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2 MEMBRANE ROOFING

2.1 GENERAL

2.1.1 Scope

- 1 This Part specifies requirements for flexible roof coverings of various types.
- 2 Related Sections are as follows:

Section 5 Concrete
Section 15 Thermal Insulation of Buildings
Section 18 Carpentry, Joinery and Ironmongery

2.1.2 References

- 1 The following standards are adopted and referred to in this Part:
 - ASTM C981Standard Guide for Design of Built-Up Bituminous Membrane Waterproofing Systems for Building Decks
 - ASTM D412Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
 - ASTM D1227Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing
 - ASTM D2240.....Standard Test Method for Rubber Property—Durometer Hardness
 - ASTM D4541.....Test Method for Pull Off Strength of Coatings Using Portable Adhesion Testers
 - ASTM D4637/D4637M Standard Specification for EPDM Sheet Used In Single-Ply Roof Membrane (reinforced sheets only)
 - ASTM D6221/D6221M Standard Specification for Reinforced Bituminous Flashing Sheets for Roofing and Waterproofing
 - ASTM D6769/D6769M Standard Guide for Application of Fully Adhered, Cold-Applied, Prefabricated Reinforced Modified Bituminous Membrane Waterproofing Systems
 - ASTM D7693/D7693M Standard Guide for Application of Heat Weldable Modified Bituminous Waterproofing Membranes Systems for New Concrete Decks
 - ASTM E96.....Standard Test Methods for Water Vapor Transmission of Materials
 - ASTM F2873Standard Practice for the Installation of Self-Leveling Underlayment and the Preparation of Surface to Receive Resilient Flooring
 - ASTM G154Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

- BS 812.....Testing aggregates
- BS 1070.....Black paint (tar based)
- BS 1202.....Nails
- BS 1210.....Wood screws
- BS 1494.....Fixing accessories for building purposes
- BS 1521.....Waterproof building papers
- BS 3416.....Bitumen based coatings for cold application, suitable for use in contact with potable water
- BS 3690.....Bitumens for building and civil engineering
- BS 4016.....Building papers (breather type)
- BS 5284.....Methods of sampling and testing mastic asphalt used in building and Civil Engineering

- BS 6229.....Flat roofs with continuously supported coverings
- BS 6920.....Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water
- BS 7533-4Pavements constructed with clay, natural stone or concrete pavers.
Code of practice for the construction of pavements of precast concrete flags or natural stone slabs
- BS 8000.....Workmanship on Building Sites
- BS 8217.....Code of practice for built-up felt roofing
- EN 1339Concrete paving flags. Requirements and test methods
- EN 1340Concrete kerb units. Requirements and test methods
- EN 12039Flexible sheets for waterproofing. Bitumen sheets for roof waterproofing. Determination of adhesion of granules.
- EN 12597Bitumen and bituminous binders. Terminology
- EN 12620Aggregates for concrete
- EN 13304Bitumen and bituminous binders. Framework for specification of oxidised bitumen
- EN 13305Bitumen and bituminous binders. Framework for specification of hard industrial bitumens
- EN 13707Flexible sheets for waterproofing. Reinforced bitumen sheets for roof waterproofing. Definitions and characteristics
- EN 13748-2Terrazzo tiles. Terrazzo tiles for external use
- EN 14023Bitumen and bituminous binders. Specification framework for polymer modified bitumens.
- EN 14691Flexible sheets for waterproofing. Waterproofing of concrete bridge decks and other concrete surfaces trafficable by vehicles. Compatibility by heat conditioning
- EN 14692Flexible sheets for waterproofing. Waterproofing of concrete bridge decks and other concrete surfaces trafficable by vehicles. Determination of the resistance to compaction of an asphalt
- EN 14693Flexible sheets for waterproofing. Waterproofing of concrete bridge decks and other concrete surfaces trafficable by vehicles. Determination of the behaviour of bitumen sheets during application of mastic asphalt
- EN 15836-2.....Plastics. Plasticized poly(vinyl chloride) (PVC-P) membranes for inground swimming pools. Reinforced membranes of nominal thickness equal to or greater than 1,5 mm

2.1.3 General Description of Workmanship

- 1 The roof coverings are not to be applied to a damp base and care is to be taken to ensure that no moisture is trapped between successive layers.
- 2 Skirtings are to be a minimum of 150 mm above the roof finish at any point.
- 3 Protective finishes and surface treatments are to be applied as soon as possible after completion of the roof coverings.
- 4 Projections passing through the roof covering are to be provided with hoods or caps to permit the roof covering to terminate beneath the hood and be protected by it from weather elements.
- 5 Outlets for surface water, whether in gutters or roof areas, are to be set slightly below the adjacent roof surface and be suitably flashed to allow a bonded lap of roofing felt and flashing material of 100 mm (minimum).

- 6 Roof waterproofing materials shall be applied by specialist personnel or a specialist subcontractor having previous experience of the system and approved by the Engineer's Representative. The specialist sub-contractor shall provide the guarantee specified in Part 1 of this Section in favour of Public Works Authority.
- 7 On completion of application of waterproofing material to an existing concrete roof but before the application of insulation and protection, the Contractor shall seal off all rainwater outlets and flood the roof to a depth of 25mm. The Contractor shall make up any loss of water due to evaporation or leaks. After 48 hours, visual inspection of the roof shall be undertaken from inside the building in the presence of the Engineer's Representative to establish if there are any leaks in the structure. The Contractor shall locate and seal any leaks. The test shall be repeated at the Contractor's expense until no leaks exist.
- 8 On new roofs the test detailed in sub-clause 7 shall be carried out prior to application of lightweight screed and waterproofing membrane.

2.2 BUILT-UP BITUMINOUS FELT ROOFING

2.2.1 General Requirements

- 1 This section specifies built-up bituminous felt roofing on new roofs and for repairs to existing roofs.

2.2.2 Delivery, Storage and Marking

- 1 Roofing materials shall be delivered to the Site in original sealed packages or containers marked with the name and brand, or trademark of the manufacturer or seller.
- 2 Roofing materials shall be kept dry and stored in weathertight facilities or under canvas tarps. Use of polyethylene or plastic tarps to cover materials is not permitted. Roofing materials shall be stored above ground or deck level on wood pallets. Ground under stored materials shall be covered with a plastic cover.
- 3 Rolled materials (felts, base sheets, paper) shall be stored on end. Materials shall not be stored on top of rolled materials.
- 4 Aggregate are to be maintained in a surface dry condition as defined by BS 812 and BS 882.
- 5 Materials shall be protected from damage from handling, weather and construction operations before, during, and after installation.

2.2.3 Materials

- 1 Built-up bituminous materials are to conform to applicable Standards listed in Clause 2.1.2.
- 2 Asphalt materials (general) include:
 - (a) primer
 - (b) organic felt
 - (c) asphalt
 - (d) glass reinforced felt
 - (e) venting asphalt base sheet
 - (f) mineral surface roll roofing
 - (g) roof cement
- 3 Coal tar materials include:
 - (a) primer
 - (b) organic felt

- (c) coal-tar bitumen
- (d) roof cement

- 4 Miscellaneous component requirements are as follows:
- (a) aggregate requirements include:
 - (i) aggregates to comply with requirements of BS 882.
 - (ii) chippings are to be approved, clean, crushed white or pale grey aggregate size 15 to 30 mm.
 - (iii) (rounded gravel shall e free of sharp angular or broken pieces.
 - (b) roof walkway requirements include:
 - (i) prefabricated asphalt plank consisting of a homogeneous core or asphalt, plasticizers and inert fillers, bonded by heat and pressure between two saturated and coated sheets of felt. The top side of planks shall be surfaced with ceramic granules.
 - (ii) concrete masonry paving units shall comply with BS 1197 and BS 7263.
 - (c) building paper (sheathing paper) shall comply with BS 1521 and BS 4016.
- 5 Fasteners to be used include the following:
- (a) nails and staples shall comply with BS 1210 and BS 1202
 - (b) nails for securing built-up flashing and base sheets to wood deck shall be either:
 - (i) zinc coated steel roofing nails with a minimum head diameter of 9 mm through metal discs at least 25 mm across
 - (ii) one piece nails with an integral flat cap at least 24 mm across.
 - (c) fasteners for securing building paper and dry felt edge strips to wood nailing and decks shall be either:
 - (i) zinc coated steel roofing nails with a minimum head diameter of 16 mm
 - (ii) flat top crown, zinc coated staples
 - (d) nails for plywood are to be annular thread type and shall penetrate plywood by at least 19 mm
 - (e) nails for securing built-up flashing to masonry shall be either:
 - (i) hardened steel nails through metal discs at least 25 mm in diameter
 - (ii) one piece nails with an integral flat cap at least 24 mm across.
 - (f) nails for securing venting base sheet to insulating concrete shall be galvanized steel self-clinching type having a integral flat cap at least 25 mm across. They are to have a holding power of not less than 130 kg when pulled from approximate dense concrete
 - (g) nails for securing base sheet, building paper, or first layer of vapour retarder to structural wood fibre decks shall be the self-clinching type having an integral flat cap not less than 25 mm across. They are to have a holding power of not less than 85 kg per fastener
 - (h) nails for securing base sheet to poured gypsum roof deck shall be specially shaped nails providing a diverging or hooking point. They shall have a flat cap not less than 32 mm across and have a withdrawal resistance of not less than 85 kg per fastener.

2.2.4 Execution of Work

- 1 Roofing materials shall not be applied if the deck will be used as a subsequent work platform, for storage of materials, or if staging or scaffolding will be erected thereon.

- 2 The entire roof deck construction of any section of the building is to be completed before roofing work is begun including:
- installation of curbs, blocking, edge strips, fillets, and other components where insulation, roofing and base flashing is attached shall be in place ready to receive insulation and roofing
 - co-ordination of roof operations with roof insulation and sheet metal work so that insulation and flashing is installed concurrently to permit continuous roofing operations.
- 3 Roofing materials are to be dry when applied.
- 4 Surfaces, including the flutes of metal deck, that become wet from any cause during progress of the work shall be dried out before roofing work is resumed. Materials shall only be applied to dry substrata.
- 5 Except for temporary protection, materials shall not be applied during damp or rainy weather, during excessive wind conditions, nor while moisture (dew or fog) is present in any amount in or on the materials to be covered or installed.
- 6 Materials shall not be applied when the temperature is below 10 °C.
- 7 Phased construction is not permitted. The installation of all layers is to be completed in the same day, including insulation, base flashings, and the layers surfaced with either the flood coat and aggregate or with a glaze coat except for the area where temporary protection is required when work is stopped.
- 8 Temporary protection shall comply with the following requirements:
- install temporary protection consisting of glazed coats and water cut-offs at the end of each day's work and when the work is halted for an indefinite period or work is stopped when precipitation is imminent
 - glaze coat all exposed surfaces of felts to seal in the bitumen coating. No felt surfaces or edges are to be left exposed
 - install temporary cap flashings over the top of base flashings where permanent flashings are not in place. Temporary cap flashings are to provide complete protection against moisture entering the roof system through or behind the base flashing. Securely anchor in place to prevent blowing off and damage by construction activities
 - provide for removal or drainage of water away from the work
 - provide temporary protection for roofing by means of duckboard walkways, plywood platforms, or other materials, as approved by the Engineer, for roof areas that are to remain intact, and that are subject to foot traffic and damage.
 - provide notches in sleepers to permit free drainage.
- 9 Heating of bitumen for installation of roofing shall comply with the following requirements:
- heat the asphalt to the equiviscous temperature ± 1 °C; at the time of application asphalt should not be heated greater than 35 °C above the equiviscous temperature
 - coal-tar bitumen is not to be heated above 215 °C with an application temperature ranging from 160 °C to 200 °C
 - at no time should bitumen be heated above the flash point temperature
 - provide heating kettles with a thermometer kept in operating condition at all times. Kettlemen are to be in attendance at all times during heating to insure that the bitumens are heated within the temperatures specified.

- 10 Asphalt or coal-tar products shall be used, except as specified below:
- (a) use asphalt only with asphalt-saturated or asphalt-impregnated felts
 - (b) use coal-tar pitch and coal-tar-saturated felts in conjunction with coal-tar roofing
 - (c) Asphalt-saturated felts may be used for flashings.
- 11 Installation of roofing materials with hot bitumen shall comply with the following requirements:
- (a) apply bitumen in quantities required, immediately followed by felts or other materials to be embedded therein before bitumen cools below the application temperature limit
 - (b) do not apply more material than can be covered at one time
 - (c) re-coat cooled bitumen areas with hot bitumen
 - (d) roll felts into bitumen, rolling, squeezing or brushing down to firmly embed in the hot bitumen free of wrinkles, blisters, bubbles, voids, air pockets or other defects that prevent complete adhesion. Use squeegees only on glass felts
 - (e) felts shall be lapped shingle fashion for the number of layers specified starting with starter strips at right angles to slope of roof
 - (f) the laying of the roofing materials should commence at the low points
 - (g) bitumen is to separate all felts or substrata so that subsequent layers do not touch previous placed layers of felt or substrata unless noted specifically
 - (h) cut the felt to fit closely around pipes, roof drains, bitumen stops, and similar roof projections.
- 12 Laps for felts and base sheet shall be as follows:
- (a) base sheet shall be lapped 75mm
 - (b) two layers of felt with 500 and 900 mm starting widths shall be lapped 600 mm
 - (c) three layers of felt with 300, 600 and 750 mm starting widths shall be lapped 600 mm
 - (d) four layers of felt with 225, 500 mm and 750 starting widths shall be lapped 700 mm.
- 13 Primer shall be applied with 3.5 litres of primer per 10 m² of surface area unless otherwise recommended by the manufacturer and approved by the Engineer.
- 14 Quantities of bitumen used shall be as follows:
- (a) between substrata and layers of organic felt:
 - (i) asphalt, 33 to 55 kg/m²
 - (ii) coal tar, 44 to 66 kg/m²
 - (b) between substrata and layers of glass fibre felts
 - (i) asphalt, 9 to 13 kg/m²
 - (c) glaze coats:
 - (i) asphalt, 33 to 55 kg/m²
 - (ii) coal tar, 44 to 66 kg/m²
 - (d) pour or flood coats:
 - (i) asphalt, 122 to 144 kg/m²
 - (ii) coal tar, 155 to 177 kg/m²
- 15 Nailing or anchorage of felts or base sheets to nailable decks shall include the following requirements:
- (a) nails or fasteners appropriate for type of deck to be covered shall only be used.

- (b) two layers of felt shall be laid as follows:
 - (i) nail down both layers along bottom edges at intervals not to exceed 225 mm
 - (ii) nail down both layers at both edges at intervals not to exceed 225 mm
- (c) anchorage of base sheets shall be as follows:
 - (i) nail along laps and edges at intervals not to exceed 225 mm with end and edge laps solidly sealed with roof cement
 - (ii) stagger nails down centre of sheet in two rows 300 mm apart at intervals of not more than 500 mm in each row.

16 Building paper shall be laid as follows:

- (a) lay paper smoothly without buckles or wrinkles at right angles to the roof slope starting at the low point
- (b) lap each sheet of paper at least 50 mm over proceeding sheet, and at the ends
- (c) staple or nail sufficiently to hold in place until the roofing is installed.

2.2.5 Surface Preparation

- 1 Sweep decks and remove all dust, dirt and debris.
- 2 Remove projections that might penetrate or damage roofing felt materials.
- 3 Preparation of concrete decks, (except insulating concrete) for installation of roofing shall comply with the following requirements:
 - (a) test concrete decks for moisture prior to application of roofing materials. Heat bitumen as specified and pour approximately 0.5 litres of bitumen on surface to which roofing materials are to be applied. If bitumen foams upon contact with the deck or if after bitumen has cooled and bitumen is stripped from deck leaving no residue, the deck is not dry enough for application of prime coat or roofing
 - (b) prime concrete decks, including precast units, with primer as recommended by the manufacturer for certification. Keep the primer 100 mm back from the joints in precast units
 - (c) allow primer to dry before application of bitumen.
- 4 Roof surfaces of wood sheathing, gypsum, gypsum plank and cement wood fibre plank shall be covered with a layer of building paper.

2.2.6 Existing Roofs and Repair Areas

- 1 Where new penetrations occur and in areas where repairs are required, loose aggregate and aggregate that is not firmly embedded shall be removed.
- 2 Where new work to be installed, the existing membrane should be cut out and removed and a temporary seal to cut surfaces installed. The temporary seal shall consist of roof cement and one layer of 33 kg/m² glass fibre felt or fabric strip. The glass fibre felt or fabric strip shall extend 150 mm on each side of cut surface and shall be completely embedded in the roofing cement.
- 3 If the existing built-up base flashing is to be repaired, either bend up the cap flashing or temporarily remove the cap flashing. Brush and scrape away all deteriorated and loose bitumen, felts, or surface material of built-up base flashing, and repair as necessary in accordance with the requirements of this Section.
- 4 A venting base sheet shall be used over all insulating concrete and poured gypsum decks to relieve possible vapour pressures that may occur.

- 5 The same bitumen shall be used for roof repairs and alterations as used in the existing roofing construction.

2.2.7 Installation of Built-Up Roofing Membrane

- 1 The built-up roofing membrane is to be aggregate surfaced, three layer, glass fibre felt construction using asphalt or four layer organic felt and coal tar bitumen. Building paper or a base sheet is not considered as a layer.
- 2 General requirements of installation of built-up roofing membrane are as follows:
- (a) where nailers occur at roof edges under gravel stops or penetrations to receive metal base flashing, nail a continuous strip of 400 mm wide dry organic felt envelope over the nailers before the first layer sheet is applied. The organic felt strip is to be installed on top of the venting base sheet. After the membrane is installed, turn the dry felt back over the roofing, and secure in place with hot bitumen before gravel stops or other metal flanges extending out onto the membrane are installed
 - (b) where fillets occur at vertical surfaces, cut off layers of the membrane 50 mm above, the top of fillet strips. At prefabricated curbs, scuttles and other roof accessories having integral fillets, extend the membrane over the fillet and up the vertical surface to the top of the curb or nailing as shown in drawings
 - (c) where a fascia-fillet occurs at the roof edges, extend the membrane beyond the outside fillet face and cut off at the outside after the base flashing is installed. Do not cut off the venting base sheet outside the fillet face, extend it down over the outer fillet face to allow for venting
 - (d) where a recessed flashing occurs at vertical surfaces, extend layers of roofing up into recessed flashing the full depth of the recessed flashing.
- 3 Built-up roofing installed over insulation shall be sealed down as specified Clause 2.2.7-3.
- 4 Built-up roofing installed on concrete and precast concrete Units shall comply with the following requirements:
- (a) prime deck as specified Clause 2.2.4-13
 - (b) keep bitumen back 100 mm from joints in precast units
 - (c) seal down membrane as specified Clause 2.2.4.
- 5 Built-up roofing installed on nailable decks shall include requirements as follows:
- (a) on insulating concrete decks, install one layer of venting base sheet with the mineral aggregate surface down. Fasten base sheet to deck as required, followed by membrane as specified
 - (b) termination venting base sheet:
 - (i) at vertical surfaces: extend venting base sheet up vertical surface over fillets to top of base flashing or curb
 - (ii) at the roof edges under gravel stops install a venting base sheet over the blocking. The base sheet shall be extended not less than 50 mm beyond the outer edge and it shall be turned down so that venting can be accomplished
 - (iii) at the roof edge over a fascia-fillet: extend the base sheet over the top of the fillet and turn it down over the outer face of the fillet to permit venting at the edge.
 - (c) on poured gypsum, precast gypsum plank, cement-wood fibre plank, wood plank or plywood decks, install one layer of building paper followed by either:

- (i) two layers of 33 kg organic felt laying both layers down dry to deck except to seal between laps. Lap and nail as specified to deck. Follow immediately by the membranes sealed down to the felt
 - (ii) one layer of base sheet or venting base sheet. Lay base sheet down dry on the deck. Lap as specified and seal the edge laps with roofing cement. Nail as specified followed by the roofing membrane sealed down to the base sheet.
- 6 Cover the exposed surface of the last layer of felt, except on fillets and under concrete pavers or runners of wood roof walkways, with bitumen and aggregate as specified.
- #### 2.2.8 Base Flashing
- 1 Provide built-up base flashings over fillets and wherever necessary to make the work watertight.
 - 2 Install flashing before final bituminous coat and roof aggregate is installed.
 - 3 Prime vertical surfaces of masonry and concrete with asphalt primer except where the vented base sheet is required to provide edge venting.
 - 4 When applying a flashing on top of built-up roofing, up the face of fillets and up the face of the vertical surfaces, between 200 mm and 300 mm above the built-up roofing, the following shall apply:
 - (a) at fascia-fillets, extend the flashing to the top of fillet and cut off at the top of fillet
 - (b) at recessed flashings, extend the flashing full depth into the recessed flashing
 - (c) where venting base sheet is used with insulating concrete, do not seal edges of venting base sheet with bitumen in order to allow for venting.
 - 5 Flashing is to consist of two layers of 33 kg/m² glass fibre felt or fabric, surfaced capped as specified.
 - (a) extend the first layer of flashing 100 mm out on the roofing, and the second layer of flashing 75 mm beyond the first layer. Lap ends 75 mm with joints broken 500 mm in each layer
 - (b) cap sheet is to be mineral surfaced roll roofing or modified bitumen sheet extending from toe of fillet to top of base flashing. Lap the ends 75 mm with joints not coinciding with joints in under layers.
 - 6 Base flashings may be set either in asphalt (hot applied method) or in roof cement (cold applied method), with only one method only used throughout. Application of either method shall be as follows:
 - (a) cold applied method:
 - (i) embed each layer of flashing in roof cement so layers do not touch felt
 - (ii) cover the last layer of flashing with a troweled on coat of the roof cement, into which embed the cap sheet from toe of the fillet to top of the base flashing and seal laps with roof cement
 - (iii) Use cold applied method with coal tar roofing.
 - (b) hot applied method:
 - (i) embed each layer of flashing and cap sheet in asphalt so that the layers do not touch
 - (ii) set the cap sheet in hot bitumen with laps sealed with hot bitumen.
 - (c) except for venting roof edges, seal the top edge of the base flashing with roof cement.

- 7 Except at metal fascia fillets, secure top edge of the base flashing with nails on a line approximately 25 mm below the top edge, and at not more than 200 mm centres. All nail heads shall be covered with roof cement. The top of the base flashing shall be covered with counter flashing. At fascia fillets, secure the top edge of the flashing with fascia compression clamps.

2.2.9 Stripping

- 1 Before the final bituminous coat and roof aggregate is installed, cover that portion of the horizontal flanges of metal base flashings, gravel stops, and other flanges extending out onto the roofing with a composition flashing consisting of two layers of glass fibre felt or fabric. Use organic felt with coal tar bitumen for stripping.
- 2 Extend the first layer of flashing out on the roofing 100 mm beyond the edge of the flange and the second layer 75 mm beyond the edge of the first layer. Cut edges to fit tight against vertical members of the protruding flange.
- 3 Each layer of flashing shall be embedded in hot bitumen or roofing cement.

2.2.10 Roof Pour Coat and Aggregate

- 1 After bituminous base flashing and stripping have been installed uniformly coat the entire roof surface except fillets with hot asphalt or coal-tar bitumen poured on, as directed in Clause 2.2.4 of this Part.
- 2 While still hot, embed necessary amount of aggregate to cover the roofing felt completely without bare spots, but not less than 888 kg/m² of dry gravel or 666 kg/m² of dry slag. The aggregate cover shall be such that no bitumen is left exposed.
- 3 Placing the aggregate material in piles or rows on bare or glaze coated felt before placement is prohibited.

2.2.11 Roof Walkways

- 1 Walkways may be concrete masonry units or prefabricated asphalt planks.
- 2 Place concrete masonry units on top of the pour coat. Aggregate shall not be embedded under runners of wood roof walkways. Butt concrete masonry units to provide a continuous walkway surface.
- 3 When prefabricated asphalt planks are used, sweep away loose roof aggregate from the areas to receive planks. Set the planks in hot bitumen poured over the firmly embedded roof aggregate as specified for pour coat. Maintain a minimum of 75 mm to a maximum of 150 mm space between planks.

2.2.12 Alterations to Existing Roofs

- 1 Roof repair and alteration work is to match existing roofing material and construction. Bitumen compatible with the existing bitumen shall be used for roof repair and alterations.
- 2 Make cut-outs of existing roof system to confirm the condition of the roof. Cuts are to be made in the presence of the Engineer in locations as directed by the Engineer. Each cut-out opening shall be photographed. The cut-out area shall be repaired immediately upon confirmation of the condition of the roof. Any moisture found in the roof membrane or insulation shall be reported to the Engineer.
- 3 Repairs to existing membrane and base flashing shall be carried out as follows:
 - (a) remove temporary patches prior to starting repair work
 - (b) blisters and fish mouths:

- (i) cut blisters open and turn membrane back to fully adhered portion. Cut fish mouth so membrane can be turned back and subsequently laid flat
- (ii) heat membrane to facilitate bending and to dry out surface of blistered areas exposed
- (iii) seal down turned back membrane in hot bitumen. Roll to insure full adhesion and embedment in substrata
- (iv) cover cut areas with two layers of felt. Extend first layer 100 mm beyond cut area edge. Extend second layer 100 mm beyond first layer. Seal down in hot bitumen as specified for new work. Resurface as specified.
- (c) exposed felts:
 - (i) cut away exposed deteriorated edges of organic felt
 - (ii) glaze coat felt edges
 - (iii) resurface as specified.
- (d) built-up base flashing:
 - (i) restore felts and cap sheet removed, lapping 100 mm over existing remaining
 - (ii) install new felts and cap sheet as specified for new work.
- (e) horizontal metal flanges:
 - (i) remove loose, buckled, or torn stripping
 - (ii) remove loose fasteners and install new fasteners
 - (iii) restrip flanges as specified for new work.
- (f) resurfacing:
 - (i) over repaired membrane, re-pour and embed new or cleaned aggregate as specified for new work
 - (ii) cover all membrane areas. Do not leave any exposed membrane surface.

2.3 COLD APPLIED BITUMINOUS COATING

2.3.1 General Requirements

- 1 The Contractor is to clean and prepare roofing surface areas immediately prior to application of bitumen coating. Black bitumen coating solutions to be applied in accordance with BS 3416, BS 6920.
- 2 Application of cold applied bituminous solution is to be done by a qualified experienced personnel.
- 3 All openings and roof vents are to have watertight flashings.

2.4 PREPARED ROLL ROOFING

2.4.1 General Requirements

- 1 Prepared roll roofing is the top layer in a built-up roofing membrane. Standard prepared roll roofing material consists of a glass fibre mat coated on both sides with a stabilised asphalt coating and surface coated with non-combustible ceramic granules.
- 2 Prepared roll roofing material is to be compatible with, and manufactured by the supplier of, the built up roofing membrane.
- 3 Prepared roll roofing is to be sealed with hot bitumen or cold adhesive as recommended by manufacturer.
- 4 The Contractor shall guarantee roll roofing for fifteen (15) years.

2.5 MODIFIED BITUMINOUS SHEET

2.5.1 General Requirements

- 1 Modified bituminous sheet is a cold applied membrane composed primarily of modified bituminous material prefabricated in sheet form.
- 2 Modified bituminous sheet is reinforced with glass fibre, polypropylene, or polyester fabric which may be bonded to a plastic sheet, and supplied in this form by the manufacturer.
- 3 The standard sheet thickness shall be 4 mm.
- 4 The sheet is to be provided with a release sheet to prevent bonding of the sheet to itself.

2.6 SINGLE LAYER MEMBRANE

2.6.1 General Requirement

- 1 A single layer membrane is a 4mm (minimum) single layer bituminous felt membrane and is torch applied.
- 2 Overlaps in the applied membrane are to be in the same direction as the roof slope.
- 3 Base flashing items as specified in Clause 2.2.8 of this part are to be completed prior to the installation of the single layer membrane.

2.7 FLUID APPLIED MEMBRANES

2.7.1 General Description

- 1 Liquid applied membranes shall be non-aqueous and should consist of a one component high quality polyurethane elastomeric coating or a two component coal tar polyurethane elastomer.
- 2 If polyurethane elastomeric coating is used then it shall cure by reacting with the humidity to form an elastic strong film with excellent adhesion to different substrate.
- 3 Elastomeric waterproofing liquid membrane shall have the minimum following properties or equivalent standards:-

Tensile Strength, ASTM D412:	> 5 N/mm ²
Elongation, ASTM D412:	> 500 %
Shore A, ASTM D2240:	> 70
Vapor transmission, ASTM E96:	0.8 gr/m ²
QUV accelerated weathering test, ASTM G154:	(2000hrs) Passed
Service Temperature:	-40 to 80°C

- 4 If two component coal tar polyurethane elastomer used then it shall cure, when mixed, to form a flexible, elastomeric waterproof membrane having the following minimum properties after ageing:

Tensile strength:	4.0 N/mm ² .
Elongation:	300-400 %
Shore Hardness:	I.R.H.D. 70 %.
Total Solids:	90-95 %
Moisture vapour transmission:	8.5 ml/m ² /24 hours

- 5 The waterproofing membrane is to incorporate the sealer/primer, reinforcing and reflective coating materials recommended by the manufacturer of the membrane.

- 6 The Contractor is to submit to the Engineer the manufacturer's literature concerning the shelf life of each component material of the system to be used, together with authoritative evidence of the dates of production

2.7.2 Liquid Applied Waterproofing Systems

- 1 Surfaces receiving the waterproof membrane are to be treated with the recommended primer, sealer and allowed to dry.
- 2 When all the surfaces receiving the membrane and the equipment to be used are ready, the materials are to be mixed in strict accordance with the manufacturer's instructions using a mechanical mixer. Only that amount which can be used within the pot life of the material is to be prepared.
- 3 Reinforcing strips at construction and movement joints, shrinkage cracks, pipe inlets/outlets, electrical conduit, air-conditioning ducting etc., must be applied in the widths and thickness recommended by the manufacturer prior to final applications of the membrane.
- 4 When the reinforcing strips and expansion joint covers have cured, the membrane is to be applied using an airless spray, trowel, squeegee or any other recommended method producing the required membrane thickness.
- 5 Site operatives are to be kept off the membrane until it has cured sufficiently to accept foot traffic. Tackiness of the surface may be neutralised by dusting with dry cement. Areas where labourers will be working applying topping materials should be covered with a protective layer of fibreboard.
- 6 Surfaces which are not to receive a permanent protective covering are to be treated with a solar reflective finish recommended by the manufacturer of the membrane.

2.8 COATED SPRAY APPLIED FOAM

2.8.1 Description

- 1 This Clause specifies general requirements for spray applied foam insulation which is covered with a protective coating.

2.8.2 Installation

- 1 Prior to spray application of the foam all welding or other hot work required on the roof is to be completed and all surfaces not to receive the insulation are to be securely wrapped or otherwise protected with suitable covering.
- 2 The equipment used by the Contractor is to provide thorough mixing of components and be calibrated prior to commencing work to ensure correct metering of the material components.
- 3 Under no circumstance should spraying be carried out in the presence of water or when the wind speed is in excess of 25 kilometres per hour.
- 4 The foam to be applied in minimum 12 mm layers to build up the specified thickness.
- 5 The first coat or layer of the protective covering is to be applied the same day the foam insulation is installed.
- 6 If for any reason more than 48 hours elapses between application of the foam and a protective coating, the foam surface is to be inspected for contamination or oxidation. Should either be present, the surface is to be brushed with a stiff broom or mechanically scoured and reformed prior to application of the protective covering.

2.9 PERMEABLE FILTER MEMBRANE

2.9.1 General Requirements

- 1 Permeable filter membrane are to be chemically stable and made of rot resistant fabric, manufactured from synthetic, thermally bonded, non woven fibre weighing not less than 140 g/m² and minimum 0.7 mm thick. The membrane is to be capable of freely passing water but preventing the passage of salt and clay particles.
- 2 Application and execution of workmanship must comply with procedures recommended by the manufacturer.
- 3 Fabric must be applied around projections or areas of reinforcement in the widths and thickness recommended by the manufacturer prior to final applications of the membrane.

2.10 PROTECTED MEMBRANE

2.10.1 General Requirements

- 1 Protective membranes to membrane roofing shall be as specified in Part 4 of this Section.

2.11 TORCH APPLIED WATERPROOF MEMBRANE

2.11.1 General Requirements

- 1 Torch applied waterproofing membrane shall consist of a reinforced bitumen-polymer membrane having the following properties:

Thickness		Min.1.5mm
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Tensile Strength	BS 2782, (EN 12311-1)	Min.375N/5cm
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Elongation	BS 2782, (EN 12311-1)	Min.40%
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Tear Resistance	ASTM D1004, (ASTM D5147)	Min100N/mm
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Moisture Vapour Permeability	BS 2782,(ASTM E96)	Max.8.5g/m ² /day
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- 2 The waterproofing system shall incorporate the priming and reflective coating materials recommended by the manufacturer of the membrane.
- 3 The waterproofing system shall be applied strictly in accordance with the instructions supplied by the manufacturer.

END OF PART