 ROUTINE TESTS ON BULK SUPPLIES THROUGHOUT PLANT MIXING

7.4.1 The Quality Assurance procedures for the supply of component materials and asphalt mixtures shall include carrying out tests in order to:

- check on the consistency of bulk supplies;
- compare with the properties and gradings of the samples approved; and
- check on the capability of the dryers to function efficiently with aggregates of variable moisture content.

7.4.2 The tests should include those listed in Table 7.3.

7.5 ROUTINE TESTS ON MIXTURES THROUGHOUT PLANT MIXING

7.5.1 As part of the Quality Assurance requirements in Clause 2.4, the Contractor (or his materials supplier on his behalf) shall carry out the tests in Table 7.4 on mixtures prepared for the works. The procedure shall ensure that the position of plant mixtures from which test samples are taken or specimens made are fully traceable in the finished pavement layer.

TABLE 7.2 TESTS FOR PROPORTIONING AND DESIGN OF MIXTURES

Situation	Clause No.	Test	
		Title	Reference
Laboratory design	4.3	Grading	BS EN 933-1
		Binder drainage	BS EN 12697-18 Part B
Trials	6.2 & 6.3	Sampling	BS EN 12697-27
		Analysis	BS EN 12697-1 & -2
		Cores	BS EN 12697-27
		Thickness	BS EN 12697-36
		Aggregate grading	BS EN 933-1
		Binder content	BS EN 12697-1
		Relative hydraulic conductivity	BS EN 12697-40

TABLE 7.3 ROUTINE TESTS ON BULK SUPPLIES

Test	Clause	Reference
Sieve analysis of aggregates	5.3.1 & 5.3.1	BS EN 933-1
Flakiness Index	5.3.2	BS EN 933-3
Resistance to fragmentation	5.3.3	BS EN 1097-2
Sieve analysis of filler	5.3.4	BS EN 933-10
Bulk density of filler	5.3.5	BS EN 1097-7
Moisture content of aggregates at and after mixing	5.7	BS EN 12697-14

7.5.2 If either the grading or the binder content of any individual test, out of the total number of tests for the day's production of that mixture, fails to comply with the specified requirements, the additional tests specified in Clause 5.13 shall be carried out.

TABLE 7.4 ROUTINE TESTS ON MIXTURES

Test	Clause	Reference
Analysis of the plant mixtures	5.13.1	BS EN 12697-1 BS EN 12697-2
Temperature of mixture in transport	5.8 & 5.14	BS EN 12697-13

7.6 ROUTINE TESTS DURING LAYING AND ON COMPACTED COURSES

The Contractor shall undertake the series of tests on asphalt materials incorporated into the works necessary to comply with the relevant specification clauses as listed in Table 7.5.

TABLE 7.5 ROUTINE TESTS DURING LAYING

Test	Clause	Reference
Material temperature	5.8	BS EN 12697-13
Air temperature	5.11	–
Course thickness	5.16	BS EN 12697-36
Finished levels	5.25	–
Surface accuracy	5.26.1	Appendix B
Relative hydraulic conductivity	5.27	BS EN 12697-40
Recovered binder penetration	5.28	BS EN 12697-3 or -4, then BS 2000- 49

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

A.1 SCOPE

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.

A.2 APPARATUS AND REAGENTS

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.

A.3 PREPARATION OF TEST PORTIONS

A.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.

A.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 A.1.

A.4 PREPARATION OF AGGREGATE TEST SPECIMENS FOR EACH FRACTION

A.4.1 The grading 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 grading 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.

A.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.

A.4.3 One test specimen, of mass in accordance with Table A.1, shall be taken out of each fraction retained after completion of sub-Clause A.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 A.3.2. The grading recorded shall be that obtained from all the material sieved out.

TABLE A.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

A.5 PROCEDURE

Procedure for each test specimen 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.

A.6 CALCULATION AND EXPRESSION OF TEST RESULTS

A.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.

A.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.

A.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.

A.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.

A.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.)

A.7 PRECISION

As in BS EN 1367-2, Annex A.

A.8 TEST REPORT

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

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

EXAMPLE A.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 A.6.2, indent (b).

EXAMPLE A.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 A.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 A.6.3.

Appendix B – Straightedge Test

B.1 SCOPE

This Appendix shall be followed to determine the surface accuracy of bituminous surfacing layers in this Specification.

B.2 APPARATUS

B.2.1 The straightedge for the tests shall be purpose made and 3 m long. It shall have a flat square edge of metal, at least 75 mm wide, along the full length of its base. The straightedge shall be fitted with lifting hand grips or handles.

B.2.2 A calibrated wedge may be used to determine the straightedge clearance. The wedge should have an angle of (5.75 ± 0.05)°, and engraved at 10 mm intervals across the incline, starting at the apex, representing clearances increasing in 1 mm intervals up the incline.

B.3 PROCEDURE

B.3.1 The straightedge shall be placed unsupported on the surface, anywhere in any direction, other than across the crown of a camber or across a drainage channel. The location shall be selected by the Project/Works Services Manager or his representative, and the tests shall be carried out in his presence.

B.3.2 Twenty tests shall be made for every 1000 m² laid and at least half of these tests shall be across lane joints.

B.3.3 The Contractor shall mark with white paint all areas which fail to comply with the specified requirement.

Appendix C – Guidance on Suitable Temperatures and Wind Speeds for Laying

C.1 In addition to the requirements in Clause 5.11, Table C.1 gives recommended wind speed and air temperature limits for the laying of Porous Friction Courses.

TABLE C.1 RECOMMENDED WIND SPEED AND AIR TEMPERATURE LIMITS

Bitumen Grade (pen)	Thick-ness (mm)	Max. Wind Speed (km/h)		Minimum Air Temp (°C)
		2 m height	10 m height	
160/220	20	See Figure C.1		–

(NOTE 1. The limiting wind speed and air temperatures relate to a compaction time of 3.5 min for the mid-layer temperature to fall from the specified maximum to minimum compaction temperatures.)

(NOTE 2. The values and graphs were calculated using the previous grades of bitumen, and the results for mixtures with 160/220 bitumen may need to be revised.)

B.2 Wind speed can be measured by either:

- an anemometer erected at a height of (10 ± 0.5) m situated on the airfield; or
- a portable anemometer erected at a height of (2.0 ± 0.1) m situated in close proximity to the laying works.

The anemometer should be fitted with a digital accumulative device. The average wind speed over the previous hour should be used to define the prevailing wind speed.

(NOTE 1. If the wind speed is increasing, anemometer readings should be made at 15 min intervals.)

(NOTE 2. To aid planning works, weather forecasts may be obtained from the nearest Regional Weather Centre.)

C.3 * Meteorological records for the airfield are available.

OR

* No clause.

(* NOTE 1. Project Manager to select alternative for specific job specification; advice given in Clause Z.6 of Appendix Z.)

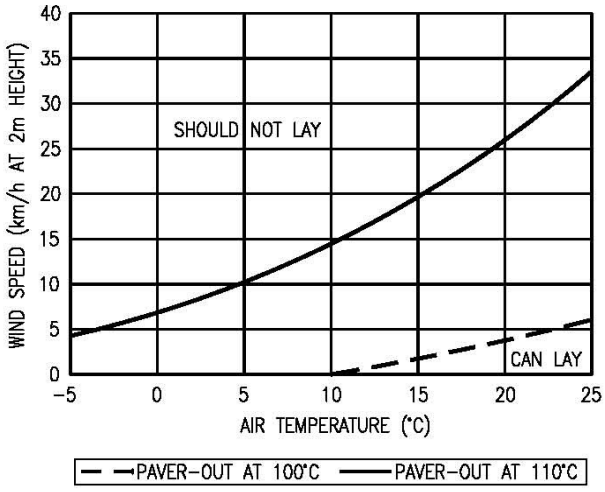

Figure C.1 – Acceptable weather conditions for laying 20 mm thickness of Porous Friction Course with 160/220 bitumen

(NOTE 2. The descriptions “Should not lay” and “Can lay” apply to above and below the lines, respectively, for both of the two paver-out temperatures shown.)

Appendix D – Recommended Roller Types and Sequence

D.1 The recommended roller types and sequence are as detailed in Table D.1.

TABLE D.1 RECOMMENDED ROLLER TYPES AND SEQUENCE

Order in sequence	Roller Type	Rollers Required				
		Mass (tonnes)		Rear Wheel Width (mm)	Rear Wheel Static Force (kN/100 mm width)	
		Min.	Max.		Min.	Max.
1	Three-wheeled smooth	6	10	450	3.5	7.0
2	Three-wheeled smooth or tandem	6	10	450	3.5	7.0

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.

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.

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 body's 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 Standard, the following areas should normally be addressed:
- procurement, inspection and safe storage of constituent materials;
- training of plant operatives;
- setting up on-site mixing plants and the mixing of asphalt materials;
- off-site supply and mixing of asphalt materials;
- storage and transportation of asphalt materials prior to use/despatch;
- laying and compaction of asphalt materials;
- 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 NACCB;
- 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 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 the pertinent part of the BS EN ISO 9000 series 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 in order that the work is to the required standard. Where only part of the required elements are 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 the conformance 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 the BS EN ISO 9000 series, 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 are 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.

Y.7.6 The procedures for sampling and testing asphalt 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;
- 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 RESISTANCE TO FRAGMENTATION

Z.1.1 Approval may be given for aggregates with Los Angeles values up to 17 provided that evidence of successful use in this application is supplied. Aggregates with values greater than 17 should not be approved. Further advice can be sought from Construction Support Team, DE.

Z.2 POLISHED STONE VALUE CATEGORIES

Z.2.1 The requirement for the resistance to polishing of coarse aggregate should normally be Category PSV_{50}. For high frequency traffic, a requirement for PSV of Category $PSV_{declared\ 55}$ should be set.

Z.2.2 The frequency of trafficking is defined in "*A guide to airfield pavement design and evaluation*" (Property Services Agency 1989) but with the overriding requirements as follows:

Low frequency	Maximum of 50 movements per week by aircraft in the critical tyre pressure range; and
Medium frequency	Maximum of 500 movements per week by aircraft in the critical tyre pressure range.
High frequency	Greater than 500 movements per week by aircraft in the critical tyre pressure range.

Z.3 OFF-SITE MIXING

Z.3.1 Off-site mixing of Porous Friction Course should only be permitted with prior agreement. That approval should only be made for plants that will be engaged solely on the Defence Estates production during the contract period. Off-site mixing should be carried-out by a Contractor (or Supplier on his behalf) who has Quality Assurance registration to BS EN ISO 9000: 2000 incorporating "Sector Scheme 14" for the Quality Assurance of the Production of Asphalt with an appropriate scope of application for all aspects of the mixing and supply of asphalt materials.

(NOTE 1. See Clause 5.5.)

(NOTE 2. Many static plants stock several different paving grades of bitumen. It is therefore necessary to ensure that the correct grade of binder is used throughout.)

(NOTE 3. The costs of transporting and erecting asphalt mixing plants on site can be a disproportionately high percentage of the total cost of a surfacing contract, particularly for small works. Porous Friction Course should normally be mixed on site, but consideration may be given to mixing off site. The following points should be considered in relation to off-site mixing:

- effect on competitive tendering;
- haulage distance;
- suitability of static mixing plants including storage areas;
- testing facilities;
- exclusive use of plant during contract period;
- inspection, approval and Quality Assurance of off-site mixing plants; and
- previous experience of mixing Porous Friction Course.)

Z.3.2 The minimum requirements for the batching and mixing plant are set out in Clause 5.5. The mixing plant should carry a temperature measuring device at their output end and this should be checked during a production run to ensure that there are not wide fluctuations in temperature. Excessive feedback of the fines is deprecated. The fines/filler should be weighed into the mix and accurate binder temperature controls should be maintained. The flights in the drier drum and the plates and blades in the pug mill should be examined to ensure that they are in good condition. Also, the hot bin screens should be examined for wear and clogging. All discharge gates and the binder control valves should be checked for leakage.

(NOTE 1. A mixer capable of producing the full specified range of Porous Friction Course mixtures should have a cold bin for each aggregate size with upstand plates to ensure that there is no overspill from one bin to another, hot bins with overflow discharges, facilities for sampling and a corresponding 4 deck screening over them. Generally, the screens should be one size larger than the nominal size of the hot bins they are feeding.)

(NOTE 2. The drying drums can quite often determine the practical throughput of the plant, and their throughput capacity can vary considerably from one manufacturer to another, size for size. In general they average about 8 m to 9 m in length and a 1.50 m internal diameter drum will have a maximum throughput of about 100 tonnes/h, and a 1.8 m diameter drum about 150 tonnes/h.)

(NOTE 3. The binder addition may be either by volume or weight, preferably the latter discharging via a heat jacketed spray bar extending the full width of the pug mill.)

Z.3.3 The supply of Porous Friction Course mixed off site should comply with this Standard as if it were mixed on site.

Z.3.4 The haulage distance of mixed material should not normally exceed 50 miles. As part of the laying trials as specified in Clauses 6.2 and 6.3, the ability to achieve the 3 h limit and maximum temperature drop of 10 °C in the delivered load at the time of laying should be checked.

(NOTE. Haulage distance can affect the loss of temperature in the mix, the rate of arrival of delivery lorries with either delays due to traffic etc or a queue of lorries in front of the paver on site. Rapid changes in weather such as a downpour may lead to cessation of laying possibly resulting in dumping of mixed material. Day to day planning using local weather forecasting information is necessary. The loss of mix temperature during transit is usually less than 10 °C with modern well-insulated delivery lorries, and covering quilts are now commercially available that provide a better insulation than double sheeting. Haulage distances up to 100 miles are not unknown but 50 miles is more typical. It is recommended that, taking these factors into consideration, a maximum of 3 h is permitted between mixing the Porous Friction Course and laying to minimise temperature loss and binder hardening in the mixture. This period should also include any residence time of the mixture in storage at the plant and in delivery lorries on site. It should also be assumed that 10 °C loss in temperature will occur during this period.)

Z.3.5 Laboratory facilities and the requisite level of expertise must be available to carry out the full range of test procedures.

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

Z.4 PAVING MACHINES INCORPORATING EQUIPMENT TO APPLY TACK OR BOND COAT

The Project Manager should seek guidance from the Construction Support Team, DE. In the absence of more definitive information, approval would need to be subject to a laying trial and laboratory tests to demonstrate good adhesion, that the tack or bond coat had broken and that moisture had not been trapped.

Z.5 TEMPERATURE OF POROUS FRICTION COURSE

In assessing the temperature of the freshly laid Porous Friction Course, consideration should be given to the likelihood of the temperature at depth being greater than that at the surface. If the temperature is required to be taken, a hole should be drilled 10 mm deep, a measurement device with suitable accuracy (± 1 °C) inserted and the hole filled with glycerine. The temperature should be determined after the reading has stabilised whilst at different depths.

Z.6 METEOROLOGICAL DATA

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 Estates

FS 06	1994	Functional Standard 06, Guide to Maintenance of Airfield Pavements
SPEC 12	2007	Specification 12, Hot Rolled Asphalt and Asphalt Concrete (Macadam) for Airfields
SPEC 13	2007	Specification 13, Marshall Asphalt for Airfields
SPEC 33	2005	Specification 33, Pavement Quality Concrete for Airfields
SPEC 35	2005	Specification 35, Concrete Block Paving for Airfields
SPEC 40	2007	Specification 40, Porous Friction Course for Airfields
SPEC 49	2007	Specification 49, Stone Mastic Asphalt for Airfields
DMG 27	2005	Design and Maintenance Guide 27, A guide to Airfield Pavement Design and Evaluation
DMG 33	2005	Design and Maintenance Guide 33, Reflection Cracking on Airfield Pavements – a design guide
JSB 554	2004	Military Aviation, Aerodrome Standards and Criteria

British Standards Institution

BS 434			Bitumen road emulsions (anionic and cationic)
	Part 2	1984	Code of practice for use of bitumen road emulsions
BS 2000			Methods of test for petroleum and its products
	Part 49	2000	Bitumen and bituminous binders – Determination of needle penetration
BS 3136			Specification for cold emulsion spraying machines for roads
	Part 2	1972	Metric units
BS 594987		2007	Asphalt for roads and other paved areas – Specification for transport, laying and compaction and design protocols
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 3	1997	Procedure and terminology for simplified petrographic description
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 3	1997	Determination of particle shape – Flakiness index
	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 2	1998	Methods for the determination of resistance to fragmentation
	Part 6	2000	Determination of particle density and water absorption
	Part 7	1999	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 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
	Part 1	2005	Soluble binder content
	Part 2	2002	Determination of particle size distribution
	Part 3	2000	Bitumen recovery: rotary evaporator
	Part 4	2000	Bitumen recovery: fractionating column
	Part 11	2003	Affinity between aggregates and binder
	Part 13	2000	Temperature measurement
	Part 14	2000	Water content
	Part 18	2004	Binder drainage
	Part 27	2000	Sampling
	Part 36	2003	Thickness of a bituminous pavement
	Part 40	2005	In situ drainability
BS EN 13043		2002	Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas
BS EN 13108			Bituminous mixtures – Material specification
	Part 7	2006	Porous asphalt
BS EN 13808		2005	Bitumen and bituminous binders – Framework for specifying cationic bitumen emulsions
BS EN 30011			Guidelines for auditing quality work
	Part 1	1993	Auditing
	Part 2	1993	Qualification criteria for quality systems auditors
	Part 3	1993	Management of audit programmes
BS EN ISO 9000		2000	Quality management and quality assurance standards
PD 6692		2006	Asphalt – Guidance on the use of BS EN 12697 “Bituminous mixtures – Test methods for hot mix asphalt”

Her Majesty’s Stationery Office

DS 05-67	1980	Defence Standard 05-67, Guidance to Quality Assurance in Design