**SECTION VII - PROJECT SPECIFICATIONS**

Table of Contents

[1. GENERAL 4](#_Toc93473996)

[1.1. BRITISH STANDARDS 4](#_Toc93473997)

[2. MOBILIZATION AND DEMOBILIZATION 5](#_Toc93473998)

[2.1 SCOPE OF WORKS 5](#_Toc93473999)

[3. TEMPORARY FACILITIES 6](#_Toc93474000)

[3.1 SCOPE OF WORKS 6](#_Toc93474002)

[3.2 PROVISIONS AND REQUIREMENTS 6](#_Toc93474003)

[4. SITE EXPENSES 8](#_Toc93474004)

[4.1 SCOPE OF WORKS 8](#_Toc93474006)

[4.2 PROVISIONS AND REQUIREMENTS 8](#_Toc93474007)

[5. ENVIRONMENTAL REQUIREMENTS 9](#_Toc93474008)

[5.1 INTRODUCTION 9](#_Toc93474010)

[5.2 FEEDBACK MONITORING 9](#_Toc93474011)

[5.3 OPERATIONAL KEY CRITERIA FOR ACCEPTABLE ENVIRONMENTAL IMPACT 9](#_Toc93474012)

[5.4 ENVIRONMENTAL OBLIGATIONS 10](#_Toc93474013)

[5.5 SUBJECT OF ENVIRONMENTAL CONCERNS 10](#_Toc93474014)

[6. SURVEY AND SETTING OUT 11](#_Toc93474015)

[6.1 THE CONTRACTOR'S SETTING OUT 11](#_Toc93474017)

[6.2 SURVEY OF SEA BED – “IN SURVEY” 11](#_Toc93474018)

[7. DREDGING, RECLAMATION AND EARTH WORKS 12](#_Toc93474019)

[7.1 SCOPE OF WORKS 12](#_Toc93474021)

[7.2 REFERENCES 13](#_Toc93474022)

[7.3 UTILIZATION OF DREDGED MATERIALS 13](#_Toc93474023)

[7.4 MATERIALS 13](#_Toc93474024)

[7.5 TESTING OF MATERIALS 14](#_Toc93474025)

[7.6 WORKMANSHIP 14](#_Toc93474026)

[7.7 TOLERANCES 15](#_Toc93474029)

[7.8 INSPECTION 16](#_Toc93474030)

[8. BREAKWATERS AND REVETMENTS 17](#_Toc93474033)

[8.1 SCOPE OF WORKS 17](#_Toc93474035)

[8.2 MATERIALS 17](#_Toc93474036)

[8.3 WORKMANSHIP 20](#_Toc93474044)

[9. TACK COAT 23](#_Toc93474050)

[9.1 DESCRIPTION 23](#_Toc93474052)

[9.2 MATERIAL REQUIREMENTS FOR TACK COAT 23](#_Toc93474053)

[9.3 CONSTRUCTION REQUIREMENTS FOR TACK COAT 23](#_Toc93474055)

[10. PRIME COAT 26](#_Toc93474062)

[11. ASPHALT PAVING 29](#_Toc93474076)

[11.1 REFERENCES 29](#_Toc93474078)

[11.2 FULL PAYMENT 31](#_Toc93474079)

[11.3 PERCENT PAYMENT 31](#_Toc93474082)

[11.4 MAT AND JOINT DENSITIES 31](#_Toc93474083)

[11.5 PAY FACTOR BASED ON IN-PLACE DENSITY 32](#_Toc93474084)

[11.6 PAYMENT ADJUSTMENT FOR SMOOTHNESS 33](#_Toc93474085)

[11.7 LABORATORY AIR VOIDS AND THEORETICAL MAXIMUM DENSITY 34](#_Toc93474088)

[11.8 MEAN ABSOLUTE DEVIATION 34](#_Toc93474089)

[11.9 PAY ADJUSTMENT BASED ON GRADE 34](#_Toc93474090)

[11.10 SYSTEM DESCRIPTION 35](#_Toc93474091)

[11.11 ASPHALT MIXING PLANT 35](#_Toc93474092)

[11.12 HAULING EQUIPMENT 36](#_Toc93474093)

[11.13 MATERIAL TRANSFER VEHICLE (MTV) 36](#_Toc93474094)

[11.14 ASPHALT PAVERS 36](#_Toc93474095)

[11.15 SUBMITTALS 37](#_Toc93474099)

[11.16 QUALITY ASSURANCE 37](#_Toc93474100)

[11.17 ENVIRONMENTAL REQUIREMENTS 40](#_Toc93474107)

[11.18 AGGREGATES 41](#_Toc93474108)

[11.19 ASPHALT CEMENT BINDER 42](#_Toc93474113)

[11.20 MIX DESIGN 43](#_Toc93474114)

[11.21 EXECUTION 45](#_Toc93474117)

[11.22 CONTRACTOR QUALITY CONTROL 45](#_Toc93474118)

[11.23 PREPARATION OF ASPHALT BINDER MATERIAL 50](#_Toc93474134)

[11.24 PREPARATION OF MINERAL AGGREGATE 50](#_Toc93474135)

[11.25 PREPARATION OF HOT-MIX ASPHALT MIXTURE 50](#_Toc93474136)

[11.26 PREPARATION OF THE UNDERLYING SURFACE 50](#_Toc93474137)

[11.27 TEST SECTION 50](#_Toc93474138)

[11.28 TESTING LABORATORY 52](#_Toc93474141)

[11.29 TRANSPORTING AND PLACING 52](#_Toc93474142)

[11.30 COMPACTION OF MIXTURE 53](#_Toc93474145)

[11.31 JOINTS 53](#_Toc93474151)

[12. AIRFIELD PAINTING 55](#_Toc93474161)

[12.1 GENERAL 55](#_Toc93474163)

[12.2 REFERENCES 55](#_Toc93474164)

[12.3 SUBMITTALS 55](#_Toc93474165)

[12.4 DELIVERY AND STORAGE 56](#_Toc93474166)

[12.5 WEATHER LIMITATIONS 56](#_Toc93474167)

[12.6 EQUIPMENT 56](#_Toc93474168)

[12.7 WEATHER LIMITATIONS FOR REMOVAL 58](#_Toc93474173)

[12.8 QUALIFICATIONS FOR AIRFIELD MARKING 58](#_Toc93474174)

[12.9 PRODUCTS 59](#_Toc93474176)

[12.10 EXECUTION 59](#_Toc93474178)

[12.11 FIELD TESTING, INSPECTION, AND DEMONSTRATIONS 60](#_Toc93474185)

[12.12 TRAFFIC CONTROL AND PROTECTION 61](#_Toc93474194)

[12.13 QUALITY ASSURANCE 62](#_Toc93474195)

[13. BOUNDARY FENCING 63](#_Toc93474198)

[13.1 GENERAL 63](#_Toc93474200)

[13.2 TECHNICAL DESCRIPTION 63](#_Toc93474201)



# GENERAL

# BRITISH STANDARDS

Some or all of the following British Standards and Codes of Practice are referred to in this Specification and are deemed to form part thereof, but approved equivalent foreign standards may be complied with instead. The list is included here for convenience, but may not be exhaustive. The Contractor should refer to the text of the project specific Specification.

Copies of the publications listed below can be obtained from-

British Standards Institution Information,

Services and Marketing

Linford Wood

Milton Keynes

MK14 6LE

England

Telephone: 01908 320033

For brevity, some titles are not reproduced in full.

BS4 Structural steel sections

BS12 Portland cement

BS63 Road aggregates

BS65 Vitrified clay pipes, fittings, joints and ducts

BS76 Tars for road purposes

EN124 Gully tops and manhole tops for vehicular and pedestrian areas. Design requirements, type testing, marking, quality control

EN146 Portland blast furnace cements

DD21 3 Method for determination of the indirect tensile stiffness modulus of bituminous mixtures

EN295 Vitrified clay pipes and fittings and pipe joints for drains and sewers

BS381C Colours for identifying, coding and special purposes

BS397 Industrial safety helmets

BS410 Test sieves

BS434 Bitumen road emulsions (anionic and cationic)

BS443 Testing zinc coatings on steel wire and for quality requirements

BS476 Fire tests on building materials and structures

BS594 Rolled asphalt for roads and other paved areas

BS718 Density hydrometers

BS729 Hot dip galvanized coatings on iron and steel articles

BS743 Materials for damp proof courses

BS8I2 Testing aggregates

BS873 Road traffic signs and internally illuminated bollards

BS882 Aggregates from natural sources for concrete

BS890 Building limes

BS903 Physical testing of rubber

BS1047 Air-cooled blast furnace slag, aggregate for use in construction

BS1142 Fibre building boards

BS1199 Building sands from natural sources

# MOBILIZATION AND DEMOBILIZATION

# SCOPE OF WORKS

1. This includes mobilization and demobilization of all constructional plant, and equipment, including testing equipment deemed necessary to complete the Works
2. The Contractor shall mobilize and deliver all constructional plant and equipment required to undertake the works and all the materials for any temporary facilities required.
3. Mobilization shall include the importation and transportation to the job-site of all equipment, constructional plant and all necessary items for the execution and completion of the works. Mobilization shall also be deemed to include any site clearance work that is necessary.
4. It is the responsibility of the Contractor to ensure that all plant and equipment brought for the project are in working condition. In the event of a breakdown of constructional plant/equipment when it is beyond the ability of the personnel or when there are insufficient tools or materials at site to affect a repair in a reasonable time, the Contractor will be instructed to provide a replacement for the same at no additional cost (including mobilization) to the Owner. In such a case, no extension will be given for completion of Works. The Contractor may also be required to remove the broken plant from the Site if it is hindering the completion of any components of the Project.
5. Demobilization shall include the removal from site of all constructional plant and equipment and the removal of all temporary facilities erected by the Contractor for his convenience.
6. Mobilization costs of plant and equipment referred to herein shall be paid after the Consultant / Engineer has certified and accepted that all equipment listed for the Project and material for Temporary Works have been delivered to site or part three off, as the requirement deemed necessary.
7. Mobilization and demobilization costs have been specified for each Airport separately. The contractor may be required to provide a breakdown for the mobilization costs if in the opinion of the Consultant / Engineer, the item appears to be unbalanced or for any budgetary constraints that may have by the Owner.
8. Demobilization costs shall be paid after the Consultant / Engineer has certified and accepted that all equipment listed or as agreed has been removed form site and all temporary facilities dismantled and removed from the Site.

# TEMPORARY FACILITIES



# SCOPE OF WORKS

This item consists of the following:

1. Furnishing, erection and maintenance of all site facilities such as Contractor’s camp and yard, temporary utilities and services, safety provisions, temporary roads and temporary navigations aids required for the execution of the Works as specified below;
2. Erection of all construction plant and equipment after being delivered to site; and,
3. Disassembly and removal of all site facilities, construction plant and equipment from the site for de-mobilization.
4. The accomodation has been removed from the site. There is no accomodation. Contractor is responsible for their own accomodation and any costs associated with it.
5. based on the EIA report, all garbage must be removed from the site or burned, and is not allowed to be buried. There is no defined disposal area as this is a "fill" project. The trees need to be removed and can be burned or cut up for fire wood. Please refer to the EIA report.
6. There are no current project offices. The previous campsite has been removed.

# PROVISIONS AND REQUIREMENTS

1. The Contractor shall be responsible for temporary facilities, utilities, services and safeguards as required under the Contract.
2. Temporary and permanent utility facilities used for the construction work shall be adequate for the intended use and not be overloaded or otherwise used or arranged in any manner, which will endanger persons, premises or the works themselves.
3. The contractor needs to price their own power, water and sewage for the staff and employees.
4. Upon completion of the Works, unless otherwise directed or required, all site facilities, installations, utility services, constructional plant and equipment shall be disconnected, disassembled and removed from the Site.
5. The camp area shall be kept in a clean and tidy condition throughout the construction period. The Consultant / Engineer shall have the authority to order periodical clearings at the Contractor’s cost, provided that the site for disposing of Garbage / Debris allocated by the owner and is within the stipulated distance from the work site.
6. All accommodation, latrine and shower facilities and canteen, shall conform in every respect with regulations imposed by local health authorities.
7. The Contractor shall provide and maintain the necessary equipment as specified in contract and accessories, for construction use for the entire construction period.
8. The Contractor shall be responsible to arrange their own independent water, electricity etc. as required executing the work throughout the project. Hookups to the Airport networks will not be permitted.
9. The Contractor shall provide and maintain a temporary electricity service and distribution lines of adequate capacity for power, lighting and other construction needs.
10. All utility systems shall conform to local codes and regulations.
11. All costs associated with the provision of utilities shall be borne by the Contractor.
12. The Contractor shall maintain appropriate safety measures on site and around the work areas.
13. The Contractor shall adhere to all local codes and regulations with respect to work-safety.
14. The Contractor shall maintain appropriate notices and safety measures to warn public of dangers on site.
15. The Contractor shall provide and maintain any temporary roads and access ways Project Site when required.

# SITE EXPENSES



# SCOPE OF WORKS

This item shall cover all expenses for the staff related to the management of the site and office.

# PROVISIONS AND REQUIREMENTS

1. The site costs shall include but not be limited to the following:
2. Site office costs, including basic staff salary, overtime payments, bonuses, travel, medical fees, overseas and other allowances. Costs should also allow for stationery and office equipment.
3. Communication Facilities, to include the costs telephone, as well as walkie-talkie communication between the job site proper and the site office. Communication costs for the Contractor’s site office shall also be included here.
4. Site safety costs to include all matters related to workplace health and safety issue.
5. Site security costs.
6. First aid, to include all reasonable first aid supplies and equipment.
7. Insurance, costs of insuring the works and temporary facilities as required.
8. Waste management, to include all costs incurred in keeping the site clean.

# ENVIRONMENTAL REQUIREMENTS



# INTRODUCTION

Environmental Impact Assessment shall be prepared to the requirements of The Ministry of Environment by the Employer. It is Employer’s requirement to prepare all documentation to the requirement of The Ministry of Environment including any monitoring that maybe required and to obtain all necessary permits. The contractor shall follow all Environmental laws and regulations of Maldives in design and during implementation of the project.

The proposed construction works are, under conditions given below, expected to have only minor impact on the surrounding coastal zone.

However, this is to be expected only if relevant mitigation measures are incorporated during the construction phase as well as during the long-term operational period. In this section the objectives, obligations and criteria of such mitigation measures will be outlined.

# FEEDBACK MONITORING

During the period of dredging and reclamation, working activities may have adverse effects on the coral reef community and the terrestrial coastal zone. One of the main activities will be the dredging of basin for the reclamation.

The most widespread and visible consequence of dredging and excavation is the generation of suspended sediments and turbidly, both of which affect the corals adversely.

Other main activities with possible adverse effects are the disposal of the dredge spoils, site clearance on land and transport on land and at sea.

The Contractor shall during the construction period carry out an environmental control programme following a feedback design in order to ensure that adverse effects are detected before they become irreversible; The basic concept of a feedback monitoring program is that selected environmental key criteria, for instance live coral coverage or sedimentation rates, are observed regularly during the construction phase. If response, based on impact criteria indicating thresholds severe but not irreversible levels of impact, are crossed, steps of avoidance shall be enforced.

A metrology description for the environmental migration measures proposed for the environmental control programme shall be prepared by the Contractor for the Owners approval prior to the implementation of the environmental control programme and prior to any construction works on site.

The environmental key criteria and possible response thresholds are specified in the following sections.

# OPERATIONAL KEY CRITERIA FOR ACCEPTABLE ENVIRONMENTAL IMPACT

During construction, the response on the following operational key criteria for acceptable environmental impact shall be measured at the perimeter of the construction zone. The perimeter of the construction zone shall be clearly identified at site and shall be approved by the Consultant / Engineer before taking of the measurements.

The Response Threshold (RT) for the operational key criteria shall be:

1. Live coral coverage; No significant decrease shall occur at selected sites, representative of the coral reef community in the area, compared to likewise representative reference sites.
2. Concentration of suspended solids in surface waters over reef slope: less than 10 mg/l above ambient concentration during daylight hours and less than 20 mg/l at night.
3. Sedimentation rate on coral reef slope (5-10 m depth zone): less than 10 mg/cm2 day.

# ENVIRONMENTAL OBLIGATIONS

The Contractor has the obligations mentioned below. He shall address the issues in the methodology description for his environmental mitigation measures designed to meet the criteria mentioned in section 4.3 and the subjects listen in section 4.5:

1. To describe methodology of, carry out, an appropriate feedback-monitoring programme, and see that the response thresholds given above are not surpassed. For this programme detailed and currently updated dredging schedules should be given currently calculate the amount of spill.
2. To describe, how possible adverse impacts related to subjects listed in section 4.5 are planned to be migrated.
3. Establish emergency measures and procedures for accidental spills of hazardous substances during the construction period.
4. Make an assessment of the possible impact of any temporary physical structure on the hydraulic situation and any possible erosion following this, and take mitigation constructions into the planning of the dredging and reclamation.
5. Report to the Owner.

# SUBJECT OF ENVIRONMENTAL CONCERNS

The following list included subjects considered of environmental relevance for the construction or part thereof. The list shall be considered as guideline for the contractor in his selection of mitigating measures of relevance for his selected construction methods and they shall be subject to adjustment when experience obtained during the environmental feedback-monitoring program should call for this.

1. Dredged material. Dredged material to be used for consumption purposes must not be deposited on the reef flats or on landsides areas outside the limit of working areas. The excavation scheme should be set up in such a way that slurry plumes are minimized as much as possible on and in the vicinity of the reefs.
2. Surface run off. During the construction period, surface Water caused by heavy rainfall may carry larger amounts of sediment to the reefs. Such surface run off shall be minimized.
3. Fresh water supplies for any construction purpose or Labor force are to be brought in by the Contractor.
4. Solid waste and sewage: as a main principle, all waste is to be removed from the island before any nuisance of dust, smell or visibility is generated.
5. Waste: waste oil from machinery, bilge pumping or other use as well as any waste of hazardous substances connected to the construction activities is to be collected and transported as directed by the Consultant / Engineer.
6. Dumping: No dumping of any kind from support vessels are allowed on the reef or in the upstream waters of the island (and should otherwise follow any national regulations on dumping.
7. Dust nuisance: Activities creating dust nuisance are to be conducts under wind conditions that can the dot out to sea.
8. Anchoring of carrier and supporting ships and vessels: anchor is not allowed to be dropped on the reef crest or reef slope outside the working areas limit.

# SURVEY AND SETTING OUT



# THE CONTRACTOR'S SETTING OUT

Ground markers shall be established for the above-mentioned main reference lines. The Contractor shall protect, and maintain these permanent pound markers during the period of the Contract. The Contractor shall install, protect, and maintain during the period of the Contract, such additional permanent and/or temporary pound markers as are necessary for the execution of the Works, or as required by the Consultant / Engineer.

Sufficient working space shall be available around each pound marker to enable the Survey instruments to be erected and operated.

Further requirements regarding setting out, survey, etc. of the structures are stated in the specifications of the structures.

# SURVEY OF SEA BED – “IN SURVEY”

Initial surveying of the seabed are required prior to any dredging or reclamation works.

The areas in connection with in- and out-surveys, will extend to cover at least 100m of the seabed beyond all dredging and reclamation limits in addition to the actual dredging/reclamation area.

The Contractor shall provide all necessary equipment, instruments, Labor and crew necessary. The survey shall be made in a grid of maximum 10m spacing between the survey lines in both directions. The survey shall be detailed sufficiently for the recording of any major irregularities in the surveyed surface.

The Contractor shall shortly before the execution of any substantial survey work carry out calibration of is survey equipment in order to document that his setup can meet the specified requirements to surveys.

# DREDGING, RECLAMATION AND EARTH WORKS



# SCOPE OF WORKS

The works decided in this section of the specifications comprise dredging for:

Dredging areas, dredging depths and dredging limits are specified in the approved drawing layouts & Cross Section of Reclamation.

The specified works comprise in addition use of dredged materials for fill in reclamation areas and other parts of the stockpile area specified by the Consultant / Engineer for utilization elsewhere on the island.

The dredging works consists of excavation of coral materials below the existing seabed regardless of the nature of the materials encountered during the course of dredging. Disposal of dredged material at either Stockpile or as fill, backfill, reclamation filling or core and filter materials in Runway structures, shall be carried out in accordance with these specifications and in compliance with the drawings as directed by the Consultant / Engineer.

The works include supply of all materials and the provision of all Labor, plant and equipment required for the actual dredging, reclamation and other reuse of dredged materials as well as for all preparatory works surveys and testing required for the proper execution and completion of the works. In addition, the works shall include all required measures for reduction of the environmental impact of the dredging and be included in the Contractors Environmental Control Programme according to EIA report.

Maafaru has an existing harbor that is disconnected from the airport. Materials may be delivered at this harbor, however any damage to the existing harbor facilites will need to be repaired at contractors cost. Also, any damage to the roads leading to the airport from the harbor will need to be maintained and repaired as needed. Also, most importantly, the village has pedestrian traffic and motorbikes frequently using the roads. Any material trucks from the harbor will need to be monitored when coming to the airport to ensure safety.

The internal road inside the airport are ashphalt with curbs. The island road network is dirt. Before work begins, we will require a report showing the condtion of these roads before construction starts. The only available roads are the frontage road next to the fence and the main road coming from the harbor. Even when using these roads, spotters must be deployed to ensure nobody drives out from the cross streets when construction equipment is present. The internal streets (dirt) will not be allowed for transportation without the express written consent of the island council. There are many pedestrians and small motorbikes and these roads cannot be used. While the internal roads are of substantial strength they are not designed for heavy loads only small pickups and personnel vehicles.

Note: The EIA report was produced for an expanded scope. The quantities in the EIA report are based on this expanded scope. The current tender has a smaller reclaimation quantity than the EIA report. Contractor to verify exact quanity for their proposal. Use the RWA-MAP-SKT-066 for the current quantities and location of the scope in question.

The EIA report has all the available Bathymetric surveys. If any additional studies are required, the contractor shall make appropriate arrangements to investigate.

The only studies that have been performed are in the EIA report. Any additional studies required will be the responsibility of the contractor such as, Meterological and hydrological conditions: wind, wave, current and design water level.

# REFERENCES

The following Standards and Codes of Practice are referred to in this specification and fully or partly incorporated herein as specified:

1. Designation Title of Standards / Code of Practice
2. BS 812 Sampling and Testing of Mineral Aggregates, Sand and Fillers
3. BS 6349, Part 5 Maritime structures. Code of Practice for dredging and land reclamation
4. CIRIA/CUR: Manuel on the use of rock in coastal and shoreline Consultant / Engineering. Report no. 83/154
5. Second Addendum to the EIA for the proposed International Airport Development Project at Mafaaru, Noonu Atoll, prepared by CDE

# UTILIZATION OF DREDGED MATERIALS

All suitable material removed from the dredging areas shall, subject to the approval by the Consultant / Engineer, either be initially sorted by excavator and manual Labor or by means of grizzly plant and/or hauled to a stockpile for screening, or shall be used for reclamation, subgrade for paving work, backfill for structures, or for other purposes shown on the drawings or as directed. Materials, which are otherwise suitable but contain excess moisture shall be processed and utilized for fill.

Material from the dredging determined by the Consultant / Engineer as suitable for slope protection in revetments, filter or core material or other purposes shall be conserved and utilized as directed.

Materials from the dredging, as determined by the Consultant / Engineer, to be used in the Works shall be disposed of at the designated stockpile areas or other areas as approved by the Consultant / Engineer. Unless otherwise specified, compaction will not be required. However, the materials taken to disposal areas shall be levelled and shaped attractively to the approval by the Consultant / Engineer.

All excess material shall be delivered for other utilization on the island or disposed of as directed. It is the Contractor's responsibility to determine if sufficient material is available for the completion of the works before delivering or disposing of any materials.

# MATERIALS

The density of coral sand may be ranging from 23 to 26 kN/m3. It is estimated that the average density for coral sand and gravel from Lagoon is 24 kN/m3. The density for coral varies considerably with the type and quality of the coral. It is estimated to 22 kN/m3. The maximum dry density of dredged materials shall not be less than 1.7 g/cm3 for reclamation of land. Actual geotechnical parameters including specific gravity and density of dredged materials reused in the reclaimed structures shall be verified according to the function of the materials used in the structures and the specified quality requirements.

# TESTING OF MATERIALS

Testing of dredged material used as fill for general reclamation and as backfill shall be in accordance with the Specification for Highway Works: 1994 - Department of Transport, London.

Testing will further be required when the dredged material is reused in the construction works. This testing shall provide sufficient documentation of the material quality and ensure fulfilment of all requirements specified for the material when used in the actual structures.

# WORKMANSHIP

# Setting out of Dredging Works

All boundaries of dredging areas shall be established on the site by installation of marked in the appropriate reference lines or electronically established subject to the Consultant / Engineer's approval.

Markers shall be robust and clearly visible from all parts of the repairing area. All setting out of dredging works shall be carried out by the Contractor.

# Execution of dredging

All dredging sort and earthworks shall be carried out in compliance with the criteria and environmental mitigating measures outlined in EIA Report.

Prior to dredging or disposal of materials in any area, such area shall be cleared and its surface level shall be surveyed in the presence of the Consultant / Engineer. The survey shall be made sounding in a grid of maximum 10m spacing between the surrey lines in both directions.

The survey shall be detailed sufficiently for the recording of any major irregularities in the surveyed surface.

All materials dredged as specified on the drawings or as directed by the Consultant / Engineer shall be utilized as specified in 1.2.2

Dredging shall be carried out by using a backhoe, cutter suction dredger or other dredging equipment with sufficient capacity to dredge the dredging classes 1 thorough 3.

If the Contractor decides upon using a cutter suction dredger or similar equipment, he shall be obligated to familiarize himself with the local conditions on shore to prepare for the necessary arrangements of the spoiling area. Reference is moreover made to the environmental requirements as described in EIA report.

Pre-splitting methods for dredging in soils of class 4 shall be subject to the Consultant / Engineers acceptance. The Contractor is required to provide detailed dredging plans and adequate descriptions of solution and mitigating measures when it is found that pre-splitting is require; for the dredging. It shall be noted that blasting is not encouraged from an environmental point of view and it shall only be allowed after specify permission from the Government of the Maldives has been obtained.

The Consultant / Engineer may order the method of pre-splitting to be stopped if the materials encountered no longer warrant it.

The supply, placement and compaction of fill and backfill specified on Drawing No. shall be in accordance with the Specification for Highway Works: 1994 - Department of Transport, London, unless otherwise permitted, fills and backfill materials from dredging work shall contain no organic or other deleterious matter. Rock or other solid matter may be placed in a reclamation area subject to the Consultant / Engineer's approval. Bulky materials shall not be used as reclamation materials.

For reclamation below HIGHEST WATER LEVEL, dredged materials shall be placed directly in reclamation areas as shown on the Drawings. Large pieces of coral deposited in reclamation areas shall be spread over the full width of the reclamation area with sufficient small coral pieces or other fine material used to fill the voids in order to produce a dense, compact reclamation.

For reclamation above the HIGHEST WATER LEVEL, coral material shall be placed in level, horizontal layers not exceeding 0.25 meter (loose measurement) thick and be compacted as specified before the next layer is placed. Effective spreading equipment shall be used on each lift to obtain a uniform thickness prior to compacting. As the compaction of each layer progresses, levelling and adjustments shall be performed continuously to ensure uniform density. The degree of compaction shall not be less than 95%.

Material containing more than 25 per cent of large pieces of coral with the greatest diameter of more than 150 mm, and which cannot be placed in layers of the prescribed thickness without crushing, pulverizing or further breaking down the pieces, shall be removed and used for Some other purpose.

The contractor, at their discretion may use A TSHD or CSD. If a TSHD is desired then alternate borrow sites may be used other than what was described in the EIA. However, if the contractor wishes to use another borrow site, the contractor is responsible for any additional EIA studies, surveys and testing.

# TOLERANCES

Dredging shall be carried out to the designated depths in all parts of dredging areas with a maximum permissible over dredging of 0.3 m below the specified level (Maximum Depth) unless noted otherwise by or as agreed with the Consultant / Engineer.

Excess dredging below Maximum Depth is not accepted unless approved by the Consultant / Engineer and shall be replaced by suitable material at no cost to the Owner.

The tolerances relative to the Specified Depth for dredging of areas in general is +0mm to 300mm.

The natural unprotected profile of slopes resulting from the dredging has in general been indicated as 1:3 reflecting the expected result of dredging in sand and gravel exposed to moderate wave impact only.

# INSPECTION

# General

The Contractor shall, prior to commencement and after completion of dredging works carry out surveys of the respective areas (in-survey and out-survey)

# 

# In-survey of Existing Bottom or Ground

An area covering the entire working area, as shown in ref dwg shall be surveyed.

Maps and "raw" data shall be submitted to the Consultant / Engineer not later than one week after the scheduled execution of the in-survey.

# BREAKWATERS AND REVETMENTS



# SCOPE OF WORKS

The works specified in this Chapter of the Specifications compromises the construction of Breakwaters and revetments.

The works include supply or dredging of all materials required. According to Drawings, the specifications and the instructions from the Employer, the Contractor shall furnish all materials, equipment, tools, and Labor which are required for the construction, testing, measurement and completion of the works.

References: The following Standards and Codes of Practice are referred to in this specification:

Designation Title of Standards/Codes of Practice

1. BS 812 Parts 100-103 Sampling and Testing of Mineral Aggregates, Sand and Fillers
2. BS 6349 Part 1, Part 2 Maritime Structures
3. ISO 5081 Textiles- Woven Fabrics – Determination of Breaking Strength and Elongation (Strip Method)
4. CEM Coastal Engineering Manual. U.S. Army Corps of Engineers.

# MATERIALS

# General

All stone materials specified in the following as stone class I, II and III shall be of granite, basalt or equal igneous rock. The material shall have an apparent specific gravity of not less than 26KN/m3 with 90% of the stones having a density of at least 25KN/m3 when saturated and surface dry, according to BS 812.

The average water absorption of quarry stone must be less than 2% and the water absorption of nine of the individual stones less than 2.5%.

The loss for magnesium sulphate soundness test must be less than 12% for all rock.

Deleterious secondary minerals shall not be present. For all rock types, this is taken to be indicated by Methylene Blue absorption values of less than (0.7 g/100g).

Average point load index in the planar direction of the most pronounced layering should any visible anisotropy exist and for sampling, testing and reporting in accordance with the ISRM 1986 recommended method must be at least 4.0 Mpa with the average minus the standard deviation of the point load index of at least 3.0 Mpa.

The mill abrasion resistance index must be less than 0.004.

Quarried rock shall not contain visually observable or chemically detectable impurities or foreign matters in such quantities that these are damaging for the constructive application of the quarried stone or for the environment in which the quarried stone is applied.

All stone materials specified in the following as stone class IV, V, VI and VII may as an alternative to the above-mentioned rock be obtained from sound coral rock or beach rock. The material shall have an apparent specific gravity of not less than 24KN/m3 when saturated and surface dry.

The stone materials shall be sound, compact, hard, durable and resistant to action of seawater and free of cracks and fissures determined for the proper performance of the material in quest on.

All fill material shall be dredge and stored to suit the specific demands in the structure.

# Source of Stone Materials

The contractor shall select the source or sources of rock and shall be responsible for quarrying, supply and transport to the Site of suitable rock in sufficient quantities.

The suitability of the source or sources of rock selected by the Contractor shall be subject to the approval of the Employer. Approval of the quarry is only supplementary to other requirement of the rock.

The Contractor shall submit for the approval of the Employer an experiences geologist’s determination of the type of stones based on visual inspection of 10 respective samples.

The coral rock or beach rock dredged may be used for stone classes IV, V, VI and VII if the testing shows it comply with these specifications.

# Classification of Stone Materials

Armor layer in the break waters and filters overlaying sand fill and unspecified coral rock fill shall be constructed from the following stone classes specifying the minimum mean weight (or size) and the lower and the upper limit.

Granite:

1. Weight range: 2t to 8t
2. Mean weight: Min. 4t
3. Weight range: 1t to 4t
4. Mean weight: Min. 2t
5. Weight range: 350 kg to 1400 kg
6. Mean weight: 700 kg.

Granite or coral rocks.

1. Weight range: 100 kg to 400 kg
2. Mean weight: 200 kg
3. V (filter): 150 – 300 mm
4. VI (filter): 75 – 150 mm
5. VII (filter): 50 – 100 mm

Stone materials shall be well graded between the specified limit and comply with the following filter criteria

*d85 ≥ D15/4*

*d15 ≥ D15/7*

*d50 ≥ D50/7*

In which d represents the finer material and D represents the coarser material. Dnn means that nn% of the material by weight passes a sieve having a square mesh width of D.

For stones used as Armor stones or filter stones, the following additional requirements shall apply:

1. The stones shall be rough and angular in shape
2. The maximum stone dimension (length) shall not exceed 2.5 times the minimum dimension (thickness) of the stone.

# Testing of Materials

Inspection and testing of rock materials shall be carried out as an integral part of the Contractor’s quality control programme with the objective to ensure the quality of all parts of the work. The requirement in the following subsection shall be understood as minimum requirements. Extended testing of properties shall always be when opening new quarry fronts and in connection with any significant change in the material properties from an existing quarry front.

The test specifications given in the following subsections shall be understood as ‘State of art’ specifications. Other test standards may, subject to the Engineers acceptance, be introduced for compliance with the Contractor’s test procedures or procedures used by existing procedures. Test procedures related to possible stockpiling of rock materials near the construction site and in connection with placement of materials in the permanent works are not covered by this section of the Specification.

# Basic Procedures

From each quarry front the following properties shall be tested and fully documented prior to commencement of any production, in connection with any significant change of materials in the opinion of the engineer and as a minimum for every 5,000 m3 of delivery (all classifications) from the quarry front should be tested for the following:

1. Density
2. Water absorption
3. Resistance to weathering
4. Resistance to impact
5. Resistance to abrasion

The tests shall be carried out in accordance with the test specification accepted by the Engineer.

# Testing of Stone Weights and Stone Gradation

The Contractor shall at any time during working hours at the direction of the Engineer carry out test weighing of stones and the determination of the gradation of stones as indicated below:

**Stone Class I, II and III**

Test weighing of Armor stones will be carried out at random. The Contractor shall include in his unit prices one control weighing per 80m3 of Armor stones. Stones, which do not meet the weight requirements shall not count.

**Stone Class IV and V**

A test of the weight distribution of stone classes IV and V will be carried out on a representative sample of not less than 3.0 m3, which is spread out on a clean, hard surface (e.g. a floor of wooden boards or a concrete floor), provided by the Contractor. The Engineer selects 10 largest and the 20 smallest stones are then weighed/measured individually.

The remaining stones are then weighed and counted and the mean weight determined. The Contractor shall include in his unit prices the cost of one weight distribution test as the one described above per 1,000 m3 of stones. Tests, which do not meet the requirements, shall not be counted.

**Stone Classes VI and VII**

A test of the weight distribution of the stones in classes VI and VII shall be carried out as described under Stone Classes IV and V above, except the sample shall not be less than 1.5 m3.

# Testing of Coral Rock and Beach Rock Durability

One durability test shall be made for each 1,000 m3 of coral rock and beach rock to be used as Stone Classes IV, V, VI and VII.

The test result shall be made available for the Engineer’s immediate approval.

# WORKMANSHIP

# Placing of Stone Materials

Placing of stones shall take place in a manner which will not damage the under laying layers of stones. When placing stones up to a theoretical boundary as defined by lines in the cross sections the Drawing, the Contractor shall aim at having the stones protrude the theoretical boundary over one third of its area.

The construction of rubble mound structures must be planned and carried out with due regard to the weather and sea conditions. The responsibility for the stability of the breakwaters and revetments under the various stages of completion rests solely with Contractor.

Construction of filters shall not commence prior to the Engineer’s acceptance of the fill and the filter materials. The responsibility for the stability and integrity of the breakwaters and revetments under the various stages of completion tests solely with Contractor. To protect the structures against the wave action the Contractor shall place a shield of stone material in front of the structures. The individual filter layers shall be built up and trimmed from the bottom in such a manner, that the underlying layer is completed before commencing the overlying layer. The filter materials shall be placed with caution in order to ensure that the underlying layers already completed will not by disturbed. All materials shall be placed and compacted firmly in such a manner that the filter materials will remain fixed at the site.

# Armor Stones

When completed the Armor layer shall be in a thoroughly stable condition and with the exposed surfaces reasonably uniform in appearance.

Haphazard dumping of Armor stones will not be permitted. Above level of –0.5m Armor stones shall be carefully place by crane. Below this level Armor stones – one piece at the time- may be dumped at the waterline immediately over their final position and care shall be taken to produce as dense and stable layer as possible.

Elongated stones shall be placed with their long axis perpendicular to the slope.

Voids in Armor layers shall not be filled with small rocks.

# Other Stones and Core Material

All materials not forming part of the Armor layers may be dumped, but undue segregation shall be prevented.

# Tolerances

At the time for completion, the following tolerances shall be respected unless otherwise indicated or directed by the Engineer.

Slope of core/fill ±0.1

Filter layer, thickness of individual layer +100/-50 mm

The surface of each layer shall be leveled before construction of the next layer in order to ensure that excess thickness of one layer shall not reduce the thickness of the next beyond the tolerance.

# Geotextiles

Geotextiles shall be porous, carpet-like materials, made from synthetic fibres. Geotextiles are used as a separation layer and shall be in the form of a thin permeable membrane.

The geotextile shall be of polypropylene filter fabric and shall be resistant to air, water, chemical and bacteriological attacks. The geotextile shall fulfill the International Classification (DIN 54307) Class 4. The fabric shall be manufactured with and preserve the following mechanical properties according to DIN 54307.

**Description Property**

Weight of Cloth Min. 300g/m2

Tensile strength in:

1. warp: Min. 20 kN/m
2. weft: Min. 20 kN/m

Elongation at break: 50%

1. warp: Min. 50%
2. weft: Min. Min. 3.3 kN

Penetration

# TACK COAT



# DESCRIPTION

This work shall consist of furnishing and applying slow setting emulsified asphalt tack coat to a previously placed asphaltic base course, an existing road surface, the surface of concrete bridge decks, approach slabs and other concrete surfaces receiving asphaltic concrete wearing course, to provide bond for a superimposed course, in accordance with these Standard Specifications and to the full width indicated on the Drawings or as directed by the Engineer.

# MATERIAL REQUIREMENTS FOR TACK COAT

# Emulsified Asphalt.

Emulsified asphalt shall be of the slow-setting Cationic or Anionic type of the CSS-1h or SS-1h grades respectively and shall comply with the requirements of British Standards and the FAA, Liquid and Emulsified Asphalt. The approved emulsion will be diluted with approximately an equal quantity of water and thoroughly mixed as directed by the Engineer. The diluted emulsion shall be applied at a maximum rate of 0.50 kg/M2 as indicated on the Drawings or as directed by the Engineer.

Specific gravity of asphaltic material shall be determined by ASTN D3142 standard which shall establish the kilograms per liter based on the specific gravity at 15.5°C for the material furnished.

# CONSTRUCTION REQUIREMENTS FOR TACK COAT

# Weather Limitations

Tack coat shall not be applied when the ambient temperature is less than 13°C nor during rain, fog, dust-storms or other unsuitable weather.

# Application Temperature

The application temperature for the diluted emulsified asphalt shall be between 10°C and 60°C as directed by the Engineer.

# Equipment Required

The equipment used by the Contractor shall include an asphalt distributor in accordance with British Standards and the FAA, Asphalt Distributor, as well as a power broom and a power blower. The power broom shall be self-propelled and equipped with a cylindrical, rotating nylon bristle brush of not less than 76 cm in diameter and not less than 1.82 m in length.

The brush shall be capable of being angled to the right and left with adjustable ground pressure. In addition, the Contractor shall supply and utilize efficient and approved equipment for diluting the emulsified asphalt with water.

# Surface Preparation

The full width of the surface to be treated shall be cleaned with a power broom or power blower to remove dust, dirt or other objectionable materials. All fatty or unsuitable patches, excess cracks or joint filler and all surplus bituminous material shall be corrected in accordance with the instructions of the Engineer. The surface shall be dry when treated.

# Method of Operation

Immediately after cleaning the surface, the diluted emulsified asphalt shall be applied by means of the distributor at the temperature and rate directed by the Engineer. Hand spraying of restricted, inaccessible areas is permitted, subject to the approval of the Engineer.

The mixing and placing of the asphaltic material shall progress at a rate so that contamination of previous lifts by dust and dirt and/or loss of bond capability shall not occur. If, in the opinion of the Engineer, loss of bond capability has taken place, an additional tack coat shall be applied to the surface of the previous lifts as directed by the Engineer.

The surface of structures, curbstones and other appurtenances adjacent to areas being treated shall be protected in such a manner as to prevent their being spattered or marred.

After application, the surface shall be allowed to dry until it is in a proper condition of tackiness to receive the superimposed course. Tack coat shall be applied only so far in advance of the superimposed course placement as is necessary to obtain this proper condition of tackiness. Until the superimposed course is placed, the Contractor shall protect the tack coat from damage.

The tack coat shall be uniformly applied with the distributor within twenty-four (24) hours preceding the placement of the covering course.

If the tack coat is unavoidably damaged by rain or dust, or paving operations delayed longer than twenty-four (24) hours, it shall be allowed to dry, shall be cleaned again by a power broom or power blower and, when directed by the Engineer, a subsequent light application of tack coat applied to the surface. No additional payment will be made by the Department for this work.

Where, in the opinion of the Engineer, a tack coat is not necessary between layers of freshly placed courses, he may by written direction eliminate the tack coat, in which case there will be no payment for tack coat for the areas concerned. Any cleaning required in these areas shall be considered to be included in the overlaying asphaltic concrete course and no separate payment will be made.

# Measurement and Payment

Measurement of tack coat will be by the net number of kilograms acceptably placed in accordance with the Drawings and these Standard Specifications or as directed by the Engineer.

Measurement for the tack coat will be for the total number of kilograms actually incorporated, determined by measuring devices (meters), and by accurately determining and controlling the amount of bituminous material being applied.

The number of kilograms furnished will be determined by weighing the material on scales furnished by and at the expense of the Contractor.

Payment for the Item, Tack Coat, will be incidental to the asphalt item in the Bills of Quantities, which shall be full compensation for materials, tools, equipment and labor necessary for the proper completion of the work.

When each lift in each course of asphaltic material is not placed expeditiously and the previous lift is exposed to dust and dirt and/or loses its bonding capability, the Engineer shall direct the Contractor to apply a tack coat to the surface of each lift, and no separate payment will be made.

# PRIME COAT



# DESCRIPTION

This work shall consist of furnishing and applying liquid asphalt prime coat and blotter material, if required, to previously prepared and approved absorbent surfaces (subgrade or granular base/subbase courses) immediately prior to placing superimposed construction in accordance with these Standard Specifications and to the full width indicated on the Drawings, or as required by field conditions. Such work shall be performed as specified herein or as directed by the Engineer.

# MATERIAL REQUIREMENTS FOR PRIME COAT

# Liquid Asphalt

Liquid asphalt shall be of the medium curing type MC-70 grade and shall comply with the requirements of the specifications given in British Standards and the FAA, Liquid and Emulsified Asphalts. The application rate shall be between 0.25 and 0.50 kg/M2 as indicated on the Drawings or as directed by the Engineer.

Specific gravity of asphaltic material shall be determined by ASTM D3142 standard which shall establish the kilograms per liter based on the specific gravity at 15.5°C for the material furnished.

# Blotter Material

Blotter material, if required, shall be clean natural sand and shall comply with the requirements of the specifications given in British Standards and the FAA, Fine Aggregate for Asphalt Works.

# CONSTRUCTION REQUIREMENTS

# Weather Limitations

Prime coat shall not be applied when the ambient temperature is less than 13°C nor during rain, fog, dust-storms or other unsuitable weather.

# Application Temperature

The application temperature for the MC-70 liquid asphalt shall be between 60°C and 85°C as directed by the Engineer.

# Equipment Required

The equipment used by the Contractor shall include an asphalt distributor in accordance with British Standards and the FAA, Asphalt Distributor, as well as a power broom and a power blower. The power broom shall be self-propelled and equipped with a cylindrical, rotating nylon bristle brush of not less than 76 cm in diameter and not less than 1.82 m in length.

The brush shall be capable of being angled to the right and left with adjustable ground pressure. Where necessary for the proper preparation of the surface, motor graders, rollers, water trucks, and other related equipment shall also be provided.

# Surface Preparation

Immediately before applying the prime coat, all loose dirt, earth and other objectionable material shall be removed from the surface with a power broom of approved design and/or a power blower as required, and any ruts, soft spots or unacceptable irregularities in the surface shall be repaired in accordance with the instructions of the Engineer.

If the Engineer so requires, the surface shall be lightly bladed and rolled immediately prior to the application of the prime coat, in which case brooming or blowing may not be required. The Engineer may direct that a light application of water be made just prior to the application of liquid asphalt to facilitate penetration. Priming will not be permitted by the Engineer when there is free water present on the surface.

# Method of Operation

After preparing the road surface as above, the liquid asphalt shall be applied by means of the distributor at the temperature and rate directed by the Engineer. Hand-spraying of restricted, inaccessible areas is permitted, subject to the approval of the Engineer.

The prime coat shall usually be applied to one half or one third of the road width at a time. When applied in two or more lanes, there shall be a slight overlap of asphalt material along adjoining edges of the lanes. It should be noted that no overlapping is allowed at the transverse joints and that thick paper shall be used at the joint to protect the previous application and the joining application shall begin on the paper. After use, the paper shall be removed and satisfactorily disposed of by the Contractor. Care shall be taken that the application of bituminous material at the junctions of spreads is not in excess of the specified amount. Excess bituminous material shall be removed from the surface.

The prime coat shall be uniformly applied with the distributor within a maximum of forty-eight (48) hours preceding placement of asphaltic concrete paving.

# Maintenance and Traffic

Traffic shall not be permitted on the primed surface until the asphaltic material has penetrated and dried and, in the judgment of the Engineer, will not be picked up under traffic. If it becomes necessary to permit traffic prior to that time, but in no case sooner than twenty-four (24) hours after the application of the asphaltic material, blotter material shall be applied as directed by the Engineer and traffic shall be permitted to use the lanes so treated. Blotter material shall be spread from trucks operated backward so that the wheels will not travel in uncovered wet asphaltic material. When applying blotter material to an asphalt treated lane that adjoins a lane that has not been treated, a strip at least 20 cm wide along the adjoining edge shall be left devoid of blotter material in order to permit an overlap of asphalt material.

The Contractor shall maintain the primed surface in a good clean condition and prior to the application of the next course, any surface irregularities shall be corrected and all excessive blotter material, dirt or other objectionable materials shall be removed.

# Measurement and Payment

Measurement of prime coat shall be by the net number of kilograms acceptably placed in accordance with the Drawings and these Standard Specifications or as directed by the Engineer.

Measurement for the prime coat will be for the total number of kilograms actually incorporated, determined by measuring devices (meters), and by accurately determining and controlling the amount of bituminous material being applied.

The number of kilograms (kg) furnished will be determined by weighing the material on scales furnished by and at the expense of the Contractor.

Payment for the Item, Prime Coat, will be included in asphalt prices in the Bills of Quantities and is incidental to this item, which shall be full compensation for materials, tools, equipment and labor necessary for the proper completion of the work.

# ASPHALT PAVING



# REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 156 (2013) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

AASHTO T 308 (2010) Standard Method of Test for Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method

AASHTO T 329 (2013) Standard Test Method for Moisture Content of Hot Mix Asphalt (HMA) by Oven Method

ASPHALT INSTITUTE (AI)

AI MS-2 (1997 6th Ed) Mix Design Methods

ASTM INTERNATIONAL (ASTM)

ASTM C117 (2013) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing

ASTM C1252 (2006) Standard Test Methods for Uncompacted Void Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture, and Grading)

ASTM C127 (2012) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate

ASTM C128 (2012) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate

ASTM C131/C131M (2014) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

ASTM C136 (2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM C142/C142M (2010) Standard Test Method for Clay Lumps and Friable Particles in Aggregates

ASTM C29/C29M (2009) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate

ASTM C566 (2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying

ASTM D140/D140M (2014) Standard Practice for Sampling Bituminous Materials

ASTM D1461 (2011) Moisture or Volatile Distillates in Bituminous Paving Mixtures

ASTM D2172/D2172M (2011) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures

ASTM D2419 (2014) Sand Equivalent Value of Soils and Fine Aggregate

ASTM D242/D242M (2009; R 2014) Mineral Filler for Bituminous Paving Mixtures

ASTM D2489/D2489M (2008) Estimating Degree of Particle Coating of Bituminous-Aggregate Mixtures

ASTM D2726/D2726M (2014) Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures

ASTM D3665 (2012) Random Sampling of Construction Materials

ASTM D3666 (2013) Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

ASTM D4125/D4125M (2010) Asphalt Content of Bituminous Mixtures by the Nuclear Method

ASTM D4791 (2010) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

ASTM D4867/D4867M (2009; R 2014) Effect of Moisture on Asphalt Concrete Paving Mixtures

ASTM D5444 (2008) Mechanical Size Analysis of Extracted Aggregate

ASTM D6307 (2010) Asphalt Content of Hot Mix Asphalt by Ignition Method

ASTM D6925 (2009) Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

ASTM D6926 (2010) Standard Practice for Preparation of Bituminous Specimens Using Marshall Apparatus

ASTM D6927 (2006) Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures

ASTM D979/D979M (2012) Sampling Bituminous Paving Mixtures

ASTM E1274 (2003; R 2012) Standard Test Method for Measuring Pavement Roughness Using a Profilograph

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 171 (1995) Standard Test Method for Determining Percentage of Crushed Particles in Aggregate

Note: Under the final conditions there would be a height limitation as shown in the drawing (pg.218/578, Volume II), The location of the proposed asphalt plant station does not meet the height requirement, Those height limitation are based on the final configuration of the new airstrip. The existing airstrip is 70 meters from the centerline. Nevertheless, based on a temporary basis, your asphalt plant may still be erected there. In your technical submission, a drawing or sketch showing the location and height of the asphalt plant be shown. If the contractor wants to propose another location, that is fine but should be shown in the technical submission for review and is subject to approval from the authorities.

# FULL PAYMENT

# Method of Measurement

The amount paid will be the percentage complete of hot-mix asphalt mixture used in the accepted work. .

# Basis of Payment

Quantities of hot-mix asphalt, determined as specified above, will be paid for at respective contract unit prices or at reduced prices adjusted in accordance with paragraphs PERCENT PAYMENT and QUALITY ASSURANCE. Payment will constitute full compensation for furnishing all materials, equipment, plant, and tools; and for all labor and other incidentals necessary to complete work required by this section of the specification.

# PERCENT PAYMENT

When a lot of material fails to meet the specification requirementsfor 100 percent pay as outlined in the following paragraphs, that lot shall be removed and replaced, or accepted at a reduced price which will be computed by multiplying the unit price by the lot's pay factor. The lot pay factor is determined by taking the lowest computed pay factor based on laboratory air voids, in-place density, grade or smoothness (each discussed below).

Pay factors based on different criteria (i.e., laboratory air voids and in-place density) of the same lot will not be multiplied together to get a lower lot pay factor. At the end of the project, an average of all lot pay factors will be calculated. If this average lot pay factor exceeds 95.0 percent and no individual lot has a pay factor less than 75.1 percent, then the percentpayment for the entire project will be 100 percent of the unit bid price. If the average lot pay factor is less than 95.0 percent, then each lot will be paid for at the unit price multiplied by the lot's pay factor. For any lots which are less than 2,000 short tons, a weighted lot pay factor will be used to calculate the average lot pay factor.

# MAT AND JOINT DENSITIES

The average in-place mat and joint densities are expressed as a percentage of the average theoretical maximum density (TMD) for the lot. The average TMD for each lot will be determined as the average TMD of the two random samples per lot. The average in-place mat density and joint density for a lot are determined and compared with Table 1 to calculate a single pay factor per lot based on in-place density, as described below.

First, a pay factor for both mat density and joint density are determined from Table 1.The area associated with the joint is then determined and will be considered to be 3 m wide times the length of completed longitudinal construction joint in the lot. This area will not exceed the total lot size. The length of joint to be considered will be that length where a new lane has been placed against an adjacent lane of hot-mix asphalt pavement, either an adjacent freshly paved lane or one paved at any time previously. The area associated with the joint is expressed as a percentage of the total lot area.

A weighted pay factor for the joint is determined based on this percentage (see example below). The pay factor for mat density and the weighted pay factor for joint density are compared and the lowest selected. This selected pay factor is the pay factor based on density for the lot. When the TMD on both sides of a longitudinal joint is different, the average of these two TMD will be used as the TMD needed to calculate the percent joint density. Rejected lots shall be removed and replaced.

Rejected areas adjacent to longitudinal joints shall be removed 100 mm into the cold (existing) lane. All density results for a lot will be completed and reported within twenty-four (24) hours after the construction of that lot.

**Table 1: Pay Factor Based on In-place Density**

| **Average Mat Density**  **(4 cores)** | **Pay Factor, percent** | **Average Joint Density**  **(4 cores)** |
| --- | --- | --- |
| 94.0 - 96.0 | 100.0 | Above 92.5 |
| 93.9 | 100.0 | 92.4 |
| 93.8 or 96.1 | 99.9 | 92.3 |
| 93.7 | 99.8 | 92.2 |
| 93.6 or 96.2 | 99.6 | 92.1 |
| 93.5 | 99.4 | 92.0 |
| 93.4 or 96.3 | 99.1 | 91.9 |
| 93.3 | 98.7 | 91.8 |
| 93.2 or 96.4 | 98.3 | 91.7 |
| 93.1 | 97.8 | 91.6 |
| 93.0 or 96.5 | 97.3 | 91.5 |
| 92.9 | 96.3 | 91.4 |
| 92.8 or 96.6 | 94.1 | 91.3 |
| 92.7 | 92.2 | 91.2 |
| 92.6 or 96.7 | 90.3 | 91.1 |
| 92.5 | 87.9 | 91.0 |
| 92.4 or 96.8 | 85.0 | 90.9 |
| Below 92.3 or above 96.9 | Reject | Below 90.9 |

# PAY FACTOR BASED ON IN-PLACE DENSITY

An example of the computation of a pay factor (in I-P units only) based on in-place density, is as follows: Assume the following test results for field density made on the lot: (1) Average mat density = 93.2 percent (of lab TMD). (2) Average joint density = 91.5 percent (of lab TMD). (3) Total area of lot = 30,000 square feet. (4) Length of completed longitudinal construction joint = 2000 feet.

* + - Step 1: Determine pay factor based on mat density and on joint density, using Table 1:

Mat density of 93.2 percent = 98.3 pay factor.

Joint density of 91.5 percent = 97.3 pay factor.

* + - Step 2: Determine ratio of joint area (length of longitudinal joint x 10 ft.) to mat area (total paved area in the lot): Multiply the length of completed longitudinal construction joint by the specified 10 ft. width and divide by the mat area (total paved area in the lot).

(2,000 ft. x 10 ft.)/30,000 sq.ft. = 0.6667 ratio of joint area to mat area (ratio).

* + - Step 3: Weighted pay factor (wpf) for joint is determined as indicated below:

wpf = joint pay factor + (100 - joint pay factor) (1 - ratio) wpf = 97.3 + (100-97.3) (1-.6667) = 98.2 percent

* + - Step 4: Compare weighted pay factor for joint density to pay factor for mat density and select the smaller:

Pay factor for mat density: 98.3 percent. Weighted pay factor for joint density: 98.2 percent

Select the smaller of the two values as pay factor based on density: 98.2 percent

# PAYMENT ADJUSTMENT FOR SMOOTHNESS

# Straightedge Testing

Location and deviation from straightedge for all measurements shall be recorded. When between 5.0 and 10.0 percent of all measurements made within a lot exceed the tolerance specified in paragraph Smoothness Requirements below, after any reduction of high spots or removal and replacement, the computed pay factor for that lot based on surface smoothness, will be 95 percent. When more than 10.0 percent of all measurements exceed the tolerance, the computed pay factor will be 90 percent. When between 10.0 and 15.0 percent of all measurements exceed the tolerance, the computed pay factor will be 85 percent.

When 15.0 percent or more of the measurements exceed the tolerance, the lot shall be removed and replaced at no additional cost to the Government. Regardless of the above, any small individual area with surface deviation which exceeds the tolerance given above by more than 50 percent shall be removed and replaced at no additional cost to the Government.

# Profilograph Testing

Location and data from all profilograph measurements shall be recorded. When the Profile Index of a lot exceeds the tolerance specified in paragraph Smoothness Requirements by 16 mm/km, but less than 32 mm/km, after any reduction of high spots or removal and replacement, the computed pay factor for that lot based on surface smoothness will be 95 percent. When the Profile Index exceeds the tolerance by 32 mm/km, but less than 47 mm/km, the computed pay factor will be 90 percent. When the Profile Index exceeds the tolerance by 47 mm/km, but less than 55 mm/km, the computed pay factor will be 80 percent. When the Profile Index exceeds the tolerance by 55 mm/km or more, the lot shall be removed and replaced at no additional cost to the Owner. Regardless of the above, any small individual area with surface deviation which exceeds the tolerance given above by more than 70 mm/km or more, shall be removed and replaced at no additional cost to the Government.

# LABORATORY AIR VOIDS AND THEORETICAL MAXIMUM DENSITY

Laboratory air voids will be calculated in accordance with ASTM D3203/D3203M by determining the Marshall density of each lab compacted specimen using the laboratory-prepared, thoroughly dry method in ASTM D2726/D2726M and determining the theoretical maximum density (TMD) of two of the sub-lots using ASTM D2041/D2041M. Laboratory air void calculations for each lot will use the average theoretical maximum density values obtained for the lot.

The mean absolute deviation of the four laboratory air void contents (one from each sub-lot) from the JMF air void content will be evaluated and a pay factor determined from Table 2. All laboratory air void tests will be completed and reported within 24 hours after completion of construction of each lot. The TMD is also used for computation of compaction, as required in paragraph: Mat and Joint Densities above.

# MEAN ABSOLUTE DEVIATION

An example of the computation of mean absolute deviation for laboratory air voids is as follows: Assume that the laboratory air voids are determined from 4 random samples of a lot (where 3 specimens were compacted from each sample). The average laboratory air voids for each sub-lot sample are determined to be 3.5, 3.0, 4.0, and 3.7. Assume that the target air voids from the JMF is 4.0. The mean absolute deviation is then:

Mean Absolute Deviation = (|3.5 - 4.0| + |3.0 - 4.0| + |4.0 - 4.0| + |3.7 - 4.0|)/4

= (0.5 + 1.0 + 0.0 + 0.3)/4 = (1.8)/4 = 0.45

The mean absolute deviation for laboratory air voids is determined to be 0.45. It can be seen from Table 2 that the lot's pay factor based on laboratory air voids, is 100 percent.

**Table 2: Pay Factor Based on Laboratory Air Voids**

| **Mean Absolute Deviation of Lab Air Voids from JMF** | **Pay Factor, Percent** |
| --- | --- |
| 0.60 or less | 100 |
| 0.61 - 0.80 | 98 |
| 0.81 - 1.00 | 95 |
| 1.01 - 1.20 | 90 |
| Above 1.20 | reject (0) |

# PAY ADJUSTMENT BASED ON GRADE

Within 5 working days after completion of a particular lot incorporating the final wearing course, test the final wearing surface of the pavement for conformance with specified plan grade requirements. All testing shall be performed in the presence of the Project Manager/Consultant. The final wearing surface of pavement shall conform to the elevations and cross sections shown and shall vary not more than 9 mm for runways or 15 mm for taxiways and aprons from the plan grade established and approved at site of work. Finished surfaces at juncture with other pavements shall coincide with finished surfaces of abutting pavements. Deviation from the plan elevation will not be permitted in areas of pavements where closer conformance with planned elevation is required for the proper functioning of drainage and other appurtenant structures involved.

The grade will be determined by running lines of levels at intervals of 7.6 m, or less, longitudinally and transversely, to determine the elevation of the completed pavement surface. Detailed notes of the results of the testing shall be kept and a copy furnished to the Project Manager/Consultant immediately after each day's testing. When more than 5 percent but less than 10 percent of all measurements made within a lot are outside the 9 or 15 mm tolerance, the pay factor based on grade for that lot will be 95 percent.

When more than 10.0 percent but less than 20.0 percent of all measurements are outside the tolerance, the pay factor shall be 85 percent. In areas where the grade exceeds the tolerance by more than 20.0 percent, remove the surface lift full depth; and replace the lift with hot-mix asphalt to meet specification requirements, at no additional cost to the Government. Diamond grinding may be used to remove high spots to meet grade requirements. Skin patching for correcting low areas or planeing or milling for correcting high areas will not be permitted.

# SYSTEM DESCRIPTION

Perform the work consisting of pavement courses composed of mineral aggregate and asphalt material heated and mixed in a central mixing plant and placed on a prepared course. Hot-mix asphalt (HMA) designed and constructed in accordance with this section shall conform to the lines, grades, thicknesses, and typical cross sections shown on the drawings.

Construct each course to the depth, section, or elevation required by the drawings and rolled, finished, and approved before the placement of the next course. Submit proposed Placement Plan, indicating lane widths, longitudinal joints, and transverse joints for each course or lift.

# ASPHALT MIXING PLANT

Plants used for the preparation of hot-mix asphalt shall conform to the requirements of AASHTO M 156 with the following changes:

Truck Scales. Weigh the asphalt mixture on approved scales furnished by the Contractor, or on certified public scales at the Contractor's expense. Scales shall be inspected and sealed at least annually by an approved calibration laboratory.

Testing Facilities. Provide laboratory facilities at the plant for the use of the Project Manager/Consultant's acceptance testing and the Contractor's quality control testing.

Inspection of Plant. The Project Manager/Consultant shall have access at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and material properties; checking the temperatures maintained in the preparation of the mixtures and for taking samples. Provide assistance as requested, for the Government to procure any desired samples.

Storage Bins. The asphalt mixture may be stored in non-insulated storage bins for a period of time not exceeding 3 hours. The asphalt mixture may be stored in insulated storage bins for a period of time not exceeding 8 hours. The mix drawn from bins shall meet the same requirements as mix loaded directly into trucks.

# HAULING EQUIPMENT

Trucks used for hauling hot-mix asphalt shall have tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Petroleum based products shall not be used as a release agent. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers (tarps) shall be securely fastened.

# MATERIAL TRANSFER VEHICLE (MTV)

Material transfer Vehicles shall be required due to the improvement in smoothness and decrease in both physical and thermal segregation. To transfer the material from the hauling equipment to the paver, use a self-propelled, material transfer vehicle with a swing conveyor that can deliver material to the paver without making contact with the paver. The MTV shall be able to move back and forth between the hauling equipment and the paver providing material transfer to the paver, while allowing the paver to operate at a constant speed. The Material Transfer Vehicle will have remixing and storage capability to prevent physical and thermal segregation.

# ASPHALT PAVERS

Mechanical spreading and finishing equipment shall consist of a self-powered paver, capable of spreading and finishing the mixture to the specified line, grade, and cross section. The screed of the paver shall be capable of laying a uniform mixture to meet the specified thickness, smoothness, and grade without physical or temperature segregation, the full width of the material being placed. The screed will be equipped with a compaction device and it will be used during all placement.

# Receiving Hopper

The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed without segregation. The screed shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

# Automatic Grade Controls

If an automatic grade control device is used, the paver shall be equipped with a control system capable of automatically maintaining the specified screed elevation. The control system shall be automatically actuated from either a reference line and/or through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent. A transverse slope controller shall not be used to control grade. The controls shall be capable of working in conjunction with any of the following attachments:

Ski-type device of not less than 9.14 m in length.

Short ski or shoe for joint matching.

Laser control.

# Rollers

Rollers shall be in good condition and shall be operated at slow speeds to avoid displacement of the asphalt mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. Equipment which causes excessive crushing of the aggregate shall not be used.

# SUBMITTALS

SD-02 Shop Drawings

Placement Plan

SD-03 Product Data

Mix Design

Contractor Quality Control

SD-04 Samples

Asphalt Cement Binder

Aggregates

SD-06 Test Reports

Aggregates

QC Monitoring

SD-07 Certificates

Asphalt Cement Binder

Testing Laboratory

# QUALITY ASSURANCE

The Project Manager/Consultant's quality assurance (QA) program for this project is separate and distinct from the Contractor's quality control (QC) program specified in Part 3. Testing for acceptability of work will be performed by the Project Manager/Consultant or by an independent laboratory hired by the Government Representative or Engineer, except for grade and smoothness testing which shall be performed by the Contractor.

Acceptance of the plant produced mix and in-place requirements will be on a lot to lot basis. A standard lot for all requirements will be equal to 2,000 metric tons. Where appropriate, adjustment in payment for individual lots of hot-mix asphalt will be made based on in-place density, laboratory air voids, grade and smoothness in accordance with the following paragraphs.

Grade and surface smoothness determinations will be made on the lot as a whole. Exceptions or adjustments to this will be made in situations where the mix within one lot is placed as part of both the intermediate and surface courses, thus grade and smoothness measurements for the entire lot cannot be made. In order to evaluate laboratory air voids and in-place (field) density, each lot will be divided into four equal sub-lots.

# Sub-lot Sampling

One random mixture sample for determining laboratory air voids, theoretical maximum density, and for any additional testing the Project Manager/Consultant desires, will be taken from a loaded truck delivering mixture to each sub-lot, or other appropriate location for each sub-lot. All samples will be selected randomly, using commonly recognized methods of assuring randomness conforming to ASTM D3665 and employing tables of random numbers or computer programs. Laboratory air voids will be determined from three laboratory compacted specimens of each sub-lot sample in accordance with ASTM D6926. The specimens will be compacted within 2 hours of the time the mixture was loaded into trucks at the asphalt plant. Samples will not be reheated prior to compaction and insulated containers will be used as necessary to maintain the temperature.

# Additional Sampling and Testing

The Project Manager/Consultant reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. The cost of any additional testing will be paid for by the Government. Testing in these areas will be treated as a separate lot. Payment will be made for the quantity of HMA represented by these tests in accordance with the provisions of this section.

# In-place Density

For determining in-place density, one random core (100 mm or 150 mm in diameter) will be taken at locations identified by the Project Manager/Consultant from the mat (interior of the lane) of each sub-lot, and one random core will be taken from the joint (immediately over joint) of each sub-lot, in accordance with ASTM D979/D979M. Fill all core holes with hot-mix. The core holes shall be dry and tack coated before filling. Each random core will be full thickness of the layer being placed. When the random core is less than 25 mm thick, it will not be included in the analysis. In this case, another random core will be taken. After air drying to meet the requirements for laboratory-prepared, thoroughly dry specimens, cores obtained from the mat and from the joints will be used for in-place density determination in accordance with ASTM D2726/D2726M.

# Surface Smoothness

Use one of the following methods to test and evaluate surface smoothness of the finished surface of the pavement final grade. All testing shall be performed in the presence of the Project Manager/Consultant. Detailed notes of the results of the testing shall be kept and a copy furnished to the Project Manager/Consultant immediately after each day's testing. The profilograph method shall be used for all longitudinal and transverse testing, except where the runs would be less than 60 m in length and the ends where the straightedge shall be used. Where drawings show required deviations from a plane surface (crowns, drainage inlets, etc.), the surface shall be finished to meet the approval of the Project Manager/Consultant.

# Smoothness Requirements

Straightedge Testing: The finished surfaces of the pavements shall have no abrupt change of 3 mm or more, and all pavements shall be within the tolerances specified in Table 3 when checked with an approved 4 m straightedge.

**Table 3: Straightedge Surface Smoothness—Pavements**

|  |  |  |
| --- | --- | --- |
| **Pavement Category** | **Direction of Testing** | **Tolerance, mm** |
| Runways and taxiway | Longitudinal | 3 |
| Transverse | 6 |
| Shoulders (outside edge stripe) | Transverse | 6 |
| Longitudinal | Not Required |
| Calibration hardstands and compass swinging bases | Longitudinal | 3 |
| Transverse | 3 |
| All other airfields and helicopter paved areas | Longitudinal | 6 |
| Transverse | 6 |

Profilograph Testing: The finished surfaces of the pavements shall have no abrupt change of 3 mm or more, and all pavements shall have a Profile Index not greater than specified in Table 4 when tested with an approved California-type profilograph. If the extent of the pavement in either direction is less than 60 m, that direction shall be tested by the straightedge method and shall meet requirements specified above.

**Table 4: Profilograph Surface Smoothness--Pavements**

|  |  |  |
| --- | --- | --- |
| **Pavement Category** | **Direction of Testing** | **Maximum Specified Profile Index (mm/km)** |
| Runways | Longitudinal | 110 |
| Transverse | (Use Straightedge) |
| Taxiways | Longitudinal | 140 |
| Transverse | (Use Straightedge) |
| Shoulders (outside edge stripe) | Transverse | (Use Straightedge) |
| Longitudinal | Not Required |
| Calibration Hardstands and Compass Swinging Bases |  | (Use Straightedge) |
| All Other Airfield and Helicopter Paved Areas | Longitudinal | 140 |
| Transverse | 140 |

# Testing Method

After the final rolling, but not later than 24 hours after placement, the surface of the pavement in each entire lot shall be tested in such a manner as to reveal all surface irregularities exceeding the tolerances specified above. Separate testing of individual sub-lots is not required. If any pavement areas are diamond ground, these areas shall be retested immediately after grinding. The area corrected by grinding shall not exceed 10 percent of the total area of the lot.

The entire area of the pavement shall be tested in both a longitudinal and a transverse direction on parallel lines. The transverse lines shall be 4.5 m or less apart, as directed. The longitudinal lines shall be at the centerline of each paving lane for lines less than 6.1 m and at the third points for lanes 6.1 m or greater. Other areas having obvious deviations shall also be tested. Longitudinal testing lines shall be continuous across all joints.

Straightedge Testing. The straightedge shall be held in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points.

Profilograph Testing. Profilograph testing shall be performed using an approved California profilograph and procedures described in ASTM E1274. The equipment shall utilize electronic recording and automatic computerized reduction of data to indicate "must-grind" bumps and the Profile Index for the pavement. The "blanking band" shall be 5 mm wide and the "bump template" shall span 25 mm with an offset of 10 mm. The profilograph shall be operated by an approved, factory-trained operator on the alignments specified above. A copy of the reduced tapes shall be furnished to the Project Manager/Consultant at the end of each day's testing.

Bumps ("Must Grind" Areas). Any bumps ("must grind" areas) shown on the profilograph trace which exceed 10 mm in height shall be reduced by diamond grinding until they do not exceed 7.5 mm when retested. Such grinding shall be tapered in all directions to provide smooth transitions to areas not requiring grinding. The following will not be permitted:

skin patching for correcting low areas,

planeing or milling for correcting high areas. At the Contractor's option, pavement areas, including ground areas, may be rechecked with the profilograph in order to record a lower Profile Index.

# ENVIRONMENTAL REQUIREMENTS

The hot-mix asphalt shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 5. The temperature requirements may be waived by the RSAF Representative or Engineer, if requested; however, all other requirements, including compaction, shall be met.

**Table 5: Surface Temperature Limitations of Underlying Course**

| **Mat Thickness, mm** | **Degrees C°** |
| --- | --- |
| 75 or greater | 4 |
| Less than 75 | 7 |

# AGGREGATES

Aggregates shall consist of crushed stone, crushed gravel, crushed slag, screenings, natural sand and mineral filler, as required. The portion of material retained on the 4.75 mm sieve is coarse aggregate. The portion of material passing the 4.75 mm sieve and retained on the 0.075 mm sieve is fine aggregate. The portion passing the 0.075 mm sieve is defined as mineral filler. Submit sufficient materials to produce 90 kg of blended mixture for mix design verification. All aggregate test results and samples shall be submitted to the Project Manager/Consultant at least fourteen (14) days prior to start of construction. Aggregate testing shall have been performed within 90 days of performing the mix design.

# Coarse Aggregate

Coarse aggregate shall consist of sound, tough, durable particles, free from films of material that would prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances. The coarse aggregate particles shall meet the following requirements:

The percentage of loss shall not be greater than 40 percent after 500 revolutions when tested in accordance with ASTM C131/C131M.

At least 75 percent by weight of coarse aggregate shall have at least two or more fractured faces when tested in accordance with COE CRD-C 171. Fractured faces shall be produced by crushing.

The particle shape shall be essentially cubical and the aggregate shall not contain more than 20 percent, by weight, of flat and elongated particles (3:1 ratio of maximum to minimum) when tested in accordance with ASTM D4791.

Slag shall be air-cooled, blast furnace slag, and shall have a compacted weight of not less than 1200 kg/cubic meter when tested in accordance with ASTM C29/C29M.

Clay lumps and friable particles shall not exceed 0.3 percent, by weight, when tested in accordance with ASTM C142/C142M.

# Fine Aggregate

Fine aggregate shall consist of clean, sound, tough, durable particles. The aggregate particles shall be free from coatings of clay, silt, or any objectionable material and shall contain no clay balls. The fine aggregate particles shall meet the following requirements:

The quantity of natural sand (noncrushed material) added to the aggregate blend shall not exceed 15 percent by weight of total aggregate.

The individual fine aggregate sources shall have a sand equivalent value greater than 45 when tested in accordance with ASTM D2419.

The fine aggregate portion of the blended aggregate shall have an uncompacted void content greater than 45.0 percent when tested in accordance with ASTM C1252 Method A.

Clay lumps and friable particles shall not exceed 0.3 percent, by weight, when tested in accordance with ASTM C142/C142M.

# Mineral Filler

Mineral filler shall be nonplastic material meeting the requirements of ASTM D242/D242M.

# Aggregate Gradation

The combined aggregate gradation shall conform to one of the gradations specified in Table 6, when tested in accordance with ASTM C136 and ASTM C117, and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but grade uniformly from coarse to fine. The JMF shall be within the specification limits; however, the gradation can exceed the limits when the allowable deviation from the JMF shown in Tables 9 and 10 are applied.

**Table 6: Aggregate Gradations**

|  | **Gradation 1 (Intermediate Courses Only)** | **Gradation 2 (Intermediate and Surface Courses Only)** | **Gradation 3 (Shoulders and Leveling Courses Only)** |
| --- | --- | --- | --- |
| Sieve Size, mm | Percent Passing by Mass | Percent Passing by Mass | Percent Passing by Mass |
| 25.0 | 100 | --- | --- |
| 19.0 | 90-100 | 100 | --- |
| 12.5 | 68-88 | 90-100 | 100 |
| 9.5 | 60-82 | 69-89 | 90-100 |
| 4.75 | 45-67 | 53-73 | 58-78 |
| 2.36 | 32-54 | 38-60 | 40-60 |
| 1.18 | 22-44 | 26-48 | 28-48 |
| 0.60 | 15-35 | 18-38 | 18-38 |
| 0.30 | 9-25 | 11-27 | 11-27 |
| 0.15 | 6-18 | 6-18 | 6-18 |
| 0.075 | 3-6 | 3-6 | 3-6 |

# ASPHALT CEMENT BINDER

Asphalt cement binder shall conform to AASHTO M 320 Performance Grade (PG) 76-22. Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Copies of these certifications shall be submitted to the Project Manager/Consultant. The supplier is defined as the last source of any modification to the binder. The Project Manager/Consultant may sample and test the binder at the mix plant at any time before or during mix production. Samples for this verification testing shall be obtained in accordance with ASTM D140/D140M and in the presence of the Project Manager/Consultant.

These samples shall be furnished to the Project Manager/Consultant for the verification testing, which shall be at no cost to the Contractor. Submit 20 L sample of the asphalt cement specified for mix design verification and approval not less than fourteen (14) days before start of the test section.

# MIX DESIGN

Develop the mix design. The Job Mix formula (JMF) shall have been developed and aggregates tested no earlier than 6 months before contract award. The asphalt mix shall be composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt material. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of Table 6. No hot-mix asphalt for payment shall be produced until a JMF has been approved. The hot-mix asphalt shall be designed using hand-held hammer procedures contained in AI MS-2 and the criteria shown in Table 7. Samples shall be prepared at various asphalt contents and compacted in accordance with ASTM D6925.

Laboratory compaction temperatures for Polymer Modified Asphalts shall be as recommended by the asphalt cement manufacturer. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D4867/D4867M is less than 75, the aggregates shall be rejected or the asphalt mixture treated with an anti-stripping agent. The amount of anti-stripping agent added shall be sufficient to produce a TSR of not less than 75. If an antistrip agent is required, it shall be provided at no additional cost to the Government. Sufficient materials to produce 90 kg of blended mixture shall be provided to the Project Manager/Consultant for verification of mix design at least fourteen (14) days prior to construction of test section.

# JMF Requirements

Submit the proposed JMF in writing, for approval, at least 14 days prior to the start of the test section, including as a minimum:

Percent passing each sieve size.

Percent of asphalt cement.

Percent of each aggregate and mineral filler to be used.

Asphalt viscosity grade, penetration grade, or performance grade.

Number of blows of hammer per side of molded specimen.

Laboratory mixing temperature.

Lab compaction temperature.

Temperature-viscosity relationship of the asphalt cement.

Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size.

Graphical plots and summary tabulation of stability, flow, air voids, voids in the mineral aggregate, and unit weight versus asphalt content as shown in AI MS-2. Summary tabulation shall include individual specimen data for each specimen tested.

Specific gravity and absorption of each aggregate.

Percent natural sand.

Percent particles with two or more fractured faces (in coarse aggregate).

Fine aggregate angularity.

Percent flat or elongated particles (in coarse aggregate).

Tensile Strength Ratio and wet/dry specimen test results.

Antistrip agent (if required).

List of all modifiers.

Percentage and properties (asphalt content, binder properties, and aggregate properties) of RAP in accordance with paragraph RECYCLED HOT-MIX ASPHALT, if RAP is used.

**Table 7: Marshall Design Criteria**

| **Test Property** | **75 Blow Mix** |
| --- | --- |
| Stability, N minimum | 9560(1) |
| Flow, 0.25 mm | 8-16(2) |
| Air voids, percent | 4(4) |
| Percent Voids in mineral aggregate (minimum) | See Table 8 |
| Dust Proportion(3) | 0.8-1.2 |
| TSR, minimum percent | 75 |
| TSR Conditioned Strength (minimum kPa) | 415 |
| (1) This is a minimum requirement. The average during construction shall be significantly higher than this number to ensure compliance with the specifications. | |
| (2) The flow requirement is not applicable for Polymer Modified Asphalts | |
| (3) Dust Proportion is calculated as the aggregate content, expressed as a percent of mass, passing the 0.075 mm sieve, divided by the effective asphalt content, in percent of total mass of the mixture. | |
| (4) Select the JMF asphalt content corresponding to an air void content of 4 percent. Verify the other properties of Table 7 meet the specification requirements at this asphalt content. | |

**Table 8: Minimum Percent Voids in Mineral Aggregate (VMA)(1)**

| **Aggregate (See Table 6)** | **Minimum VMA, percent** |
| --- | --- |
| Gradation 1 | 13 |
| Gradation 2 | 14 |
| Gradation 3 | 15 |
| (1) Calculate VMA in accordance with AI MS-2, based on ASTM D2726/D2726M bulk specific gravity for the aggregate. | |

# Adjustments to JMF

The JMF for each mixture shall be in effect until a new formula is approved in writing by the Project Manager/Consultant. Should a change in sources of any materials be made, a new mix design shall be performed and a new JMF approved before the new material is used. The Contractor will be allowed to make minor adjustments within the specification limits to the JMF to optimize mix volumetric properties. Adjustments to the original JMF shall be limited to plus or minus 4 percent on the 4.75 mm and coarser sieves; plus or minus 3 percent on the 2.36 mm to 0.30 mm sieves; and plus or minus 1 percent on the 0.15 mm sieve. Adjustments to the JMF shall be limited to plus or minus 1.0 percent on the 0.075 mm sieve. Asphalt content adjustments shall be limited to plus or minus 0.40 from the original JMF. If adjustments are needed that exceed these limits, a new mix design shall be developed.

# EXECUTION

# CONTRACTOR QUALITY CONTROL

# General Quality Control Requirements

Submit the approved Quality Control Plan. Hot-mix asphalt for payment shall not be produced until the quality control plan has been approved. The plan shall address all elements which affect the quality of the pavement including, but not limited to:

Mix Design and unique JMF identification code

Aggregate Grading

Quality of Materials

Stockpile Management and procedures to prevent contamination

Proportioning

Mixing and Transportation

Correlation of mechanical hammer to hand hammer. Determine the number of blows of the mechanical hammer required to provide the same density of the JMF as provided by the hand hammer. Use the average of three specimens per trial blow application.

Mixture Volumetrics

Moisture Content of Mixtures

Placing and Finishing

Joints

Compaction, including HMA-PCC joints

Surface Smoothness

Truck bed release agent

# Testing Laboratory

Provide a fully equipped asphalt laboratory located at the plant or job site. It shall be equipped with heating and air conditioning units to maintain a temperature of 24 plus or minus 2.3°C. Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. The Project Manager/Consultant shall be permitted unrestricted access to inspect the Contractor's laboratory facility, to witness quality control activities, and to perform any check testing desired.

The Project Manager/Consultant will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to adversely affect test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are corrected.

# Quality Control Testing

Perform all quality control tests applicable to these specifications and as set forth in the Quality Control Program. The testing program shall include, but shall not be limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, moisture in the asphalt mixture, laboratory air voids, stability, flow, in-place density, grade and smoothness. A Quality Control Testing Plan shall be developed as part of the Quality Control Program.

# Asphalt Content

A minimum of two tests to determine asphalt content will be performed per lot (a lot is defined in paragraph QUALITY ASSURANCE) by one of the following methods: extraction method in accordance with ASTM D2172/D2172M, Method A or B, the ignition method in accordance with the AASHTO T 308, ASTM D6307, or the nuclear method in accordance with ASTM D4125/D4125M, provided each method is calibrated for the specific mix being used. For the extraction method, the weight of ash, as described in ASTM D2172/D2172M, shall be determined as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. The last weight of ash value obtained shall be used in the calculation of the asphalt content for the mixture.

# Aggregate Properties

Aggregate gradations shall be determined a minimum of twice per lot from mechanical analysis of recovered aggregate in accordance with ASTM D5444 or ASTM D6307. For batch plants, aggregates shall be tested in accordance with ASTM C136 using actual batch weights to determine the combined aggregate gradation of the mixture. The specific gravity of each aggregate size grouping shall be determined for each 18,000 metric tons in accordance with ASTM C127 or ASTM C128. Fractured faces for gravel sources shall be determined for each 18,000 metric tons in accordance with COE CRD-C 171. The uncompacted void content of manufactured sand shall be determined for each 18,000 metric tons in accordance with ASTM C1252 Method A.

# Temperatures

Temperatures shall be checked at least four times per lot, at necessary locations, to determine the temperature at the dryer, the asphalt cement in the storage tank, the asphalt mixture at the plant, and the asphalt mixture at the job site.

# Aggregate Moisture

The moisture content of aggregate used for production shall be determined a minimum of once per lot in accordance with ASTM C566.

# Moisture Content of Mixture

The moisture content of the mixture shall be determined at least once per lot in accordance with AASHTO T 329.

# Laboratory Air Voids, VMA, Marshall Stability and Flow

Mixture samples shall be taken at least four times per lot and compacted into specimens, using 75 blows per side with the Marshall hand-held hammer as described in ASTM D6926. After compaction, the laboratory air voids and VMA of each specimen shall be determined, as well as the Marshall Stability and flow, as described in ASTM D6927. The VMA shall be within the limits of Table 8.

# In-Place Density

Conduct any necessary testing to ensure the specified density is achieved. A nuclear gauge or other non-destructive testing device may be used to monitor pavement density.

# Grade and Smoothness

Conduct the necessary checks to ensure the grade and smoothness requirements are met in accordance with paragraph QUALITY ASSURANCE.

# Additional Testing

Any additional testing, which the Contractor deems necessary to control the process, may be performed at the Contractor's option.

# QC Monitoring

Submit all QC test results to the Project Manager/Consultant on a daily basis as the tests are performed. The Project Manager/Consultant reserves the right to monitor any of the Contractor's quality control testing and to perform duplicate testing as a check to the Contractor's quality control testing.

# Sampling

When directed by the Project Manager/Consultant, sample and test any material which appears inconsistent with similar material being produced, unless such material is voluntarily removed and replaced or deficiencies corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.

# Control Charts

For process control, establish and maintain linear control charts on both individual samples and the running average of last four samples for the parameters listed in Table 9, as a minimum. These control charts shall be posted as directed by the RSAF Representative or Engineer and shall be kept current at all times. The control charts shall identify the project number, the test parameter being plotted, the individual sample numbers, the Action and Suspension Limits listed in Table 9 applicable to the test parameter being plotted, and the Contractor's test results.

Target values (JMF) shall also be shown on the control charts as indicators of central tendency for the cumulative percent passing, asphalt content, and laboratory air voids parameters. When the test results exceed either applicable Action Limit, take immediate steps to bring the process back in control. When the test results exceed either applicable Suspension Limit, halt production until the problem is solved. When the Suspension Limit is exceeded for individual values or running average values, the Project Manager/Consultant has the option to require the Contractor to remove and replace the material represented by the samples or to leave in place and base acceptance on mixture volumetric properties and in place density.

Use the control charts as part of the process control system for identifying trends so that potential problems can be corrected before they occur. Decisions concerning mix modifications shall be made based on analysis of the results provided in the control charts. The Quality Control Plan shall indicate the appropriate action which shall be taken to bring the process into control when certain parameters exceed their Action Limits.

**Table 9: Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts**

|  | **Individual Samples** | | **Running Average of Last Four Samples** | |
| --- | --- | --- | --- | --- |
| Parameter to be Plotted | Action Limit | Suspension Limit | Action Limit | Suspension Limit |
| 4.75 mm sieve, Cumulative Percent Passing, deviation from JMF target; plus or minus values | 6 | 8 | 4 | 5 |
| 0.6 mm sieve, Cumulative Percent Passing, deviation from JMF target; plus or minus values | 4 | 6 | 3 | 4 |
| 0.075 mm sieve, Cumulative Percent Passing, deviation from JMF target; plus or minus values | 1.4 | 2.0 | 1.1 | 1.5 |
| Asphalt content, percent deviation from JMF target; plus or minus value | 0.4 | 0.5 | 0.2 | 0.3 |
| Laboratory Air Voids, percent deviation from JMF target value | No specific action and suspension limits set since this parameter is used to determine percent payment | | | |
| In-place Mat Density, percent of TMD | No specific action and suspension limits set since this parameter is used to determine percent payment | | | |
| In-place Joint Density, percent of TMD | No specific action and suspension limits set since this parameter is used to determine percent payment | | | |
| **VMA** | | | | |
| Gradation 1 | 13.3 | 13.0 | 13.5 | 13.0 |
| Gradation 2 | 14.3 | 14.0 | 14.5 | 14.0 |
| Gradation 3 | 15.3 | 15.0 | 15.0 | 15.0 |
| **Stability, N (minimum)** | | | | |
| 75 blow JMF | 7,830 | 7,290 | 9,560 | 9,030 |
| 50 blow JMF | 4,230 | 3,690 | 6,000 | 5,470 |
| **Flow, 0.25 mm** | | | | |
| 75 blow JMF | 8 min. | 7 min. | 9 min. | 8 min. |
| 16 max. | 17 max. | 15 max. | 16 max. |
| 50 blow JMF | 8 min. | 7 min. | 9 min. | 8 min. |
| 18 max. | 19 max. | 17 max. | 18 max. |

# PREPARATION OF ASPHALT BINDER MATERIAL

The asphalt cement material shall be heated avoiding local overheating and providing a continuous supply of the asphalt material to the mixer at a uniform temperature. The temperature of unmodified asphalts shall be no more than 160°C when added to the aggregates. Performance Graded (PG) asphalts shall be within the temperature range of 141 to 168°C when added to the aggregates.

# PREPARATION OF MINERAL AGGREGATE

The aggregate for the mixture shall be heated and dried prior to mixing. No damage shall occur to the aggregates due to the maximum temperature and rate of heating used. The temperature of the aggregate and mineral filler shall not exceed 175°C when the asphalt cement is added. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

# PREPARATION OF HOT-MIX ASPHALT MIXTURE

The aggregates and the asphalt cement shall be weighed or metered and introduced into the mixer in the amount specified by the JMF. The combined materials shall be mixed until the aggregate obtains a thorough and uniform coating of asphalt binder (testing in accordance with ASTM D2489/D2489M may be required by the Project Manager/Consultant) and is thoroughly distributed throughout the mixture. The moisture content of all hot-mix asphalt upon discharge from the plant shall not exceed 0.5 percent by total weight of mixture as measured by ASTM D1461.

# PREPARATION OF THE UNDERLYING SURFACE

Immediately before placing the hot mix asphalt, the underlying course shall be cleaned of dust and debris. A prime coat and/or tack coat shall be applied in accordance with the contract specifications.

# TEST SECTION

Prior to full production, place a test section for each JMF used. Construct a test section consisting of a maximum of 250 tons and two paver passes wide placed in two lanes, with a longitudinal cold joint. The test section shall be of the same depth as the course which it represents. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section.

The equipment used in construction of the test section shall be the same equipment to be used on the remainder of the course represented by the test section. The test section shall be placed as part of the project pavement as approved by the Project Manager/Consultant.

# Sampling and Testing for Test Section

One random sample shall be taken at the plant; triplicate specimens compacted, and tested for stability, flow, and laboratory air voids. A portion of the same sample shall be tested for theoretical maximum density (TMD), aggregate gradation and asphalt content. An additional portion of the sample shall be tested to determine the Tensile Strength Ratio (TSR). Adjust the compactive effort as required to provide TSR specimens with an air void content of 7 plus/minus 1 percent. Four randomly selected cores shall be taken from the finished pavement mat, and four from the longitudinal joint, and tested for density. Random sampling shall be in accordance with procedures contained in ASTM D3665. The test results shall be within the tolerances or exceed the minimum values shown in Table 10 for work to continue. If all test results meet the specified requirements, the test section shall remain as part of the project pavement. If test results exceed the tolerances shown, the test section shall be removed and replaced at no cost to the Government and another test section shall be constructed.

**Table 10. Test Section Requirements for Material and Mixture Properties**

| **Property** | **Specification Limit** |
| --- | --- |
| Aggregate Gradation-Percent Passing (Individual Test Result) | |
| 4.75 mm and larger | JMF plus or minus 8 |
| 2.36, 1.18, 0.60, and 0.30 mm | JMF plus or minus 6 |
| 0.15 and 0.075 mm | JMF plus or minus 2.0 |
| Asphalt Content, Percent (Individual Test Result) | JMF plus or minus 0.5 |
| Laboratory Air Voids, Percent (Average of 3 specimens) | JMF plus or minus 1.0 |
| VMA, Percent (Average of 3 specimens) | See Table 8 |
| Tensile Strength Ratio (TSR) (At 7 percent plus/minus 1 percent air void content) | 75 percent minimum |
| Conditioned Strength | 415 kPa minimum |
| Mat Density, Percent of TMD (Average of 4 Random Cores) | 92.0 - 96.0 |
| Joint Density, Percent of TMD (Average of 4 Random Cores) | 90.5 minimum |
| Stability, N (Average of 3 specimens) | 9,560 minimum |
| Flow, 0.25 mm (Average of 3 specimens) | 8 - 18 |

# Additional Test Sections

If the initial test section should prove to be unacceptable, the necessary adjustments to the JMF, plant operation, placing procedures, and/or rolling procedures shall be made. A second test section shall then be placed. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. Full production shall not begin until an acceptable section has been constructed and accepted.

# TESTING LABORATORY

The laboratories used to develop the JMF, perform Contractor Quality Control testing, and for Government acceptance testing shall meet the requirements of ASTM D3666. All required test methods shall be performed by an accredited laboratory. Submit a certification of compliance signed by the manager of the laboratory stating that it meets these requirements to the Project Manager/Consultant prior to the start of construction. The laboratory shall maintain this validation for the duration of the project. The certification shall contain as a minimum:

1. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.
2. A listing of equipment to be used in developing the job mix.
3. A copy of the laboratory's quality control system.
4. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

# TRANSPORTING AND PLACING

# Transporting

The hot-mix asphalt shall be transported from the mixing plant to the site in clean, tight vehicles. Deliveries shall be scheduled so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver. Adequate artificial lighting shall be provided for night placements. Hauling over freshly placed material will not be permitted until the material has been compacted as specified, and allowed to cool to 60°C.

# Placing

The mix shall be placed in lifts of adequate thickness and compacted at a temperature suitable for obtaining density, surface smoothness, and other specified requirements. Upon arrival, the mixture shall be placed to the full width by an asphalt paver; it shall be struck off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and conform to the grade and contour indicated. Waste mixture shall not be broadcast onto the mat or recycled into the paver hopper. Collect waste mixture and dispose off-site. The speed of the paver shall be regulated to eliminate pulling and tearing of the asphalt mat. Placement of the mixture shall begin along the centerline of a crowned section or on the high side of areas with a one-way slope. The mixture shall be placed in consecutive adjacent strips having a minimum width of 3 m. The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least 300 mm; however, the joint in the surface course shall be at the centerline of the pavement. Transverse joints in one course shall be offset by at least 3 m from transverse joints in the previous course. Transverse joints in adjacent lanes shall be offset a minimum of 3 m. On isolated areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread and luted by hand tools.

# COMPACTION OF MIXTURE

# General

# After placing, the mixture shall be thoroughly and uniformly compacted by rolling. The surface shall be compacted as soon as possible without causing displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used are at the discretion of the Contractor, with the exception that application of more than three passes with a vibratory roller in the vibrating mode is prohibited. The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Correct at once any displacement occurring as a result of reversing the direction of the roller, or from any other cause.

# Furnish sufficient rollers to handle the output of the plant. Continue rolling until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained. To prevent adhesion of the mixture to the roller, keep the wheels properly moistened, but excessive water will not be permitted. In areas not accessible to the roller, thoroughly compact the mixture with hand tampers. Remove the full depth of any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or is in any way defective, replace with fresh hot mixture and immediately compact to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching will not be allowed.

# Segregation

# The Project Manager/Consultant can sample and test any material that looks deficient. When the in-place material appears to be segregated, the Project Manager/Consultant has the option to sample the material and have it tested and compared to the aggregate gradation, asphalt content, and in-place density requirements in Table 10. If the material fails to meet these specification requirements, the extent of the segregated material will be removed and replaced the full depth of the layer of asphalt mixture at no additional cost to the Government. When segregation occurs in the mat, take appropriate action to correct the process so that additional segregation does not occur.

# JOINTS

The formation of joints shall be made ensuring a continuous bond between the courses and to obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade.

# Transverse Joints

The roller shall not pass over the unprotected end of the freshly laid mixture, except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course. The tapered edge shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing the adjacent lane. The cutback material shall be removed from the project. In both methods, all contact surfaces shall be given a light tack coat of asphalt material before placing any fresh mixture against the joint.

# Longitudinal Joints

Longitudinal joints which are irregular, damaged, uncompacted, cold (less than 80°C at the time of placing the adjacent lane), or otherwise defective, shall be cut back a maximum of 75 mm from the top edge of the lift with a cutting wheel to expose a clean, sound, near vertical surface for the full depth of the course. All cutback material shall be removed from the project. Cutting equipment that uses water as a cooling or cutting agent shall not be permitted. All contact surfaces shall be given a light tack coat of asphalt material prior to placing any fresh mixture against the joint.

# HMA-Portland Cement Concrete Joints

Joints between HMA and PCC will require specific construction procedures for the HMA. The following criteria are applicable to the first 3 m or paver width of HMA adjacent to the PCC.

# Pave the HMA side of the joint in a direction parallel to the joint.

# Place the HMA side sufficiently high so that when fully compacted the HMA will be greater than 3 mm but less than 6 mm higher than the PCC side of the joint.

# Compaction shall be provided with steel wheel rollers and at least one rubber tire roller. The rubber tire roller shall be at least 18 metric tons in weight and have tires that are inflated to at least 620 kPa. Avoid spalling the PCC during placement and compaction of the HMA. Steel wheel rollers shall be operated in a way that prevents spalling the PCC. Any damage to PCC edges or joints shall be repaired as directed by the Project Manager/Consultant. If damage to the PCC joint or edge exceeds a total of 1 m, the PCC panel shall be removed and replaced at no additional expense to the Government.

# After compaction is finished the HMA shall be leveled by grinding so that the HMA side is less than 3 mm higher than the PCC side. The HMA immediately adjacent to the joint shall not be lower than the PCC after the grinding operation. Transition the grinding into the HMA in a way that ensures good smoothness and provides drainage of water. The joint and adjacent materials when completed shall meet all of the requirements for grade and smoothness. Measure smoothness across the PCC-HMA joint using a 4 m straightedge. The acceptable tolerance is 3 mm.

# Consider the HMA next to the PCC as a separate lot for evaluation. Lots are based on individual lifts. Do not comingle cores from different lifts for density evaluation purposes. Take four cores for each lot of material placed adjacent to the joint. The size of lot shall be 3 m wide by the length of the joint being paved. Lots are based on individual lifts and shall not be comingled for density evaluation purposes. Locate the center of each of the four cores 150 mm from the edge of the concrete. Take each core at a random location along the length of the joint. The requirements for density for this lot, adjacent to the joint, are the same as that for the mat specified earlier.

# All procedures, including repair of damaged PCC, shall be in accordance with the approved Quality Control Plan.

# AIRFIELD PAINTING



# GENERAL

# REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

ICRI 03732 (1997) Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-B-1325 (Rev D; Notice 1) Beads (Glass Spheres) Retro-Reflective (Metric)

FS TT-P-1952 (Rev E) Paint, Traffic and Airfield Markings, Waterborne

# SUBMITTALS

SD-03 Product Data

* Reflective media for airfields
* Reflective media for roads and streets
* Paints for airfields
* Paints for roads and streets
* Equipment
* Lists of proposed equipment, including descriptive data, and notifications of proposed Contractor actions as specified in this section. List of removal equipment shall include descriptive data indicating area of coverage per pass, pressure adjustment range, tank and flow capacities, and safety precautions required for the equipment operation.

SD-06 Test Reports

* Reflective media for airfields
* Reflective media for roads and streets
* Paints for airfields
* Paints for roads and streets
* Certified reports from sampling and testing made in accordance with paragraph entitled "Sampling and Testing" prior to the use of the materials at the jobsite. Testing shall be performed in an approved independent laboratory.

SD-07 Certificates

* Qualifications
* Reflective media for airfields
* Reflective media for roads and streets
* Paints for airfields
* Paints for roads and streets
* Volatile Organic Compound, (VOC)
* Certificate stating that the proposed pavement marking paint meets the VOC regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located.
* Construction equipment list

SD-08 Manufacturer's Instructions

* Paints for airfields
* Paints for roads and streets
* Submit manufacturer's Material Safety Data Sheets.

# DELIVERY AND STORAGE

Deliver paints and paint materials in original sealed containers that plainly show the designated name, specification number, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer. Provide storage facilities at the job site, only in areas approved by the Project Manager/Consultant or authorized representative, for maintaining materials at temperatures recommended by the manufacturer.

# WEATHER LIMITATIONS

Apply paint to clean, dry surfaces, and unless otherwise approved, only when the air and pavement surface temperature is at least 2.7°C above the dew point and the air and pavement temperatures are above 5°C and less than 35°C for oil-based materials; above 10°C and less than 43°C for water-based materials. Maintain paint temperature within these same limits.

# EQUIPMENT

Machines, tools, and equipment used in the performance of the work shall be approved by the Project Manager/Consultant and maintained in satisfactory operating condition. Submit construction equipment list for approval by the Project Manager/Consultant.

# Mobile and Maneuverable

Application equipment shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.

# Paint Application Equipment

1. Hand-Operated, Push-Type Machines

Provide hand-operated push-type applicator machine of a type commonly used for application of paint to pavement surfaces. Paint applicator machine shall be acceptable for marking small street and parking areas. Applicator machine shall be equipped with the necessary paint tanks and spraying nozzles, and shall be capable of applying paint uniformly at coverage specified. Applicator for water-based markings shall be equipped with non-stick coated hoses; metal parts in contact with the paint material shall be constructed of grade 302, 304, 316, or equal stainless steel.

1. Self-Propelled or Mobile-Drawn Pneumatic Spraying Machines

Provide self-propelled or mobile-drawn pneumatic spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results. Provide machine having a speed during application capable of applying the stripe widths indicated at the paint coverage rate specified herein and of even uniform thickness with clear-cut edges. Provide equipment used for marking streets and highways capable of placing the prescribed number of lines at a single pass as solid lines, intermittent lines, or a combination of solid and intermittent lines using a maximum of three different colors of paint as specified. The equipment for applying the paint for airfield pavements shall be a self-propelled or mobile-drawn pneumatic spraying machine with an arrangement of atomizing nozzles capable of applying a width of line at any one time in multiples of 102 mm from 102 mm to 1 m at a speed of at least 5 miles per hour. Provide paint applicator with paint reservoirs or tanks of sufficient capacity and suitable gages to apply paint in accordance with requirements specified. Equip tanks with suitable air-driven mechanical agitators. Equip spray mechanism with quick-action valves conveniently located, and include necessary pressure regulators and gages in full view and reach of the operator. Install paint strainers in paint supply lines to ensure freedom from residue and foreign matter that may cause malfunction of the spray guns. The paint applicator shall be readily adaptable for attachment of an air-actuated dispenser for the reflective media approved for use. Provide pneumatic spray guns for hand application of paint in areas where the mobile paint applicator cannot be used. Applicator for water-based markings shall be equipped with non-stick coated hoses; metal parts in contact with the paint material shall be constructed of grade 302, 304, 316, or equal stainless steel.

# Reflective Media Dispenser

The dispenser for applying the reflective media shall be attached to the paint dispenser and shall operate automatically and simultaneously with the applicator through the same control mechanism. The dispenser shall be capable of adjustment and designed to provide uniform flow of reflective media over the full length and width of the stripe at the rate of coverage specified in paragraph APPLICATION, at all operating speeds of the applicator to which it is attached.

# Surface Preparation Equipment

1. Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 70.8 L/sec of air at a pressure of not less than 620 kPa at each nozzle used, and shall be equipped with traps that will maintain the compressed air free of oil and water.

1. Waterblast Equipment

The water pressure shall be specified at 17.9 MPa at 60°C in order to adequately clean the surfaces to be marked. The Contractor shall install a gate valve and a back-flow prevention device on the fire hydrant tap as designated by the Project Manager/Consultant. The Contractor shall furnish all equipment, material, and labor required to obtain and deliver water from the designated fire hydrant to the work area(s).

1. Marking Removal Equipment

Equipment shall be mounted on rubber tires and shall be capable of removing markings from the pavement without damaging the pavement surface or joint sealant. Waterblasting equipment shall be capable of producing an adjustable, pressurized stream of water. Sandblasting equipment shall include an air compressor, hoses, and nozzles. The compressor shall be equipped with traps to maintain the air free of oil and water.

1. Chemical Equipment

Chemical equipment shall be capable of application and removal of chemicals from the pavement surface, and shall leave only non-toxic biodegradable residue.

1. Traffic Controls

Suitable warning signs shall be placed near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions. Small markers shall be placed along newly painted lines to control traffic and prevent damage to newly painted surfaces. Painting equipment shall be marked with large warning signs indicating slow-moving painting equipment in operation.

# WEATHER LIMITATIONS FOR REMOVAL

Pavement surface shall be free of snow, ice, or slush. Surface temperature shall be at least 5°C and rising at the beginning of operations, except those involving shot or sand blasting. Operation shall cease during thunderstorms. Operation shall cease during rainfall, except for waterblasting and removal of previously applied chemicals. Waterblasting shall cease where surface water accumulation alters the effectiveness of material removal.

# QUALIFICATIONS FOR AIRFIELD MARKING

Submit certification of qualifications in resume format showing airfield pavement marking personnel have experience working on airfields, operating equipment and performing airfield pavement marking work a minimum of fourteen (14) days before pavement marking work is to be performed. Include with resume a list of references complete with points of contact and telephone numbers.

# Airfield Pavement Marking Qualifications

Provide certification for pavement marking machine operator and Foreman demonstrating experience working on a minimum of two (2) airfield pavement marking projects of similar size and scope. Provide resume demonstrating airfield pavement marking personnel have a minimum of two (2) years of experience operating marking equipment to be used on project and performing pavement marking work.

The Project Manager/Consultant reserves the right to require additional proof of competency or to reject personnel and call for alternate airfield pavement marking personnel.

# PRODUCTS

# Materials

Provide materials conforming to the requirements specified herein.

Paints for Airfields FS TT-P-1952, color as indicated.

Paints for Roads and Streets FS TT-P-1952, color as indicated or selected.

Reflective Media for Airfields FS TT-B-1325, Type I, Gradation A.

Reflective Media for Roads and Streets FS TT-B-1325, Type I, Gradation A.

# EXECUTION

# Surface Preparation

Allow new pavement surfaces to cure for a period of not less than thirty (30) days before application of marking materials. Thoroughly clean surfaces to be marked before application of the paint. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods as required. Remove rubber deposits, residual curing compounds, and other coatings adhering to the pavement by water blasting.

For Portland Cement Concrete pavement, grinding, light shot blasting, and light scarification, to a resulting profile equal to ICRI 03732 CSP 2, CSP 3, and CSP 4, respectively, can be used in addition to water blasting, to either remove existing coatings or for surface preparation on most pavements: shot blasting shall not be used on airfield pavements due to the potential of Foreign Object Damage (FOD) to aircraft.

Scrub affected areas, where oil or grease is present on old pavements to be marked, with several applications of trisodium phosphate solution or other approved detergent or degreaser and rinse thoroughly after each application. After cleaning any oil-soaked areas, seal with shellac or primer recommended by the manufacturer to prevent bleeding through the new paint. Do not commence painting in any area until pavement surfaces are dry and clean.

# Application

1. Testing for Moisture

Apply pavement markings to dry pavement only. The Contractor shall test the pavement surface for moisture before beginning work after each period of rainfall, fog, high humidity, or cleaning, or when the ambient temperature has fallen below the dew point.

Do not commence marking until the pavement is sufficiently dry and the pavement condition has been approved by the CO or authorized representative. Employ the "plastic wrap method" to test the pavement for moisture as follows: Cover the pavement with a 300 mm by 300 mm (12 inch by 12 inch) section of clear plastic wrap and seal the edges with tape. After 15 minutes, examine the plastic wrap for any visible moisture accumulation inside the plastic. Do not begin marking operations until the test can be performed with no visible moisture accumulation inside the plastic wrap.

1. Rate of Application
   1. Reflective Markings

Apply paint evenly to the pavement area to be coated at a rate of 2.5 plus or minus 0.10 square meter per liter. Apply glass spheres uniformly to the wet paint on airfield pavement at a rate of (1,198) and on road and street pavement at a rate of (719) plus or minus (60) g of glass spheres per liter. Collect and record readings for white and yellow retroreflective markings at the rate of one reading per 300 linear meters. The minimum acceptable average for white markings is 200 millicandelas per square meter per lux (mcd/m2/lx) (measured with Mirolux 12 Retroreflectometer or similar instrument as agreed). The minimum acceptable average for yellow markings is 175 millicandelas per square meter per lux (mcd/m2/lx). Readings shall be computed by averaging a minimum of 10 readings taken within the area at random locations. Areas not meeting the retroreflective requirements stated above shall be re-marked.

* 1. Nonreflective Markings

Apply paint evenly to the pavement surface to be coated at a rate of 2.5 plus or minus 0.10 square meter per liter.

* 1. Painting

Apply paint pneumatically with approved equipment at rate of coverage specified herein. Provide guidelines and templates as necessary to control paint application. Take special precautions in marking numbers, letters, and symbols. Manually paint numbers, letters, and symbols. Sharply outline all edges of markings. The maximum drying time requirements of the paint specifications will be strictly enforced, to prevent undue softening of bitumen, and pickup, displacement or discoloration by tires of traffic. Discontinue painting operations if there is a deficiency in drying of the markings until cause of the slow drying is determined and corrected.

* 1. Reflective Media

Application of reflective media shall immediately follow the application of paint. Accomplish drop-on application of the glass spheres to ensure even distribution at the specified rate of coverage. Should there be malfunction of either paint applicator or reflective media dispenser, discontinue operations until deficiency is corrected.

# FIELD TESTING, INSPECTION, AND DEMONSTRATIONS

# Sampling and Testing

As soon as the paint and reflective materials are available for sampling, obtain by random selection from the sealed containers, two quart samples of each batch in the presence of the Project Manager/Consultant. Accomplish adequate mixing prior to sampling to ensure a uniform, representative sample. A batch is defined as that quantity of material processed by the manufacturer at one time and identified by number on the label. Clearly identify samples by designated name, specification number, batch number, project contract number, intended use, and quantity involved. At the discretion of the Project Manager/Consultant, samples provided may be tested by the Government for verification.

# Inspection

Examine material at the job site to determine that it is the material referenced in the report of test results or certificate of compliance. A certificate of compliance shall be accompanied by test results substantiating conformance to the specified requirements.

# Surface Preparations and Application Procedures

Surface preparations and application procedures will be examined by the Government Engineer to determine conformance with the requirements specified. Approve each separate operation prior to initiation of subsequent operations.

# Surface Preparation Demonstration

Prior to surface preparation, demonstrate surface preparation using the proposed materials, methods and equipment according to the procedures outlined. Prepare areas large enough to determine cleanliness, adhesion of remaining coating and rate of cleaning.

# Test Stripe Demonstration

Prior to paint application; demonstrate test stripe application within the work area using the proposed materials and equipment. Apply separate test stripes in each of the line widths and configurations required herein using the proposed equipment. The test stripes shall be long enough to determine the proper speed and operating pressures for the vehicle(s) and machinery, but not less than 15 meters long.

# Application Rate Demonstration

During the Test Stripe Demonstration, demonstrate compliance with the application rates specified herein. Document the equipment speed and operating pressures required to meet the specified rates in each configuration of the equipment and provide a copy of the documentation to the Project Manager/Consultant or authorized representative 30 days prior to proceeding with the work.

# Retroreflective Value Demonstration

After the test stripes have cured to a "no-track" condition, demonstrate compliance with the average retroreflective values specified herein. Take a minimum of ten readings on each test stripe with a Mirolux 12 Retroreflectometer, or similar instrument with the same measuring geometry and direct readout in millicandelas per square meter per lux (mcd/m2/lx).

# Level of Performance Demonstration

The Project Manager/Consultant will be present the application demonstrations to observe the results obtained and to validate the operating parameters of the vehicle(s) and equipment. If accepted by the Project Manager/Consultant, the test stripe shall be the measure of performance required for this project. Work shall not proceed until the demonstration results are satisfactory to the Project Manager/Consultant.

# TRAFFIC CONTROL AND PROTECTION

Place warning signs near the beginning of the work site and well ahead of the work site for alerting approaching traffic from both directions. Place small markers along newly painted lines to control traffic and prevent damage to newly painted surfaces. Mark painting equipment with large warning signs indicating slow-moving painting equipment in operation. Do not use foil-backed material for temporary pavement marking because of its potential to conduct electricity during accidents involving downed power lines.

# QUALITY ASSURANCE

Demonstrate success of bond of reflective media, new paint marking and the pavement surface, vacuum cured surface of new marking after a seven (7) day dry time. Inspect newly applied markings for signs of bond failure based on visual inspection and comparison to results from Test Stripe Demonstration paragraph.

# Reflective Media and Coating Bond Verification

Within seven (7) days after pavement marking application, use industrial vacuum to sweep new markings. Visually inspect the pavement markings and the material captured by the vacuum. Verify that no significant loss of reflective media has occurred to the pavement marking due to the vacuum cleaning.

# Reflective Media and Coating Application Verification

Use a wet film thickness gauge to measure the application of wet paint.

Use a microscope or magnifying glass to evaluate the embedment of glass beads in the paint. Verify the glass bead embedment with approximately 50 percent of the beads embedded and 50 percent of the beads exposed.

# BOUNDARY FENCING



# GENERAL

This part of the Specification shall cover all items related to security and other fence installation works for the Project. Works shall include all items required for the tendered Project, as well as all auxiliary works.

All works shall further be carried out in full compliance with all local rules and regulations and the Specification shall further be read, if applicable for the Project.

# TECHNICAL DESCRIPTION

# General Guideline

All fence posts and struts shall be anchored in rigid concrete foundations (concrete grade C 40), and reaching at least 80 cm below and 10 cm above ground level. The depth of foundations shall be statically computed by the Bidder/Contractor and shall be approved by ADWEA/ADDC/AADC. In the vicinity of gates, adequate provisions to fix the fences shall be provided. Gate foundations shall also be of reinforced concrete.

Fencing mesh of external perimeter and security fences shall have at least 20 cm encasement into a continuous, reinforced concrete ground beam of 20 x 40 cm.

If required fencing, gates, doors, etc., have to be properly connected to an earthing/ grounding system.

The Bidder/Contractor shall supply references for the plastic coating to be used on the galvanized wire demonstrating suitability and longevity in the Maldives’s harsh climatic environment. In addition, the Bidder/Contractor shall furnish a guarantee bond on all fencing materials, covering a period of ten years.

# Steel Fencing Posts

The posts for fencing shall be of high grade steel of tubular or conical triangular hollow sections of the required size and shape. The posts shall be hot dip galvanized internally and externally. Before hot-dip galvanizing of the posts, strong T-shaped flanges to receive fixing brackets shall be welded.

Corner posts shall be equipped with corner turnbuckles for bracing wires and joint clamps for horizontal bracing rails and reverse bracing. All components shall be plastic-coated to increase the corrosion protection properties.

Application : Height of internal fence shall be 3.40m.

# Wire-Mesh

Chain link wire-mesh shall be of minimum 4 mm diameter wires, opening size of not more than 50 x 50 mm. Mesh shall be hot-dip galvanized and provided with plastic coating, color to the discretion of ADWEA/ADDC/AADC.

The wire mesh shall be new and unused, and in single length between the posts. The plastic coating shall be thick and elastic, durable and should be able to withstand a temperature up to + 90°C.

Alternative fence systems utilizing welded mesh may be proposed for approval.

# Barbed Wire

The barbed wire shall be of stainless steel with two strands twisted and four pinned barbs.

The strands of the barbed wire shall be of required gauge three. Four rows shall be provided above the wire-mesh or as instructed by ADWEA/ADDC/AADC.

In case of flat tape, the tape shall be of stainless steel with a minimum thickness of 0.6 mm and with a bond length of not less than 20 mm.

# Gates

Gates for areas fenced with chain link fence shall be made of frames from trapezoidal or triangle hollow steel sections according to the fence design may be proposed. These gates shall be fitted with adjustable hinges and bronze bushes with greasing points. The in-fill of such gates may be of chain link wire mesh or welded mesh as used for the fence.

Gates shall be lockable and the drop-bolts of inactive leafs shall be locked in the closed position by the active gate to prevent opening.

The corrosion protection shall be provided by hot dip galvanizing and subsequent plastic coating of the gates.