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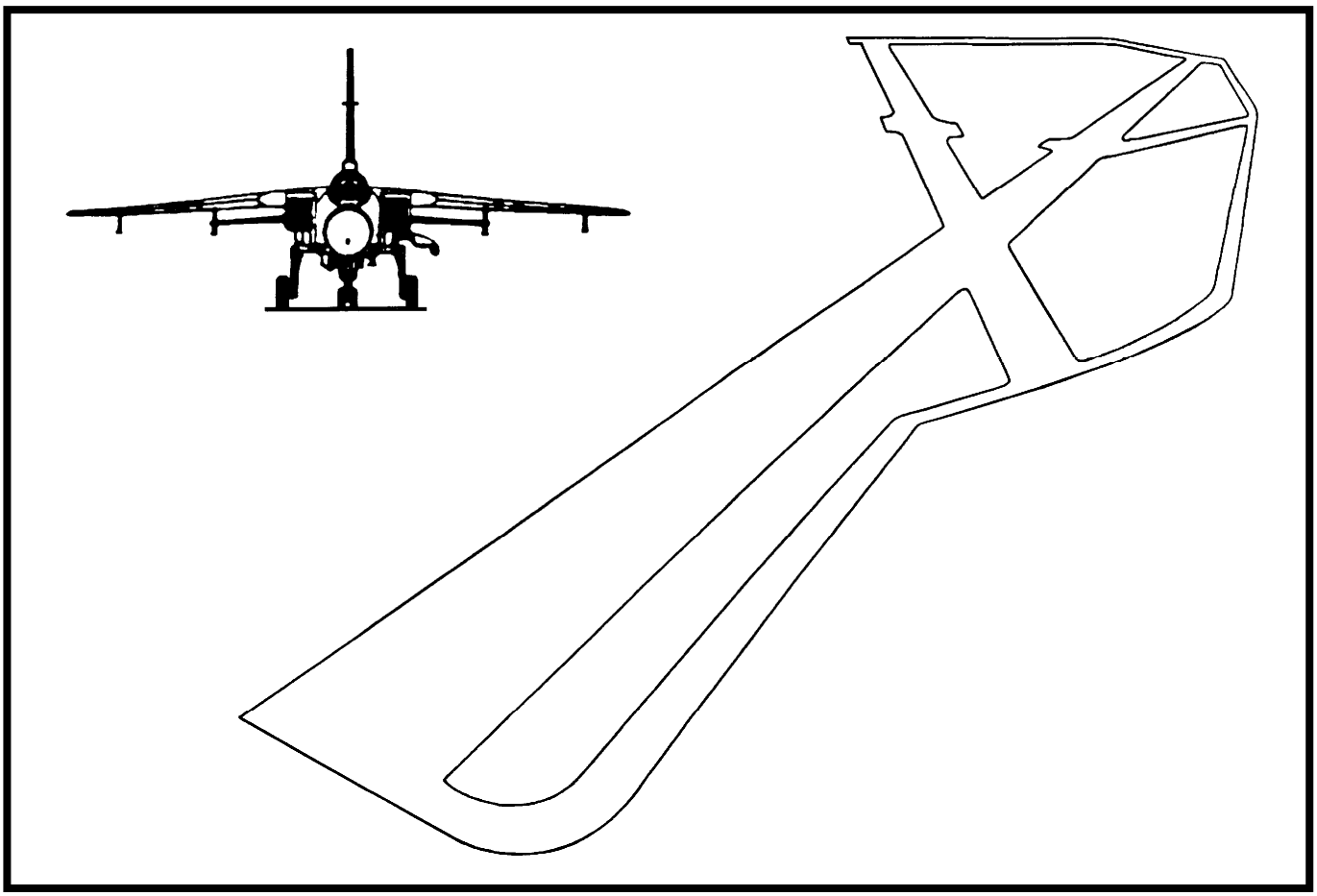

Hot Rolled Asphalt and Asphalt Concrete (Macadam) for Airfields

DEFENCE ESTATES
MINISTRY OF DEFENCE

Specification 12

Hot Rolled Asphalt and Asphalt Concrete (Macadam) for Airfields

July 2010

PROFESSIONAL AND TECHNICAL SERVICES
DEFENCE ESTATES

Ministry of Defence

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Foreword

This document is for the use of Top Level Budget Holders (TLBHs) for application by the Project Sponsors and their Project Managers, Property Managers (PROM), Establishment Works Consultants (EWC), Works Service Managers (WSM) and other parties involved with airfield pavement works.

This Defence Estates Specification supersedes the previous edition published in 1995.

This DE Specification was prepared under the patronage of Professional and Technical Services, 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
Professional and Technical Services
Defence Estates
Kingston Road
Sutton Coldfield
West Midlands
B75 7RL

Tel: 121 311 2119 or Sutton Coldfield MI 2119

This Specification, "*Hot Rolled Asphalt and Asphalt Concrete (Macadam) 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

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 Hot Rolled Asphalt and Asphalt Concrete (Macadam), is one of a series being produced by DE to lay down specification requirements for airfield pavement works. The following clauses in this Section are intended to set out the applications of Hot Rolled Asphalt and Asphalt Concrete (Macadam) 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 a result of equal quality.

1.2 FUNCTIONAL REQUIREMENTS OF AIRFIELD PAVEMENTS

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

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

1.2.2 Main Length of Runways

It is important on the main length of a runway to have good rideability and wet weather skid resistance. Asphalt surfacings generally give better rideability than PQC. Good skid resistance/friction characteristics are achieved by a combination of good surface shape to effect efficient surface water run-off and also surface texture to increase friction and allow water to disperse from under the tyre contact area. The technique of providing texture on asphalt road surfacings by the provision of rolled-in chippings is not acceptable on airfield pavements because materials which are likely to pluck out or spall on the surface of a pavement are a potential FOD (Foreign Object Damage) hazard to aircraft, particularly with regard to ingestion by jet engines. The methods currently favoured for providing suitable friction characteristics on new asphalt surfacings on MOD runways are as follows:

a. The provision of a 20 mm thick Porous Friction Course (not included in this Standard) on asphalt surfacing. This is the most favoured construction option but it would not be specified in certain situations including dusty regions, very cold climates, runways used for STOL (short take-offs and landings) operations and where night-time construction work necessitates numerous transverse construction joints.
b. By grooving an asphalt surface with continuous grooves cut perpendicular to the centre-line of the runway.
c. By the provision of a coarse graded slurry seal over an asphalt surfacing. This is the least favoured option.

1.2.3 Runway Ends and Adjoining Aircraft Holding Areas

Service conditions can be severe in these areas where jet blast and fuel spillage are likely to be most damaging and aircraft carry out sharp turns. To avoid excessive tyre wear being caused to turning aircraft, it is usual to reduce the friction properties at runway ends compared with that provided on the main lengths. The material most frequently used on runways ends and holding areas at MOD airfields is PQC. However with certain aircraft, the effect of jet blast on the pavement surface is not critical (e.g. piston engined aircraft, turboprops or turbojets where the jet exhaust is located at a safe height above the pavement). In these instances, asphalt provided with a fuel

resistant surface treatment or alternatively incorporating a fuel resistant binder is likely to be a viable and economic alternative to PQC. Possible future change of aircraft type or use by visiting or temporarily based aircraft of other types need to be considered when making the decision.

1.2.4 Taxiways

Friction characteristics and rideability on taxiways are not as critical as for runways. Fuel and jet blast are not normally a critical consideration in these areas such that asphalt surfacings are generally a viable and economic construction option. This Standard for Hot Rolled Asphalt and Asphalt Concrete (Macadam) is considered to provide an option for taxiway surfaces.

1.2.5 Parking and Servicing Aprons

Friction characteristics and rideability for parking and servicing aprons are not as critical as for the main length of a runway. In general, the need for resistance to fuel and oil spillages and to indentation by high tyre pressure tyres of standing aircraft and to damage from dropped tools, etc., will be such as to require the provision of a concrete surface. In certain circumstances, however, when the frequency of use is very low, asphalt surfacings, including Hot Rolled Asphalt and Asphalt Concrete (Macadam) in accordance with this Standard may be a viable and economic alternative to a concrete surface. Such alternatives may incorporate modified binders or the provision of a fuel resistant surface treatment.

1.2.6 Vertical Take Off and Landing (VTOL) Pads and Engine Running Platforms (ERPs)

VTOL pads for Harrier operations and ERPs for high performance jet aircraft provide the most severe conditions for pavements on the MOD airfields. PQC is normally provided in these areas. Its life-span is dependent on frequency and mode of usage but currently the average life-span is 10 years. This compares with an average life-span in excess of 30 years for PQC in other areas of an airfield.

1.2.7 Short Take Off and Landing (STOL) Runways/Strips

Consideration should be given to the use of PQC for STOL runways/strips that are to be used by aircraft with thrust vectoring capability. Further advice on a project/works specific basis can be obtained from Professional and Technical Services, DE.

1.2.8 French Drains Adjacent to Airfield Pavements

Where French drains are provided adjacent or in proximity to airfield pavements, their surfaces must be stabilised in order to safeguard against the risk of FOD to aircraft. This can be achieved by the provision of a 100 mm thick Pervious Macadam topping to French drains.

1.3 PAVEMENT MATERIAL SELECTION PRINCIPLES

1.3.1 Unless the severity of service use of a pavement demands the use of concrete, asphalt surfacing material will normally be used.

1.3.2 The principal asphalt surfacing material used on MOD Airfields is Marshall Asphalt surface and binder course. Marshall Asphalt is a highly controlled and consistent material, provides a high stability and meets the specialist performance requirements for most airfield pavement applications. To aid proper control and make sure that the performance criteria will be met Marshall Asphalt is, wherever physically and economically possible, mixed on site. A separate DE Specification entitled “Marshall Asphalt for Airfield Pavement Works” gives details.

1.3.3 When either a new or existing airfield pavement is to be provided with an asphalt surfacing, apart from specialist surface treatments (e.g. Porous Friction Course), Marshall Asphalt will be the preferred choice of material. However, there are circumstances in which, for economic and practical reasons, it will be preferable to use an alternative asphalt material. Such circumstances might include the following:

a. A small Scope of Work.
b. At Airfields where aircraft usage is low.
c. At Airfields not subject to regular trafficking by aircraft with high tyre pressures.

1.3.4 Further comment is given on the application of these factors in Clause 1.4. Generally, they should be considered in combination rather than separately. Thus, if c. above applies but the volume of material is large enough to justify on-site mixing, then Marshall Asphalt would normally be the appropriate material to use.

1.3.5 In general, use of Hot Rolled Asphalt and/or Asphalt Concrete (Macadam) is applicable as a cheaper and more easily provided alternative for limited, non-critical areas of aircraft operating surfaces.

1.4 APPLICATION AND LIMITATIONS OF THIS STANDARD

1.4.1 Specifically, the use and specification for asphalt surfacing for aircraft pavement works must meet the functional requirements of the pavement concerned, and therefore careful evaluation is necessary before a decision can be made.

1.4.2 The specification requirements in this Standard provide an alternative to Marshall Asphalt for the situations outlined in sub-Clause 1.3.3. Specification requirements are provided based on BS EN 13108-4 and BS 594987 for Hot Rolled Asphalt and on BS EN 13108-1 and BS 594987 for asphalt Concrete (Macadam) but with additional requirements to meet the specialist performance requirements of airfield pavements. Specification requirements for Pervious Macadam 'topping to French drains' are also provided in this Standard based on BS EN 13108-7 and BS 594987.

1.4.3 This Standard is not a substitute or replacement for Marshall Asphalt surface and binder courses. However, as outlined in Clause 1.3, it provides alternative specification requirements for asphalt surfacing which should, in certain circumstances, be a more practical and economic solution than Marshall Asphalt. Specification requirements for Asphalt Concrete (Macadam) surface courses are included as an option for limited applications (i.e. for use by aircraft with low tyre pressures). However, Asphalt Concrete (Macadam) surface courses are rarely used for airfield pavements because of poor durability and stability.

1.4.4 Runway Friction Requirements
The friction characteristics on the main length of a runway must meet the criteria in JSP 554. Prior to using the specifications in this Standard for runway resurfacing works, the Project Manager should first obtain advice from Professional and Technical Services, DE on surface texture requirements. Alternatives to texturing Hot Rolled Asphalt are given in sub-Clause 1.2.2 (a) and (c).

1.4.5 Limited Scope of Work
Marshall Asphalt involves special mix designs and laying methods and enhanced levels of control compared with conventional Hot Rolled Asphalt. Furthermore, to achieve the high quality control and consistency of production, it is normally a requirement to provide an on-site mixing plant. Hence, for small works, Marshall Asphalt is likely to be an unrealistic proposition. The specification requirements in this Standard should, in these circumstances, provide a viable alternative to Marshall Asphalt and give a significant saving in cost and mobilisation time.

1.4.6 Type of Aircraft and Frequency of Usage
These two design parameters have a considerable effect on the performance of asphalt surfacings. At airfields where aircraft usage and aircraft tyre pressures are low, the need for a high performance specification as provided by Marshall Asphalt may be unjustified. In these circumstances, the specification requirements in this Standard are likely to provide a viable alternative to Marshall Asphalt and give a significant saving in cost and in construction mobilisation time. However, for large scale works at critical or busy airfields, notwithstanding usage being mainly by aircraft with low tyre pressures, the consistency and enhanced performance provided by Marshall Asphalt is to be preferred over the specification requirements in this Standard. Laboratory tests carried out as part of the development of this Standard and experience gained from highway works have shown that high stability, as required for airfield pavement surfacings, can be achieved by designed Hot Rolled Asphalt mixtures. However, there is a lack of experience of the performance of these Asphalt mixtures when subject to regular usage by aircraft with high tyre pressures. It is, therefore, recommended that the asphalt surfacings in this Standard are limited to locations where usage by aircraft with high tyre pressures is low as defined by Clauses Z.1 and Z.2 of Appendix Z to this Standard.

1.4.7 Climate
The specification requirements in this Standard are not intended for use in hot climates.

1.5 SPECIFICATION CLAUSES FOR HOT ROLLED ASPHALT AND ASPHALT CONCRETE (MACADAM)

Specification clauses are contained in Sections 2 to 9 and Appendices A to C of this Standard with Guidance Notes given on suitable temperatures and wind speeds for laying in Appendix C. Guidance Notes for the Project Manager on Quality Systems are given in Appendix Y and for the preparation of job specifications in Appendix Z.

1.6 ADVICE FROM PROFESSIONAL AND TECHNICAL SERVICES, DE

Clauses 1.2, 1.3 and 1.4 provide general advice on the application of this Standard. However, having regard to the various design parameters affecting the choice of construction and specification, including scope of work, aircraft type and frequency

of usage, location of pavement on an airfield, design life, time-scale constraints and existing pavement constructions, the guidance notes cannot be exhaustive. Further advice on a project/works specific basis can be obtained from Professional and Technical Services, 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

2.2.1 Hot Rolled Asphalt, Asphalt Concrete (Macadam) and Pervious Macadam shall be specified to the requirements of BS EN 13108-4, BS EN 13108-1 and BS EN 13108-7, respectively, subject to the overriding clauses in this Specification. Hot Rolled Asphalt and Asphalt Concrete (Macadam), including Pervious Macadam, shall be mixed, transported and laid to the requirements of BS 594987, respectively, subject to the overriding clauses in this Specification.

2.2.2 The requirements of this Specification for any material are arranged in the following parts for the relevant material type as given in Table 2.1.

2.3 USE OF HOT ROLLED ASPHALT, ASPHALT CONCRETE (MACADAM) AND PERVIOUS MACADAM

Hot Rolled Asphalt surface course, Asphalt Concrete (Macadam) surface course, Asphalt Concrete (Macadam) binder course and Pervious Macadam drain topping shall be used in the locations indicated on the project drawings.

(NOTE. Advice for the Project Manager on the selection of the materials for specific job specifications is given in Clauses Z.1 to Z.3 of Appendix Z.)

2.4 QUALITY ASSURANCE FOR THE SUPPLY OF ASPHALT MATERIALS

2.4.1 All asphalt mixtures to be used in the works shall be CE marked. A copy of the CE marking information for any mixture, covering all the relevant properties, shall be given to the Project Manager at least 24 h prior to that asphalt first being incorporated into the works.

2.4.2 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 Assurance accreditation to the BS EN ISO 9000 series for those operations.

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

TABLE 2.1 REQUIREMENTS OF THIS SPECIFICATION

	Hot Rolled Asphalt	Asphalt Concrete (Macadam)	Pervious Macadam
General	Section 2	Section 2	Section 2
Materials	Section 3	Section 3	Section 3
Design and Composition	Section 4	Section 5	Section 6
Plant and Workmanship	Section 7	Section 7	Section 7
Trials	Section 8	Section 8	–
Tests	Section 9	Section 9	Section 9
Magnesium Sulfate Test	Appendix A		
Staightedge Test	Appendix B		
Temperatures & Wind Speeds for Laying	Appendix C		

2.4.3 Each production unit or depot involved in the work shall be registered under a Quality Management scheme to BS EN ISO 9000 series and under “Sector Scheme 14”, The 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.)

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

2.4.5 The Contractor shall be responsible for having all testing for the supply of asphalt materials carried out in accordance with the requirements of Section 9 and provide the Project Manager with a written copy of the results in accordance with Clause 9.1.

2.4.6 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 for a particular material shall be as shown in Table 3.1.

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 9.2 and carried out by the Contractor.

3.1.3 All aggregates used in the Asphalt 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.

(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.

OR

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

(NOTE. Project Manager to select option for specific job specification; advice given in Clause 0 of Appendix Y.)

3.1.6 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.

3.2 COARSE AGGREGATES

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

TABLE 3.1 TYPES OF AGGREGATE PERMITTED

Material	Aggregates					
	Coarse			Fine		
	Crushed Rock	Slag	Gravel	Crushed Rock	Slag	Sand
Hot Rolled Asphalt	Yes	No	No	Yes	No	Yes
Asphalt Concrete (Macadam)	Yes	*	*	Yes	*	Yes
Pervious Macadam	Yes	Yes	No	N/A	N/A	N/A

Yes Suitable for use in material.
No Not for use in material.
* Not for use in material when used for surface course, but suitable when used for other courses.
N/A Not applicable.

TABLE 3.2 REQUIRED PROPERTIES FOR COARSE AGGREGATES

Property	Test Method	Aggregate type	Material		
			Hot Rolled Asphalt	Asphalt Concrete (Macadam)	Pervious Macadam
Resistance to freezing and thawing	BS EN 1367-2/ Appendix A ‡	Each source Each fraction	MS_{18} MS_{30}	MS_{18} MS_{30}	– –
Shape	BS EN 933-3	All	FI_{35}	FI_{35}	FI_{35}
Resistance to fragmentation	BS EN 1097-2	All except gravel Gravel	LA_{30} n/a	LA_{30} LA_{25}	LA_{30} n/a
Water absorption	BS EN 933-3	All except slag Blast furnace slag	$WA_{24}2$ n/a	$WA_{24}2$ $WA_{24}4$	$WA_{24}2$ $WA_{24}4$
Affinity between aggregate and bitumen	BS EN 12697-11 Part B	All	Not greater than 6 particles from a 150 particle test sample		
Resistance to Polishing	BS EN 1097-8	Runway surface course Taxiway surface course	$PSV_{declared}$ * $PSV_{declared}$ *	$PSV_{declared}$ * $PSV_{declared}$ *	– –
Sulfur Content	BS EN 1744-1	Blast furnace slag	n/a	≤ 2 %	≤ 2 %
Volume Stability	BS EN 1744-1	Blast furnace slag	n/a	$V_{3.5}$	$V_{3.5}$
Bulk Density	BS EN 1097-6	Blast furnace slag	n/a	≥ 1.12 Mg/m³	≥ 1.12 Mg/m³

‡ 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.

– No category or limit.

* Project Manager to provide value for specific job specification; advice given in Clause Z.5 of Appendix Z.

n/a Not applicable.

3.3 FINE AGGREGATES

3.3.1 Subject to the limitations set in Table 3.1, fine aggregates shall be:

- natural bank, river, dune, or pit sand;
- blast furnace or steel slag;
- crushed rock; or
- blends of sand, slag and crushed rock

and shall be free from loosely bonded aggregations and other foreign matter. Sea-dredged sand shall not be permitted.

3.3.2 The properties of the fine aggregate shall conform to the BS EN 13043 Categories shown in Table 3.3.

3.4 ADDED FILLER

3.4.1 All filler aggregate used in the Hot Rolled Asphalt and Asphalt Concrete (Macadam) shall be CE marked.

3.4.2 The type of filler aggregate to be used for a particular material shall be selected from the alternatives in Table 3.4.

3.4.3 Filler aggregate shall be stored in dry conditions.

3.4.4 The grading of added filler aggregate shall conform to Clause 5.2.1 of BS EN 13043.

3.4.5 The loose bulk density in kerosene of added filler aggregate, other than hydrated lime, 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.

TABLE 3.3 REQUIRED PROPERTIES FOR FINE AGGREGATES

Property	Test Method	Aggregate type	Hot Rolled Asphalt	Asphalt Concrete (Macadam)	Pervious Macadam
Resistance to freezing and thawing	BS EN 1367-2/ Appendix A ‡	Each source ‡ Each fraction ‡	MS_{18} MS_{30}	MS_{18} MS_{30}	– –
Water absorption	BS EN 1097-6	All	$WA_{24}2$	$WA_{24}2$	$WA_{24}2$
Affinity between aggregate and bitumen	BS EN 12697-11 Part B	Parent rock if crushed rock fines	Not greater than 6 particles from a 150 particle test sample		

– No limit

‡ 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 fractions of the fine aggregate. Advice on the use of the test with non-standard aggregate fractions is given in Appendix A.

TABLE 3.4 ACCEPTABLE TYPES OF FILLER AGGREGATE

Material	Filler Aggregate Type			
	Cement (BS EN 197-1)	Crushed Limestone	Crushed Rock	Hydrated lime (BS EN 459-1)
Hot Rolled Asphalt	Yes	Yes	Yes	No
Asphalt Concrete (Macadam)	Yes	Yes	Yes	Yes
Pervious Macadam	Yes	No	No	Yes

Yes Suitable for use in material.
No Not for use in material.

TABLE 3.5 ACCEPTABILITY OF PAVING GRADE BITUMENS

Material		Bitumen (BS EN 12591) Grade			
		40/60	70/100	100/150	160/220
Hot Rolled Asphalt		Yes	Yes	Yes	No
Asphalt Concrete (Macadam)	Surface course	No	No	Yes	Yes
	Binder course	Yes	Yes	Yes	No
Pervious Macadam		No	No	No	Yes

Yes Suitable for use in material / course.
No Not for use in material / course.

3.5 BINDER

3.5.1 All binder used in the Hot Rolled Asphalt and Asphalt Concrete (Macadam) shall be CE marked.

3.5.2 The binder to be used for a particular material shall be in accordance with Table 3.5.

3.5.3 The particular grade of bitumen for a material shall be selected based on a number of factors in accordance with the requirements of Sections 4, 5 and 6 for Hot Rolled Asphalt, Asphalt Concrete (Macadam) and Pervious Macadam, respectively.

3.5.4 The binder shall be paving grade petroleum 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.

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

3.5.5 Copies of certificates for the binder shall be passed to the Project Manager for his retention.

3.6 TACK AND BOND COATS

3.6.1 Prior to laying surface and regulating courses, a bond coat shall be applied to the existing surface. Prior to laying binder courses and ramps, either a tack coat or a bond coat shall be applied to the existing surface.

OR

Prior to laying any course other than base, either a tack coat or a bond coat shall be applied to the existing surface.

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

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

3.6.3 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.

3.7 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. Where the course thickness exceeds the layer thickness allowed in Clause 3.8, the course shall be laid and compacted in two or more layers.

(NOTE. Increasing the thickness of a mat can considerably increase the time that it will take to cool to a temperature below which it cannot be effectively compacted. Therefore, in adverse weather (high winds and/or cold temperatures), the use of a greater course thickness will increase the possibility of having sufficient time to complete compaction.)

3.8 AGGREGATE SIZE

The aggregate size for the particular material and nominal layer thickness to be used shall be in accordance with Table 3.6.

3.9 FIBRES

Cellulose or mineral fibres may be used in pervious macadam.

(NOTE. Fibres can be used to reduce the binder drainage from a mixture.)

TABLE 3.6 AGGREGATE SIZES FOR MATERIAL AND NOMINAL LAYER THICKNESS

Surfacing Material		Nominal Layer Thickness (mm)	Aggregate size (mm)
Hot Rolled Asphalt	Surface course	30 – 45 45 – 50	0/10 0/14
	Regulating and ramping	0 – 30 20 – 50 25 – 60	0/2 0/10 0/14
Asphalt Concrete (Macadam)	Surface course	40 – 50	0/14
	Binder course	50 – 60 65 – 75	0/20 0/32
	Regulating and ramping	0 – 30 20 – 40 20 – 50 30 – 70 40 – 100	0/2 0/6 0/14 0/20 0/32
Pervious Macadam		100	0/32

4 Design and Composition of Hot Rolled Asphalt

4.1 GENERAL

4.1.1 All Hot Rolled Asphalt incorporated into the permanent works shall be CE Marked in accordance with BS EN 13108-4.

4.1.2 Hot Rolled Asphalt surface course shall be transported, laid and compacted according to the requirements of BS 594987 and subject to the overriding clauses in this Specification. The production of Hot Rolled Asphalt shall be carried out by a Contractor (or Supplier on his behalf) who has Quality Assurance registration 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.)

4.1.3 The composition of Hot Rolled Asphalt surface course mixtures shall be selected from the alternatives in Clause 4.5, according to the specified thickness. The mixtures shall be designated 'recipe' or 'design' according to Table 4.1 with design mixtures complying with Clause 4.2 and recipe mixtures complying with Clause 4.3.

TABLE 4.1 ACCEPTABLE COMPOSITIONS OF HOT ROLLED ASPHALT SURFACE COURSE MIXTURES

Location	Recipe Mixtures	Design Mixtures	
		Type A	Type B
‡, *	†, *	†, *	†, *
‡, *	†, *	†, *	†, *
‡, *	†, *	†, *	†, *

‡ Project Manager to state location(s) with drawing references as appropriate.
† Project Manager to either tick the relevant box or state any specific requirements (e.g. bitumen grade).
* Advice for Project Manager given in Clauses Z.1, Z.6 and Z.7 of Appendix Z.

4.2 DESIGN MIXTURES

4.2.1 The composition of design mixtures shall comply with the requirements for either a Type A or a Type B mixture as directed by sub-Clause 4.1.3.

4.2.2 Design Hot Rolled Asphalt mixtures shall be designed by the Contractor in his laboratory, using the aggregate size-appropriate to the layer thickness as specified in Clause 3.8.

4.2.3 At the target binder content for design mixtures, the Marshall stability determined in accordance with BS EN 12697-34 shall conform to the BS EN 13108-1 Category of *.

* Project Manager to provide Category for specific job specification; advice given in Clause Z.7 of Appendix Z.

(NOTE 1. Where 40 mm thick surface course or thinner is specified, a binder of greater penetration than 40/60 grade bitumen is recommended provided the minimum stability requirement can be achieved. Extra workability will be gained and more time for compaction will be available.)

(NOTE 2. If it is necessary to increase the binder content to more than the optimum binder content to achieve the target binder content with an air voids content of less than 4.0 %, the stability value at the target binder content shall meet the minimum requirement above.)

(NOTE 3. The target binder content should be pitched such that, at the binder content of target + 0.4 %, the minimum stability value can be achieved and, at the target -0.4 % binder content, the air voids conforms to BS EN 13108-4 Category $V_{max\,4}$.)

4.2.4 At the target binder content for design mixtures, the air voids content determined in accordance with BS EN 12697-5 shall conform to the BS EN 13108-4 Categories V_{max4} and $V_{min2,0}$.

(NOTE. A well compacted mat having a design air voids content of less than 4 % is expected to provide good durability.)

4.2.5 Full details of the design mixture shall be provided to the Project Manager at least 1 week prior to laying the surfacing (or the laying trials).

4.2.6 Plant mixtures shall be manufactured using the same aggregate, filler aggregate and binder as used in the design test.

4.3 RECIPE MIXTURES

4.3.1 Recipe mixtures shall be used at the locations permitted in sub-Clause 4.1.3.

4.3.2 Recipe mixtures shall be manufactured according to the relevant aggregate grading and binder content derived from the relevant envelopes in BS EN 13108-4, and subject to any additional Clauses in this Specification.

4.4 COMPOSITION OF HOT ROLLED ASPHALT MIXTURE TYPE A

4.4.1 Mixtures of Hot Rolled Asphalt Type A shall be design mixtures that have an upper sieve size, *D*, of 10 mm and comply with Table 4.2.

4.4.2 The limits for binder content on analysis shall be ± 0.4 % of the target binder content in the approved mix design.

4.5 COMPOSITION OF HOT ROLLED ASPHALT MIXTURE TYPE B

4.5.1 The BS EN 13108-4 mixtures in Table 4.3 may be used subject within the restrictions described therein.

(NOTE 1. 100/150 paving grade bitumen is recommended in order to provide good workability. In many instances, it should be feasible to meet a 7.5 kN stability requirement using a 100/150 paving grade bitumen.)

(NOTE 2. Mixtures 55/10 and 55/14 tend to segregate when hand laid, and mini-pavers should be used if small or intricate areas have to be laid. If hand laying cannot be avoided, mixtures 30/14 or 35/14 should be used for that part of the work.)

4.5.2 The limits in BS EN 13108-21 shall be applied to the mixture composition on analysis.

TABLE 4.2 PROPERTIES OF HOT ROLLED ASPHALT MIXTURE TYPE A

Component or Property	Requirement	
Filler Aggregate	Portland cement or limestone; at least 60 % of the material passing the 0.063 mm sieve shall consist of added filler aggregate	
Target Aggregate Grading	Sieve (mm)	Mass passing (%)
	14 10 6.3 2.0 0.5 0.25 0.063	100 70 – 100 60 – 78 42 – 54 19 – 35 12 – 24 3.0 – 6.0
Binder	70/100 pen or 100/150 pen grade paving bitumen †	
Target Binder Content	Determined in accordance with the criteria in Clause 4.2 but not less than 5.4 %	
Course Thickness	40 mm to 45 mm (wider limits may be used for regulating and ramping, see Clause 3.8)	

† Use of 100/150 pen grade paving bitumen will improve workability at the expense of some stability.

4.6 MIXING, DELIVERY AND COMPACTION TEMPERATURES

4.6.1 Hot Rolled Asphalts shall be mixed, delivered, laid and compacted within the material temperature limits given in Table 4.4.

(NOTE. Compliance with the mixing temperature limits given in Clause 5.11 of BS EN 13108-4:2006 incorporating 2008 corrigendum will be achieved by these values.)

TABLE 4.3 HOT ROLLED ASPHALT TYPE B MIXTURES

Course	Thickness (mm)	Paving Grade of Bitumen *	BS EN 13108-4 / PD 6691 Reference	Mixture type
Surface course	30 – 40	40/60, 70/100 or 100/150	HRA 30/10 F surf	Recipe †
	40 – 45	40/60, 70/100 or 100/150	HRA 30/14 F surf	Recipe †
	45 – 50	40/60, 70/100 or 100/150	HRA 35/14 F surf	Recipe †
	40 – 45	40/60, 70/100 or 100/150	HRA 55/10 F surf	Design ‡
	45 – 50	40/60, 70/100 or 100/150	HRA 55/14 F surf	Design ‡
Regulating and ramping	0 – 30	40/60, 70/100 or 100/150	HRA 0/2 F surf	Recipe †
	25 – 50	40/60, 70/100 or 100/150	HRA 50/10 bin	Recipe †
	25 – 60	40/60, 70/100 or 100/150	HRA 50/14 bin	Recipe †

‡ Design mixtures to Clause 4.2; **NOT TO BE LAID BY HAND**.
† Recipe mixtures to Clause 4.3; use only were permitted in accordance with sub-Clause 4.1.3.
* The use of bitumen with higher penetration will improve workability and widen the compaction window, at the expense of some stability.

TABLE 4.4 HOT ROLLED ASPHALT TEMPERATURES

Course	Pen Paving Bitumen Grade	Temperature (°C)			
		Mixing (Max)	Delivery (Min)	Recommended Paver-out (Min)*	Compaction (Min)‡
Surface course or regulating / ramping	40/60	185	140	130	100
	70/100	180	135	125	90
	100/150	170	130	115	75

* Recommended values that 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.
‡ These values are the mid-layer temperatures at which completion of compaction should have been achieved.

4.6.2 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:

- whilst discharging from the delivery lorry into the paver hopper;
- immediately before restarting the spreader following stoppage; and
- at any time the Project Manager or his representative directs.

4.6.3 The rolling procedure shall have been completed before the surfacing temperature has fallen to the minimum compaction temperature.

5 Design and Composition of Asphalt Concrete (Macadam)

5.1 GENERAL

5.1.1 All Asphalt Concrete (Macadam) incorporated into the permanent works shall be CE Marked in accordance with BS EN 13108-1.

5.1.2 Asphalt Concrete (Macadam) binder course and surface course shall be transported, laid and compacted according to the requirements of BS 594987, and subject to the overriding clauses in this Specification. The production of Asphalt Concrete (Macadam) shall be carried out by a Contractor (or Supplier on his behalf) who has Quality Assurance registration 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.)

5.1.3 Mixtures shall be manufactured according to the relevant aggregate grading and binder content derived from the relevant envelopes in BS EN 13108-1, and subject to any additional clauses in this Specification.

5.2 COMPOSITION OF ASPHALT CONCRETE (MACADAM) MIXTURES

5.2.1 The Asphalt Concrete (Macadam) mixtures shall be selected from the alternatives in Table 5.1 according to the layer and specified thickness.

5.2.2 The target gradings of Asphalt Concrete (Macadam) mixtures shall comply with Table 5.2.

5.2.3 The target binder contents of Asphalt Concrete (Macadam) mixtures shall comply with Table 5.3.

5.2.4 The limits in BS EN 13108-21 shall be applied to the mixture composition on analysis.

5.3 MIXING, DELIVERY AND COMPACTION TEMPERATURES

5.3.1 Asphalt Concrete (Macadam) shall be mixed and delivered within the material temperature limits given in Clause 5.2.10 of BS EN 13108-1.

TABLE 5.1 ACCEPTABLE ASPHALT CONCRETE (MACADAM) MIXTURES

Course	Thickness (mm)	Paving Grade of Bitumen *	BS EN 13108-1 Reference
Surface course	40† – 50	100/150 (or 160/220 ‡)	0/14 to Table 5.4 grading
Binder course	50 – 60 65 – 75	40/60, 70/100 or 100/150 40/60, 70/100 or 100/150	0/20 to Table 5.4 grading 0/32 to Table 5.4 grading
Regulating and ramping	0 – 30 20 – 40 30 – 70 40 – 100	100/150 (or 160/220 ‡) 100/150 40/60, 70/100 or 100/150 40/60, 70/100 or 100/150	0/4 to Table 5.4 grading 0/6 to Table 5.4 grading 0/20 to Table 5.4 grading 0/32 to Table 5.4 grading

* Project Manager to provide bitumen grade and material type (DBM or HDM) for specific job specification; advice given in Clause Z.8 of Appendix Z.

‡ Project Manager to delete unless required for specific job specification; advice given in Clause Z.8 of Appendix Z.

† Thickness may be reduced to 20 mm when used in ramps.

TABLE 5.2 TARGET AGGREGATE GRADINGS FOR ASPHALT CONCRETE (MACADAM) MIXTURES

Sieve Size (mm)	Proportion by mass passing (%) for mixture designation						
	AC 4 fine surf	AC 6 dense surf	AC 14 close surf	AC 20 dense bin	AC 20 HDM bin	AC 32 dense bin	AC 32 HDM bin
40						100	100
32				100	100	99 – 100	99 – 100
20			100	99 – 100	99 – 100	80 – 86	80 – 86
14 *			100	70 – 80	70 – 80	65 – 75	65 – 75
10		100	77 – 83	61 – 63	61 – 63	–	–
6.3	100	98	52 – 58	47	47	52	52
2.0	98	42 – 56	25 – 31	27 – 33	27 – 33	27 – 33	27 – 33
1.0	69 – 87	24 – 46	14 – 26	–	–	–	–
0.25	18 – 36	11 – 19	–	11 – 15	11 – 15	11 – 15	11 – 15
0.063	7 – 14	4 – 8	4.5 – 6.5	6	8	6	8

* Informative limits on an additional sieve to those required by BS EN 13108-1 other than for AC 14 close surf mixture.

TABLE 5.3 TARGET BINDER CONTENTS FOR ASPHALT CONCRETE (MACADAM) MIXTURES

Aggregate Type	Target binder content † (%) for mixture designation						
	AC 4 fine surf	AC 6 dense surf	AC 14 close surf	AC 20 dense bin	AC 20 HDM bin	AC 32 dense bin	AC 32 HDM bin
Limestone	6.2	6.0	4.9	4.6	4.6	4.6	4.6
Basalt	6.6	6.3	5.1	4.7	4.7	4.7	4.7
Other crushed rock	6.5	6.2	5.1	4.6	4.6	4.6	4.6
Blast furnace slag of bulk density:							
1.44 Mg/m³	6.8	6.6	N/A	5.4	5.4	5.4	5.4
1.36 Mg/m³	7.2	7.0	N/A	5.8	5.8	5.8	5.8
1.28 Mg/m³	7.6	7.6	N/A	6.2	6.2	6.2	6.2
1.20 Mg/m³	7.8	8.0	N/A	6.6	6.6	6.6	6.6
1.12 Mg/m³	8.2	8.4	N/A	7.0	7.0	7.0	7.0
Steel slag	6.2	5.6	N/A	4.2	4.2	4.2	4.2
Gravel	N/A	N/A	N/A	5.0	5.0	5.0	5.0

† The target binder content is before applying any correction for aggregate density (as for determining the BS EN 13108-1 Categories B_{min} and B_{max}).

5.3.2 Asphalt Concrete (Macadam) shall be laid and compacted within the material temperature limits given in Table 5.4.

5.3.3 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:

- whilst discharging from the delivery lorry into the paver hopper;
- immediately before restarting the spreader following stoppage; and
- at any time the Project Manager or his representative directs.

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

TABLE 5.4 ASPHALT CONCRETE (MACADAM) TEMPERATURES

Course	Bitumen Grade (1/10 mm)	Min. Temperature (°C) Paver-out*	Comp-action ‡
Binder (dense) (HDM)	100/150 40/60 40/60	110 120 140	85 95 115
Surface	160/220 100/150	105 110	75 85
Regulating & ramping	40/60 100/150 160/220	110 110 110	85 85 85

* Recommended values that 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.

‡ These values are the mid-layer temperatures at which completion of compaction should have been achieved.

6 Design and Composition of Pervious Macadam

6.1 GENERAL

Pervious Macadam shall be transported, laid and compacted according to the requirements of BS 594987, and subject to the overriding clauses in this Specification. The production of Pervious Macadam 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.)

6.2 DESIGN MIXTURES

6.2.1 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 3.0 % when using 160/220 paving grade binder and not less than 4.0 % when using a modified binder without correction for aggregate density.

(NOTE 1. If the maximum target binder content is less than the minimum category, 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 limits are before applying any correction for aggregate density as for determining the BS EN 13108-7 Category B_{min}.)

6.2.2 The Binder Drainage Tests shall be carried out at:

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

For other modifiers, the base bitumen used shall be 160/220 paving grade bitumen.

6.2.3 The Binder Drainage Test shall be carried out at the mid-point of the grading limits using the same coarse aggregates and filler aggregate option as 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 may be used.)

(NOTE 3. 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 manufacturer's instructions. Full details should be supplied to and advice sought from Professional and Technical Services, DE prior to approval to use a proprietary system being given.)

6.2.4 The Contractor shall provide full details of the Binder Drainage Tests to the Project Manager.

6.2.5 Plant mixtures shall be manufactured using the same aggregate, filler aggregate, fibre and binder as used in the Binder Drainage Test. The mixing temperature shall not exceed that specified in 6.2.2 for the Binder Drainage Test.

6.3 RECIPE MIXTURES

Recipe mixtures shall use 160/220 paving grade unmodified bitumen with a target binder content of 3.4 % when the coarse aggregate is crushed rock and 4.3 % when it is slag. The manufacturing tolerance on the target binder content shall be ± 0.3 %. Cellulose fibres can also be used.

6.4 COMPOSITION OF PERVIOUS MACADAM

6.4.1 The aggregate grading shall comply within the limits of Table 6.1. The Contractor shall target at the mid-point of the grading limits.

TABLE 6.1 PERVIOUS MACADAM GRADING LIMITS

Sieve (mm)	Mass passing (%)
40	100
31.5	90 – 100
20	10 – 30
14	4 – 6

6.4.2 Fine aggregate shall not be added.

6.4.3 The mixture shall contain by mass of the total mixture either:

- 2 % of hydrated lime;
- 4 % of Ordinary Portland Cement, by mass of the total aggregates; or
- Up to 1.5 % of Stearine Amine or other approved wetting agent by mass of the total binder content so long as it can be demonstrated to the approval of the Project manager that no drainage of the binder from the aggregate takes place during transport to the point of placing.

(NOTE 1. Project Manager to delete final option when not required for specific job specifications; advice given in Clause Z.9 of Appendix Z.)

(NOTE 2. The Contractor shall state which filler aggregate option he chooses.)

6.4.4 Depending on the application, the binder selected shall be either:

- 160/220 paving grade bitumen; or
- 160/220 paving grade with an approved modifier.

Pervious Macadam using unmodified 160/220 paving grade bitumen shall only be used for small works and for remedial works to French drain toppings with the approval of the Project Manager.

(NOTE. Pervious Macadam using 160/220 paving grade bitumen and a modifier will have a higher binder content than unmodified Pervious Macadam, and is expected to have improved durability; it should be used for new works.)

6.5 MIXING, DELIVERY AND COMPACTION TEMPERATURES

6.5.1 Pervious Macadams shall be mixed and delivered within the material temperature limits given in Clause 5.12 of BS EN 13108-7.

6.5.2 Pervious Macadams shall be laid and compacted within the material temperature limits given in Table 6.2.

TABLE 6.2 PERVIOUS MACADAM TEMPERATURES

Paving Grade of Bitumen	Min. Temperature (°C)	
	Paver-out *	Compaction ‡
160/220	85	65
160/220 plus natural rubber	85	65
160/220 plus other modifier	†	†

† In accordance with the Supplier's recommendation.

* Recommended values that 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.

‡ These values are the mid-layer temperatures at which completion of compaction should have been achieved.

6.5.3 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:

- whilst discharging from the delivery lorry; and
- at any time the Project Manager or his representative directs.

6.5.4 The rolling procedure shall have been completed before the surfacing temperature has fallen to the minimum compaction temperature.

7 Plant and Workmanship

7.1 GENERAL

7.1.1 Mixtures shall be transported, laid and compacted according to the BS 594987 and subject to any additional clauses in this Specification.

7.1.2 The standard of workmanship and finish of all surfacing included in this Contract shall be equal in all respects to that of the "Approved" areas established in the trials in accordance with Section 8.

7.2 WEATHER CONDITIONS FOR LAYING

7.2.1 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.

7.2.2 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.)

7.3 REDUCTION IN SURFACE LEVEL OF ASPHALT SURFACES

Where the surface level of an existing asphalt surface is being reduced, thicknesses shall be removed 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.

7.4 REDUCTION IN SURFACE LEVEL OF CONCRETE SURFACES

7.4.1 Where the surface level of an existing concrete surface is being reduced, thicknesses from fine fractions up to the limits as specified hereafter shall be removed by scabbling or planing. Scabbling or planing shall be carried out by machines operated in a manner that results in a minimum of over-cutting and uniform exposure of the aggregate, without shattering or otherwise damaging the concrete slabs.

7.4.2 Unless directed by the Project Manager, such reductions in level shall be bounded by joints in the concrete pavement. Where they are not and where the scabbling or planing is not tapered to zero depth, the area to be reduced in level shall first be defined by saw cuts, 5 mm deeper than the depth of the scabbling or planing.

7.4.3 The surface treated as above shall be thoroughly cleaned with hand brooms and all loose debris shall be collected and removed.

7.4.4 Before the area is surfaced, a tack or bond coat appropriate to the surfacing material shall be applied as specified in Clause 7.9 and the exposed vertical edges shall be painted with hot bitumen. The new surfacing shall be made to firmly adhere to the vertical edges.

7.4.5 The whole of the concrete layer shall be removed for its full depth where the thickness required to be removed is greater than the lesser of:

- 100 mm; and
- one third the depth of the slab.

Where the concrete is in bays less than 4.5 m square, the boundary of the area to be removed shall be defined by bay joints. Where the bays are larger, part bays may be removed such that the remaining portion shall not be less than 2.25 m by the full length or full width of the bay.

7.4.6 Care shall be taken to ensure that all concrete remaining in the vicinity of cutting-out remains sound and without fracture and that disturbance to sub-bases and underlying layers is minimised.

7.5 PREPARATION OF EXISTING ASPHALT SURFACES

7.5.1 Before the tack or bond coat is applied, all vegetable growth and loose aggregate or other particles shall be removed from all cracks in the existing asphalt surfacing on which new surfacing is to be laid. Loose laitance and other spalling or debonded slurry seal shall be removed from the surface. The surfaces shall be swept until standing water, mud, grit and all other extraneous matter has been removed. Immediately ahead of tack or bond coating, all dust shall be removed by vacuum extraction cleaning, with or without high pressure water at the discretion of the Project Manager.

(NOTE 1. Cleaning machines applying high pressure water and vacuum extraction are very effective in removing debris and cleaning the surface. Water pressures about 50 Bar are adequate for general cleaning, but higher pressures may be used subject to the Project Manager's discretion. At very high pressures, damage to the surfacing can result.)

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

7.5.2 Existing overbanding of the surfacing shall be removed when required by the Project Manager.

(NOTE. When resurfacing comprises only a surface course, it will normally be a requirement to at least remove thick depositions of overbanding.)

7.6 PREPARATION OF EXISTING CONCRETE SURFACES

7.6.1 Before the tack or bond coat is applied, all vegetable growth and loose debris including concrete fractions shall be removed from all cracks, joints and joint edges in the existing concrete surfacing on which the new asphalt surfacing is to be laid. The surface shall be thoroughly cleaned and all loose debris shall be collected and removed.

(NOTE 1. Cleaning machines applying high pressure water and vacuum extraction are very effective in removing debris and cleaning the surface. Water pressures about 50 Bar are adequate for general cleaning, but higher pressures may be used subject to the Project Manager's discretion. At very high pressures, damage to the surfacing can result.)

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

7.6.2 All joints in the concrete paving shall be examined and a joint preparation programme shall be agreed between the Contractor and the Project Manager.

7.6.3 When directed, the joint sealing compound shall be removed in joints 20 mm wide or greater where the sealant has lost its original properties and can be removed by hand methods. The sealant shall be replaced with lightly compacted 0/4 mm size asphalt concrete (macadam) in accordance with BS EN 13108-1 and complying with Table 5.5. The asphalt shall be laid to a convex finish slightly proud of the general surface level.

7.6.4 In all other cases, the joints shall be prepared by cutting-off any compound which has extruded above the general level of the pavement with heated tools so as to be flush with the concrete surface. Any unfilled joints less than 20 mm wide may be ignored.

7.6.5 Loose laitance and other spalling or debonded slurry seal shall be removed from the surfaces which shall then be swept until standing water, mud, grit and all other extraneous matter has been removed. Immediately ahead of tack or bond coating, all dust shall be removed by vacuum extraction cleaning, with or without high pressure water at the discretion of the Project Manager.

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

7.7.1 Ravelled joints, ravelled cracks and potholes shall be made good before the new surfacing is laid.

7.7.2 Trenches shall be formed by carefully cutting out the existing asphalt surfacing on either side of the joints or cracks to the full depth of the surface course and, if directed, to the underside of the binder course or to the top of the underlying concrete or pavement base. The new material shall be bonded into the old surfacing.

7.7.3 The cross section of the trench shall be a minimum of 200 mm wide. The side walls of the trench shall be clean vertical cuts and shall be stepped-back a minimum of 50 mm on each side at a convenient plane of separation between any two courses of the existing surfacing. When the existing pavement level is not to be raised, the edges of the trench or patch shall be defined by means of saw

cuts extending to the full depth of the surface course.

7.7.4 All loose and crumbling fractions shall be removed from the bottom and sides of the trench. The bottom and sides shall be completely painted with tack coat.

7.7.5 The defective surfacing shall be replaced with the specified surface course material. It shall be placed in the trenches in lifts of about 50 mm each which shall be compacted separately with approved mechanical or hand tampers as specified in Clauses 7.15 and/or 7.16.

7.7.6 At the time of compaction, the mixture shall be at the specified temperature. The final layer shall be laid so as not to leave a concave finish below the general surface after thorough compaction by rolling.

7.7.7 All loose material shall be removed from any potholes, the bottom and sides of the depressions painted with tack coat and then the potholes backfilled, compacted and finished in accordance with sub-Clauses 7.7.5 and 7.7.6.

(NOTE. Further guidance on making good is given in DE Functional Standard 06, "*Guide to Airfield Pavement Maintenance*".)

7.8 TRANSPORTING PLANT MIXTURES

7.8.1 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 shall be suitable for the spreading equipment in use and shall have insulated bodies.

7.8.2 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.

7.8.3 The temperature of the load in every transporting vehicle shall be checked in accordance with BS EN 12697-13 whilst discharging from the delivery lorry into the paver hopper. If the temperature of any batch is below the minimum delivery temperature specified in Clause 4.6 for Hot Rolled Asphalt, Clause 5.3 for Asphalt Concrete (Macadam) or Clause 6.5 for Pervious Macadam, the load shall be rejected and shall be removed from site immediately. If the delivery temperature of Pervious Macadam is greater than 100 °C when 160/220 paving grade bitumen has been used, or greater than 120 °C if modified 160/220 paving grade bitumen has been used, the load shall be rejected and shall be removed from site immediately.

7.8.4 Each delivery of mixed material to the contract works, whether batched on-site or off-site, shall be accompanied by a delivery ticket giving the following details:

- Delivery ticket number;
- Vehicle registration number;
- Material type and mix classification;
- Penetration grade of bitumen used; and
- Quantity.

For material batched off-site, the delivery ticket shall also give the following details:

- Customer name and Delivery site number;
- Source of supply;
- Date and time loaded; and
- Date and time delivered.

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

7.9 TACK AND BOND COAT APPLICATION

7.9.1 The type of tack or bond coat to be used for the particular material being laid is as specified in Clause 3.6.

7.9.2 Tack and bond coats shall be applied not more than 48 h in advance of surfacing. The target rate of application shall be in accordance with BS 594987. Tack and bond coat may be applied to damp surfaces but ponded or standing water shall be removed as specified in Clauses 7.5 and 7.6.

7.9.3 Tack and bond coats 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 or bond coat has 'broken'. If the Contractor wishes to use such equipment, he shall seek prior written approval from the Project Manager. Advice for Project Manager is given in Clause Z.10 of Appendix Z.)

7.9.4 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 too shall be protected.

7.9.5 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.

7.10 PERMITTED TOLERANCE OF COURSE THICKNESS

7.10.1 The total compacted thickness of any course of the surfacing material at any point shall not be less than the specified course thickness or exceed this thickness by more than the limits of Table 7.1.

TABLE 7.1 COURSE THICKNESS TOLERANCES

Surfacing Material	Maximum Permitted Tolerance on the Specified Course Thickness (mm)	
	Binder course	Surface course
Hot Rolled Asphalt	n/a	+ 10* / - 0
Asphalt Concrete (Macadam)	+ 25 / - 0	+ 10* / - 0
Pervious Macadam	n/a	+ 25 / - 0

* Except in ramps (see Clause 7.22).
n/a Not applicable.

7.10.2 A core sample 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.

7.11 REGULATION OF EXISTING SURFACES

7.11.1 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.

7.11.2 Regulation for depths less than 40 mm shall be carried out with a relevant mixture from Clauses 4.4, 4.5 and/or 5.2 subject to the following requirements:

- Regulation for depths 0 to 20 mm where it is to be immediately beneath a design mixture Hot Rolled Asphalt surface course:
  - 0/4 F Hot Rolled Asphalt shall be used; and
  - The paving bitumen penetration grade shall be 70/100 unless the surface course is a 10 kN design stability, when the penetration grade shall be 40/60.
- The positioning of regulating courses shall be planned to minimise the use of 0/4 F Hot Rolled Asphalt.
- Regulation for depths 20 mm to 30 mm where it is to be immediately beneath a design mixture Hot Rolled Asphalt surface course, Hot Rolled Asphalt complying with the same design stability requirement as the surface course (i.e. as required by sub-Clause 4.2.1) shall be used.
- Regulation for depths 30 mm to 40 mm where it is to be immediately beneath a design mixture Hot Rolled Asphalt surface course:
  - Hot Rolled Asphalt complying with the same design stability requirement as the surface course (i.e. as required by sub-Clause 4.2.1); or
  - 0/20 DBM or 0/20 HDM binder course, when the penetration grade shall be 40/60.

7.11.3 Regulation for depths in excess of 40 mm shall be carried out with a relevant mixture from Clauses 4.4, 4.5 and/or 5.2 except that, where it is to be immediately beneath a design mixture Hot Rolled Asphalt surface course, it shall be either:

- Hot Rolled Asphalt complying with the same design stability requirement as the surface course (i.e. as required by sub-Clause 4.2.1);
- 0/20 DBM or 0/20 HDM binder course, when the penetration grade shall be 40/60; or
- 0/32 DBM or 0/32 HDM binder course, when the penetration grade shall be 40/60.

7.11.4 Regulation of the existing surface shall continue, subject to the tolerances specified in Clause 7.10, until the regulated surface, when tested with a straightedge in accordance with BS EN 13036-7, achieves an accuracy of:

- 10 mm in 3 m when a surface course only is to be overlaid on it; or
- 25 mm in 3 m when a binder course and surface course are to be overlaid on it.

7.12 LAYING REQUIREMENTS

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

7.12.2 The mixtures shall be spread to surcharged depths necessary to give the specified course thickness, and to comply with the finished levels and profiles shown on the drawings, after compaction.

7.12.3 Surface course shall be laid on binder courses as soon as practicable in order to provide adhesion with the binder course. Binder courses which have been left exposed for more than seven days shall be tack or bond coated in accordance with Clause 7.9 before the laying of surface course.

7.12.4 The use of hand-rakes shall be prohibited when the mixtures are laid by spreading and finishing machines in accordance with Clause 7.14 except at joint edges and around manholes and pits, where their use shall be restricted to an absolute minimum.

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

7.12.6 At all times, the courses shall be kept free from all extraneous matter.

7.13 SAMPLING OF MIXED MATERIALS

7.13.1 Bulk samples of the mixed material sent to the site, as required in sub-Clause 9.5.1, shall be taken by the Contractor and divided. One sample shall be analysed for grading and binder content, and the other retained for reference in the case of a dispute.

7.13.2 The samples can be taken at the batching plant or at the site, with the alternative selected to be notified at Tender Stage. If the sample is to be taken at the site, it shall be taken from the paver screws after approximately half of the lorry load has been discharged through the paver.

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

7.14 SPREADING BY MACHINE

7.14.1 Except where the conditions of Clause 7.16 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 asphalt 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.)

7.14.2 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.

7.14.3 Each spreader shall be maintained in good mechanical condition and shall be correctly adjusted for operation at the speed consistent with the character and rate of delivery of the mixture and the thickness and agreed rolling procedures for the 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.

7.14.4 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 7.12 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.

7.14.5 Intermittent stopping of the spreader shall be avoided and the rate of delivery to the spreader shall be so regulated to enable the spreader to be operated continuously.

7.15 COMPACTION

7.15.1 The surfacing shall be uniformly compacted in the manner approved during the laying of the trial area described in Clause 8.3, using the type of equipment and loads applied as agreed with the Project Manager.

7.15.2 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).

7.15.3 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 only enough 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.

7.15.4 Rollers shall move at a slow but uniform speed which should not exceed 5 km/h and any pronounced steering 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 mix. Rollers shall not be left standing on the new surfacing within 24 h of laying.

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

7.16 SPREADING AND COMPACTING BY HAND

7.16.1 Spreading by hand will be permitted for:

- filling potholes and cracks;
- repairing joints;
- the regulation of existing surfaces as specified in Clause 7.11;
- feathering;
- shaping drainage channels if impracticable by machine;
- the replacement of old or defective surfacing when the areas are small;
- areas of irregular shape; and
- laying Pervious Macadam over French drains.

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 7.14.

7.16.2 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 be spread portion by portion without a 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.

7.16.3 The exposed edges of manhole frames, grating 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 asphalt surfacing. The surfacing shall then be packed tightly around the fixture and firmly tamped into position.

7.16.4 On completion of compaction, the finished surface of the surface course and other materials as used shall be level with the fixture to the accuracy specified in Clause 7.25. Shaping and dishing to the sides of catchpits shall be carefully carried out to the profiles shown on the drawings. In places inaccessible to the rollers that are specified in Clause 7.15, compaction shall be achieved by suitable vibrating rollers or by tamping.

7.17 TOPPING TO FRENCH DRAINS

7.17.1 Spreading of Pervious Macadam may proceed provided the weather conditions comply

with Clause 7.2. The covers on the delivery lorry shall only be rolled back sufficiently to discharge sufficient material for immediate use. At the discretion of the Project Manager, Pervious Macadam may be laid by a small width screed paver where support on either side of the French drain is deemed sufficient. Alternatively, Pervious Macadam shall be spread with hot shovels carefully to avoid contamination from adjacent vegetable growth or other foreign material. It shall be spread portion by portion in a single uniform layer along the length of the drain to the required width, and levelled off with hot hand rakes by skilled operators to give the correct shape and profile after compaction.

7.17.2 The Pervious Macadam shall be compacted by a smooth wheeled tandem roller of mass not exceeding 3 tonnes having a roller width not exceeding that of the French Drain. No vibration shall be permitted. Pervious Macadam shall be laid within 3 h of manufacture.

7.18 LONGITUDINAL LANE JOINTS, GENERAL

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.

7.19 LONGITUDINAL LANE JOINTS IN MATERIALS OTHER THAN PERVIOUS MACADAM

7.19.1 The exposed vertical edges of the longitudinal lane joints in the surfacing materials shall be carefully cut back and trimmed to firm material in the compacted lane, or for a minimum of one half and a times the layer thickness, whichever is the greater, and all loose material arising from this operation shall be removed from the pavement before the cut edge is painted.

7.19.2 Edge rolling shall only be used as an alternative to cutting back if it can be demonstrated during the trials to the Project Manager that satisfactory standards of compaction, surface/joint finish and adhesion can be achieved.

(NOTE. Cores should be taken for test at these joints to demonstrate good adhesion and bulk density within the specified limits.)

7.19.3 Cutting back and trimming will not be required when two or more spreading units operate in echelon in close proximity, permitting adjacent lanes to be continuously compacted before the material around the joint between the lanes falls below the compaction temperature specified in Clause 4.6 for Hot Rolled Asphalt or Clause 5.3 for Asphalt Concrete (Macadam).

7.19.4 After cutting back and trimming, the exposed vertical edges of the longitudinal lane joints shall be thoroughly cleaned of all adherent material and shall then be painted with a uniform thickness of bitumen just ahead of the spreading unit laying the adjacent lane. Painting shall completely and uniformly cover the exposed edge for its full depth. Excess material to the top and base of the joints, streakiness and blobs shall be avoided.

7.19.5 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 7.25.

7.19.6 When laying during cool windy weather, a joint heater may be used subject to the discretion of the Project Manager.

7.20 TRANSVERSE JOINTS

7.20.1 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.

7.20.2 The exposed vertical edges of the transverse joints of all layers 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. The exposed joint edges shall then be cleaned and painted with bitumen as specified in Clause 7.19 immediately before the laying of the lane continues.

7.20.3 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 7.25.

7.21 JOINTS BETWEEN NEW SURFACING AND EXISTING PAVEMENTS

7.21.1 Existing asphalt surfacing against which new surfacing is to be laid shall be cut back as necessary to a line removing all loose or weathered material and shall be finished with a vertical edge. Immediately prior to the laying of new material, either:

- a thin uniform coating of 40/60 or 70/100 paving grade bitumen; or
- an approved joint seal in accordance with the manufacturer's instructions,

shall be applied over the complete face.

7.21.2 Where asphalt resurfacing is ramped into an existing asphalt surface and the ramp ends at a point abutting an existing concrete surface, the exposed vertical face of the concrete shall be cleaned thoroughly and either:

- a thin uniform coating of 40/60 or 70/100 paving grade bitumen; or
- an approved joint seal in accordance with the manufacturer's instructions,

shall be applied over the complete face within 2 h prior to laying the asphalt surfacing.

7.21.3 The edge of existing concrete surfacing against which a completely new asphalt surfacing is to be laid shall be exposed and thoroughly cleaned to its full depth and for the appropriate length. Unless shown otherwise on the drawings, an expansion joint shall then be formed below the new surfacing by:

- placing a joint filler of non-extruding, heat and rot-proof board against the bottom of the exposed concrete face that is 25 mm thick and of a height equal to the depth of the concrete slab less the greater of:
  - 100 mm and
  - the total thickness of the new surfacing;
- installing an approved joint sealing material in accordance with the manufacturer's instructions to the upper margin of the exposed face; and
- carrying the new surfacing over the top of the joint filler within 2 h of installing the joint sealing material.

The new surfacing at the junction shall be a minimum of 100 mm thick for a distance of at least 3 m back from the junction, laid in a minimum of two layers.

7.22 RAMPS BETWEEN NEW SURFACING AND EXISTING PAVEMENTS

7.22.1 Junctions to be made with ramps between the new surfacing and existing pavements are shown on the drawings, for which typical details are given in Figures 7.1 and 7.2.

7.22.2 Where appropriate, the new binder course shall be reduced in thickness at a slope parallel to that of the finished surface to a minimum thickness of 40 mm. It shall be further feathered down at the same slope in hand-laid surface course or binder course material using the materials specified in sub-Clause 7.11.2.

7.22.3 The width of these reductions in level shall be as shown on the drawings and shall be formed so the surface course remains within the tolerances of thickness specified in Clause 7.10 at all points within it. The surface course shall, however, be permitted to exceed the higher tolerance in the limited area immediately following the end of the binder course ramping.

7.22.4 Where the existing surface is asphalt, the end of the ramp furthest away from the new surfacing shall be defined by a clean saw cut to the depth shown in Figure 7.2 before planing is commenced.

7.22.5 Where the existing surface is concrete, the end of the ramp furthest away from the new surfacing shall be along the line of existing joints or grooves. The surface so prepared shall be thoroughly cleared of all loose materials and either:

- a thin uniform coating of 40/60 or 70/100 paving grade bitumen; or
- an approved joint seal in accordance with the manufacturer's instructions,

shall be applied over the complete face within 2 h prior to laying the asphalt surfacing.

7.22.6 The exposed vertical edges of the existing surfacing shall be painted with bitumen and the new surfacing shall be compacted against it.

7.22.7 In areas where ramping as described above is not considered necessary (i.e. non-trafficked areas), a ramp finished to a step not exceeding 15 mm in the material specified in sub-Clause 7.11.2 is permissible.

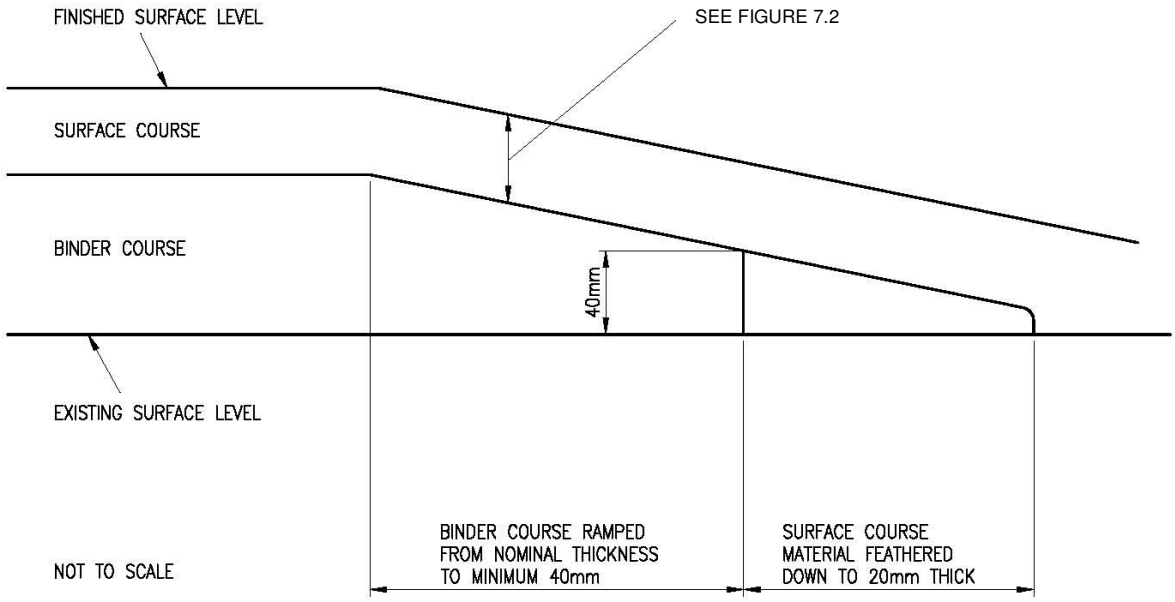

Figure 7.1 – Ramps between New Surfacing and Existing Pavements

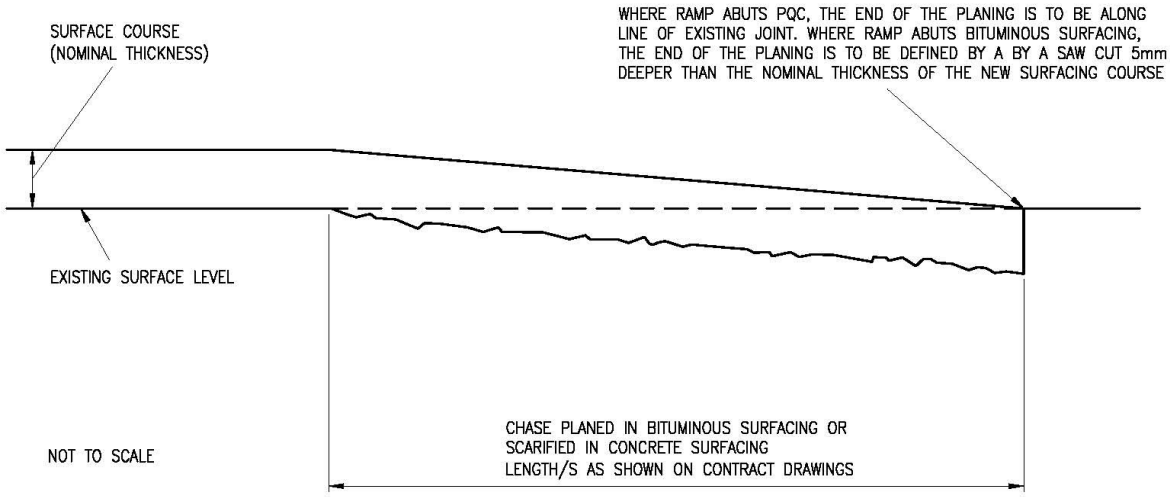

Figure 7.2 – Ramps between Surface Course and Existing Pavements

7.23 TEMPORARY RAMPS

(NOTE. This is a specimen clause only; the Project Manager must agree the details with the Aerodrome Authority/Station staff on a job-specific basis. Further advice for the Project manager is given in Clause Z.11 of Appendix Z.)

7.23.1 Temporary ramps (e.g. to enable aircraft operations to continue during daylight hours with construction work being carried out at night) shall be constructed in the same manner as specified in Clause 7.22. However, where the Contractor can demonstrate to the satisfaction of the Project Manager that he can provide an acceptable and sound surfacing without the use of the saw cut, the saw cutting may be omitted.

7.23.2 Prior to the commencement of each * work, the Contractor shall obtain the approval of the Project Manager to the proposed layout of the temporary ramps. At no time shall there be more than one ramp in the length of each Hot Rolled

Asphalt or Asphalt Concrete (Macadam) course and the ramps shall be transverse to the line of aircraft movement or as directed by the Project Manager. The ramps shall slope in the same direction unless directed otherwise. On runways, the construction work shall proceed from the primary takeoff/landing end such that temporary ramps slope down in the direction of aircraft movement. If the Contractor proposes to lay any areas of the ramps by hand methods or methods not approved in the trial areas, he shall seek prior approval of the Project Manager.

* Project Manager to provide the relevant period for the specific job specification; advice is given in Clause Z.11 of Appendix Z.

7.23.3 Temporary ramps shall be arranged so as to avoid covering manholes and aviation ground lighting fixtures whenever practicable. When this is not practicable, the manholes and aviation ground lighting fixtures shall be covered by the temporary ramps.

OR

Temporary ramps shall be arranged so as to avoid covering manholes and aviation ground lighting fixtures wherever practicable. When this is not practicable, ramping, which must be smoothed over as approved and described in sub-Clause 7.23.7, shall also be carried out to all edges of manhole surrounds and aviation ground lighting fixtures.

(NOTE. Project Manager to select option for specific job specification; advice given in sub-Clause 0 of Appendix Z.)

7.23.4 Ramps on the runway surface within * m of the centre line shall conform with the following requirements:

- The gradient of any ramp shall not exceed ± * in the longitudinal direction;
- The gradient of any ramp shall not exceed ± * in the transverse direction, and there shall be no transverse ramps within * m of the runway centre line;
- The depth of any ramp shall not exceed * mm;
- The spacing of successive ramps shall not be less than * m in the longitudinal direction;
- The profile of the ramps shall be such that it does not create ponding on the surface; and
- All ramps shall be planed into the existing surface to ensure a minimum thickness of * mm of ramping material.

* Project Manager to provide values (if clause is required) for specific job specification after agreement with the Aerodrome Authority/Station staff; advice is given in Clause Z.11 of Appendix Z.

7.23.5 Ramps on the taxiway and the extended taxiway to a point * m from the runway centre line shall conform with the following requirements:

- The gradient of any ramp shall not exceed ± * in the longitudinal direction;
- The gradient of any ramp shall not exceed ± * in the transverse direction;
- The profile of the ramps shall be such that it does not create ponding on the surface; and
- All ramps shall be planed into the existing surface to ensure a minimum thickness of * mm of ramping material.

* Project Manager to provide values (if clause is required) for specific job specification after agreement with the Aerodrome Authority/Station staff; advice is given in Clause Z.11 of Appendix Z.

7.23.6 Ramps on the runway paved shoulders shall conform with the following requirements:

- The gradient of any ramp shall not exceed ± * in the longitudinal direction; and
- The gradient of any ramp shall not exceed ± * in the transverse direction.

* Project Manager to provide values (if clause is required) for specific job specification after agreement with the Aerodrome Authority/Station staff; advice is given in Clause Z.11 of Appendix Z.

7.23.7 All ramps shall be inspected prior to the completion of each * work and are to be modified or made good to the satisfaction of the Project Manager where he deems them to be unsatisfactory. There shall be no uncovered tack or bond coat material, oil, petrol, grease or similar contaminants and no steps, ruts, pits or bumps of greater than 3 mm in height/depth. The surface shall be cleaned and swept of all plant, equipment, unsound or ragged materials, debris, dirt and similar, all to the satisfaction of the Project Manager.

* Project Manager to provide the relevant period for the specific job specification; advice is given in Clause Z.11 of Appendix Z.

7.23.8 All or part of the temporary ramps are to be planed out at the commencement of the next period of work to ensure that a minimum of * mm of material can be laid. The planning out of the ramps and laying of the new material is to be carried out in accordance with Clause 7.22.

* Project Manager to provide value (if clause is required) for specific job specification after agreement with the Aerodrome Authority/Station staff; advice is given in Clause Z.11 of Appendix Z.

7.24 FINISHED LEVELS

7.24.1 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.

7.24.2 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 removal of the appropriate thickness of the offending area by heating and planing, carried out as specified in Clause 7.3, or by total removal, as detailed in Clause 7.29, when the depth to be removed exceeds 60 mm.

7.25 SURFACE ACCURACY

7.25.1 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 that specified in Table 7.2 anywhere in any direction, other than across the crown of a camber or across a drainage channel.

TABLE 7.2 SURFACE REGULARITY

Surfacing	Maximum Gap under a 3 m long test straightedge (mm)
Surface course	3
Binder course	10
French drain	10

7.25.2 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.

7.25.3 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 Clauses 7.29 and 7.30.

7.25.4 Any non-complying area shall be removed for the full width of the lane and replaced with material that shall satisfy the acceptance criteria.

7.26 AIR VOIDS CONTENT OF DESIGNED HOT ROLLED ASPHALT

7.26.1 After the surfacing has cooled to ambient temperature, at least one 150 mm diameter core shall be extracted as required by Clause 9.6 for the determination of air voids content in accordance with BS EN 12697-5 (using the same method as was used for the design). The running mean of 6 cores shall not exceed 5.5 % nor be less than 1.0 %, and an individual result shall not exceed 6.5 %. Where an individual location result exceeds 6.5 %, additional cores shall be taken at 10 m intervals on either side of that location and their air voids contents measured to determine the length of non-complying area. Where the running mean of 6 cores exceeds 5.5 %, the length of the non-complying area shall be from where the first to where the last of the 6 cores were taken. The non-complying area shall be removed for the full width of the lane. A minimum length of 25 m of defective material shall be removed and replaced with material that shall satisfy the acceptance criteria. Reheating a surfacing using an infra-red heater and re-compaction shall not be permitted.

OR

Cores do not have to be taken for the determination of air void content.

(NOTE. Project Manager to select alternative for specific job specification, deleting sub-Clause 7.26.2 if the latter option is chosen; advice given in Clause Z.12 of Appendix Z.)

7.26.2 Cores shall be taken so that the whole core is located within 500 mm of the edge of a longitudinal joint for at least one in every three cores sampled.

7.27 PERCENTAGE REFUSAL DENSITY OF BINDER COURSE ASPHALT CONCRETE (MACADAM)

7.27.1 Percentage Refusal Density (PRD) is the compaction degree with a reference density of refusal. Compaction degree, reference density

and refusal are as defined in Annex C to BS EN 13108-20: 2006 under Clause C.4, Clause C.3 and reference C.1.14 of Table C.1, respectively.

7.27.2 After the surfacing has cooled to ambient temperature, at least one 150 mm diameter core shall be extracted as required by Clause 9.6 for the determination of PRD. The average PRD of a running mean of 6 cores shall not be less than 93 %. Where a length of surfacing does not comply with the average requirement, further cores shall be extracted midway between the locations of the original cores and the new running mean of PRD for 6 cores at the chosen spacing determined. If this running mean does not comply with the PRD requirement, the non-complying area shall be removed for the total lane width. A minimum length of 25 m of defective material shall be removed and replaced with complying material.

OR

Cores do not have to be taken for the determination of Percentage Refusal Density.

(NOTE 1. Reheating a surface using an infra-red heater and re-compaction shall not be permitted.)

(NOTE 2. Project Manager to select alternative for specific job specification, deleting sub-Clause 7.27.3 if the latter option is chosen; advice given in Clause Z.12 of Appendix Z.)

7.27.3 Cores shall be taken so that the whole core is located within 500 mm of the edge of the pavement for at least one in every three cores sampled.

7.28 TRAFFIC ON FINISHED SURFACING

7.28.1 No trafficking of freshly laid surfacing is permitted until the surfacing has cooled to ambient temperature and no stopping or parking of vehicles is permitted within:

- 24 h of laying a surfacing in summer conditions; and
- 12 h of laying a surfacing in winter conditions.

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.

7.28.2 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 8).

(NOTE. Advice for the Project Manager on the assessment of the temperature of freshly laid surfacing is given in Clause Z.13 of Appendix Z.)

7.28.3 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.

7.29 CUTTING OUT DEFECTIVE OR OLD SURFACING

7.29.1 When defective surfacing is cut out, the full depth of the layer shall be removed. The area to be cut out shall extend across the full width of the lane between the longitudinal joints, and shall extend at least 300 mm beyond the defective area into sound material. The area of the lane to be cut out shall be defined by straight saw cuts, at least 40 mm deep or the full thickness of the layer, whichever is the thinner.

7.29.2 The area shall be cut away carefully by approved mechanical scabbling or planing machines. Pneumatic spade cutters may also be used if the risk of damage to operatives from hand arm vibration syndrome (vibration white finger) has been minimised and the remaining risk has been assessed as acceptable. Where spade cutters are used, the cutting tool blades shall overlap the previous cut on each move and each cut shall penetrate the course for its full thickness.

7.29.3 The surface of the exposed material below shall be thoroughly cleared of all loose fragments and cleaned, using high-pressure water and vacuum extraction, or as directed by the Project Manager.

7.29.4 Replacement shall not begin until the Project Manager has approved the conditions of cleanliness of the base.

7.29.5 When the level of the pavement is to be raised by 20 mm or more, saw cutting shall be omitted.

(NOTE. Guidance may be found in DE Functional Standard 06, "*Guide to Maintenance of Airfield Pavements*".)

7.30 REPLACEMENT OF DEFECTIVE OR OLD SURFACING

7.30.1 A tack or bond coat in accordance with Clause 7.9 shall be applied over the exposed base, care being taken to include all corners, angles and irregularities. The exposed vertical faces of the surfacing shall be painted with bitumen.

7.30.2 The replacement surfacing shall comply with the specified course thicknesses shown on the drawings and tolerances specified in Clause 7.10, and with the standards detailed in this Specification.

7.31 FILLING CORE HOLES

The walls and base of all holes from which core samples have been cut are to be painted with bitumen and filled with the specified surfacing material, well rammed in lifts not exceeding 50 mm.

7.32 GROOVING OF HOT ROLLED ASPHALT SURFACE COURSES

7.32.1 Where the drawings indicate that new or existing surfaces are to be grooved, the grooves shall be formed 4 mm wide and 4 mm deep at 25 mm centres. Grooving operations shall not commence within 24 h of laying the surfacing and only proceed provided the surface temperature is less than 40 °C.

7.32.2 The surface of the surface course shall be grooved across the pavement at right angles to the pavement edges with grooves which follow across the pavement in a continuous line without break.

7.32.3 The machine for grooving shall be a sawing machine incorporating a minimum of 12 N° blades and an automatic guidance system to ensure that the spacings between peripheral grooves on successive passes remain constant. **The Contractor shall state the type and technical details of the machine he proposes to use for grooving at the time of tender.**

7.32.4 At all times during cutting, a high pressure water and vacuum extraction cleaning machine shall be in attendance to pick up the detritus arising, whether wet or dry, as soon as possible after the grooving machine has passed so that the work area is left in a clean condition free of all loose material and of wet or dry slurry at the end of each shift. Care shall be taken not to wash slurry down the drainage catchpits.

7.32.5 Prior to commencing work, the Contractor shall carry out a trial on an area of disused pavement selected by the Project Manager to prove the suitability of the sawing and cleaning equipment. Until approval of the trial is given, grooving work as required by the Contract will not be permitted to start.

8 Trials

8.1 GENERAL

Trials shall be carried out on all asphalt mixtures, other than Pervious Macadam drainage material, proposed for use in the Works. For small works, the procedures and requirements for the preliminary and final trials may be combined and/or modified at the discretion of the Project Manager.

8.2 PRELIMINARY TRIALS

8.2.1 For each asphalt, after the design mixture or recipe mixture has been approved by the Project Manager (see Clauses 4.2, 4.3 and 5.2), the Contractor shall mix at least one 20 tonne batch of the material for laying in preliminary trials. At the discretion of the Project Manager, this requirement may be modified for regulation or ramping material.

8.2.2 Preliminary trial mixtures, for design or recipe mixtures, 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 design binder content or specified figure for recipe mixtures.

8.2.3 Preliminary trial mixtures for design Hot Rolled Asphalt mixtures shall be made up from the laboratory design mixtures determined in accordance with Clause 4.2.

8.2.4 The preliminary trial mixtures shall be laid on disused pavements within the airfield boundary, in locations selected by the Project Manager. The materials shall be laid and compacted according to the requirements of BS 594987 and this Specification, according to material type and specified thickness.

8.2.5 The mixture shall be transported to the airfield and laid and compacted on a clean firm and level test area, not being part of the works, using delivery, paving and compaction machinery that the Contractor proposes to use during the works. The area shall be tack or bond coated prior to laying. The Contractor shall select paving and compaction operations such that no laying defects such as dragging or surface blemishes result, to the satisfaction of the Project Manager. The Project Manager may order further 20 tonne loads to be laid until a satisfactory result is achieved.

(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))

8.2.6 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.

8.2.7 The Contractor shall submit the results of an analysis, carried out in accordance with BS EN 12697-1 and BS EN 12697-2, to the Project Manager for each load of the trial mixture laid to demonstrate compliance with the requirements of Clauses 4.4, 4.5 or 5.2.

8.2.8 If the preliminary trials indicate that the trial mixtures are unsatisfactory for mechanical spreading and compacting, or fail to produce the specified surface accuracy or result in surface blemishes which are unacceptable, the proportion of binder and the grading of the combined aggregates and filler aggregate may be slightly modified within the limits of the Specification.

(NOTE. If changes outside of the specification limits are required, a new design may be necessary for non-recipe mixtures.)

8.2.9 Further preliminary trials shall then be laid to demonstrate that a satisfactory mixture has been achieved. The Project Manager will then agree the mixture and appropriate specification limits and authorise the laying of a final trial area as described in Clause 8.3.

8.2.10 After completion of all preliminary trials, the edges of the lanes shall be feathered off in asphalt surfacing as necessary for the requirements of vehicular traffic to the approval of the Project Manager.

8.3 FINAL TRIAL AREAS

8.3.1 Following completion of the preliminary trials described in Clause 8.2, a trial area of surfacing, not less than 60 m or more than 300 m long by two lanes wide, shall be laid for each layer thickness for each mixture. Duplicate areas shall be laid for each additional spreader and for each thickness on which each particular spreading unit will be working. The trial areas shall be laid along the outside edges of the pavements in positions approved by the Project Manager.

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

8.3.3 The Contractor shall submit the results of an analysis, carried out in accordance with BS EN 12697-1 and BS EN 12697-2, to the Project Manager for each lorry load of the trial mixture laid to demonstrate compliance with the requirements of Clauses 4.4, 4.5 or 5.2.

8.3.4 When the trial surfacing has cooled to ambient temperature, six 150 mm diameter cores shall be cut using an approved coring machine according to BS EN 12697-27. The cores shall be evenly spaced along the length of the trial surfacing with at least two cores being located within 500 mm of the edge of a longitudinal joint. The initial and final cores shall not be taken within 7 m of the ends of the length of surfacing. From these cores, the thickness shall be determined in accordance with BS EN 12697-36 and:

- for Hot Rolled Asphalts, the bulk density, maximum density and air voids content shall be determined according to the methods in BS EN 12697-6, BS EN 12697-5 and BS EN 12697-8 (using the same options as used for the design), respectively; the air voids content shall comply with BS EN 13108-4 categories $V_{\text{min } 1,0}$ and $V_{\text{max } 6}$.
- for Asphalt Concrete (Macadam) mixtures, the Percentage Refusal Density (PRD) shall be determined for each core according to sub-Clause 7.27.1; the compaction level shall be deemed acceptable if the average PRD of the six determinations is not less than 93 %.

(NOTE 1. There is limited information available on the use of the Percentage Refusal Density Test on surface course Asphalt Concrete (Macadam) mixtures and experience of the use of this test should be forwarded to Professional and Technical Services, DE.)

(NOTE 2. For very small works and at the discretion of the Project Manager, the Air Voids content for Hot Rolled Asphalts and the Percentage Refusal Density Test for Asphalt Concrete (Macadam) mixtures may be omitted.)

8.3.5 The Contractor shall demonstrate the effectiveness of his compaction method as defined by the requirements of sub-Clause 8.3.4. The standard of finish, including that of 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.

8.3.6 When the Project Manager has approved the trial area, the Contractor shall confirm in writing the weights, proportions and overall grading of the mixture used in the trial to the Project Manager and they shall be used thereafter as targets for future plant mixing with due regard for the tolerances in this Specification.

8.3.7 The approved length of the trial area shall be permanently marked 'Approved' and dated and the approved longitudinal and transverse joints are to be permanently defined.

8.3.8 If the trial area is approved, it shall be allowed to remain. Otherwise, the full length shall be removed as specified in Clause 7.1 and replaced with new material to the required standard at the Contractor's expense.

8.3.9 Until approval has been given, the general laying of asphalt surfacing required by the Contract will not be permitted to start.

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

8.3.11 If for any reason the quality, grading or supply source of any of the aggregates is changed, a new mixture shall be designed and approved on the basis of further trial areas.

8.3.12 Based on the trials, the rollers and rolling method to be adopted for each course shall be agreed with and approved by the Project Manager.

8.3.13 No change shall be made afterwards 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.

9 Summary of Tests

9.1 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.

9.2 TESTS FOR INITIAL APPROVAL OF MATERIALS

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

9.2.2 In addition to 9.2.1, the Contractor (or his materials supplier(s) on his behalf) shall have carried out the aggregate tests in Table 9.1 for comparison with the relevant specification clauses.

TABLE 9.1 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

9.2.3 In addition, the Contractor shall submit the appropriate certificates for binder and other constituents, including tack or bond coat, and also for tack or bond coat spray bar equipment.

9.3 TEST 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 asphalt mixtures showing conformity with all requirements of Section 4 for Hot Rolled Asphalt, Section 5 for Asphalt Concrete (Macadam) or Section 6 for Pervious Macadam and the relevant specification clauses in Table 9.2.

9.4 ROUTINE TESTS ON BULK SUPPLIES THROUGHOUT PLANT MIXING

9.4.1 The Quality Assurance procedures for the supply of component material 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 conformity declaration; and
- check on the capability of the dryers to function efficiently with aggregates of variable moisture content.

The tests shall include those in Table 9.3.

9.4.2 If the result of any test indicates that the bulk deliveries are not of a grading or quality consistent with the declaration of conformity, 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, if stored on site, shall remove all material condemned by the Project Manager for this reason from the aerodrome.

9.4.3 Where the material is mixed off site, any condemned material shall be carefully removed from the stockpiles to be used for the work.

TABLE 9.2 TESTS FOR DESIGN OF MIXTURE

Component or material to be tested	Clause Number	Test	
		Title	Reference
Designed Hot Rolled Asphalt	4.2	Marshall Air voids content	BS EN 12697-34 BS EN 12697-5
Designed and recipe Hot Rolled Asphalt	4.3, 4.4, 4.5	Analysis	BS EN 12697-1 BS EN 12697-2
Asphalt Concrete (Macadam)	5.2	Analysis	BS EN 12697-1 BS EN 12697-2
Pervious Macadam	6.2 6.4	Binder drainage Analysis	BS EN 12697-18 BS EN 12697-1 BS EN 12697-2
Trials	8.3	Analysis Cores Thickness Bulk density Maximum density Air voids content Percentage Refusal Density	BS EN 12697-1 BS EN 12697-2 BS EN 12697-27 BS EN 12697-36 BS EN 12697-6 BS EN 12697-5 BS EN 12697-8 Sub-Clause 7.27.1

TABLE 9.3 TESTS FOR TRIALS OF MIXTURES

Test	Test Method	Representative Sample From	Minimum Frequency	Use For Results
Sieve analysis of aggregates	BS EN 933-2	Each stockpile	Daily on receipt	Comparison with the grading of the initial samples
Moisture content of aggregates at/after mixing	Samples shall be weighed, dried in a ventilated oven at a controlled temperature of 175 °C ± 2 °C for 24 h, and then weighed again	After completion of mixing process but without the addition of binder	Weekly	To take measures in order to improve the drying processes if the difference in the weight of the sample before and after oven drying exceeds 0.5 %
Sieve analysis of filler aggregate	BS EN 933-2		Daily	Comparison with the declaration of conformity
Bulk density in kerosene of filler aggregate	BS EN 1097-3: Annex B		Weekly	

9.5 ROUTINE TESTS ON MIXTURES THROUGHOUT PLANT MIXING

9.5.1 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 listed in Table 9.4 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 9.4 ROUTINE TESTS ON PLANT MIXTURES

Test	Test Method	Sample From	Minimum Frequency	Use For Results
Analysis of the plant mixtures	BS EN 12697-1 BS EN 12697-2	After the completion of the mixing process	Every 4 h but not less than twice a day for each mixer in use	Determination of binder contents and aggregate/filler proportioning and grading – results plotted on graphs in order to show comparison with the grading curve of the mixture approved in accordance with Clause 8.3 and the relevant binder content
Temperature	BS EN 12697-13	Lorry	Every load	Check for compliance with Clauses 4.6, 5.3 and 7.8

9.5.2 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 9.7 shall be carried out.

9.6 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 listed in Table 9.5.

9.7 ADDITIONAL TESTS WHEN ROUTINE TESTS ON THE MIXTURES AND ON THE COMPACTED COURSES FAIL

9.7.1 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 grading, and binder content;
- course thickness;
- air voids content for Hot Rolled Asphalt;
- percentage refusal density for asphalt Concrete (Macadam); or
- surface accuracy.

9.7.2 These additional tests (other than for surface accuracy) shall be made on:

- four 300 mm square samples for checking grading and binder content;
- four 150 mm diameter cores for checking course thickness; or
- as specified in Clauses 7.26 and 7.27 for checking air voids content and percentage refusal density, respectively.

The samples or 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.

9.7.3 If any one of the additional test results for aggregate/filler grading, binder content or course thickness also indicate failure to meet the specified requirement, further tests shall be made on 3 more samples or cores. These samples or 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 samples or 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 7.29 and 7.30.

9.7.4 When a routine test fails to meet the requirements of Clause 7.25, an additional 20 straightedge tests in accordance with BS EN 13036-7 shall be made over the area between the adjacent points where the routine test was undertaken for which the results complied with the requirements of Clause 7.25. If three or more of these additional tests also fail to meet the specified requirement, this area of the surfacing shall be condemned. The condemned areas shall be removed and replaced by the Contractor, at his own expense, as specified in Clauses 7.29 and 7.30.

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

TABLE 9.5 ROUTINE TESTS DURING LAYING AND COMPACTION

Test	Ref. Clause	Test Method	Sample From	Minimum Frequency	Use For Results
Wind speed and air temperature	7.2	n/a	n/a	Whenever laying planned	Assess suitability of weather conditions for laying.
Material temperature	4.6, 5.3 and 7.8	BS EN 12697-13	Paving train	Each load	Check on delivery temperature
Surface accuracy	7.25	BS EN 13036-7	Previous day's work	Daily	Ensure compliance; if more than 2 tests in each group of 20 fail to comply, the additional tests specified in Clause 9.7 shall be carried out
Finished Levels	7.24	n/a			Ensure compliance
Core samples	7.26 and 7.27	BS EN 12697-27	Previous day's work	Samples from every † laid (or from every 2 h work, whichever is the more frequent); and at locations agreed with the Project Manager	
Course thickness	7.10	n/a			Ensure compliance; if any test fails to comply, the additional tests specified in Clause 9.7 shall be carried out. *
Air voids content	7.26	BS EN 12697-5			Ensure compliance; if the test results fail to comply, the additional tests specified in Clause 7.26 shall be carried out.
Percentage refusal density	7.27	Sub-Clause 7.27.1			Ensure compliance; if the test results fail to comply, the additional tests specified in Clause 7.27 shall be carried out.

† Project Manager to provide value for specific job specification; advice given in Clause Z.14 of Appendix Z.
* The requirements of Clauses 7.5, 7.6 and 7.9 shall be checked when cores fail in adhesion, and the necessary corrections and adjustments shall be made to eliminate the cause of the failure.

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 7.2, Table C.1 gives recommended wind speed and air temperature limits for the laying of Hot Rolled Asphalt surface courses, of Asphalt Concrete (Macadam) surface courses and binder courses and of Pervious Macadam drain topping. The table also gives guidance for regulating layers and ramps.

TABLE C.1 RECOMMENDED WIND SPEED AND AIR TEMPERATURE LIMITS

Material and Course	Paving Grade Bitumen (pen)	Thickness (mm)	Max wind speed (km/h) 2 m height	10 m height	Min. Air Temp. (°C)
Hot Rolled Asphalt surface course	40/60	40	As in Figure C.1		
	40/60	50	40 35	50 45	1 0
	70 /100	40	As in Figure C.2		
	70 /100	50	40	50	0
	100/150	40 – 50	40	50	0
Hot Rolled Asphalt regulating / ramping	40/60	up to 30	See Note 3		
	70/100	up to 30			
	100/150	up to 30			
Asphalt Concrete (Macadam) binder course	100/150	50	40 35	50 45	3 0
	100/150	60	40	50	0
DBM 50 binder course	40/60	50	See Figure C.3		
	40/60	60	40	50	0
HDM binder course	40/60	50	See Figure C.3		
	40/60	60	40	50	0
Asphalt Concrete (Macadam) surface course	160/220	40	See Figure C.4		
	160/220	50	40	50	0
	100/150	40	See Figure c.4		
	100/150	50	40 30	50 40	3 0
Asphalt Concrete (Macadam) regulating / ramping	100/150	up to 50	See Note 3		
Pervious Macadam	160/220	100	40	50	0

(NOTE 1. Where two sets of limiting wind speed and air temperatures are given, laying can proceed provided the weather conditions conform to either set.)

(NOTE 2. The limiting wind speed and air temperatures relate to a compaction time of 8 min for the mid-layer temperature to fall from the specified maximum to minimum compaction temperatures.)

(NOTE 3. Very thin asphalt layers cool very quickly. At 15 mm thickness less than 2 min is theoretically available for compaction within the specified compaction temperature limits. Prompt rolling is essential and it is recommended that this material should only be laid in still conditions.)

(NOTE 4. The values and graphs were calculated using the previous grades of bitumen, and the results for mixtures with 70/100, 100/150 and 160/220 bitumen may need to be revised.)

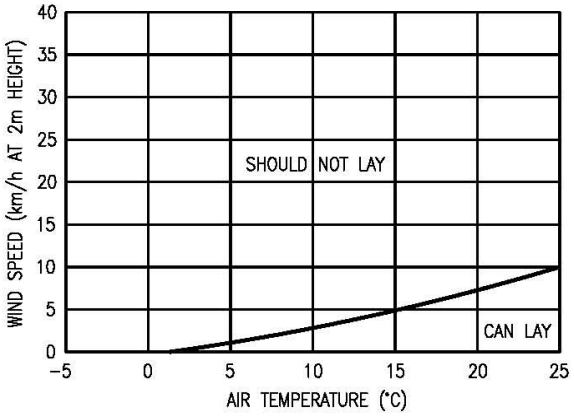

Figure C.1 – Acceptable weather conditions for laying 40 mm thicknesses of Hot Rolled Asphalt surface course with 40/60 bitumen

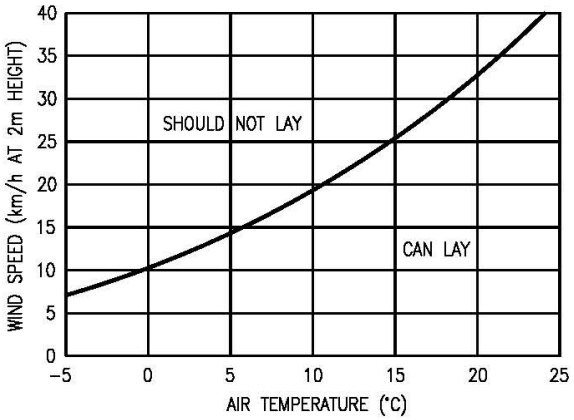

Figure C.2 – Acceptable weather conditions for laying 40 mm thickness of Hot Rolled Asphalt surface course with 70/100 bitumen

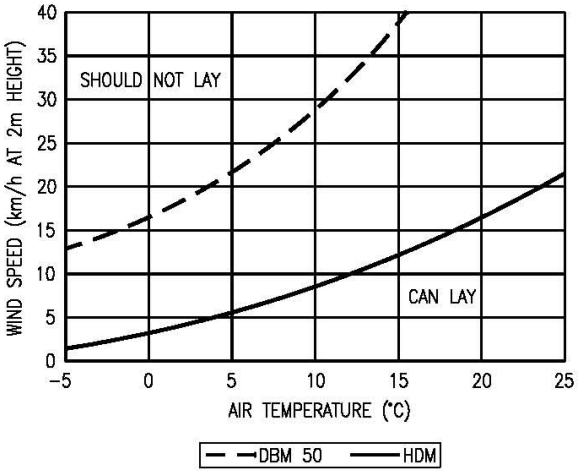

Figure C.3 – Acceptable weather conditions for laying 50 mm thicknesses of Asphalt Concrete (Macadam) binder course with 40/60 bitumen

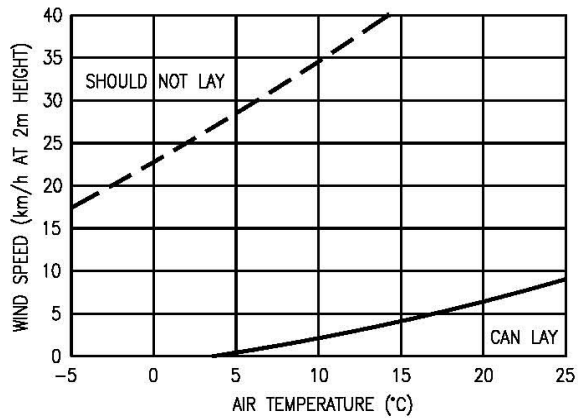

Figure C.4 – Acceptable weather conditions for laying 40 mm thicknesses of Asphalt Concrete (Macadam) surface course with 100/150 or 160/220 bitumen

C.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 ± 0.1) 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. Project Manager to select alternative for specific job specification; advice given in Clause Z.15 of Appendix Z.)

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 Management System can be undertaken.

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

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

Y.6 ASPECTS TO ASSESS TENDER ACCEPTABILITY

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

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

- proof of registration to 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 the work is to the required standard. Where only part of the required elements is covered in the Quality Management System, it may be acceptable for the tenderer to address these areas in his Quality Plan and to compile site-specific procedures for unique elements of the Contract.

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

- the Quality System that will be enforced throughout the duration of the Contract;
- the method and procedures to be used to ensure the positive identification and issue status of specifications, drawings, inspection instructions and other data including the requirements for the approval of operational procedures, equipment, staff, operative training and outputs;
- the method and procedures to be used to ensure 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 will be requirements for the Supplier to carry out tests on the materials, etc. The Supplier may not have his own test laboratory, in which case he will send samples out to a test house. Any test laboratory, whether part of the Supplier's organisation or an independent test house, conducting the tests for initial approval of materials and design of mixtures should be a United Kingdom Accreditation System (UKAS) accredited test house with an appropriate test schedule. Site laboratories used to carry out routine tests on bulk supplies and mixtures throughout plant mixing shall be either UKAS accredited or, subject to the Project Manager's approval, work to a Quality Assurance scheme.

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

Y.7.5 Rates of sampling and testing must be appropriate to the Contract and stated clearly in the Quality Plan. Where rates are stipulated in the Contract (see Section 9), 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 LIMITATION ON THE USE OF HOT ROLLED ASPHALT

Z.1.1 Hot Rolled Asphalt may be used for surface courses in relation to aircraft tyre pressures and frequency of trafficking in accordance with Table Z.1.

Z.1.2 The frequency of trafficking is as 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.1.3 Notwithstanding Table Z.1, recipe Hot Rolled Asphalt mixtures may be specified for hand laying small areas.

Z.1.4 The Specification for Hot Rolled Asphalt is for surface courses only.

Z.1.5 Prior to using this Specification for Hot Rolled Asphalt for runway resurfacing work, the Project manager shall obtain advice from Professional and Technical Services, DE regarding such matters as grooving and surface texture requirements or the application of coarse textured slurry seal (normally the least favoured option).

Z.2 LIMITATION ON THE USE OF ASPHALT CONCRETE (MACADAM)

Z.2.1 Asphalt Concrete (Macadam) may be used for surface courses and binder courses in relation to aircraft tyre pressures and frequency of trafficking in accordance with Table Z.2.

(NOTE. Close graded surface course Asphalt Concrete (Macadam) may have a low texture depth, and hence poor skid resistance, when new. It is therefore not normally recommended for runways. Consideration should be given to applying a coarse slurry seal when new if surfacing a runway to provide some surface texture, and within 5 years in other situations to seal the surface and arrest binder hardening.)

TABLE Z.1 TRAFFICKING LIMITATIONS ON THE USE OF HOT ROLLED ASPHALT

Tyre Pressure MPa (psi)	Frequency of Trafficking					
	Low		Medium		High	
	Recipe mixture	Design mixture	Recipe mixture	Design mixture	Recipe mixture	Design mixture
up to 0.7 (100)	Yes	Yes	No (Yes)	Yes	No	Yes
0.7 to 1.4 (100 to 200)	No	Yes	No	Yes	No	Yes
More than 1.4 (200)	No	Yes	No	Yes †	No	Yes †

Yes Hot Rolled Asphalt is permitted.
No Hot Rolled Asphalt is not permitted.
(Yes) Hot Rolled Asphalt is permitted in the cooler, northern regions of the UK only, subject to prior advice being sought from Professional and Technical Services, DE.
Yes † Hot Rolled Asphalt is permitted for small works only, subject to prior advice being sought from Professional and Technical Services, DE.

TABLE Z.2 TRAFFICKING LIMITATIONS ON THE USE OF ASPHALT CONCRETE (MACADAM)

Tyre Pressure MPa (psi)	Frequency of Trafficking								
	Low			Medium			High		
	Binder course	Surface course		Binder course	Surface course		Binder course	Surface course	
		Recipe	Design		Recipe	Design		Recipe	Design
up to 0.7 (100)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
0.7 to 1.4 (100 to 200)	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
More than 1.4 (200)	Yes	No	Yes	No	No	Yes †	No	No	Yes †

Yes Asphalt Concrete (Macadam) is permitted for that course.
No Asphalt Concrete (Macadam) is not permitted for that course.
Yes † Design Asphalt Concrete (Macadam) is permitted for small works only, subject to prior advice being sought from Professional and Technical Services, DE.

Z.2.2 The frequency of trafficking is as defined in sub-Clause Z.1.2.

Z.3 USE OF PERVIOUS MACADAM

Pervious Macadam is used as a topping to protect French drains.

Z.4 RESISTANCE TO FREEZING AND THAWING OF AGGREGATES

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

Z.5 PSV CATEGORY FOR SURFACE COURSES

Z.5.1 The requirement for the resistance to polishing of coarse aggregate on runway surface courses should normally be Category PSV_{50}. For high frequency traffic (as defined in Sub-Clause Z.1.2), a requirement for PSV of Category $PSV_{declared\ 55}$ should be set.

Z.5.2 The requirement for the resistance to polishing of coarse aggregate on taxiway surface courses should be Category PSV_{44}. However, for low frequency traffic (as defined in Sub-Clause Z.1.2), the category PSV_{NR} may be used except for fast exit taxiways.

Z.6 STABILITY OF DESIGN HOT ROLLED ASPHALT AND ASPHALT CONCRETE (MACADAM) MIXTURES

The Hot Rolled Asphalt design mixtures specified in Clause 4.5 would be expected to provide a higher stability than the Asphalt Concrete (Macadam) mixtures specified in Clause 4.4.

Z.7 HOT ROLLED ASPHALT AND ASPHALT CONCRETE (MACADAM) DESIGN MIXTURES

Z.7.1 The minimum stability requirements for Hot Rolled Asphalt and Asphalt Concrete (Macadam) design mixtures should be selected according to Table Z.3.

Z.7.2 The frequency of trafficking is as defined in Sub-Clause Z.1.2.

TABLE Z.3 STABILITY REQUIREMENTS FOR HOT ROLLED ASPHALT

Tyre Pressure MPa (psi)	Stability Category: Frequency of Trafficking Low	Medium	High
Up to 0.7 (100)	$S_{min5,0}$	$S_{min5,0}$	$S_{min7,5}$ ($S_{min5,0}$)
0.7 to 1.4 (100–200)	$S_{min5,0}$	$S_{min7,5}$ ($S_{min5,0}$)	S_{min10}
More than 1.4 (200)	$S_{min7,5}$	S_{min10} ‡	S_{min10} ‡

( ) Bracketed Categories apply in the cooler, northern regions of the UK only, subject to prior advice being sought from Professional and Technical Services, DE.
‡ Hot Rolled Asphalt or Asphalt Concrete (Macadam) should be permitted for small works only subject to advice being sought from Professional and Technical Services, DE.

Z.8 BITUMEN GRADES FOR USE WITH ASPHALT CONCRETE (MACADAM)

Z.8.1 The grade of bitumen for surface course and binder course Asphalt Concrete (Macadam) may be selected from the Table Z.4.

Z.8.2 In cooler, northern regions of the UK, the use of 160/220 paving grade bitumen allows for greater longevity provided adequate structural performance can be achieved. Where 40 mm thick surface course is specified, the use of 160/220 paving grade bitumen also maximises the compaction time.

Z.8.3 The frequency of trafficking is as defined in sub-Clause Z.1.2.

Z.9 WETTING AGENTS

It is recommended that the option to use Stearine Amine or other approved wetting agent is restricted to small works only.

Z.10 PAVING MACHINES INCORPORATING EQUIPMENT TO APPLY TACK OR BOND COAT

The Project Manager should seek guidance from Professional and Technical Services, 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.11 TEMPORARY RAMPS

Z.11.1 Phased working to allow aircraft operations to continue, either throughout or at intervals during the construction period (e.g. night working and daytime flying) may necessitate the provision of temporary ramps. Guidance is provided at Appendix 3A of CAP 168, *Licensing of Aerodromes* (Civil Aviation Authority).
Clause 7.23 may need to be modified or augmented for specific job specifications and must be subject to prior agreement with the Aerodrome Authority/Station staff.

TABLE Z.4 GRADE OF BITUMEN

Tyre Pressure MPa (psi)	Frequency of Trafficking: Low Binder course	Low Surface course	Medium Binder course	Medium Surface course	High Binder course	High Surface course
up to 0.7 (100)	100/150	100/150 (160/220)	100/150	100/150 (160/220)	100/150	100/150
0.7 to 1.4 (100 – 200)	40/60 ‡	No	40/60 ‡	No	40/60 †	No
More than 1.4 (200)	40/60 †	No	No	No	No	No

( ) Bracketed values apply in the cooler, northern regions of the UK only, subject to prior advice being sought from Professional and Technical Services, DE.
‡ For use in DBM 50 or, with increased filler content, in HDM.
† For use only with increased filler content in HDM.

Z.11.2 The choice of whether to cover over or ramp around manholes and aviation ground lighting fixtures will depend upon, respectively:

- the services located in the manhole and the importance of maintaining immediate access to them; and
- the needs of the Aerodrome to maintain all ground lighting fixtures operational.

Agreement should be sought with the Aerodrome Authority/Station staff.

Z.11.3 Typical values that can be used in sub-Clauses 7.23.4 to 7.23.6 subject to agreement with the Aerodrome Authority/Station staff are as given in Table Z.5.

Z.12 ROUTINE TESTING

Routine testing of designed Hot Rolled Asphalt for air voids content and of binder course Asphalt Concrete (Macadam) for percentage refusal density throughout the construction period may be omitted for small works only.

Z.13 TEMPERATURE OF SURFACING

In assessing the temperature of the freshly laid surfacing, 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 40 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.14 REGULARITY FOR TAKING CORE SAMPLES

The regularity for taking cores for monitoring should be a minimum of one every 1000 m². For small works, the regularity may have to be increased to obtain sufficient results to make an assessment on.

Z.15 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.

TABLE Z.5 TYPICAL VALUES FOR TEMPORARY RAMPS

	Sub-Clause 7.23.4	Sub-Clause 7.23.5	Sub-Clause 7.23.6
Distance from runway centre line: Limit of applicability of Sub-Clause Minimum for transverse ramps	 22.5 m 10.0 m	 22.5 m †	 n/a n/a
Maximum longitudinal gradient Maximum transverse gradient	1.0 % * 2.0 %	2.0 % * 2.5 %	2.0 % * 2.5 %
Minimum spacing of ramps Min. thickness of ramp material Maximum depth of ramp	110 m 40 mm 75 mm	† 40 mm †	n/a n/a n/a

* If the existing longitudinal gradient is at, or close to, the maximum permissible in the standard criterion then, depending on the direction of working, it may be necessary to obtain dispensation from the Aerodrome Authority/Station staff to increase this value for temporary ramps.

† Not normally applicable, but otherwise to be agreed with the Aerodrome Authority/Station staff on a job specific basis.

References

Defence Estate, Ministry of Defence

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 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 58		1984	Bitumen and bituminous binders – Sampling bituminous binders
BS EN 197			Cement
	Part 1	2000	Composition, specifications and conformity criteria for common cements
BS EN 459			Building lime
	Part 1	2001	Definitions, specifications and conformity criteria
BS EN 933			Tests for geometrical properties of aggregates
	Part 2	1996	Determination of particle size – Test sieves, nominal size of apertures
	Part 3	1997	Determination of particle size – Flakiness
BS EN 1097			Test for mechanical and physical properties of aggregates
	Part 2	1998	Methods for the determination of resistance to fragmentation
	Part 3	1998	Methods for the determination of loose bulk density and voids
	Part 6	2000	Determination of particle density and water absorption
	Part 8	2000	Determination of the polished stone value
BS EN 1367			Test for thermal and freezing and thawing properties of aggregates
	Part 2	1998	Magnesium sulfate test
BS EN 1744			Tests for chemical properties of aggregates
	Part 1	1998	Chemical analysis
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	2000	Soluble binder content
	Part 2	2002	Determination of particle size distribution
	Part 5	2002	Determination of the maximum density
	Part 6	2003	Determination of bulk density of bituminous specimens
	Part 8	2003	Determination of voids characteristics of bituminous specimen
	Part 11	2003	Affinity between aggregates and binder
	Part 13	2000	Temperature measurement
	Part 18	2004	Binder drainage
	Part 27	2000	Sampling
	Part 34	2004	Marshall test
	Part 36	2003	Thickness of a bituminous pavement
BS EN 13036			Road & Airfield Characteristics – Test methods
	Part 7	2003	Method of measuring surface irregularities: The straightedge test
BS EN 13043		2002	Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas
BS EN 13808		2005	Bitumen and bituminous binders – Framework for specifying cationic bitumen emulsions
BS EN 13108			Bituminous mixtures – Material specification
	Part 1	2006	Asphalt concrete
	Part 4	2006	Hot rolled asphalt
	Part 8	2006	Porous asphalt
	Part 20	2006	Type testing of asphalt mixes
	Part 21	2006	Factory production control
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 6691		2007	Asphalt – Guidance on the use of BS EN 13108 “Bituminousd Mixtures – Material specification”

Her Majesty’s Stationery Office

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

Civil Aviation Authority

CAP 168	Licensing of Aerodromes