

Volume 3

Technical Specifications

PROJECT INFORMATION

Project Name: Construction of a National Diagnostic Facility

Owner Name: Government of St. Lucia represented by Office of the National Authorising Officer

Description: Construction of a New National Diagnostic Facility

Address: Union, Castries, Saint Lucia

Owner Project No.: ATP-SLU/TSV-007/1401/LC **(to be confirmed by Client)**

Consultant's Name: FDL Consult Inc.



Consultant's Project No.: 1503.17-SLU-DS- Diagnostic Centre

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100 GENERAL AND PRELIMINARY

101 Definitions

For the purpose of this specification, the following definitions apply:

“Approved' ' Directed' or ' Selected”	Approval
Allow	Where this term occurs in the document the cost of the item is at the risk of the Contractor
“Supervisor’s Representative ,” “ Supervisors Representative” , “ Architect” “BS”, and “ASTM”	Supervisor’s Representative as defined in the Special Conditions of Contract the latest British Standard Specification, British Code of Practice, and American Society of Testing and Materials respectively
' local'	Saint Lucia
Demolition	Work done to dismantle or take apart and remove an existing building or facility
Hazardous Materials	General term to encompass any and all materials which have been contaminated by substances which are dangerous or potentially dangerous to the public. It is inclusive of materials which if not properly contained could continue to spread and contaminate soil, ground water or become airborne
Hazardous Materials	General term to encompass any and all materials which have been contaminated by substances which are dangerous or potentially dangerous to the public. It is inclusive of materials which if not properly contained could continue to spread and contaminate soil, ground water or become airborne
Method Statement	The defined method or process to be followed for demolition of a specific project.
Selective Demolition	Typically refers to demolition work done to only parts of buildings or facilities for retrofit for renovation type work.

102 **Applicability**

This General Specification for Building is applicable to all building works in connection with the construction, alteration and maintenance of buildings unless overridden by the General Conditions of Contract, Special Conditions of Contract, or the instructions of the Supervisors Representative.

103 **Abbreviations**

Abbreviations used shall have the following meanings:

BS	British Standard
BS EN	European Standard
SMACNA	Sheet Metal and Air Conditioning Contractors
CS	Construction Standard
GS	General Specification
IEE	Institute of Electrical Engineers
ISO	International Organization for Standardization Publication
PS	Particular Specification
PW	Public Works
SR	Supervisor's Representative

104 **Applications of specification**

Materials and workmanship specified in one Section of this GS shall apply to the same items in other Sections.

105 **Possession and Use of the Site**

The Contractor shall request possession of the Site from the Supervisor's Representative when required and in accordance with his programme of Works. The Client shall grant possession in accordance with Article 9 of the Conditions of Contract.

When the Contractor is given possession of the Site he shall be given authority to carry out the Works instructed by the Supervisor's Representative under the Contract.

The Contractor shall not enter the Site for additional investigations or to execute the Works until he has been granted possession. If the Contractor requires to enter the Site prior to being granted possession for other reasons and the Supervisor's Representative agrees, he shall demonstrate that he has the necessary insurances and has arranged appropriate safety measures.

During possession of the Site, or portion of the Site, the Contractor shall be responsible for providing lighting, protection and other measures to make the temporary works, material storage, excavations, partially finished works, etc. safe for the public and road use.

106 Co-operation

The Contractor shall co-operate with the Sub-Contractors on site and co-ordinate his work with theirs to the fullest extent. The Contractor's programme shall be drawn up in such a manner as to agree with the Sub-Contractor's programme.

The cost of all measures taken to ensure complete co-operation between the Contractors, the Sub Contractors shall be included in the tender price.

107 Completion Period

The Contract Works are to be completed within the period of implementation as stipulated in Article 34 of the General Conditions of Contract.

108 Protection against Damage

The Contractor shall take all necessary precautions to avoid causing any unwarranted damage to roads, lands, properties, trees and other features during the currency of the Contract.

Where any portion of the Works is close to, across, or under any existing apparatus of Utility Companies, the Highway Authority or other parties, the Contractor shall temporarily support and work round, under or adjacent to all apparatus in a manner designed to avoid damage, leakage or danger, and to ensure uninterrupted operation.

Should any leakages or damage be discovered, the Contractor shall at once notify the Supervisor's Representative and the Utility Company, Highway Authority or owner concerned, as appropriate, and the Contractor shall afford every facility for the immediate repair or replacement of the apparatus affected.

The Contractor shall fully reinstate at his expense and to the Supervisor's Representative satisfaction any damage caused by any of his operations.

Damage includes all actions that would lead to environmental damage such as tipping of waste, fuel or oil and destruction by plant and equipment.

If existing structures are encountered which will prevent the construction of the Works as designed, the Contractor shall notify the Supervisor's Representative of his proposed changes and make such reasonable modifications as are necessary to the satisfaction of the Supervisor's Representative.

109 Project Signs/Notice Boards

The Contractor shall provide and erect one (1) suitable notice board as detailed by the Supervisor's Representative not less than 2.4 meters wide by 1.2 meters high mounted on suitable posts at a location to be advised by the Supervisor's Representative. Colours, text and size of lettering shall be to the approval of the Supervisor's Representative. Each sign shall give the following information:

- Project Title
- Name of Supervisor
- Name of Supervisor's Representative
- Name of Contractor
- Name and logo of Funding Agency

No other notice boards or signs of any description shall be erected unless directed or approved.

110 Working Hours

Working hour restrictions may apply to the Site including the delivery of materials and equipment. Details are given in the Contract.

111 Particular matters to be brought to the attention of the Contractor

The Contractor shall take note that the construction works is to be carried out within a commercial and residential zone. Noise levels at properties adjacent to the Works shall be limited to Leq 70 dB (A) and Lmax 85dB (A) (maximum noise level in any hour).

The Contractor's hours of working shall be limited to normal working hours (06.00 to 18.00). Night working and weekend working shall only be permitted with the written approval of the Supervisor's Representative.

The Contractor shall ensure that any nuisance caused by dust is kept to a minimum by appropriate measures including the use of water sprayed on the surface. If in the opinion of the Supervisor's Representative the Contractor is taking insufficient precautions to avoid such dust nuisance the Supervisor's Representative may issue a written warning and in the event of subsequent dust nuisance the Contractor shall be liable to liquidated damages in accordance with the Conditions of Contract and be responsible, at no cost to the Supervisor, for any cleaning of property that the Supervisor's Representative deems to have been adversely affect by dust.

112 "Directed" and "Approved"

The terms "directed" and "approved" in the Specification mean "directed by the Supervisor's Representative" and "approved by the Supervisor's Representative" except where the context clearly implies another meaning.

113 Staff

The Contractor shall provide such competent skilled labour as may be required for the satisfactory execution of the Contract.

If the Supervisor's Representative is of the opinion that any members of the Contractor staff is incompetent or has been guilty of a serious breach of his duties, he may by notice to the Contractor call upon him to require that such person be replaced.

The Contractor shall arrange for a senior representative to attend all progress and site meetings.

114 Accommodation for Staff

Workmen shall not be permitted to live on the Site except in particular and stated circumstances:

Habitable floor area of 3.5 m² per workman, with 3 m floor to ceiling height. Window area to be 10% of floor area, with 33% to open for ventilation

Kitchen constructed of fire resisting materials, located 6 m minimum from any structure not of fire resisting materials.

Ground floors of concrete or other approved material.

Drinking water and ablution facilities

Sufficient garbage bins, to be emptied daily.

115 Access by Officials and Visitors

Authorised government and Ministry officials shall at all times have access to the work wherever it is in preparation or progress, and the Contractor shall provide proper facilities for such access and for inspection.

Where the Site has conditions requiring access by archaeologists, environmental or conservation officials, this will be detailed in the Contract.

Where visitor access is required to the site offices, particular care shall be taken to ensure that this access is safe and adequately signposted.

116 Local Trade Practices

The Contractor and his employees shall comply with all rules, practices and/or Local Agreements which shall be in force in the area of the site and shall avoid any complications which may cause strikes or trade disputes among his own or other workmen.

117 Workmanship and Quality Control

The onus rests on the Contractor to produce work, which conforms in quality and accuracy of detail to the requirements of the Specifications and Drawings. The Contractor must, at his own expense institute a quality control system and provide experienced technical staff and equipment to ensure adequate supervision and control of the Works at all times.

The costs of the supervision and process control including testing to be carried out by the Contractor in compliance with the above requirements shall be deemed included in the rates tendered for the related items of work.

The Contractor's attention is drawn to the provisions of the various sections of the Specifications regarding the minimum frequency of testing that shall be required to be undertaken as part of the quality control process. The Contractor shall increase this frequency where necessary to ensure adequate control at his own discretion or as ordered by the Supervisor's Representative.

The Contractor shall submit to the Supervisor's Representative the results of all relevant tests, measurements and levels indicating compliance with the Specifications on completion of every part of the work for the Supervisor's Representative's examinations.

118 Codes of Practice/Standards

The whole of the Works shall be carried out in accordance with the rules, regulations or other requirements of the local and other authorities as outlined in the sections of this Specification. The Contractor shall pay all fees and charges in connection therewith.

Wherever Standards, Codes of Practice and other similar references have been quoted in the Specification, the latest current edition of such Standard, Code of Practice or other similar reference shall apply. The Contractor may propose the use of alternative standards provided that:

The alternative is, in the opinion of the Supervisor's Representative, equal to or superior to that quoted in the Specification;

The Contractor provides the Supervisor's Representative with a copy in English of the proposed alternative standard when he submits his design and calculations or other proposals.

119 Authorities and Regulations

The installation shall comply with the requirement of any Acts of Parliament, Bye-Laws, Rules and Regulations of Local Authorities, Public Supply Authorities, Insurance Offices, etc., that may be applicable to the works and shall be in accordance with the requirements of the Factories Acts, the Health and Safety at Works Act, (especially the Electricity at Work Regulations 1989), etc., Statutory Rules and Orders relating thereto and any applicable British Standard and Codes of Practices, BSEN and ISO Standards.

The complete electrical installation shall comply with BS7671 including all Amendments (current Edition of the IEE Regulations for Electrical Installations hereafter referred to as the IEE Regulations).

Air conditioning, heating, ventilating systems and water systems shall comply with the requirements of the Chartered Institution of Building Services Supervisors Representatives. Sprinkler installation shall comply with the Rules and Regulations of the Fire Officers Committee, 29th Edition.

When in this Specification attention is drawn to a specific regulation requirement, Standard or Code of Practice, this will not absolve the Contractor from complying with all regulations, requirements, standards or Codes of Practices as a whole.

120 Health and Safety Plan

The Contractor shall provide the Supervisor's Representative with a copy of the written safety policy and any revisions thereof which he has prepared as a supervisor and which relate to the execution of the Works. Prior to commencement of work on the Site, the Contractor shall provide the Supervisor's Representative with a copy of the relevant notices submitted to the Government of Saint Lucia to satisfy Health and Safety Requirements and shall inform the Supervisor's Representative of the name and location of his appointed safety supervisor(s).

The Contractor shall also provide the Supervisor's Representative with written details of any control measures he proposes to institute in compliance with the control of substances hazardous to health.

121 Suspension of Work in Unsafe Conditions

Where The Supervisor's Representative Judges that the Contractor is conducting work in unsafe conditions or that the workmen are in danger of death or injury, he shall instruct the Contractor to remedy the situation and render the working conditions safe. If the Contractor fails to do so within 24 hours, The Supervisor's Representative shall suspend work in that area until such time that the Contractor shall demonstrate that he has made the necessary provisions to remedy the situation and render the working conditions safe. The Supervisor's Representative shall suspend work immediately if the danger is deemed serious.

Where there is also a danger to the public and the Contractor has failed to remedy the situation within a reasonable time, the Supervisor's Representative shall take the necessary action for remedy and deduct the cost thereof from the money owed to the Contractor.

122 Safety of Works and Adjacent Structures

The Contractor shall at his own expense provide and erect to the approval of the Supervisor's Representative all supports required to protect efficiently all structures or works requiring support as a result of the Works and shall remove the same on completion.

123 Site Tidiness

The Contractor shall be responsible for the proper tidiness of the Site and Works and remove rubbish and waste promptly from the Site. Disposal of site waste and rubbish shall comply with the regulations of the local Waste Management Authority. All materials, plant and equipment shall also be stored or positioned in an orderly manner.

124 Traffic Control, Pedestrian Access and Demarcation of Site

The Contractor shall observe all traffic regulations, the requirements of the Acts and By-Laws of Saint Lucia for regulation of traffic on roads forming part of the site or used to transport materials to the site. The Contractor shall ensure that movement of vehicles within the site is

restricted to only equipment and vehicles required for the execution of the Works. For security purposes, no unauthorised vehicles shall be allowed to enter the site.

Prior to commencement, the Contractor shall erect barriers, signs and devices for the guidance of road users, the protection of pedestrians and the public and to limit and enclose the site as necessary, all to the approval of the Supervisor's Representative.

125 Abatement of Nuisance

The Contractor shall adopt such measures, as the Supervisor's Representative may consider reasonable and necessary to minimize nuisance from dust, noise, or other cause. During periods of dry weather, the site shall be watered a minimum of 3 times a day if necessary to avoid the spread of dust arising from the execution of the Works.

126 Existing Utilities and Underground Services

The Contractor shall adequately notify and seek the cooperation of all the Utility owners well in advance of commencing any excavation works. He shall clearly mark the approximate locations of these utility lines or structures so indicated with the assistance of the Utility owners or operators.

If the Contractor and Utility operators are unclear of the precise location of a particular utility line or structure, the Contractor shall request and obtain permission for an approved test pit from the Supervisor's Representative.

The Contractor shall execute the Works in such a manner that he does not damage or interfere with existing services on or near the Site. If damage or interference is so caused, the Contractor shall make his own arrangements, to the approval of the Supervisor's Representative and the relevant authority, to execute the repairs at his own cost. If the service authority concerned elects to make good the damage, the Contractor shall give all facilities and shall pay all charges.

The Contractor shall make his own arrangements for any diversion or removal of services, which he may require for his own convenience or method of working, and shall obtain the prior approval of the Supervisor's Representative to such arrangements.

Where public utility services are to be diverted the works shall be carried out in such a way that the service is maintained while the diversion is installed. The existing service shall not be broken into until the diversion is in place. Should temporary diversions of services be required, the Contractor shall be responsible for arranging such temporary diversions with the relevant Authority who shall carry out the work of diverting the services.

The planning and coordination of the work with and of the service authorities shall be the Contractor's responsibility and due allowance for such shall be made in the Contractor's programme.

127 Condition Survey

Prior to commencement, the Contractor shall, in conjunction with the Supervisor's Representative, conduct a condition survey of existing buildings, roads, pavements, sidewalks, fencing, poles, wires, survey bench marks and monuments adjacent to the site which may be

affected by the Works. The Contractor shall record (and if necessary film) the survey and provide the Supervisor's Representative with a copy of the condition survey information for future reference if necessary.

128 Materials on and Under Site

Materials arising from clearance of the Site, soil stripping and excavations shall belong to the Supervisor and shall not be removed from the Site except as required by the Contract and with the approval of the Supervisor's Representative.

129 Temporary Fencing/Security of Site

The Contractor shall be responsible for ensuring that the Site is adequately fenced. The Contractor shall do this work prior to starting work on the relevant portion of the Site. The Contractor shall regularly inspect and maintain all such fencing, any defects being made good without delay.

Access shall be provided in temporary/Site fencing as necessary for the use of the occupiers of adjacent lands. Temporary site fencing shall remain in position until either it is replaced by permanent fencing or the Works are sufficiently completed to enable that portion of the Site to be brought into use.

The type and height of temporary fencing shall be to the Supervisor's Representative's satisfaction where not stated elsewhere in the Contract.

Where required by the Contract the Contractor shall be responsible for making the Site secure with lockable access gates and security lighting to suit local conditions.

130 Interference with Land Interests

The Contractor shall confine his constructional operations within the Site, or such other areas of land as may be negotiated, and shall instruct his employees, and those of his sub-contractors, not to trespass.

Subject to any unavoidable disturbance that may be necessitated by the execution of the Contract, the Contractor shall not interfere with any sporting, fishing or other rights that may be enjoyed on or near the site.

Before exercising any right negotiated by him in connection with way leaves or accommodation outside the site, the Contractor shall notify the Supervisor's Representative in writing of such arrangements.

Normally on site living accommodation will not be permitted but where it is unavoidable, this will be detailed in the Contract.

131 Protection of Structures

Heavy equipment shall not be operated in such a manner and in such proximity to existing or new structures or other permanent works as to cause their displacement or damage them in any way. New structures shall have attained adequate strength before being subjected to backfilling operations, impacts, vibrations or other such forces.

132 Emergency Arrangements

The Contractor shall maintain arrangements whereby he can quickly call out labour outside normal working hours to carry out any work needed for an emergency associated with the Works. The Representative Supervisor's shall be provided at all times with a list of addresses and telephone numbers of the Contractor's staff who are currently responsible for organising emergency work.

The Contractor shall acquaint himself and his employees with any relevant local arrangements that are in existence for dealing with emergencies.

133 Hazardous Substances

No hazardous substances shall be brought on to the Site or used for any purpose unless the Contractor has previously obtained the written approval of the Supervisor's Representative and has obtained the necessary permits.

The Contractor shall obtain the Supervisors Representative's approval in writing prior to storing and locations of any hazardous substance on the Site.

The Contractor shall comply with Specific local or National codes and laws, for example, those concerning storage of fuel and flammable substances and explosives.

134 Drains, Streams, Watercourses etc.

Drains, pipes, canals, channels, water courses or streams affected by the Contractor's operations are to be maintained by temporary channels or pumping if necessary and on completion restored to their original condition as soon as possible after the relevant operations have ceased. The Contractor shall notify the Supervisor's Representative in writing 14 days in advance of his intention to start any part of the Works affecting watercourses, canals, streams, drains, pipes, channels etc. The Contractor shall be responsible for maintaining the watercourses within the Site in effective working condition.

The Contractor shall execute the works in a manner that shall avoid the pollution or siltation of rivers, streams or the sea. If in the opinion of the Supervisor's Representative the Contractor is taking insufficient precautions to avoid such pollution or siltation, the Supervisor's Representative may issue a written warning and in the event of subsequent damage, pollution or siltation the Contractor shall be subject to liquidated damages in accordance of the Contract.

135 Keeping Works Free from Water

Except where underwater construction is required the Contractor shall execute all work in the dry, and shall construct any temporary drains or other works that may be necessary for the purpose. During excavation or otherwise during the execution of the works, the Contractor shall not obstruct flow of surface drainage or natural watercourses. The Contractor shall protect open excavation and the works against flood and damage due to surface runoff of water from any other source.

The Contractor shall keep excavations free from water while installation work is in progress. Disposal of water should be carried out in a manner not detrimental to the environment, the public or property and in keeping with the specifications.

136 Damage to Access Roads

The Contractor shall ensure that damage to any public or private roads, footpaths and tracks used by any vehicles or plant proceeding to or from the Site is kept to a minimum and he shall be responsible for the cost of all repairs necessary to restore such roads, tracks or footpaths to the satisfaction of the Supervisor's Representative and/or controlling authorities.

137 Setting out of the Works & Surveys

At least one bench mark and two horizontal control points shall be indicated to the Contractor by the Supervisor's Representative at the site.

The Contractor shall be responsible for checking that the basic survey points are in place at the commencement of the Contract, and if any are missing, or appear to have been disturbed, the Contractor shall inform the Supervisor's Representative who shall make arrangements to re-establish the points.

After this basic survey and setting out has been agreed by the Supervisor's Representative, the Contractor shall be responsible for its maintenance and re-establishment of any portion lost or destroyed.

Should the Contractor discover any error in line or level in basic setting out, he shall at once notify the Supervisor's Representative who shall then issue amended drawings or instructions regarding the correction of the error.

The Contractor shall establish temporary bench marks at intervals and shall provide the Supervisor's Representative with a schedule of their levels.

Prior to the construction of any earthworks, excavation or other work in any area of the site, the levels of the existing ground above or below water shall be agreed between the Contractor and the Supervisor's Representative. If the Contractor fails to take the requisite levels, then the ground levels shown on the drawings or determined by the Supervisor's Representative shall be taken as correct.

The Contractor shall give the Supervisor's Representative not less than 48 hours' notice in writing of his intention to set out or take levels for any part of the Works in order that arrangements may be made to carry out any joint measurements or any checks required.

During the progress of the Works, the Contractor shall not remove, damage, alter or destroy in any way any survey controls. Should the Contractor consider that any survey control shall be interfered with by the construction Works or shall ultimately be above or below the final level of the finished Works, he shall notify the Supervisor's Representative who, if he considers it necessary, shall make arrangements for the removal and replacement of the survey control.

If the Contractor removes or disturbs a survey control without the prior permission of the Supervisor's Representative, he shall be liable for the full cost of its replacement.

138 Faulty Work

Any work, which fails to comply with these Specifications, shall be rejected and the Contractor shall, at his own expense, make good any defects as directed by and to the satisfaction of the Supervisor's Representative.

139 Assistance to the Supervisor's Representative

The Contractor shall provide for the exclusive use of the Supervisor's Representative all instruments (which shall be new or in proven good condition) appliances, protective clothing, rubber boots, and labour required for checking the setting out of the Works, testing, inspection and for any other attendance on the Supervisor's Representative.

140 Photographs

The Supervisor's Representative shall also utilize, for recording the day to day works, the digital camera supplied under the contract to record all relevant aspects of the construction of the works.

141 Site Office for the Supervisor's Representative

The Contractor shall provide, furnish, equip, maintain and clean a site office as detailed for the exclusive use of the Supervisor's Representative. Where a septic tank has to be provided, the Contractor shall be responsible for obtaining the relevant approvals, its installation, regular emptying etc. and removal on completion. The office(s) shall be ready for use and occupation within 7 days of the Date of Commencement of the Works and fully serviced within 14 days of that date.

The Contractor shall be responsible for providing all sanitary services necessary for keeping rest rooms in a clean, neat and hygienic condition. When no community public sewage treatment is available, the Contractor shall provide the necessary collection and disposal systems. The Contractor shall also make provision for the removal of all solid waste and rubbish.

The Contractor shall provide a constant supply of clean potable water suitable for human consumption and 110/220-volt electrical supply to the facilities. Power sources shall be suitable for office use with an anticipated large variance in load factor. 3-phase power shall be supplied. The source of power shall be either from a recognized power-supply authority or by an on-site generator supplied by the Contractor.

Power shall be distributed by means of enclosed distribution boards with adequate weather and tamper protection, suitably rated circuit breakers, earth-leakage units or fuses, and by means of adequately sized underground cables and earth conductors. Sizing of cables and rating of protective and control devices shall take into account the load and fault currents that can occur on the system. The Contractor shall maintain at all times the power supply, the distribution network and the wiring installation of all buildings and structures at the highest standard of safety and usability.

The Contractor shall supply emergency firefighting and ‘first aid’ medical equipment of a type acceptable to the Supervisor’s Representative at each facility. No separate payment shall be made in respect of such equipment and full compensation for the supply shall be deemed to be included in the tendered rates for the various items in the Bill of Quantities.

The Contractor shall provide all labour, equipment and materials, which may be necessary for keeping the offices in a neat and clean condition. Any necessary repairs shall be made immediately at the request of the Supervisor’s Representative. The Contractor shall provide consumables (e.g. soap and towels) for the offices and miscellaneous materials for use in addition to the regular cleaning services required.

The Contractor shall include in his rates in the Bill of Quantities, the cost of all such maintenance activities and no other payment shall be made. Should the Contractor fail to provide services to the satisfaction of the Supervisor’s Representative, the Supervisor’s Representative shall have the right to provide such services and the cost of such services shall be deducted from the monies due or that become due to the Contractor.

142 Fire Prevention and Protection

The Contractor shall perform all work in a fire-safe manner. He shall supply and maintain on the site adequate fire-fighting equipment. The Contractor shall comply with all current applicable fire regulations.

143 Public Safety and Convenience

The Contractor shall mark all open trenches and other obstructions by approved signs, fences, barricades, and lights for the safety of the public.

144 Works Off – Site

When major components of the Works are manufactured off-Site, the Contractor shall make arrangements to provide an adequate and secure office at or adjacent to the place of, and during the period of, manufacture and testing.

The Contractor shall give written notice to the Supervisor’s Representative of the workshops and places where work is being, or is about to be, carried out from which materials of manufactured articles are about to be or are being supplied. He shall also give such notice and keep the Supervisor’s Representative advised of the times when such materials will be ready to be inspected, so that such inspection may take place without delaying the delivery of the materials to the site. Such notices shall be given at such times as will permit the inspection of the whole of the work at all stages of the processes of manufacture and not simply when the goods are completed ready for delivery.

At least four weeks prior to the placing of any orders for major components of the Works the Contractor shall forward to the Supervisor’s Representative for approval full and detailed particulars and samples when requested of the materials/ components that he intends to procure for the Works. All these items shall comply with the Specification and shall bear necessary approvals for use in St. Lucia.

145 Safeguard the Environment

The Contractor shall execute all works and take any measures for environmental protection and impact mitigation in accordance with the laws in force in St. Lucia. He shall obtain all the necessary updated information concerning the Organisation for Environmental Protection in St. Lucia and obtain all the necessary authorisations and carry out complementary studies whenever necessary. He shall obtain environmental approvals for all temporary works.

During the works, including site mobilisation and the maintenance period, the Contractor and his sub-contractors, in compliance with the norms and regulations in force, shall implement the following mitigation measures:

- Reduction of Equipment and Plant noise when working in urban areas and in proximity to occupied buildings.
- Control of vibration from plant and equipment in urban areas and in proximity to buildings and other structures.
- Optimum location for crushers, bitumen plants, batching plants and other similar plants, in order to minimise their adverse impact on the natural and human environments.
- Enforcement of an adequate traffic management plan to minimise the disturbance caused by the site traffic and to safeguard the public and the Contractor's labour.
- Protection of rivers, lakes, lands in crop and any areas surrounding the Site, against any pollution, which may originate either from the permanent road works or from other activities related to the Contractor's organisation.
- Control of the method of storage of materials, with strict observance of the standards and specifications regarding the most sensitive items such as fuel, bitumen, lubricants, cement, explosive, etc.
- Protection and accurate reinstatement at the end of the works of borrow pits, quarries, services and diversion roads and any other temporary or preparatory work.
- Provision and installation of specific equipment and the relevant monitoring of noise, gas, dust, liquids and other pollutants derived from Site activities.
- Reduction of the emission of pollutants when they reach maximum admissible levels, in accordance with the St. Lucia n current legislation and norms.
- Biodegradable materials shall be carefully buried in locations approved by the Supervisor's Representative and the local environmental Agency in order to prevent any pollution of underground water.

The Contractor shall, at the request of the Supervisor's Representative, carry out whatever environmental measurements are required to demonstrate that the requirements of this Clause are being respected. The tests shall be carried out at the locations and times required by the Supervisor's Representative, and the Contractor shall carry out such tests at his own expense with instruments supplied by him.

146 Contractor's Equipment

Details of all Contractor's equipment to be used by the Contractor in the execution of the Works shall be submitted to the Supervisor's Representative prior to its use.

If in the Representative Supervisor's opinion circumstances arise where it is reasonable that the use of the Contractor's equipment should be suspended either temporarily or permanently, the Contractor shall change the method of performing the work affected. In particular, this will apply

where it is impossible or unsafe to excavate except by hand methods, due to the proximity of, and danger to, existing roads, structures, or services.

The Contractor shall be deemed to have no cause for claims against the WASCO on account of having to carry out the work by another method, nor shall he be deemed to have cause for claim if any order issued by the Supervisor's Representative results in the Contractor's equipment having to stand idle for a period of any duration whatsoever or having to be removed.

147 Accommodation for the Contractor

The Contractor shall provide, erect, service and maintain all necessary buildings as offices, housing or plant/yard/stores for himself, his staff and his employees.

The Contractor shall arrange the supply of electricity, fresh water, telephone, compressed air and other services as are necessary to his Site establishment and shall provide, maintain and remove on completion all pipes, cables and fittings which carry such services to his operations.

The Contractor shall provide an adequate supply of safe drinking water on the Site. All electrical installations forming part of the Temporary Works shall comply with the current National Regulations.

The Contractor shall make all necessary arrangements for the purchase or rental of land, for his offices, housing, plant yard, stores, and with the supply of electricity and water and sewage and waste disposal (including the construction of septic tanks).

All buildings shall comply with the appropriate local or National regulations and the Contractor shall provide the appropriate Authority with sufficient details of the establishment so that approval of that Authority can be obtained by the Contractor prior to construction. The Contractor shall also construct and maintain adequate roads or paths to all buildings.

All huts, buildings, fixtures and fittings provided under this Section shall be removed and the site reinstated at the end of the Contract.

148 Clearance of Site on Completion

A Performance Certificate will not be issued before the Contractor has removed all his machinery, equipment, plant, waste material from the Site and the Site reinstated to the satisfaction of the Supervisor's Representative.

149 Contractor's Responsibility for Design

Where indicated in the Particular Specification, the Contractor shall be responsible for the general and detailed design of the complete equipment and structures to be provided and for the dimensions and arrangements of the various parts. The Contractor shall be responsible for checking the dimensions and installation conditions of the existing plant and for the design of any modifications required.

The design, construction and finish of the complete equipment and other items supplied under this Contract shall be according to first class treatment works practice and each item of

equipment shall be in every way suitable for continuous operation over the full range of duties. The plant shall be as simple and maintenance free as possible.

150 Approvals for Contractor's Proposals

The Contractor shall supply 4 copies of the following documentation, giving details of his proposals for approval, to the Supervisor's Representative within 4 weeks of the Contract Start Date, or other specified time.

Four copies of design and working and construction drawings and data including calculation and erection information.

Four copies of all technical specifications of all plant and equipment proposed for the works.

Details of dead and live loads imposed by each item of plant on its foundations and any specific fixing arrangements required.

General arrangement drawings showing the layout of the site, buildings, roads, pipelines, existing and new installations;

Method Statement, including process aspects, sequence, plant and materials, and planning of the Works.

151 Joint Measurement of Extras

In the event of the Contractor having to execute any work or provide any material with regard to which he intends to claim extras, he shall make arrangements to take measurements of the said works or material and inform the Supervisor's Representative accordingly, who will join the Contractor for a joint survey. If these measurements are not taken jointly and recorded before the work will be executed, the Contractor's measurement will not be recognised by the Supervisor's Representative.

The fact of such joint measurement having been made will in no way bind the Supervisor's Representative to recognise the claim. The Supervisor's Representative shall at all times have access to the Contractor's diary and may daily check the progress of relevant works, but this shall in no way bind the Supervisor's Representative to accept the claim nor the value of the work other than by joint measurement nor shall it confirm the Supervisor's Representative's agreement to any statement in the diary.

152 Purchase of Materials

Unless specified otherwise, at least thirty (30) days prior to purchase of each batch of material to be used in the Works the Contractor shall furnish the Supervisor's Representative with the manufacture's specifications and recommendations of the material he intends to use, including present full manufacturers address, for approval by the Supervisor's Representative.

200 MATERIALS AND WORKMANSHIP - GENERAL

201 Published Standards

Except where otherwise specified plant, materials and workmanship shall comply with the relevant International Standards and Codes of Practice issued by the International Standards Organisation.

Generally, the materials and workmanship of the goods to be supplied in Bills including materials and equipment which will be purchased from outside St. Lucia shall comply with the appropriate International Standard (ISO) or in specific cases the German (DIN) or British Standard (BS) or Code of Practice (CP) or Euronorm (EN). All suppliers of goods and materials that are referred to above shall be certified to ISO 9001 or EN 29001.

Other authoritative standards which ensure an equal or higher quality than the standards and code specified will be subject to the Supervisor Representative's prior review and written approval. Differences between the standards specified and the proposed alternative standards must be fully described in writing by the Contractor and submitted to the Supervisor Representative's at least 28 days prior to the date when the Contractor requires the Supervisor Representative's approval.

The Contractor shall obtain and keep on site at least one copy of the standards and codes of practice that are referred to in the specifications, or approved above, and of each other standard which applies to materials which are being supplied to, or workmanship which is executed on the Works. Copies of these codes and standards shall at all times be available for inspection by the Supervisor Representative's.

All standards used will be the current version as available at the date of signing of the Contract. A Contractor proposing to use alternative versions of specified codes and standards shall submit the alternative version to the Supervisor Representative's for approval in accordance with the requirements outlined in the above paragraph.

All materials and workmanship not fully specified herein or covered by an approved standard shall be of such kind as is used in first class work and suitable to the climate in the project area.

Where the requirements of any such standard specification or regulation conflict with the requirements of this specification or any item on the drawings, then the Contractor should refer to the Supervisor Representative's for clarification before proceeding with that section of the works.

202 Codes and Standards

ISO, EN, IEC, BS, ANSI, ASTM, AASHTO or DIN codes and standards of the latest edition shall be part of this specification.

In all cases EC standards will be acceptable. Standards of other nationalities will be acceptable subject to the approval of the Employer where they can be demonstrated by the Contractor to be at least equal to, or more stringent than the equivalent specified standards.

202.1 Manufacturer's recommendations

Handle, store and fix each material in accordance with manufacturer's recommendations. Submit copies of these recommendations to the Supervisors Representative when requested before work is commenced.

202.2 Compliance with standards

When specified or when requested by the supervisor's representative, provide test certificates or obtain from the manufacturer's guarantees that materials specified are to a BS or other internationally recognized standard.

202.3 Specialist work

When specified, specialist work shall be carried out by a firm whose name is included on the appropriate DEVB List or the list of approved specialist contractors included in the Contract.

202.4 Specialist materials

When specified, specialist materials shall be obtained from a firm whose name is included on the appropriate DEVB List or the list of approved specialist suppliers included in the Contract.

202.5 Single source

When a choice of manufacturer is permitted for any material, either obtain the entire quantity required to complete the work from one manufacturer or, if a change in the source of supply is contemplated after deliveries of the material has begun, obtain approval for such a change in the source of supply.

202.6 Choice of material

When a choice of type or size of material is allowed (e.g. glazed wall tiles, mosaic tiles), the same type and size selected by the Contractor shall be used throughout for all work in like locations.

202.7 Sample of materials

Submit samples of all materials required for the Works as the Supervisors Representative may reasonably direct and do not confirm orders until approval has been obtained. Keep approved samples on the Site for comparison with materials used in the Works. When there is a choice of material, colour or texture, samples shall be submitted for approval.

202.8 Samples of finished work

Make samples of finished work as specified or as required by the Supervisor's Representative and obtain approval before proceeding with the work. Retain samples on the Site for comparison with the completed work.

202.9 Mix proportions

Unless otherwise specified, mix proportions shall be by volume.

202.10 Tests

Make tests on materials and workmanship as specified or as instructed by the Supervisors Representative.

Provide test samples under the supervision of the Supervisors Representative and when required, submit samples to an approved Laboratory. Mark samples and clearly indicate on test records the location or delivery from which the test sample was taken. Submit copies of test certificates to the Supervisors Representative and keep all test records on the Site.

Submit samples of materials, carry out tests and obtain approval before the materials are used in the Works.

202.11 Protection from weather

Cover up, protect and secure the Works and the Specialist Works from damage by inclement weather, including providing sufficient staff, adequate plant and any other requirements necessary to ensure protection during typhoon and heavy rainstorm conditions.

202.12 Removal of water

Keep the Site and all trenches and excavations thereon free from all water arising from rain, springs, drains, percolating water and the like by pumping or otherwise. Ensure that such removal of water has no detrimental effect on adjacent property.

202.13 Cleanliness

Store materials and plant neatly, remove rubbish and debris as they accumulate, and keep the Site and the Works clean and tidy.

202.14 Protection from overloading

Protect the Works from damage due to overloading. Obtain details of design loads from the Supervisors Representative.

202.15 Drying the Works

When specified, provide temporary equipment, fuel and attendance for drying and controlling the humidity of the Works.

202.16 Work at completion

Clean the Works thoroughly inside and outside and leave the Works without damage and ready for occupation on completion, including polishing floors, windows and similar finishes.

202.17 Security at completion

Leave the Works secure, with all accesses locked. Account for all keys, which should be appropriately tagged, and transfer these to the Supervisors Representative.

202.18 Tolerances

Unless otherwise specified, the maximum permitted tolerances in construction shall be in accordance with BS 5606.

The structural limits for lift shafts at any level shall be in accordance with BS 5655: Pt. 6, where applicable

202.19 Conducting of compliance tests and surveys on site

Compliance tests conducted on site on structural works shall be carried out by the Laboratories of the Ministry of Infrastructure or by an approved independent testing firm with the prior approval of the Supervisors Representative.

Surveys conducted on site shall be carried out by a Surveyor with recognized expertise subject to the prior approval of the Supervisors Representative.

300 SUBMITTALS

301 General

Wherever submittals are required hereunder, all such submittals shall be submitted to the Supervisors Representative by the Contractor.

Within 14 Days after the date of commencement as stated in the Notice to Proceed, the Contractor shall submit the following items to the Supervisors Representative for review and approval:

- A preliminary schedule of Shop Drawings, sample, and proposed substitutes or
- “or-equal” submittals.
- A list of all permits and licenses the Contractor shall obtain indicating the agency required to grant the permit and the expected date of submittal for the
- Permit and required date for receipt of the permit.
- A complete progress schedule for all phases of the Project.
- Material Safety Data Sheets on products used on the Project.
- A traffic maintenance plan, as required.
- A plan for temporary erosion control and pollution control, as required.
- A letter designating the Contractor’s Superintendent, defining that person’s responsibility and authority.
- A letter designating the Contractor’s safety representative

No payments shall be made to the Contractor until all of these items are submitted in their entirety, as determined by the Supervisors Representative.

302 Method statements

Construction method statements shall be prepared for the principal elements of the Works and shall be submitted to the Supervisor’s Representative for review at least 28 days prior to the programmed activity commencement.

Construction method statements shall make due allowance for all requirements and restrictions imposed by the Contract. Each method statement shall comprise a step by step schedule of specific operations or activities with description, date, times and duration of each step. The statements shall be supported by sketches, diagrams or other supportive detail as necessary to enable a clear understanding of the method and significance of each step of work or operation.

Construction method statements shall include, but not be limited to, the following topics as relevant to the particular operation:

- the method of working;
- temporary works details;
- labour resources to be used;
- construction equipment to be used;
- safety measures; and
- Pedestrian, light vehicular and emergency access.

303 Progress schedules and cashflow statements

The progress schedule shall be in Bar Chart or Critical Path Method (CPM) form as required by the Supervisors Representative.

The progress schedule shall show the order in which the Contractor proposes to carry out the Work and the contemplated date on which the Contractor and their Subcontractors will start and finish each of the salient features of the Work, including any scheduled periods of shutdown. The schedule shall also indicate any anticipated periods of multiple-shift Work.

The programme shall be updated following any major variations or extension of time given, and when any critical operation has fallen behind its planned programme by more than 10 per cent, and in any case at 91 day intervals. Such revised schedule(s) shall conform with the contract time and take into account delays which may have been encountered in the performance of the Work. In submitting a revised schedule, the Contractor shall state specifically the reason for the revision and the adjustments made in his schedule or methods of operation to ensure the completion of all the Work within the contract time.

On a regular base, the Contractor shall supply the following documents to the Supervisor's Representative:

- Cash Flow (monthly);
- List of Labour and Plant (monthly).

The submission will show cash flow up to the end of the Contract. The Contractor shall also submit to the Supervisor's Representative at the end of each calendar month, or at such other times as may be agreed, detailed schedules and reports on plant and labour on Site, divided into categories, and show separately the Contractor's and each sub-contractor's labour and plant. As far as the plant is concerned, the condition of each item shall be indicated in the schedules.

304 Shop drawing submittal

Wherever called for in the Contract Documents, or where required by the Supervisors Representative, the Contractor shall furnish to the Supervisors Representative, for review and approval, copies of each Shop Drawing submittal. The term "Shop Drawings" as used herein shall be understood to include detail design calculations, Shop Drawings, fabrication drawings, installation drawings, erection drawings, lists, graphs, operating instructions, catalog sheets, data sheets, and similar items.

All Shop Drawing submittals shall be accompanied by the agreed standard submittal transmittal form. Any submittal not accompanied by such a form, or where all applicable items on the form are not completed, will be returned for re-submittal.

Normally, a separate transmittal form shall be used for each specific item or class of material or equipment for which a submittal is required. Transmittal of a submittal of various items using a single transmittal form will be permitted only when the items taken together constitute a manufacturer's "package" or are so functionally related that expediency indicates review of the group or package as a whole. A multiple-page submittal shall be collated into sets, and each set shall be stapled or bound, as appropriate, prior to transmittal to the Supervisors Representative.

Except as may otherwise be provided herein, the Supervisors Representative will return prints of each submittal to the Contractor with its comments noted thereon, within 15 calendar days following receipt of them by the Supervisors Representative. It is considered reasonable that the Contractor shall make a complete and acceptable submittal to the Supervisors Representative by the second submission of a submittal item. The Supervisors Representative's maximum review period for each submittal including all re-submittals will be 30 days per submission. In other works, for a submittal that requires two re-submittals before it is complete, the maximum review period for that submittal could be 90 days.

Where submittals are returned to the Contractor marked "No Exceptions Taken," formal revision and resubmission of said submittal will not be required.

Where submittals are returned to the Contractor marked "Make Corrections Noted," formal revision and resubmission of said submittal is not required.

Where submittals are returned to the Contractor marked "Amend- Resubmit," the Contractor shall revise said submittal and shall resubmit the required number of copies of said revised submittal to the Supervisors Representative.

Where the submittal is returned to the Contractor marked "Rejected- Resubmit," the Contractor Shall revise said submittal and shall resubmit the required number of copies of said revised submittal to the Supervisors Representative.

Fabrication of an item may be commenced only after the Supervisors Representative has reviewed the pertinent submittal and returned copies to the Contractor marked either "No Exceptions Taken" or "Make Corrections Noted." Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as the basis for changes to the Contract requirements only a Change Order can alter the Contract Price, Contract Time, or Specifications.

All Contractor Shop Drawing submittals shall be carefully reviewed by an authorized representative of the Contractor, prior to submission to the Supervisors Representative. Each submittal shall be dated, signed, and certified by the Contractor, as being correct and in strict conformance with the Contract Documents. In the case of Shop Drawings, each sheet shall be dated, signed, and certified. No consideration for review by the Supervisors Representative of any Contractor submittal will be made for any items which have not been so certified by the Contractor. All non-certified submittals will be returned to the Contractor without action taken by the Supervisors Representative, and any delays caused by thereby shall be the total responsibility of the Contractor.

The Supervisors Representative's review of Contractor Shop Drawing submittals shall not relieve the Contractor of the entire responsibility for the correctness of details and dimensions. The Contractor shall assume all responsibility and risk for any misfits due to any errors in Contractor submittals. The Contractor shall be responsible for the dimensions and the design of adequate connections and details.

305 Samples submittal

Wherever in the Specifications samples are required, the Contractor shall submit not less than three (3) samples of each item or material to the Supervisors Representative for acceptance at no additional cost.

Samples, as required herein, shall be submitted for acceptance a minimum of 28 days prior to ordering such material for delivery to the job site, and shall be submitted in an orderly sequence so that dependent materials or equipment can be assembled and reviewed without causing delays in the Work.

All samples shall be individually and indelibly labeled or tagged indicating thereon all specified physical characteristics and supplier's names for identification and submitted to the Supervisors Representative for acceptance. Upon receiving acceptance of the Supervisors Representative, one (1) set of the samples will be stamped and dated by the Supervisors Representative and returned to the Contractor, and one (1) set of samples will be retained by the Supervisors Representative, and one (1) set of samples shall remain at the job site until completion of the Work.

Unless clearly stated otherwise, it is assumed that all colors and textures of specified items presented in sample submittal are from the manufacturer's standard colors and standard materials, products, or equipment lines. If the samples represent non-standard colors, materials, products or equipment lines, and their selection will require an increase in Contract Time or Contract Price, the Contractor will clearly indicate this on the transmittal page of the submittal.

306 Proposed substitutes or "or-equal" item

Whenever materials or equipment are specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular supplier, the naming of the item is intended to establish the type, function, and equality required. If the name is followed by the words "or-equal" indicating that a substitution is permitted, materials or equipment of other suppliers may be accepted by the Supervisors Representative if sufficient information is submitted by the Contractor to allow the Supervisors Representative to determine that the material or equipment proposed is equivalent or equal to that named, subject to the following requirements:

- The burden of proof as to the type, function, and quality of any such substitute material or equipment shall be upon the Contractor.
- The Supervisors Representative will be the sole judge as to the type, function, and quality of any such substitute material or equipment and the Supervisors Representative's decision shall be final.
- The Supervisors Representative may require the Contractor, to furnish at the Contractor's expense, additional data about the proposed substitute.
- The Owner may require the Contractor to furnish at the Contractor's expense a special performance guarantee or other surety with respect to any substitute.
- Acceptance by the Supervisors Representative of a substitute item proposed by the Contractor shall not relieve the Contractor of the responsibility for full compliance with the Contract Documents and for adequacy of the substitute item.

- The Contractor shall be responsible for resultant changes and all additional costs which the accepted substitution requires in the Contractor's Work, the Work of its Subcontractors and of other Contractors, and shall effect such changes without cost to the Owner. This shall include the cost for redesign and claims of other Contractor affected by the resulting change.

The procedure for review by the Supervisors Representative will include the following:

- If the Contractor proposes to furnish or use a substitute item of material or equipment, the Contractor shall make written application to the Supervisors Representative on the "Substitution Request Form" for acceptance thereof.
- Unless otherwise provided by law or authorized in writing by the Supervisors Representative, the "Substitution Request Form(s)" shall be submitted within the 21-day period after Notice to Proceed.
- Wherever a proposed substitute material or equipment has not been submitted within said 21-day period, or wherever the submission of a proposed substitute material or equipment has been judged to be unacceptable by the Supervisors Representative, the Contractor shall provide material or equipment named in the Contract Documents.
- The Contractor shall certify that the proposed substitute will perform adequately the functions and achieve the results called for by the general design, be similar and of equal substance to that specified, and be suited to the same use as that specified.
- The Supervisors Representative will be allowed a reasonable time within which to evaluate each proposed substitute. In no case will this reasonable time period be less than 30 days.
- As applicable, no Shop Drawing submittals will be made for a substitute item nor will any substitute item be ordered, installed, or utilized without the Supervisors Representative's, prior written acceptance of the Contractor's "Substitution Request Form" which will be evidenced by a Change Order.
- The Supervisors Representative will record the time required by the Supervisors Representative in evaluating substitutions proposed by the Contractor and in making changes in the Contract Documents occasioned thereby. Whether or not the Supervisors Representative accepts a proposed substitute, the Contractor shall reimburse the Owner for the charges of the Supervisors Representative for evaluating each proposed substitute.

The Contractor's application using the "Substitution Request Form" shall contain the following statements and/or information which shall be considered by the Supervisors Representative in evaluating the proposed substitution:

- The evaluation and acceptance of the proposed substitute will not prejudice the Contractor's achievement of Substantial Completion on time.
- Whether or not acceptance of the substitute for use in the Work will require a change in any of the Contract Documents to adopt the design to the proposed Substitute.
- Whether or not incorporation or use of the substitute in connection with the work is subject to payment of any license fee or royalty.
- All variations of the proposed substitute for that specified will be identified.
- Available maintenance, repair, and replacement service and its estimated cost will be indicated.
- Itemized estimate of all costs that will result directly or indirectly from acceptance of such substitute, including cost of redesign and claims of other contractors affected by the resulting change.

307 Material certification submittal

The Supervisors Representative may permit the use, prior to sampling, inspection and testing, of certain materials or assemblies when accompanied by manufacturer's material certifications stating that such materials or assemblies fully comply with the requirements of the Contract. The certification shall be signed by the manufacturer, and will specifically reference the material's compliance with the relevant British or American Standards specified in the applicable Contract Documents.

Material certifications shall be submitted to the Supervisors Representative prior to incorporating the item into the Work.

Materials or assemblies used on the basis of material certifications may be sampled, inspected and/or tested at any time, and if found not in conformity with these specifications, will be subject to rejection whether in place or not.

308 Record drawings submittals

The Contractor shall keep and maintain, at the job site, one record set of Drawings.

On these, it shall mark all project conditions, locations, configurations, and any other changes or deviations which may vary from the details represented on the original Contract Drawings, including buried or concealed construction and utility features which are revealed during the course of construction. Special attention shall be given to recording the horizontal and vertical location of all buried utilities that differ from the locations indicated, or which were not indicated on the Contract Drawings. Said record drawings shall be supplemented by any detailed sketches as necessary or directed to indicate, fully, the Work as actually constructed. These master record Drawings, of the Contractor's representation of as-built conditions, including all revisions made necessary by Addenda, Change Orders, and the like shall be maintained up-to-date during the progress of the Work.

In the case of those Drawings which depict the detail requirement for equipment to be assembled and wired in the factory, such as motor control centers and the like, the record drawings shall be updated by indicating those portions which are superseded by Change Order Drawings or final Shop Drawings, and by including appropriate reference information describing the Change Orders by number and the Shop Drawings by manufacturer, Drawing, and revision numbers.

Record drawings shall be accessible to the Supervisors Representative at all times during the construction period and shall be delivered to the Supervisors Representative on the 20th working day of every third month after the month in which the Notice to Proceed is given as well as upon completion of the Work.

Final payment will not be acted upon until the Contractor-prepared Record Drawings have been delivered to the Supervisors Representative.

309 Operation and maintenance manual

309.1 General

The Contractor shall provide suitably bound operating and maintenance manuals for all plant installed and rehabilitated within the works. The introduction shall include a general description of each works and its operation.

The instructions shall be clearly written in the English language and shall be suitable for all staff categories that will need to use them.

The manuals shall form the basis for training of the Employer's personnel and therefore the greatest importance will be attached to completeness and clarity of presentation.

It is emphasised that a collection of standard pamphlets of a general nature accompanied by drawings and descriptive matters relating to the Plant as installed, will not be acceptable. In particular, information supplied by Sub-Contractors and manufacturers employed by the Contractor, shall be co-ordinated into the comprehensive manual. Cross-referencing of descriptive matter, drawings and spare part lists must be complete.

The Contractor shall submit for approval, duplicate draft copies of the operation and maintenance manuals.

309.2 Operating Instructions

Operating instructions shall give a detailed description for all operations likely to be carried out during the life of the plant. The instructions shall cover the installation, refurbishing, commissioning, testing, operation and troubleshooting of the entire plant.

The instruction manuals shall describe the installation as a whole and shall give a step-by-step procedure for any operation likely to be carried out daily, weekly, and monthly and at longer intervals to ensure trouble-free operation. Where applicable, fault location charts shall be included to facilitate tracing the cause of malfunctions or breakdown and correcting faults.

A separate section shall be allocated for each type of equipment which shall contain all relevant information concerning the construction and operating principles of that item.

309.3 Maintenance Instructions

Maintenance instructions shall include a list of all lubricants, charts showing lubrication, checking, and testing and replacement procedures to be carried out at routine intervals to ensure trouble-free operations.

Detailed instructions shall be provided to cover the procedures for disassembly, remedial repairs and assembly of individual items of plant.

A spares schedule shall be included consisting of a complete list of itemised spare parts for all mechanical and electrical plant with ordering references and part numbers. Parts shall be identified on equipment sectional drawings.

Any special maintenance tools shall be listed and detailed.

A separate section of the manual shall be devoted to standard schedule sheets that can be used by the Employer's staff for recording routine maintenance tasks for all items of plant requiring servicing.

309.4 Minimum Inclusions

Concurrently with the progress of work on Site the Contractor shall prepare the Operating and Maintenance Instruction Manuals which shall include where applicable:

- Schedule of approved as built Drawings and documents.
- Detailed description of the plant and its method of operation, control and protection.
- Recommended operation and routine check procedures.
- Recommended care and maintenance routines together with the procedures for the repair and re-commissioning of major items of plant.
- Recommended emergency control procedures.

Maker's descriptive literature and technical data sheets in respect of each item of the plant including the recommended installation, care, maintenance and overhaul instructions, parts list etc. whereby the plant may be maintained correctly and whereby replacement spare parts, may be ordered without difficulty.

Exploded views of all items of plant with each component and reference number cross referenced to the appropriate data sheet and spares schedule.

Schedule of the principal items of plant and components showing the title, maker, maker's type reference, serial number, rating etc. whereby reference to each is simplified.

Test results and curves, including all electrical test data and reports.

Particular reference is to be made in the operating and maintenance instructions to the:

- Safety precautions and instructions to be taken when operating the plant;
- Pre-start check list;
- Bearings and moving parts which require special attention;
- Type of lubricants to be used, and lubrication intervals;
- Routine tests which are recommended to confirm that the plant is in good working order.
- Fault finding guide.

Two draft copies of the manuals shall be submitted to the Supervisor's Representative for his approval 2 weeks, or as otherwise specified, prior to the Tests on Completion. The Manuals shall be used for commissioning and test running under the Supervisors Representative's supervision when their content and accuracy will be checked.

The final 3 copies of the Manuals, incorporating amendments and additions as instructed by the Supervisors Representative, shall be provided upon the satisfactory completion of the installation and testing of the Works, within 6 weeks of the issue of the Certificate of Completion, or other specified time.

400 SITE CLEARANCE

401 General

401.1 Scope of Work

Site clearance shall conform to the general order or procedure for the Contract and shall be as detailed by the Contractor in his programme as submitted in accordance with the Conditions of Contract.

401.2 Interference with Adjacent Activities and Third Parties

Demolition and alteration works shall be carried out in such a manner so as to cause as little dust, noise and inconvenience as possible to the occupants of the adjacent buildings and the public. The Contractor shall be held responsible for any claims which may arise from the disregard of this Section. Debris and other materials arising from the demolitions must be lowered in baskets, barrows, covered chutes etc. and debris is to be kept well-watered during the works to prevent dust.

401.3 Old Materials

All salvageable materials such as all fixed furniture and fittings, doors, windows etc. shall be handed over to the Supervisor for storage or re-use as directed by the Supervisor's Representative.

401.4 Existing Mains and Services

The Contractor shall ensure that all temporary or permanent diversions of existing mains and services have been properly completed prior to commencing any site clearance or demolition work.

All other old materials are to be removed from the site by the Contractor. Old materials shall not be re-used in the works except with the written permission of the Supervisor's Representative.

401.5 Items of Value

Any items of archaeological, historical or geological interest shall be safeguarded and the Contractor shall carry out the Clerk of Work's instructions concerning preservation or removal.

401.6 Hazardous Materials

- The treatment of hazardous materials encountered in site clearance and demolition shall comply with best practice, and the Contractor shall seek consent from the Supervisor's Representative.
- Compliance with this Sub-Section does not confer immunity from relevant legal requirements.

401.7 Use of Existing Roads

The Contractor shall only use the existing roads and access routes for his operations that are designated on the Drawings. Such roads shall be kept in a clean and safe condition and any damage shall be reinstated on the day that it occurs and on completion of the Works as directed

by the Supervisor's Representative. The Contractor shall supply, erect, maintain, and remove on completion of the Works all road signs and warnings as necessary for the safety of all.

401.8 Temporary Access Ways

In addition to the requirements of the Conditions of Contract, the Contractor shall provide and maintain any additional temporary access ways to the site of the Works and tipping points as necessary and shall remove them on completion of the Works. All areas so disturbed shall be fully reinstated as directed by the Supervisor's Representative.

402 Site Clearance

Existing Fences, Hedges and Walls

Where only partial clearance of an existing fence, hedge or wall is necessary, the severance shall be made good either by its continuation in a different direction or by its termination as shown on the Drawings.

Underground Structures

Underground structures, chambers and foundations shall be demolished to the depths shown on the Drawings, properly cleaned out and filled. To permit free drainage, holes shall be made over at least 10% of the area of slabs, basements etc. that are not removed and that are liable to hold water.

Disused Pipes and Ducts

- Disused pipes and ducts, together with any bed, haunch or surround within 1m of the lowest level of any site clearance, demolition or excavation shall be removed and the trenches back-filled in accordance with the Earthworks specification, unless an alternative treatment is shown on the Drawings.
- Disused pipes and ducts, together with any bed, haunch or surround over 1m below the lowest level of any site clearance, demolition or excavation shall be left in place unless an alternative treatment is shown on the Drawings. In this case the ends of any such pipes or ducts shall be sealed with a structural grade of concrete to the satisfaction of the Supervisor's Representative.

Bushes etc.

Bushes undergrowth or small trees, the trunks of which are less than 300mm in girth at 1m above ground level, tree stumps less than 100mm in diameter and hedges shall be uprooted and disposed of by the Contractor.

Existing Trees, Stumps and Roots

Trees shall be uprooted or cut down as near to ground level as possible. Stumps and tree roots shall be grubbed up or blasted as directed by the Supervisor's Representative. The Contractor shall dispose of all felled timber unless otherwise stated. Holes left by removal of the stumps shall, within one week, be filled with acceptable material and compacted in accordance with the Earthworks Specification.

Trees etc. to be preserved

The Contractor shall ensure that individual trees, shrubs, other features and areas that are shown on the Drawings to be preserved are suitably identified and protected.

Topsoil

Topsoil excavated for the purposes of site clearance shall be reserved for re-use.

Disposal of Arisings

Materials arising from site clearance shall become the property of the Contractor unless stated otherwise and shall be removed from the Site.

500 EARTHWORKS

501 Definition of Earthworks Material

The following definitions of earthworks materials shall apply to this and other Sub-Sections of the Specification in which reference is made to the defined materials:

Top soil shall mean the top layer of soil that can support vegetation;

Suitable material shall comprise all that material which arises from excavations within the Sites and which is approved by the Supervisor's Representative as acceptable for use in the Works.

Unsuitable material shall mean other than suitable material and shall comprise:

- Material from swamps, marshes and bogs
- Peat, logs, stumps and perishable materials
- Material susceptible to spontaneous combustion, and
- Clay of liquid limit exceeding 90 and/or plasticity index exceeding 65
- Soft material shall mean all material other than that defined as hard material or rock hereunder
- Hard material shall mean all material that cannot be ripped with a Caterpillar D6 bulldozer with a single tooth ripper tyre or similar equipment

Original Surface means the surface of the ground before any work has been carried out.

Final Surface means the surface indicated on the Drawings to which excavation is to be carried out.

Commencing Surface (in relation to individual Items in the Bill of Quantities) means the surface of the ground or underlying construction layer before any work covered by an individual Item has been carried out.

Excavated Surface (in relation to individual Items in the Bill of Quantities) means the surface elevation to which the excavation has been carried out under a particular Item of work.

Subgrade is the final compacted and prepared surface upon which a road pavement is to be constructed. The term 'formation level' is to be taken to be synonymous with 'subgrade'.

Road bed is the natural in situ material on which the fill or, in the absence of fill any pavement layers are constructed.

Embankment (or fill) is that portion of earthworks utilizing generated native or approved imported material which lies above the road bed and is bounded by the side slopes shown on the Drawings and upon which the road base materials are to be placed. Material which is imported to replace unsuitable material excavated from the road bed shall also be classified as fill.

Pavement layers are the upper strata of the road comprising the sub-base if any, base and surfacing materials.

502 Classifications

Topsoil is fertile, friable soil of a loamy character and usually covered by natural vegetation that is native to the region. Topsoil shall not be taken from swampy areas unless authorised by the Supervisor's Representative.

Common Excavation Material is any material that can be excavated without recourse to the methods described under rock and shall be classified as 'common' excavation material.

502.1 Rock

Any material that, in the opinion of the Supervisor's Representative (who shall take into account the situation in which the excavation is taking place), requires for its removal blasting or the use of a compressor and hand tools.

Material that can be effectively ripped and removed using a single tine operated by a tracked type machine of specified flywheel power <425 horsepower, shall not be classified as rock. The cost of proving rock shall be included in the Contractor's rates and no extra payment shall be made for this cost.

502.2 Isolated Boulders

Isolated and competent boulders of < 1m³ in size occurring within any mass of material and that can be removed by the Contractor's ordinary earthmoving plant and suitably disposed of to the Clerk of Work satisfaction, shall be measured as 'common' material. Otherwise, such boulders shall be considered 'rock' material.

Cut is earthworks material generated by the various excavation processes.

502.3 Unsuitable Material

Refers to earthworks or excavated material, which in the opinion of the Supervisor's Representative, is not suitable as fill and is to be removed to an approved disposal site or spoiled outside the road reserve.

Such material shall include that deemed to be unsuitable in the opinion of the Supervisor's Representative, including any materials:

Found in swampy areas such as peat, buried logs, tree stumps, and perishable material and any that may be susceptible to spontaneous combustion;

That are otherwise unsuitable for use in the location where they are required to be placed;

That have an excessive moisture content and that cannot be effectively dried.

Surplus Material is that which is judged by the Supervisor's Representative to be suitable for use as fill but that is surplus to the filling requirement and must be 'spoiled'. The Supervisor's Representative shall direct whether such material shall be disposed of as 'overfill' in embankment side slopes or shall be disposed of in authorised spoil areas outside the road reserve.

Fill is common material and shall be compacted to 95% of BS Heavy Compaction as defined in BS 1377.

Selected Fill is common or selected material and shall be compacted to 98% of its maximum compaction (BS 1377). Selected fill shall have a minimum depth of 200 mm.

502.4 Borrow

Borrow is any suitable earthworks materials that, with the prior approval of the Supervisor's Representative, can be obtained by over-excavation or from borrow sources outside the road reserve. All borrow shall be authorised by the Supervisor's Representative. His authorisation shall be granted only if the cut operation does not yield sufficient fill or the Contractor makes a request, accepted by the Supervisor's Representative, that he be permitted to use spoil material (paid for as material for re-use) located at a distance and to borrow material nearer at hand, for re-use without payment.

The Contractor shall obtain the prior permission of the Supervisor's Representative before developing any borrow.

502.5 From Cuttings

In certain circumstances, where widening of cuttings is necessary, borrow may be obtained from excavating within the road reserve, preferably on the inside of bends. Such widening shall be worked in single machine widths and extend to the full depth of the cutting or drain. When widening cuttings, the side drain shall generally be sited at the foot of the new cut face, the cut slope shall be to the same batter as the original face and the shoulder shall extend across the widening at the same cross fall as the original cross-section.

502.6 From Borrow Areas

The Contractor may be authorised to obtain borrow material from a source outside the road reserve. In that case, the Contractor shall be responsible for locating the source, undertaking all necessary negotiations with Local Government or other occupier, preparing and signing legal agreements, making payment and giving proper notice to enter upon the land, and obtaining all the necessary consents.

The Contractor shall include in his rates for all other costs, including prior investigation and sampling, fencing, stripping, removal of overburden, operating transportation, drainage and reinstatement at the conclusion of the borrowing operation, including the provision and maintenance of haul roads.

Borrow areas that in the opinion of the Supervisor's Representative would provide materials suitable for the road pavement, or for selected fill, shall not be used for other purposes unless expressly authorised by the Supervisor's Representative.

The Supervisor's Representative shall give prior approval to sites of borrow areas. When the use of the borrow area is terminated the Supervisor's Representative shall have the power to withhold payments in interim certificates for borrow pending reinstatement of such borrow area to his satisfaction.

Rock Fill is broken material derived from hard non-weathering homogeneous rock and which contains more than 25% by volume of particles larger than 150 mm in greatest dimension. All rock fill must receive the prior approval of the Supervisor's Representative before use.

502.7 Spoil Areas

By prior permission of the Supervisor's Representative, surplus material other than rock or rippable material may be disposed to spoil by the widening of embankments providing such widening and the Contractor's method of working shall not, in the opinion of the Supervisor's Representative, affect adversely or endanger the embankments, or put embankment toes or toe drains outside the road reserve and providing that the shaping and trimming of the extended embankments is completed as specified. No additional payments shall be made.

The Contractor shall on no account place spoil outside the road reserve without first obtaining the permission of the Supervisor's Representative and the owner of the land. He shall not dump or otherwise dispose of surplus material over precipices.

The Contractor shall be responsible for locating suitable spoil areas outside the road reserve, undertaking all negotiations with the Local Government Authorities or other occupier, preparing and signing legal agreements, making payment and giving proper notice to enter upon the land. The Supervisor's Representative shall give prior approval to sites of spoil areas. When the use of the area is terminated, the Supervisor's Representative shall have the power to withhold payments in interim certificates for spoil pending reinstatement of such spoil areas to his satisfaction.

The Contractor's rates shall be deemed to include any payments to be made to Local Government Authorities or private owners, as well as other costs, such as stripping the area, transportation, drainage provisions and reinstatement at the conclusion of works.

503 Setting out of the works and Surveys

Prior to the commencement of each type of excavation or filling the Contractor shall carry out a survey of the existing ground surface in conjunction with the Supervisor's Representative to establish the commencing surface for the purpose of measurement of quantities. Levels shall be taken at cross sections at not more than 2 meter intervals unless directed otherwise.

The Contractor shall plot the results on plans and sections and submit copies to the Supervisor's Representative for his approval and subsequent use in measurement.

504 General Earthworks Operations

This Section deals (after site clearance and removal of topsoil) with the excavation of cuttings including grading of site, the preparation of foundations, drainage works and landscaping.

504.1 Order of Works

The construction of cuttings and embankments shall proceed in a methodical and orderly manner - generally from one end of the work section to the other. Work is to proceed after due regard for overall balancing of earthwork quantities, so that cuttings are excavated continuously and each embankment is completed before the next is commenced.

The Contractor shall submit a general programme for earthworks to the Supervisor's Representative and having obtained the Supervisor's Representative's approval, shall as far as possible adhere to its provisions.

All trimming of cuttings, embankments, ditches etc. to the specified slopes and shapes, shall be carried out concurrently with the earthworks that are being undertaken at any particular location.

504.2 Use of Materials

The Contractor shall (unless the Supervisor's Representative instructs otherwise) undertake cuts and fills in the manner specified in this Section and according to the approved earthworks programme. However, the Supervisor's Representative may direct where materials of different quality shall be used and/or order borrow from approved sources, (whether from widened cuttings or elsewhere) to be introduced or for materials to be spoiled. The Contractor shall borrow or spoil only after verbal approval, which is to be subsequently confirmed in writing by the Supervisor's Representative.

Unsuitable Material

Upon coming across unsuitable material, the Contractor shall, immediately bring this to the attention of the Supervisor's Representative. Any unsuitable material, which by the Contractor's operations or due to his method of working has been included in the Works (whether or not it has already been declared unsuitable by the Supervisor's Representative) shall be removed to spoil by the Contractor and replaced with suitable materials at the Contractor's expense.

Removal and Re-use of Topsoil

The removal of topsoil, where directed, shall be to an average depth of 150mm, or as otherwise directed, prior to bulk excavation or filling operations, and shall be placed in thin layers on designated areas within the road reserve or stockpiled for re-use.

The Contractor shall notify the Supervisor's Representative at least 5 days before he intends to start topsoil stripping operations.

Slope areas to receive top soil shall be disked or scarified to a depth of 100 mm or as otherwise directed by the Supervisor's Representative prior to placing topsoil. After the Supervisor's Representative has approved the graded areas, topsoil shall be spread to a depth, which, after settlement, shall provide the nominal depth shown on the plans or as instructed. Spreading shall not be done when the ground or the topsoil itself is excessively wet or in a general condition detrimental to the work.

The roadway surfaces shall be kept clean during hauling and spreading operations.

After spreading has been completed, large clods, stones larger than 50 mm and any roots, stumps or debris shall be raked, removed, and disposed of at an approved location. Spread topsoil shall be lightly tamped as approved by the Supervisor's Representative in order to reduce erosion on the finished surface.

505 Excavation – General

Excavation shall be carried out to the lines, levels and profiles shown on the Drawings or to such other lines, levels and profiles as the Supervisor's Representative may direct or approve in writing. The Contractor shall carry out the work in such a way to avoid disturbance to the surrounding ground. Particular care shall be taken to maintain stability when excavating in proximity to existing works.

The work shall be carried out in a careful manner to ensure that the exposed surfaces are as sound as the nature of the material permits and that no point shall protrude inside the lines shown on the Drawings except as otherwise specified or agreed by the Supervisor's Representative. In soft excavation, which is to remain open permanently, exposed faces shall be formed accurately to the required slopes and profiles. Excavations in rock, which remain open permanently shall be so trimmed that no point protrudes within the required profile.

Excavation in areas of subsidence shall be carried out to the depth directed by the Supervisor's Representative and leaving side slopes to a maximum of 45°. The exposed formation surface shall be compacted to 95% of BS Heavy Compaction as defined in BS 1377. A permeable separator geotextile shall be placed at the bottom of the excavated area as may be decided by the Supervisor's Representative before commencing backfill. The geotextile should meet the minimum requirements of Section **Error! Reference source not found.**

Excavated material from the Works selected for reuse shall be placed directly in its final position or may be stacked on Site provided suitable precautions are taken to prevent excessive change in moisture content. Otherwise it shall be removed to spoil tips as noted above.

The Contractor shall be responsible for keeping all excavations free from water from whatever cause arising and shall provide such pumping capacity and other measures as may be necessary for this purpose.

The Contractor shall properly support the sides of excavations and shall be responsible for their safety.

Where shown on the drawings, cut slopes are to be formed to a benched profile with each bench being cut as the overall excavation proceeds. The dimensions of benches shall be sufficient to permit the operation of placing and compaction equipment thereon to generally a minimum width of 2-3 m. Dimensions of heights and widths of benches together with any required cut-off ditches and toe walls are included in the Drawings.

The Contractor shall notify the Supervisor's Representative without delay of any permeable strata, fissures or unusual ground encountered during excavation.

506 Excavation beyond True Lines and Levels

If for any reason whatsoever excavations are carried out beyond their true line and level other than at the direction of the Supervisor's Representative, the Contractor shall at his own cost make good to the required line and level with approved material and/or deal with the matter in such a manner as the Supervisor's Representative may direct.

507 Approval of excavation

When excavations have been taken out accurately to the profiles or dimensions required for the work, the Contractor shall inform the Supervisor's Representative so that he may carry out an inspection. If, after his inspection the Supervisor's Representative requires additional excavation to be carried out, the Contractor shall do so to such new profiles or dimensions as the Supervisor's Representative may direct.

Before any fill or pavement forming part of the permanent works is placed, the Contractor shall conduct the specified tests. The Contractor shall obtain the agreement of the Supervisor's Representative that the underlying layer is satisfactory prior to placing any further layer.

The Contractor shall maintain open excavations in an approved condition, and shall rectify the effects of deterioration due to weather.

508 Excavation for Structural Foundations

Prior to commencement of any excavation, the Contractor shall notify the Supervisor's Representative in advance to allow for checking of layouts and dimensions and for measurements, cross sections and control levels to be established.

Where suitable material is encountered during excavation against which the casting of concrete is permissible, that part of the trench or foundation pit shall be excavated neat to the dimensions of the base, unless directed otherwise by the Supervisor's Representative. Over excavation (over break) in such suitable stable material shall be backfilled with the same Class of concrete as that in the base - or with mass concrete fill as may be directed by the Supervisor's Representative.

When material suitable for founding is encountered above the designed founding level, excavation to final grade shall not be made until the Supervisor's Representative has inspected the excavation and before any working blinding layer is placed.

Where in the opinion of the Supervisor's Representative unsuitable material is encountered at founding level such material shall be removed and replaced with approved compacted granular fill. Boulders, logs or any other unsuitable material excavated shall be removed.

No concrete shall be placed before the excavation has been cleaned, inspected and approved by the Supervisor's Representative. A concrete working floor [blinding layer] of 75 mm thickness shall be placed underneath all bases except, where otherwise directed by the Supervisor's Representative.

Where required rock sockets shall be excavated for bridge pier foundations and to the dimensions shown on the drawings. They shall be formed in rock formations of adequate strength, quality and thickness and may be extended at the direction of the Supervisor's Representative until suitable for supporting the required loading.

509 Founding on Rock

Where a structure is required to be founded on rock but is not required to penetrate into it, all soft overburden shall be removed and the surface of the rock cleared of any loose material by barring and wedging. Where the foundation is required to penetrate into the rock, excavation of the rock may be carried out using a suitable excavator with a rock bucket, or by the use of approved pneumatic tools so that the exposed surface is sound.

510 Trench Excavation

Trench excavation shall be performed by the use of hand tools and approved mechanical equipment, in such manner as to minimize disturbance of the sides and bottom of the excavation.

Trenches for pipes shall be excavated to a sufficient depth and width to enable the pipe and the specified joint, bedding, haunching and surrounding to be accommodated.

511 Trenches

The Contractor shall carry out excavation in a safe manner such that the sides of the trench are adequately supported and stable.

The Contractor shall leave a clear adequate space between the edge of the excavation and the inner toes of the spoil banks.

Trenches shall be excavated to the lines and levels shown on the drawings. Trenches shall not be excavated too far in advance of pipe laying and shall be sufficiently wide to allow proper and efficient jointing to be carried out in clean and dry conditions. Due allowance shall be made for bedding and surrounds where these are specified.

The bottoms of all trenches shall be trimmed to grade and level and thoroughly compacted by ramming before any bedding is placed or pipes laid.

The widths of trenches crossing roads or at other locations as directed shall be as narrow as practically possible. The maximum width measured between undisturbed soil in the trench sides shall not exceed the outside diameter of the pipe being laid plus 550 mm for pipes up to and including 230 mm in diameter and plus 750 mm for pipes over 230 mm in diameter.

512 Channels

Channels shall be excavated by methods, which shall not endanger the stability of the side slopes.

Existing channels, which are to be reshaped, cleared and trimmed, shall be cleared of all weeds and growth and the beds graded to the required levels. The area of waterway shown is the minimum required and the sides of channels shall be trimmed to the required slope so as to provide widths not less than those shown on the Drawings.

Side banks of channels shall be trimmed to a neat appearance and even surfaces.

513 Disposal of Spoil Material

Possible spoil areas to be used for disposal of surplus excavated materials shall be as shown on the Drawings or as otherwise approved by the Supervisor's Representative.

The Contractor shall organize and carry out the placing of spoil in such a way that flow passages to existing streams and creeks are not diverted. Contamination of existing rivers shall be avoided and suitable drainage, grassing and turfing shall be provided to prevent erosion of spoil materials.

The Contractor shall submit to the Supervisor's Representative for approval all necessary data showing mucking areas, working methods and drainage and stabilizing provisions before placing of spoil in any areas.

514 Quarries and Borrow Pits

The Contractor shall select his own quarry site or sites but before opening up any quarry he shall supply the Supervisor's Representative with: an adequate number of borehole logs and details of test pits; and any other such information that the Supervisor's Representative may require to satisfy himself that the quarry site or sites selected by the Contractor may be expected to provide sufficient stone of the specified quality to complete the Works. In the event of the site or sites selected by the Contractor being shown by such information in the opinion of the Supervisor's Representative to be incapable of supplying the requirements of the Contract for reasons of either quality or quantity, the Supervisor's Representative shall require the Contractor to investigate further sites in a similar manner until the Supervisor's Representative is satisfied that adequate supplies of the specified stone may be anticipated.

Notwithstanding satisfactory borehole logs, the Supervisor's Representative shall have the right to reject unsatisfactory stone exposed when the quarry is opened. The Contractor shall make provision for the cost of all the exploratory work described above in the rates inserted in the Bills of Quantities.

The quarries shall be run in a safe manner and on completion of the Works, they shall be left in a tidy state with all loose rock on the face barred down. No rock shall be left overhanging except with the approval of the Supervisor's Representative. All quarries shall be worked in such a manner that they do not constitute a danger to health or a nuisance to the neighbourhood, either during the operation of the quarries or after completion of the works.

The Contractor shall obtain the Supervisor's Representative's approval for the sites of borrow pits. The Contractor shall leave all borrow pits in a tidy and regular state, and he shall ensure that where possible they are self-draining at all times and do not constitute a danger to health.

515 Approval of Excavations

The Contractor shall obtain approval of excavations prior to placing pavement layers, fill or concrete. The Contractor shall maintain open excavations in an approved condition, and shall rectify the effects of deterioration due to weather.

516 Preparation of Ground for Filling

The Contractor shall form benches in steeply sloping ground before placing fill over it.

In the areas designated "soft clay" or any other place so designated by the Supervisor's Representative, the top soil shall not be disturbed, only trees and bushes removed.

After site clearance, and before and/or after proof rolling, the Supervisor's Representative may order the excavation and removal of any material deemed unsuitable for supporting the fills or pavements to be placed thereon, and its replacement by suitable approved granular fill material compacted in 150 mm thick layers to 95% of BS Heavy Compaction as defined in BS 1377.

Paved or fill areas other than "soft clay" areas are to be proof rolled to the satisfaction of the Supervisor's Representative before placing any fill or pavement. A minimum of 5 passes shall be made by a pneumatic tired roller with mass per wheel of 1500 kg to 2000 kg or other roller as agreed by the Supervisor's Representative. On completion of proof rolling in areas where the sub-base is the succeeding layer, the formation shall have a dry density of not less than 95 per cent of the maximum dry density obtainable with BS Heavy compaction.

The limits of embankment foundation areas shall be marked on the commencing surface. The Supervisor's Representative shall inspect the layout or alternatively order the removal of unsuitable material to a spoil area to a specified depth prior to the placement of fill. The commencing surface for fill areas shall be compacted to 95% BS Heavy maximum dry density as defined in BS 1377.

Where fill is to be constructed across swampy, waterlogged or soft clayey ground that shall not support the weight of trucks or other hauling equipment, the Supervisor's Representative may direct that the lower parts of the fill be constructed by dumping successive loads in a uniformly distributed layer of thickness not greater than is necessary, to support the hauling equipment placing subsequent layers.

Light hauling equipment and light rollers shall be used whenever necessary so as not to overstress the underlying construction.

Where embankments are to be constructed over soft to cohesive lean clays, an additional removal of 500 mm may be required and the voids filled with selected granular materials.

The upper layers of embankments shall comply with the following requirements - for a depth of 300 mm below the subgrade, materials and construction shall comply with the requirements for selected material.

The Contractor shall be responsible for the location of suitable capping layer material and selected material fill to meet the above specified requirements. The use of any necessary borrow pits shall be subject to the approval of the Supervisor's Representative.

Any additional costs involved in excavation in small areas and depths - as a separate operation or location, shall be deemed to be covered by the rates for cut and fill, as entered in the Bill of Quantities.

Where material falling within the subgrade is classified as suitable for use but fails to meet the specified requirements for subgrade at formation level, the layers shall be scarified and mixed, water shall be added, or the material allowed to dry, to an appropriate moisture content – before the layer is re-compacted. Any such additional work incurred shall be considered to be at the Contractor’s expense.

During the process, the final surface of each subgrade layer shall be graded to level, parallel to the cross-fall or camber and profile shown upon the Drawings unless otherwise directed by the Supervisor’s Representative- and to the tolerances specified. The maximum compacted thickness which shall be processed and compacted at one time shall be 150 mm.

517 Earth Filling

Material for filling shall be obtained from approved sources or selected from excavations containing no vegetable or perishable matter, graded to ensure a dense, stable and homogeneous fill when compacted.

Prior to commencement of filling, the Contractor shall submit in writing to the Supervisor’s Representative for approval his proposals for carrying out the work such that the optimum use may be made of excavated material and the proposals shall include the compaction plant and methods for adjusting the moisture content of the material which he intends to use. No filling shall be carried out until the Supervisor’s Representative approves the proposals and the material intended to be used.

Construction equipment must operate over the whole area to ensure uniform compaction. Fill shall be placed in layers not exceeding 250 mm thickness, each layer being scarified and thoroughly compacted to obtain a dry density as specified below. More than 450 mm below top of fill level the density shall be not less than 90 per cent BS Heavy maximum dry density as determined by BS 1377. The top 450 mm of fill shall be compacted to a density of at least 95 per cent BS Heavy maximum dry density and shall be capable of achieving a CBR of 8 per cent when so compacted. This CBR percentage should be realized on samples, which have been compacted at optimum moisture content and soaked for 96 hours. The in-situ dry density of the compacted fill shall be determined by the sand replacement method described in Test No. 15 BS 1377 at locations ordered by the Supervisor’s Representative.

The fill material prior to compaction shall be brought to moisture content within an agreed range of the optimum, in order to obtain the required density. If watering is required, it shall be carried out in such a manner as to ensure the even distribution of water throughout the layer to be compacted and the compaction operations shall follow whilst the moisture content remains within the specified range.

Filling in layers over 250 mm compacted thickness but not exceeding 500 mm compacted thickness may be approved by the Supervisor’s Representative for mass filling where the nature of the work allows for unimpeded passage of compacting equipment, but not for backfilling of trenches or around isolated or confined foundations. Approval shall be given only if the Contractor carried out full scale compaction trials using the proposed procedures or amendments thereto shown during the trials as being necessary, and can demonstrate to the satisfaction of the Supervisor’s Representative that the degree of compaction specified in sub-section 74525 hereof can be achieved throughout the full depth of the layer.

Longitudinal and transverse joints in any two successive layers shall be staggered by a minimum distance of 1.5 times the thickness of the layer.

The Contractor shall take all necessary measures to prevent any damage or defects to the Works, which may be caused by settlements, slips or falls of embankments and shall make good such damage or defects as may occur, to the satisfaction of the Supervisor's Representative.

Any instability of any adjacent excavation resulting from the embankment not being formed to the lines, levels and profile shown in the Drawings or as ordered by the Supervisor's Representative shall be the responsibility of the Contractor. Where double handling of excavated material is necessary, the Contractor shall be responsible for the temporary disposition of the material such that it does not endanger the stability of the excavation.

518 Backfill – General

Except around structures, excavations shall be backfilled with suitable excavated material and/or approved material compacted in layers of 300mm maximum thickness to achieve a density of at least 95% of the maximum dry density (heavy compaction) determined in accordance with BS 1377.

Materials shall be placed simultaneously on both sides of an abutment, wall, or pier where necessary to equalize forces. Backfilling shall be carried out with an approved material in horizontal layers not exceeding 150 mm in depth after compaction. Each layer shall be moistened or dried as necessary, to reach the optimum moisture content before being compacted to 95% of the maximum dry density (heavy compaction) determined in accordance with BS 1377.

519 Backfill to Structures

The Contractor shall not backfill around structures until the structural elements have attained adequate strength and the Supervisor's Representative grants approval to proceed. Unless otherwise directed, the backfill material shall be selected excavated material, thoroughly compacted in layers not exceeding 200mm deep to achieve a density of at least 95% of the maximum dry density (heavy compaction) as determined by BS 1377.

Unless otherwise permitted, no filling shall be placed against retaining walls within fourteen days of casting. Strut walls shall be constructed as necessary to prevent movement during placing and compaction.

Filling shall be placed and compacted over and around pipes, culverts, bridges and other structures so as to avoid unbalanced loading or movement.

Unless otherwise detailed, the abutments and wings of bridges shall be filled as follows:

- Where the gap between the structure and undisturbed ground is less than 900mm, backfill with sub-base material shall consist of clean, durable fill material.
- Where the gap between the structure and undisturbed ground exceeds 900mm but is less than 2m, backfill with select material, single-sized 10mm gravel.

- Where the gap between the structure and the undisturbed ground exceeds 2m, backfill the zone within 2m of the structure with select material as defined below, and backfill in the zone beyond 2m of the structure with general fill complying with General Fill requirements
- Selected well -graded granular material can consist of natural gravel, natural sand, crushed gravel, crushed rock etc. This is mainly frictional material with less than 15 per cent passing the 63-micron sieve and with a minimum acceptable uniformity coefficient of 10.

520 Backfilling Materials to Structures

Unless otherwise specified or directed the materials used for filling shall be obtained from cuttings.

The Contractor shall be required to manage and sort the materials so obtained from cuttings to ensure that the best available material, that is the most granular and least plastic is available for use in road embankments and that any loam material obtained from cutting is used for general fill over the top layers which are to be grassed.

Material used in the top 150mm below subgrades shall be free of particles larger than 75mm; material used in the top 600mm below subgrades shall be free of particles larger than 150mm; and material used in the top 1 m below sub-grades shall be free of particles larger than 300mm. Elsewhere rock material shall be broken down to less than 600mm unless otherwise permitted.

Rock material shall be broken down and evenly distributed through the fill material, and sufficient fine material shall be placed around the larger material as it is deposited to fill the voids and produce a dense, compact embankment.

Stony patches with insufficient fine material to fill the voids shall be reworked with additional fine material being blended in to achieve a dense, compact upper layer. The Contractor shall bear the cost of any reworking.

After compaction, embankment material in the subgrade zone(s) below the pavement material (select material layer or sub-base layer, where there is no select material layer) shall conform to the requirements of Section 525

The Supervisor's Representative may direct that material unsuitable for road embankments be used elsewhere on site or run to spoil. If this should result in a deficiency of material available for filling, then additional material shall be obtained as specified in Section 517.

521 Filling Under Buildings Slabs

The material to be used as general filling under raised foundations and building base slabs shall consist of suitable material obtained from adjacent excavations or approved borrow sources, and shall be placed in layers not exceeding 200 mm loose thickness. The material shall be compacted to the degree of compaction specified for earth filling.

522 Embankments

Embankments shall be formed of fill as defined and specified herein and compacted as described in the relevant Section hereafter.

Embankments shall be constructed in accordance with the profiles and true to side slope width and levels, as shown in the Contract Drawings, or as otherwise instructed or authorised or approved by the Supervisor's Representative.

Where the Contractor has been authorised to dispose of surplus fill by widening embankments, they shall be constructed to an approved size and made integral with the construction of the embankment proper.

523 Placing Fill on Slopes

Fills are normally to be formed of material generated by excavations for cuttings and side drainage ditches. Materials shall be as defined and specified, placed and compacted as described elsewhere in these Specifications.

Where the slope of the natural ground exceeds 20° it shall be cut into to form benches on which the fill is constructed, with each bench being cut as the fill is compacted and brought up. The dimensions of benches shall be sufficient to permit the operation of placing and compaction equipment thereon with a minimum width of 2 m except in rock.

The slope shall be given an initial bench at the toe of the fill as set out from the specified levels and cross-sections and protective toe walls installed where specified.

524 Rock Fill

Where shown on the Drawings, or ordered by the Supervisor's Representative, rock fill shall be placed to a finished level of not less than 300 mm below formation level.

524.1 Placement of rock fill

Rock fill shall be as defined and specified. Each layer of rock fill shall be spread, levelled and compacted by means of suitable equipment. Hauling, spreading and compacting equipment shall be operated over the full width of the layer. Layers of rock-fill spread for compaction shall not exceed 600 mm in thickness in the loose condition.

The maximum particle size shall be 1.0 m in the greatest dimension. All larger particles are to be removed and disposed to spoil. Where a deficiency in fine materials is obvious during the spreading of the layer, additional material must be selected and added, as directed by the Supervisor's Representative.

Compaction shall preferably be by a heavy roller of 15 tonne dead weight or by a vibrating roller, giving equivalent results and each layer shall be rolled over the full width of the fill with sufficient number of passes to provide no observable movement under the compacting equipment.

524.2 Treatment of Rock Fill Surfaces

When the top level of the rock fill has been reached and compaction undertaken on the layer surfaces, the top shall be saturated then 'blinded' with, small size rock material and again compacted over the full width.

This process is to be repeated until the surface no longer shows voids or crevices and in the opinion of the Supervisor's Representative is ready to receive any specified capping layer materials for compaction of the final 300 mm to formation level, in accordance with the specifications.

525 **Compaction**

This Section describes the work of placing materials in fills including the processing and compacting of the material, in formation preparation and related works in accordance with the requirements of the Specifications.

525.1 **General**

Compaction shall be carried out in a series of continuous operations over the full width of the layer concerned. The length of any section of a layer being compacted shall, whenever possible, not be less than 300 m, unless otherwise authorised by the Supervisor's Representative.

The thickness of any one layer, when measured after compaction, shall not exceed 150 mm, except where specifically indicated on the Drawings or otherwise directed.

Any new layer of less than 75 mm in compacted thickness shall be bonded to the previous layer by scarifying the latter to a depth of not less than 75 mm.

525.2 **Preparation**

The material to be compacted shall be thoroughly broken up over the width and depth of the layer by means of scarifiers or other suitable equipment and all large size aggregates, stone or lumps with a maximum dimension larger than 50% of the specified compacted thickness of the layer concerned, shall be broken down or removed.

525.3 **Drying**

Should the material be too wet, due to rain or any other cause, it shall be harrowed and allowed to dry to a moisture content that is consistent with achieving the required degree of compaction.

525.4 **Watering**

Any water required before the material is compacted, shall be added to the material in successive applications by means of water tankers fitted with proper sprinkler bars and capable of applying the water evenly and uniformly over the area concerned.

The water shall be thoroughly mixed with the material to be compacted by means of motor graders or other suitable equipment. Mixing shall continue until the required amount of water has been added and until a uniform mixture is obtained before compaction is commenced.

The moisture content of the material, when compacted, shall be such that the specified density is achieved.

The Contractor shall provide, at his own expense, the necessary staff and equipment for controlling moisture content and for ensuring adherence to specified compaction requirements.

526 Methods of Compaction

Compaction shall be carried out by means of grid rollers, sheep's foot rollers, flat-wheel road rollers, vibratory rollers and/or pneumatic-tired rollers.

The types of rollers to be used and the amount of rolling to be undertaken shall be such as to ensure that specified compaction densities are obtained.

During compaction, layers shall be maintained to the required shape and cross-section and all holes, ruts and depressions eliminated by frequent blading with motor graders.

527 Testing of Fill (To be carried out by the contractor)

Classification tests shall be carried out to ensure that true comparisons can be made between in situ densities, laboratory compaction densities and field trial densities i.e. variations in properties of materials being used in the tests are not affecting the results.

Density shall be measured by either of the methods described in BS 1377. Moisture content shall generally be determined by the 'Speedy' method with spot checks by the oven method.

The CBR test shall be carried out in accordance with standard test procedure as set out in BS 1377 and all fill material shall be tested with surcharge rings compatible with the pavement thickness.

Except when it is specified that CBR specimens shall be soaked for 96 hours, the CBR shall be measured at the moisture content estimated by the Supervisor's Representative to correspond with the moisture content pertaining under the most unfavourable conditions to which the soil may be subjected. The Supervisor's Representative shall establish the value of the moisture content at the commencement of the Works.

In situ density and Clegg Hammer tests shall be carried out routinely at 30 meter intervals on each finished layer. CBR tests shall be carried out on materials sampled from the finished layer at intervals determined by the Supervisor's Representative.

528 Finish of Subgrade

The subgrade i.e. that layer which immediately underlies the sub base, shall be finished to within +0 mm to 40 mm of the levels indicated by the Supervisor's Representative and shall be free draining.

529 Ancillary Earthwork Operations

529.1 Finishing Slopes

The slopes of cuttings and fills shall be trimmed to neat lines with all loose rock and loose boulders removed. Except in solid rock the tops and bottoms of all slopes, including the slopes of drainage ditches shall be rounded, as ordered by the Supervisor's Representative.

When so directed by the Supervisor's Representative, adjustment in slopes shall be made to avoid damage to standing trees and to harmonize with existing landscape features. The transition to such adjusted slopes shall be gradual.

All earth slopes shall be finished to smooth and uniform surfaces without any noticeable break. Embankment slopes shall be cleaned of loose materials and trimmed back to design profiles or where overfill has been permitted, back to material, which is compacted as specified.

The slopes of cuts and fills, which are designated for grassing, shall, after finishing, be prepared for top soil and grass seed application as specified.

529.2 Drainage of Earthworks

All cuttings, embankment and borrow areas shall be kept free of standing water and drainage during the construction period. The provision of any temporary drains etc., necessary for adequate drainage, shall be the Contractor's responsibility and be deemed to be included in his rates.

Should water accumulate on any part of the earthworks during construction giving rise to soaking or erosion conditions in the earthworks, the Supervisor's Representative may order the Contractor to remove and replace, at the Contractor's expense, any material that has been so affected. All drains shall be maintained throughout the Contract in working order.

Well in advance of commencing earthmoving operations over swampy or waterlogged areas, the Contractor shall cut drains and ditches and carry out any other works necessary to assist in draining the ground.

The Contractor must allow in his rates for the satisfactory draining of the earthworks at all stages during the construction and arrange his methods and order of work accordingly. No work above the subgrade shall be executed until it has been inspected and approved by the Supervisor's Representative.

The subgrade shall be cleaned of all foreign matter and any potholes, loose material, ruts, corrugations, depressions or other defects, which have appeared in the subgrade layer, due to improper drainage, traffic or any other cause, shall be corrected. If so directed by the Supervisor's Representative, the Contractor shall scarify, grade and re-compact the subgrade to line and level at his own expense.

529.3 Tolerances

The finished surface of the formation (subgrade) shall be within ± 25 mm of the specified level. In the final trimmed slopes, a tolerance of $\pm 7.5\%$ shall be permitted.

The tolerance permitted in the overall width of the bottom of cuttings shall be 75 mm in the distance between the center line of the road and the toe of the cutting slope.

The center line dimensions of embankments, measured as the distance from the center line of the road to the shoulder break point, shall be never less than the design width and shall not be more than 250 mm greater than the specified dimension.

The Contractor shall be paid for the net volume of the earthworks measured from agreed pre-construction cross-sections using the appropriate commencing surface.

Any additional material excavated or filled within or beyond these tolerances shall be at the Contractor's expense.

530 Termite Treatment

Pre-construction subterranean termite treatment of the building's foundation shall be with one of the following termiticides formulations; liquid or water dispersible granule at the recommended label rates:

Fipronil - 9.4% by weight

Imidacloprid - 75.0% by weight

Permethrin – 25.6 % by weight

Termiticide mixture shall be applied by spray immediately before pouring of concrete slab at the rate of 1 gallon per 10 square feet of surface area on compacted filling and sand beds and 4 gallons per 10 linear feet, per foot depth assuming a three-foot footing following trenching (6 inch) of the outer perimeter of the foundation wall.

Treatment shall not be carried out when rain is falling or when ground is excessively wet. A warranty of at least 5 years is required against infestation by subterranean termites, during which period the Contractor shall carry out any remedial work free of charge.

531 Top Soiling

The Contractor shall obtain topsoil from temporary dumps or approved borrow pits and shall spread it on level or sloping surfaces, planters, where ordered, to the depth shown on the Drawings.

532 Grassing

The topsoil shall be raked lightly and uniformly to give a fine tilth up to 25mm deep.

The surface shall be grassed with a local grass with creeping habit, or which the source and variety shall be approved by the Supervisor's Representative. Grass sprigs shall be planted at 0.3 m x 0.3 m spacing. The grass shall be adequately watered until such time as the grass becomes established.

Should the growth fail to become established for any reason the Contractor shall re-cultivate and replant grass as necessary in accordance with the above specification, for as many times as necessary for the grass to become established. When established between 50 and 75mm high, the grass shall be topped by cutting to leave between 25 and 50mm minimum growth and watering shall be continued as necessary until the grass is firmly established to the Supervisor's Representative's satisfaction.

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600 BUILDING DEMOLITION

601 General

601.1 Scope

This Part specifies procedures and requirements for demolition and removal of buildings, structures and related service utilities. The scope of demolition or renovation work is specified for three categories of demolition:

- Standard Demolition - typical type demolition work
- Special Demolition - demolition of partially collapsed or unsafe structures
- Selective Demolition - demolition required for alteration or expansion type work

601.2 References

The following standards are referred to in this Part:

- BS 5607 Safe use of explosives in the construction industry

601.3 General Requirements

Unless otherwise indicated or directed by the Supervisors Representative, the Contractor is to complete the demolition and removal of buildings and structures together with all foundations and retaining walls, piers, partitions and columns, and associated service utilities.

The demolition is to be carried out in a planned and safe sequence, generally in reverse order of erection, reducing the shell of the building in small lifts.

The Contractor is responsible for the removal and disposal of all debris resulting from demolition work.

Upon hand over of the Site to the Contractor, the Contractor is to take over all responsibility of the buildings to be demolished.

The Contractor is to inspect each building he is to remove and determine for himself the work involved and the equipment and the materials required for the specified demolition work.

602 Standard Demolition

602.1 Method Statement

The Contractor is to prepare a method statement which shall detail all aspects proposed demolition work and associated procedures before commencing any demolition work. The method statement shall be approved by the Supervisor's Representative before any demolition work commences. The Method Statement is to incorporate the requirements of 501.1 of this Section.

The Contractor shall establish whether any stressed components are present in the structure. The Contractor shall include a complete statement of his proposed method of demolition of the components in his method statement.

The Contractor shall establish whether any of the walls of the structure to be demolished are load bearing and shall establish whether cross walls are bonded into the abutting walls. The Contractor shall identify such walls in his method statement.

602.2 Execution

The Contractor shall completely demolish and remove buildings and structures, including all services related or connected thereto, as noted below:

- to minimum depth of 900 mm below finished grade in areas new paving is to be placed unless greater depth is required for installation of new utility service lines.
- to full depth within an area defined by hypothetical lines located 1.5 m outside building lines of new structures.
- to minimum depth of 600 mm below finished grade in all other areas unless greater depth is required for installation of new utility service lines.

Debris, including brick, concrete, stone, metals and similar materials are to become the property of Contractor and be disposed of by him, off the Site. Concrete slabs below grade that do not require removal from the site are to be broken up into pieces not exceeding 60 cm².

In removing buildings and structures of more than two stories, demolition work shall start at the highest level and progressing down to third floor level. Demolition of first and second stories may proceed simultaneously.

Where explosives are to be used, comply with the requirements of this Section and BS 5607.

The Contractor is to conduct his operations in such a manner as to avoid danger to persons and property. Once demolition work has started on any building, the work on that building is to be continued to completion, promptly and expeditiously.

Where building basements exist and the area is not to be reused, all debris is to be removed from the basement areas and concrete floors broken. The areas are then to be filled with backfill material simultaneously with the breaking of the foundation walls and floors so that the backfill material will be integrated with the pieces of broken concrete.

Concrete slabs resting on earth and forming footpaths, driveways, or the first floor of buildings without basements are to be broken up and removed from the Site unless otherwise specified.

The Contractor is responsible for removing any additional small "out" buildings or miscellaneous structures that have not been indicated in the Drawings or documentation unless otherwise instructed by the Supervisor's Representative.

Existing underground storage tanks on the Site or within the buildings to be demolished are to be removed and disposed of by the Contractor. The Contractor is to take all necessary precautions during the removal of the fluid within the tanks. Where tanks are removed, the Contractor is to backfill the resulting void with the fine aggregate. This backfill is to be

compacted in accordance with Section 500, Related to Buildings. Structures designated to become the property of the Contractor are to be removed from the Site.

Operations necessary for the removal of an existing structure or obstruction, which may damage new construction, are to be completed prior to placing the new work unless otherwise specified.

Where trees have been designated to remain, but are a hindrance to demolition work, the Contractor is to, at his own expense, temporarily relocate such trees and provide all maintenance as necessary until such time as replanting is feasible.

603 Utility Services

603.1 Demolition Related Work

The Contractor is to arrange for the disconnection of all utilities that serve buildings in accordance with the respective requirements and regulations of the relevant authority.

The Contractor shall liaise directly with the service utility authorities to assertion correct procedures and safe working practices related to disconnection of each particular utility service. The Contractor is to disconnect and properly seal, in a manner approved by the relevant authority and the Supervisors Representative, all sewer outlets that serve buildings to be demolished. The Contractor will keep the Supervisor's Representative informed of his plans for the performance of any work in connection with the sealing off of such outlets in order that proper inspection may be provided at the time the work is performed.

Demolition of utilities shall be in accordance with sub sections 602 of this unless otherwise directed by the Supervisor's Representative.

The Contractor shall demolish and remove external utility service lines as follows:

- abandoned portions of utility lines located outside areas of new buildings, or new roads, footpaths and parking areas that are less than 650 mm below proposed finished ground levels
- abandoned portions of utility lines which occur within areas of new buildings, roads, footpaths and parking areas
- abandoned utility lines that would interfere with installation of new utility lines
- other abandoned lines not specified that interface with performance of the work of this contract.

Unless otherwise stated elsewhere in the Project Documentation, the point of disconnection of utility services shall be at a point agreed with by the utility owner.

604 Special Demolition

604.1 Scope

This Clause specifies the requirements and precautions to be taken where demolition and removal of materials is required within buildings or structures which are partially collapsed or considered unsafe.

604.2 Method Statement

The requirements as set forth by Subsection 604.3 of this Section will apply unless stated otherwise in the Project Documentation.

604.3 General Requirements

Where demolition is to be done within partially collapsed or unsafe buildings, additional site specific investigations will need to be made by qualified Supervisors Representatives or specialists to determine if temporary shoring or other measures must be taken for safety of workers, the Public or other adjacent structures of properties. The Contractor is responsible for arranging for such investigations to be made before any demolition work commences. The Contractor shall incorporate the findings and results of the investigation in his method statement. The cost of any specific investigations, as described in this paragraph, shall be borne by the Contractor unless otherwise stated.

605 Selective Demolition

605.1 Scope

This Clause specifies the requirements and precautions to be taken where only parts of the interior or exterior of buildings are to be demolished, removed or replaced. This may include renovation or remodelling work, additions or expansions.

605.2 Method Statement

The requirements as set forth by Subsection 605.3 of this Section will apply unless stated otherwise.

605.3 General Requirements

Demolition work in alterations are to be undertaken with the maximum consideration for the surrounding structure and are to be limited to the minimum required in order to carry out the work. The manner and order of the work, including the design and provision of any supports and other safety precautions, will be the Contractors responsibility and shall be fully detailed in the method statement.

The design of any shoring and supports necessary to maintain the stability of any structure retained after the demolition of adjoining property are to be submitted to the Supervisor's Representative for approval. The responsibility for the sufficiency of the design is to rest with the Contractor, notwithstanding the approval of the Supervisor's Representative.

606 Temporary Work

606.1 General Requirements

The Contractor is to provide temporary works for protection of existing roads, footpaths, utilities, and structures where and when necessary.

Support is to be provided for members of framed structures before cutting them.

Where a structure's stability may be affected by the demolition of a member, temporary bracing, and guys, are to be provided to restrain the remaining members.

700 HAZARDOUS MATERIALS

701 General

This Part specifies requirements and procedures for the Contractor when encountering potential or known hazardous or toxic waste.

702 Relevant Authorities

702.1 Procedures and Contacts

The Contractor shall contact and co-ordinate with respective Government agencies in order to ensure correct implementation of approved methods and procedures to be carried out by the Contractor in connection with the removal or containment of hazardous materials. This is especially to be undertaken for the following:

- Prior to initiation of any work at the Site where known hazardous materials exist;
- Immediately upon question, suspicion, or finding of hazardous materials during demolition; all work should cease under this situation, with exception of immediate precautions taken to provide containment or until further direction or approval is given by the Supervisor's Representative.

702.2 Hazardous and Toxic Waste

When the Contractor's operations encounter or expose any abnormal condition which may indicate the presence of a hazardous or toxic waste, such operations are to be discontinued in the vicinity of the abnormal condition and the Supervisor's Representative. The Supervisor's Representative is to be notified immediately. The presence of the following may be indicators of hazardous or toxic wastes and are to be treated with extraordinary caution:

- Tanks or barrels
- Discoloured earth, metal, wood, ground water, etc.
- visible fumes
- abnormal odours
- excessively hot earth
- smoke
- Other conditions which appear abnormal.

Hazardous materials include, but are not limited to the following:

- anhydrous ammonia
- combustible liquids, compressed gasses
- dip tanks, flammable liquids
- hydrogen
- liquid petroleum gasses
- nitrous oxide
- spray finishing

Every effort is to be made by the Contractor to minimise the spread of any hazardous or toxic waste into uncontaminated areas.

703 Special Precautions

703.1 Public Safety Measures

The Contractor is to provide all safety measures to protect the public from harmful hazardous materials as required by respective authorities.

The Contractors operations will not resume until so directed by the Supervisor's Representative if any safety measures are found to be inadequate for protection from hazardous material conditions encountered during work.

703.2 Environmental Safety Measures

The Contractor is to follow and implement all procedures defined or required by related environmental or public safety authorities. These precautions will be taken at all times during the removal or confinement of hazardous materials, whether known or suspected.

The Contractor is to have present at the Site, a representative of the related approval authority during removal or confinement work, if it is a requirement the approval authority.

If previously defined safety measures are found not to exist for the type of hazardous materials in question, it will be the Contractors responsibility to establish procedures and methodology to be implemented. The procedures and methodology shall be to the approval of the Supervisors Representative.

Removal or containment work is to be performed under the constant direction and supervision of pre-approved personnel experienced with working with hazardous materials.

703.3 Documentation

The Contractor is to be responsible for processing and approval of any documentation relating to procedures required by governmental or agencies related to procedures for removal or containment of hazardous materials.

704 Disposal

704.1 Safe Disposal

Disposal of hazardous materials will be made in accordance with the requirements and regulations of the relevant authority.

800 CONCRETE

801 Concrete

Concrete shall consist of cement, graded aggregate and water thoroughly mixed, placed and compacted as specified in the following sub-sections.

802 Chlorides in Concrete

The total combined content of calcium chloride and sodium chloride in any batch of concrete is not to exceed 0.33% by weight of the amount of cement.

803 Cement

The cement used throughout the Works shall be obtained from manufacturers approved in writing by the Supervisor's Representative and shall as appropriate comply with the following specifications:

- Ordinary Portland cement: B.S. 12
- Sulphate Resisting cement: B.S. 4027

803.1 Cement Testing

All cements shall be certified by the manufacturers as complying with the requirements of the appropriate Specification. Before orders are placed the Contractor shall submit details of the proposed supplier(s) together with such information on the proposed methods of transport, storage and certification so that the Supervisor's Representative may satisfy himself that the quantity and quality required can be supplied and maintained throughout the construction period. Where necessary the Supervisor's Representative may require further representative samples of the proposed cement to be taken and forwarded to a nominated laboratory for analysis and testing before the source is approved.

Having obtained the Supervisor's Representative's approval of the source(s) of supply, transport, storage and certification of the cement, the Contractor shall not modify or change the agreed arrangements without first having obtained the Supervisor's Representative's permission.

In addition to routine test certificates which are to be supplied by the manufacturer to show the average results of sample tests made on batches of cement produced at the works, the Supervisor's Representative may also make any further tests which he shall consider necessary or advisable to satisfy himself that the cement on Site complies with the Specification and has not suffered deterioration in any manner during transit or storage.

The Contractor shall ensure that the arrangements for the storage of the cement on the Site as hereinafter specified are sufficient for the segregation and identification of each consignment until the results of the sampling and testing referred to in sub-section (3) above are available.

No cement shall be used in the Works until the Supervisor's Representative has passed it as satisfactory.

803.2 Storage of Cement

The cement shall be delivered to the site of the Works in bulk or in sound and properly sealed bags and while being loaded or unloaded and during transit to the concrete mixers whether conveyed in vehicles or by mechanical means, must be protected from the weather by effective coverings. Where directed by the Supervisor's Representative the Contractor shall supply and erect efficient screens at his own expense to prevent wastage of cement during strong winds.

If the cement is delivered in bulk, the Contractor shall provide at his own cost, approved silos of adequate size and numbers to store sufficient cement to ensure continuity of work and the cement shall be placed in these silos immediately it has been delivered on the Site. Approved precautions must be taken during unloading to ensure that the resulting dust does not constitute a nuisance.

If the cement is delivered in bags, the Contractor shall provide at his own cost perfectly weatherproof and well-ventilated sheds having a floor of wood or concrete raised at least 500 mm above the ground. The sheds shall be large enough to store sufficient cement to ensure continuity of work and each consignment must be stacked separately therein to permit easy access for inspection, testing and approval. On delivery at the Site, the cement is at once to be placed in these sheds and shall be used in the order in which it has been delivered.

Cement, which has been damaged in transit to the Site or has become stale or otherwise unsuitable, and hardened lumps or cakes of cement, which cannot be crumbled into fine powder in the hand shall not be used in the Permanent Works except with the specific approval of the Supervisor's Representative.

804 Fine Aggregates

Fine aggregate for concrete shall be clean sand complying with B.S. 882 "Aggregates from natural sources for concrete". The sand shall be from approved sources and a sand, which in the opinion of the Supervisor's Representative is not clean, shall be washed before use.

Crushed sand up to a maximum of 50% may be added to natural sand in order to achieve the required grading. Crushed sand alone may only be used with approval of the Supervisor's Representative.

Sand for use in mortar and rendering shall conform in all respects with B.S. 1198 1200, "Building sands from natural sources".

The amount of deleterious substances in fine aggregates shall not exceed the limits prescribed in the following Table 1.

Table 1: Limits for Deleterious Substances in Fine Aggregates for Concrete

Items	Mass per cent of total sample, max
Clay lumps and friable particles	3.0
Material finer than 75µm (No. 200) sieve:	
Concrete subjected to abrasion	3.0
All other concrete	5.0
Coal and lignita:	
Where surface appearance of concrete is of importance:	0.5
All other concrete	1.0

Should the amount of clay, fine silt and fine dust exceed the limits specified, then the Contractor shall refrain from using the aggregate until he satisfies the Supervisor's Representative of its suitability for making concrete of the quality required.

Fine aggregates shall be free of injurious amount of organic impurities. Except as herein provided, aggregates subjected to the test for organic impurities and producing a colour darker than the standard shall be rejected.

The use of fine aggregates failing in the test is permitted, provided that this coloration is due principally to the presence of small quantities of coal, lignite or similar discrete particles. The use of fine aggregates failing in the test is permitted, provided that, when tested for the effect of organic impurities on strength of mortar, the relative strength at seven days, calculated in accordance with test method C87, is not less than 95%.

805 Coarse Aggregate

Coarse aggregate for concrete and other purposes shall comply with B.S. 882 "Aggregates from natural sources for concrete". Subject to sub-section (6) hereof it may be either natural gravel or stone broken to the desired size and shall be obtained from quarries, pits or other sources approved by the Supervisor's Representative.

Gravel or ballast shall be free from clay, earth, loam or other organic or similar material and shall be approved by the Supervisor's Representative. Any sand that may be amongst it shall, unless otherwise directed, be removed by screening if required and kept apart. Should the sand thus obtained be suitable in the opinion of the Supervisor's Representative for use in concrete, it may be used for the purpose if it complies with the conditions specified for sand in the preceding Section. Gravel or ballast, which in the opinion of the Supervisor's Representative is not clean, shall be thoroughly washed before use.

Broken stone shall be of hard durable rock. Notwithstanding approval by the Supervisor's Representative of its source, the stone as delivered to the Works shall be subject to rejection if for any reason the Supervisor's Representative considers it unsatisfactory. It must be perfectly clean and no soft, clayey, shaley, decomposed or weathered stone shall be approved. The stone must be broken in a stone crusher of approved type to the sizes hereinafter specified and any dust or fine material below 5 mm in size made in the stone crusher is to be removed by screening

if so required and if the Supervisor's Representative so orders the stone shall be thoroughly washed by an approved method.

When so required and before the Work commences, laboratory tests shall be made of the aggregates to be used on the Works to establish their suitability for concrete. In addition to these laboratory tests, the Supervisor's Representative may require check tests of actual deliveries to be made at the Site from time to time.

The grading of coarse aggregate by analysis shall be within the limits laid down in B.S. 882 1201, Table 1, Coarse Aggregates. Should an analysis of the grain size of the material show a deficiency in any particular size such as to affect the density of the concrete, the Supervisor's Representative may require the Contractor to add such quantity of aggregate of any particular size that he may deem advisable. In every case, the material shall when mixed with sand produce a well graded mixture from the largest to the smallest size specified to ensure that concrete of high density shall be produced.

The "flakiness index" for coarse aggregate as determined by the sieve method described in B.S. 812, "Methods for sampling and testing of mineral aggregates, sands and fillers," shall not exceed 40 for 40 mm aggregate nor 35 for 20 mm and 10 mm aggregate.

The "ten per cent fines" value of the coarse aggregate determined in accordance with BS 812 shall not be less than 8 tonnes, and not less than 5 tonnes on a soaked specimen. Alternatively, the aggregate crushing value determined in accordance with BS 812 shall not exceed 35 per cent, and shall not exceed 40 per cent on a soaked specimen.

The material shall be subjected to 5 alternations of AASHTO Sodium Sulphate Soundness test T104. The weighted loss shall be not more than 12 per cent mass. Where the presence of weathering rock is suspected, petrographic tests shall be carried out to determine the proportion of secondary minerals present.

806 Storage of Aggregates

All sand and aggregate for concrete shall be stored on close fitting timber, steel or concrete stages of approved design with drainage slopes or in bins of substantial construction in such a manner as to prevent segregation of sizes and to avoid the inclusion of dirt and other foreign materials in the concrete. All such bins shall be emptied and cleaned at intervals as instructed by the Supervisor's Representative. Each size of aggregate shall be stored separately unless otherwise approved by the Supervisor's Representative.

807 Water for Concrete

Clean fresh water is to be used for the mixing of all concrete and mortar and is to be from a source approved by the Supervisor's Representative. If required by the Supervisor's Representative, samples shall be taken from the proposed source of supply and submitted to a nominated laboratory for testing in accordance with B.S. 3148 - "Tests for water for making concrete" and on the results of these tests the Supervisor's Representative shall decide whether the source is acceptable.

808 Admixtures

The use of non-corrosive additives or admixtures in concrete may be ordered or approved by the Supervisor's Representative according to circumstances. Such approval shall be given only when the Contractor has demonstrated to the satisfaction of the Supervisor's Representative that the resulting concrete is no less strong, dense and durable than that obtainable without the use of additives.

Samples of any additive or admixture proposed by the Contractor shall be submitted for testing at least 60 days in advance of use, which shall require the written approval of the Supervisor's Representative.

When additives or admixtures are used in the Works very strict control is to be maintained to ensure that the correct quantity is used at all times.

809 Integral Water Resisting Admixtures

The use of an integral water resisting admixture in concrete is recommended by the Supervisor's Representative for use in the concrete roof structure including slabs and supporting gable shaped beams. This integral water resisting admixture shall be based on a unique blend of fatty acid salts and hydrophobic materials, supplied as a white chloride free liquid; tested in accordance with BS EN 480-5:2005, BS EN 934-2:2009+A1:2012 or equivalent EU or ACP states standards.

Properties for this integral water resisting admixture shall be as follows:

Typical properties

Appearance:	White liquid
Specific gravity:	Typically, 1.05 at 20°C
Chloride content:	Nil to BS 5075

The integral water resisting admixture shall be suitable for use with all types of Portland cements and combination materials such as fly ash, PFA, GGBS limestone fines and microsilica.

Upon application of the admixture product very strict control is to be maintained to ensure that the correct quantity, dosage and curing technique is used at all times.

810 Steel for Reinforced Concrete

Steel reinforcement, other than steel for pre-stressing, used in reinforced concrete shall comply with the following British Standards as appropriate:

- B.S. 4449 Specification for Hot rolled steel bars for the reinforcement of concrete.
- B.S. 4461 Specification for Cold worked steel bars for the reinforcement of concrete.
- B.S. 4482 Hard drawn mild steel wire for the reinforcement of concrete
- B.S. 4483 Steel fabric for the reinforcement of concrete

Deformed bars of high tensile steel may be used if the Supervisor's Representative approves or it is shown on the Drawings.

The Contractor shall furnish the Supervisor's Representative with copies of the manufacturer's certificates of tests for the steel reinforcement to be supplied. The Supervisor's Representative may, however, order independent tests to be made and any steel, which does not comply in all respects with the appropriate foregoing specifications, shall be rejected.

Bends, cranks or other labours on reinforcement bars shall be carefully formed in accordance with the Drawings, B.S. 4466 "Bending dimensions and scheduling of bars for the reinforcement of concrete" and B.S. 8110 "Structural use of reinforced concrete in buildings". The bars shall be bent cold in a manner, which shall not injure the material. Bending hot at cherry red heat (i.e. not exceeding 850 0C) may be allowed except for bars, which depend for their strength on cold working. Bars bent hot shall not be cooled by quenching. Bends shall be made round a former having a diameter of at least four times the diameter of the bar except for bends in cold twisted steel bars and deformed bars of high tensile steel for which a former of at least six times the diameter of the bar shall be used. Where splices or overlapping in reinforcement is required the bars should, unless otherwise shown on the Drawings, have an overlap of not less than thirty diameters where a U-hook is employed on each of the overlapping bars and forty-five diameters for bars without hooks.

Fabric reinforcement sheets are to overlap by two meshes.

The number, size, form and position of all steel reinforcing bars, ties, links, stirrups and other parts of the reinforcement shall be in exact accordance with the Drawings and they shall be kept in the correct position and with the required cover without displacement during the process of compacting the concrete in place in a manner approved by the Supervisor's Representative. The Contractor shall provide all necessary distance pieces and spacer bars at his own cost to maintain the reinforcement in the correct position. The type of distance pieces shall be subject to the approval of the Supervisor's Representative. Timber blocks for wedging the steel off the formwork shall not be allowed. Any ties, links or stirrups connecting the bars shall be taut so that the bars are properly braced and the inside of hooks and bends shall be in actual contact with the bars around which they are intended to fit. Bars shall be bound together with best black annealed mild steel wire and the binding shall be twisted tight with pliers. The free ends of binding wire shall be bent inwards.

Before any steel reinforcement is embedded in the concrete any loose mill scale, loose rust and any oil, grease or other deleterious matter shall be removed. Partially set concrete which may adhere to the exposed bars during concreting operations shall likewise be removed.

All further working drawings and lists of reinforcement necessary to carry out the Works shall be provided by the Contractor at his own cost.

811 Concrete Classes

The classes of concrete to be used in the Works shall be as shown on the Drawings, Bills of Quantities or as directed by the Supervisor's Representative. For each class of concrete, the

characteristic 28-day crushing strengths, when tested in accordance with the following subsections, shall be as set out in the table below, the 7-day strengths shall be used only as a guide.

Concrete type	Concrete class	Maximum aggregate size [mm]	Characteristic 28 day strength [N/mm ²]	Characteristic 7 day strength [N/mm ²]	Minimum Cement content [kg/m ³]
Mass concrete	20/40	40	20	14	220
	20/20	20	20	14	250
	15/40	40	15	10	200
Blinding concrete	10/40	40	N/A	N/A	150

The term characteristic strength means the value of the strength of concrete below which not more than 5 per cent of the test results fall.

The characteristic strengths specified above are for concrete cured at a mean temperature between 75 and 23 °F. Should the curing temperature be in excess of the higher values of these ranges, the acceptable cube strength should be increased by an amount to be determined by the Supervisor's Representative.

The actual cement contents and aggregate/cement ratios shall depend on the closeness of control, which the Contractor is prepared to exercise in production and upon the quality of materials used. Where necessary the Supervisor's Representative may impose an upper or lower aggregate/cement ratio, which shall not be exceeded for any class of concrete.

Before any concrete is placed in the Works the Contractor shall submit to the Supervisor's Representative for his approval full details of the mixes he proposes to use for each class of concrete together with their expected average strengths. These mixes shall be based on the results of trial mixes as specified hereafter.

812 Concrete Mix Designs

Preliminary tests are to be carried out jointly by the Contractor and the Supervisor's Representative to determine the mixes, which shall satisfy the Specification with the available materials. These mixes shall be designed with due regard for the workability necessary to allow the Contractor to place and compact the concrete with the equipment he proposes to use in any particular situation.

The mixes shall be designed to have mean strengths that are greater than the specified characteristic cube strengths by a margin of 1.64 times the standard deviation expected from the concreting plant. The standard deviation shall be calculated from at least 40 individual cube results each representing separate batches of similar concrete produced by the same plant and under the same supervision except that no standard deviation less than 3.5 N/sq.mm shall be used as a basis for designing a mix. In the absence of such previous information, a standard deviation of 7 N/sq.mm shall be used for initial mix design purposes. It is assumed that the same standard deviation applies to both the 7 day and 28 day strengths.

813 Trial mixes

Unless there are existing data showing that the proposed mix proportions shall produce the grade of concrete required with adequate workability for full compaction by the method to be used in production, trial mixes shall be prepared under full scale conditions and tested in accordance with B.S. 1881 "Methods of testing concrete". Trial mixes shall also be made subsequently whenever a change is intended in materials or in the proportions of the materials to be used. Representative samples of the materials to be used shall be taken and three trial mixes using the proposed proportions shall be made on different days. The workability of each of these three mixes shall be determined and a batch of six cubes from each mix shall be made, three for tests at 7 days and three for tests at 28 days. The Supervisor's Representative shall normally approve the proposed mix proportions provided the average strength of the three trial mixes is not less than the designed mean strength minus the designed standard deviation and subject to the conditions noted below. Further trial mixes shall be made if the range of strength that is the maximum minus the minimum, of the three cube results in any batch exceeds 15% of the average of that batch, or if the range of the three batch averages exceeds 20% of the overall average of the batches.

814 Mixing Concrete by Machine

The concrete is to be mixed in machines of the batch mixing or other approved type. The machines are to ensure that all the concreting materials including the water are thoroughly mixed together between the time of their deposition in the mixer and before any portion of the mixture is discharged. The machines must be capable of discharging their contents while running. No hand mixing shall be permitted. Mixing shall continue until there is a thorough distribution of the materials, and the mass is of uniform colour and consistency.

814.1 Central-mix plant

Dispense liquid admixtures through a controlled flow-meter.

Use dispensers with sufficient capacity to measure, at one time, the full quantity of admixture required for each batch. If more than one admixture is used, dispense each with separate equipment.

Charge the coarse aggregate, one third of the water, and all air entraining admixture into the mixer first, then add remainder of the material.

Mix for at least 50 seconds. Begin mixing time after all cement and aggregate are in the drum. Add the remaining water during the first quarter of the mixing time. Add 4 seconds to the mixing time if timing starts the instant the skip reaches its maximum raised position. Transfer time in multiple-drum mixers is included in mixing time. Mixing time ends when the discharge chute opens.

Remove the contents of an individual mixer before a succeeding batch is charged into the drum.

814.2 Truck mixer

Do not use mixers with any section of the blades worn 25mm or more below the original manufactured height.

Do not use mixers and agitators with accumulated hard concrete or mortar in the mixing drum.

Add admixtures to the mix water before or during mixing.

Charge the batch into the drum so a portion of the mixing water enters in advance of the cement.

The entire contents of the drum shall be discharged before materials for the next batch are fed in. Should there, for any reason, be a stoppage of greater than 30 minutes duration, the drum of the mixer shall be thoroughly washed out with clean fresh water before mixing is resumed.

815 Works Test

Test cubes shall be made, cured, stored, transported and tested in compression in accordance with B.S. 1881 "Methods of testing concrete". The method of compacting cubes by vibration shall be subject to the approval of the Supervisor's Representative.

815.1 Sampling and testing

A sample of concrete shall be taken at random on eight separate occasions during each of the first five days of using a mix. Thereafter a sample shall be taken from at least 4% of the batches made, and in any case at least one sample shall be taken each day of concrete of each grade made. The number of samples per day and the times, which they shall be taken shall be varied at random or as directed by the Supervisor's Representative.

From each sample, two cubes shall be made for testing at 28 days and one for testing at 7 days for control purposes.

To ensure that the mix proportions are suitable for a particular grade of concrete 28-day test cube results shall satisfy the four conditions given below.

The works test 28-day cube results shall be examined both individually and in consecutive (but not overlapping) sets of four, for which the average and the range of each set shall be calculated. The mix proportions shall be modified to increase the strength if, in the first ten consecutive (but not overlapping) sets, any of the following conditions are not satisfied:

- not more than two individual results of the 40 cube tests shall fall below the specified characteristic cube strength,
- no value of the range in any set shall exceed 3.2 times the designed standard deviation,
- no value of the average of any set shall be less than the specified characteristic strength plus the designed standard deviation, and
- not more than one set shall have an average which is less than the specified characteristic strength plus 1.3 times the standard deviation

After ten consecutive sets of results have been obtained, the overall average and the standard deviation of the 40 results shall be calculated and any appropriate modifications made to the mix proportions. Subsequently, if any of the foregoing conditions do not apply to the individual results or the sets of four, the overall average and the standard deviation of the previous consecutive 40 results, including the non-complying set shall be calculated. If the overall average

strength minus 1.6 times the standard deviation is less than the specified characteristic works cube strength, then the mix proportions shall be modified.

816 Additional Cube Tests

In addition to the works test cube described above the Supervisor's Representative may order additional cubes to be made for the following purposes: to determine the strength of concrete at the time of stripping moulds; and to determine the duration of curing or to check testing errors.

817 Test Failure

Should any works test cube fail to attain the specified strength, an immediate examination shall be made to find the cause of the failure and a report sent to the Supervisor's Representative's Representative who shall take suitable action which may be one of the following:

- He may order the concrete corresponding to the cubes to be cut out and replaced in accordance with Article 42 of the Conditions of Contract.
- When the failure relates to concrete used in structural members, which lend themselves to being load tested such as beams, columns or slabs, the Supervisor's Representative, may order the affected member to be so tested in accordance with his instructions. If cracking or any other sign of failure appears, the concrete shall be cut out to the extent ordered by the Supervisor's Representative and replaced with sound material. Otherwise, the member may be accepted as satisfactory.
- When the failure, in the opinion of the Supervisor's Representative's Representative, is slight and occurs in a continuing concreting operation for a large mass of concrete, the next works test result may be awaited and, if the failure then persists, the Supervisor's Representative's Representative may order that concreting shall cease forthwith and not be resumed until further preliminary tests indicate that the mix has been corrected. Otherwise the concreting may be allowed to continue with the same mix.
- When the failure is serious and relates to a concrete mass, which lends itself to it, the Supervisor's Representative's Representative may order one or more test cylinders to be drilled out and tested in accordance with B.S. 1881. According to the result of these tests, the Supervisor's Representative may order the suspected concrete to be cut out and replaced in accordance with Clause 39 of the Conditions of Contract.

The cost of these tests including the provisions and placing of jacks, kentledge, deflectometers, etc., and the cutting out and replacing of concrete of inferior quality shall be borne by the Contractor if the test results show the concrete not to be in accordance with the Specification.

818 Workability

The concrete shall be of such consistency that it can be readily transported, placed and compacted in the Works without segregation of the materials. The resulting concrete shall be uniform and free from honeycombing.

Where necessary and before the mixes are approved the Contractor shall supply a section of formwork complete with reinforcement fixed in position and generally representative of the sections comprising the Works. This formwork shall be filled with concrete produced for the trial mixes and compacted in the same manner and with the same equipment to be used on the Works. The appearance of the concrete after striking the formwork shall be to the satisfaction

of the Supervisor's Representative who may otherwise require the mix to be modified and further batches of concrete made and tested as before.

A simple and convenient system of varying the water released into each batch must be installed with graduated gauges fixed to the supply tanks, which can be set by the Supervisor's Representative. The method of releasing the water into the mixer shall be such that the full measured quantity is discharged in one operation and the flow is stopped by an automatic valve or siphon arrangement only when the full quantity of water has been released. No arrangement, which permits the discharge of partial quantities of water at the discretion of the mixer driver, shall be allowed.

The Contractor shall be required to have an accurate knowledge of the moisture content of all sand and coarse aggregate as they reach the mixer and he shall make such adjustments to the mix as are necessitated by change in the moisture content of all aggregates.

819 Consistency

The Contractor shall carry out slump, compaction factor or other workability tests as required during concreting of permanent works in order to relate the degree of workability of the mix with the numerical value obtained during the trial mixes.

820 Concrete Return and Records

The Contractor shall send weekly to the Supervisor's Representative return showing the quantities of cement and the number of mixings of each class of concrete used in each section of the Works.

Records shall be kept by the Contractor of the positions in the Works of all batches of concrete, of their class and of all test cubes or other specimens taken from them. Copies of these records shall be supplied to the Supervisor's Representative.

821 Batching

The aggregates and cement shall be proportioned by means of efficient weigh batching machines except when the Supervisor's Representative has approved the use of volume batching. The machines shall be carefully maintained and cleaned and they shall be provided with simple and convenient means of checking the accuracy of the weighing mechanism, and they shall be checked when required by the Supervisor's Representative.

For volume, batching suitable gauge boxes shall be used. Cement shall be taken as weighing 1440 kg/cu.m or such other amount as may be determined by the Supervisor's Representative as a result of tests.

822 Mixing Concrete By Hand

Where it is not possible to employ machine mixing and approval has been obtained from the Supervisor's Representative, concrete shall be mixed by hand as near as practicable to the site where it is to be deposited. Clean mixing bankers or platforms of sufficient area for the proper execution of the work shall be provided. These platforms if constructed of timber shall consist of planks closely jointed so as to avoid the loss of any grout or liquid from the wet concrete.

The whole of the aggregate and cement shall be turned over on the banker in a dry state at least twice. The water shall then be added gradually through a rose head, after which the materials shall again be entirely turned over in a wet state at least three times.

823 Transport of Concrete

The concrete shall be discharged from the mixers and transported to the Works by means which shall be approved by the Supervisor's Representative and which shall prevent contamination, (by dust, rain or other causes) segregation or loss of ingredients. The means of transportation shall ensure that the concrete is of the required workability at the point and time of placing.

824 Placing of Concrete

The concrete shall be placed in the positions and sequences indicated on the Drawings, in the Specification or as directed by the Supervisor's Representative. Except where otherwise directed, concrete shall not be placed unless the Supervisor's Representative or his Representative is present and has previously examined and approved the positioning, fixing and condition of reinforcement and any other items to be embedded and the cleanliness, alignment and suitability of the containing surfaces or formwork.

The concrete shall be deposited as nearly as possible in its final position without re-handling or segregation and in such a manner as to avoid displacement of the reinforcement, other embedded items or formwork. Wherever possible bottom opening skips shall be used. Where chutes are used to convey the concrete, their slopes shall not be such as to cause segregation and suitable spouts or baffles shall be provided where necessary. Concrete shall not be dropped through a greater height than 1200 mm except with the approval of the Supervisor's Representative who may order the use of bankers and the turning over of the deposited concrete by hand before being placed.

Where pneumatic placers are used the velocity of discharge shall be regulated by suitable baffles or hoppers where necessary to prevent segregation or damage and distortion of the reinforcement, embedded items and formwork, caused by impact.

All concreting shall be carried out in sections previously ordered or approved by the Supervisor's Representative and shall proceed continuously in each section until completed and no interval shall be allowed to elapse while the work is in hand.

The concreting shall be carried out in such a way that the exposed faces of concrete shall be sound and solid, free from honeycombing and excrescences. No plastering of imperfect concrete faces shall be allowed. Any concrete that is defective in any way shall, if so ordered by the Supervisor's Representative, be cut out and replaced to such depth or be made good in such manner as the Supervisor's Representative may direct.

Where concrete is required to be placed against undisturbed ground, the entire space between the finished concrete surface and the ground, including any over break, is to be completely filled with concrete of the specified class. The concrete shall be well rammed and compacted to ensure that all cavities are filled and the concrete is everywhere in contact with the ground. Where permitted by the Supervisor's Representative, any extensive patches of over break may first be filled with concrete Class 10/40 as directed to within 100 mm of the payment line.

The Contractor shall be required to furnish the Supervisor's Representative with satisfactory evidence that all preparations, precautions and provisions have been made to ensure that the concrete is placed and compacted in accordance with this Specification before the Supervisor's Representative gives his permission for concreting to proceed.

For members involving "vertical" placing of the concrete (e.g. walls) each lift shall be deposited in layers extending for the full width between shuttering and of such depth that each layer can be easily and effectively incorporated with the layer below by the means of consolidation being employed. The layers shall be placed horizontally, sloping beds not being permitted unless particularly so specified.

For members involving "horizontal" placing of the concrete (e.g. floor and roof slabs) the concrete shall be placed along the line of the starting point in such quantities as shall allow the member to be cast to its full depth along the full width between side shuttering and then gradually brought towards the finishing point along its entire front, parallel to the starting line. The tampers for giving the required surface and compaction shall follow as closely behind as practicable.

All members shall be concreted at such a rate as shall eliminate any possibility of fresh batches of concrete being deposited immediately adjacent to batches which have commenced to set, and all members shall be poured in one continuous operation until completed; no interval being allowed to lapse while the work is in hand.

Care shall be taken to ensure that the process of placing concrete does not cause any harmful vibration to adjacent work that has hardened insufficiently.

Should any unforeseen occurrence result in a stoppage of concreting for such a time as might allow the concrete already in place to begin to set before the next batches can be consolidated in place the Contractor shall immediately insert, at this own cost, a proper end-shutter to form a proper tongue and groove construction joint, as specified normal to the work at that point which shall ensure that the section already cast is formed completely in accordance with this Specification. Any additional reinforcement required as a result of the joint shall be provided by the Contractor at his own expense.

Large, exposed (horizontal) concrete surfaces may require protection from the direct rays of the sun or other adverse weather effects. The Contractor shall take all reasonable precautions to protect the concrete surfaces in accordance with these specifications, or as approved by the Supervisor's Representative. Failure to protect such surfaces may result in rejection of the work by the Supervisor's Representative.

Consolidation of the concrete shall be affected by either hand or mechanical means and all consolidating tools must be approved by the Supervisor's Representative before being used in the Works.

The concrete shall be worked well up against whatever surface it adjoins and consolidated to such a degree that it reaches its maximum density as a homogenous mass, free from air and water holds, and penetrates to all corners of the mould and shuttering and completely surrounds the reinforcement.

Care shall be taken to ensure that neither hand tampers or mechanical vibrators come into contact with the formwork, reinforcement, or any embedded fittings and to prevent the operation of consolidation from transmitting any harmful vibrations or shocks to concrete which has not yet hardened sufficiently.

Compliance with the conditions of this Clause may require working longer hours than usual and the Contractor must allow for this in his program for concreting and in the rates for the work inserted by him in the Bill of Quantities.

825 No Partially Set Material to Be Used

All concrete must be placed and compacted in its final position within 30 minutes of discharge from the mixer unless otherwise approved. No partially set material shall be used in this work.

826 Compaction of Concrete

The concrete shall be fully compacted throughout the full extent of the layer and shall be brought up in level layers of such depth that each layer is incorporated readily and properly with the layer below with the use of internal vibrators or by spading, slicing or ramming. It shall be thoroughly worked against formwork and around any reinforcement or embedded items without displacing them.

827 Vibration of Concrete

Except where otherwise permitted by the Supervisor's Representative, concrete shall, during placing, be compacted by hand held vibrators of a type to be approved by the Supervisor's Representative. The vibrators shall be suitable for continuous operation. The vibrators shall be disposed in such a manner that the whole of the mass under treatment shall be adequately compacted at a speed commensurate with the supply of concrete from the mixers. Vibration is to continue until the concrete being placed is fully compacted and all air bubbles have been expelled. Care must be taken that segregation of mortar and aggregate by excessive vibration is avoided.

Vibration is not to be applied directly, or through the reinforcement, to sections or masses of concrete, which have hardened or after the initial set has taken place. Vibration must not be used to make the concrete flow in the formwork to cause segregation.

828 Concreting in Adverse Weather

No concreting shall be allowed to take place in the open during storms or heavy rains. Where strong winds are likely to be experienced, additional precautions to ensure protection from driving rain and dust shall also be taken. The Supervisor's Representative may withhold approval of commencement of concreting until he is satisfied that full and adequate arrangements have been made.

The concrete shall be worked well up against whatever surface it adjoins and consolidated to such a degree that it reaches its maximum density as a homogenous mass, free from air and water holds, and penetrates to all corners of the mould and shuttering and completely surrounds the reinforcement.

Care shall be taken to ensure that neither hand tampers or mechanical vibrators come into contact with the formwork, reinforcement, or any embedded fittings and to prevent the operation of consolidation from transmitting any harmful vibrations or shocks to concrete which has not yet hardened sufficiently.

Compliance with the conditions of this Clause may require working longer hours than usual and the Contractor must allow for this in his program for concreting and in the rates for the work inserted by him in the Bill of Quantities.

829 Concreting at Night or in the Dark

Where approval has been given to carry out concreting operations at night or in places where day- light is excluded, the Contractor is to provide adequate lighting at all points where mixing, transportation and placing of concrete are in progress.

830 Concreting in High Ambient Temperature

Where the ambient shade temperature exceeds 32 °C, the Contractor shall take special measures in the mixing, placing and curing of concrete. The temperature of the concrete when deposited shall not exceed 30 °C. The Contractor shall carry out all necessary special measures to ensure that the maximum concrete temperature after placing shall not exceed 50 °C or 30 °C above the concrete temperature at the time of placing whichever is the lower.

During placing, suitable means shall be provided to prevent premature stiffening of the concrete placed in contact with hot surfaces.

831 Curing and Protection

Concrete shall be protected during the first stage of hardening from the harmful effects of sunshine, drying winds, cold, rain or running water. The Contractor shall pay particular attention to the need to protect concrete immediately after the finishing operation and prior to its final set and shall submit his proposals to achieve this protection for the Supervisor's Representatives approval. Protection of concrete which has achieved its final set shall consist of one or more of the following:

- A layer of sacking, canvas, hessian, straw mats or similar absorbent material or a layer of sand, kept constantly moist by spraying with water as necessary for 7 days or such periods as may be directed by the Supervisor's Representative;
- After thoroughly wetting, a layer of approved waterproof paper or plastic membrane kept in contact with the concrete for 7 days or such period as may be directed by the Supervisor's Representative;
- Except in the cases of surfaces to which concrete has subsequently to be bonded, an approved liquid curing membrane at a rate specified by the manufacturer. On horizontal surfaces, the curing membrane shall be applied immediately after placing the concrete and on vertical surfaces immediately after removing the formwork.
- The use of saline water for curing purposes shall not be permitted.

832 Concrete Placed Under Water

Concrete shall be placed under water only where particularly so specified and approved by the Supervisor's Representative. The quantity of cement in any concrete placed under water shall be increased by at least 25% above the cement content of the appropriate approved mix. Concrete shall be placed in still water only and every precaution shall be taken to prevent the cement and fine materials from being washed out of the concrete. Concrete shall be placed either with a 'tremie' or a bottom-opening box of a type approved by the Supervisor's Representative.

Bottom opening boxes shall not be opened until they are resting on the work and the lower ends of 'tremie' pipes shall always be kept below the surface of the wet concrete already deposited.

No concrete shall be allowed to fall through water at any time. Concrete shall be placed evenly over the whole area closed by the shuttering and must not be raked over, only the minimum of screeding being allowed once the concrete has been placed.

833 Construction Joints

Concreting shall be carried out continuously up to construction joints, the position and arrangement of which shall be as indicated on the Drawings or as previously approved by the Supervisor's Representative. The Contractor is to allow for working beyond the ordinary working hours where necessary in order that each section of concrete may be completed without any lapse while the work is in hand. All construction joints are to be formed square to the work. Keyways are to be formed in all horizontal and vertical construction joints except where ordered to be omitted by the Supervisor's Representative.

Surfaces against which further concrete is to be placed shall be prepared as early as possible after casting. This preparation shall be carried out preferably when the concrete has set but not hardened by jetting with a fine spray of water or brushing with a stiff brush, just sufficient to remove the outer mortar skin and to expose the larger aggregate without its being disturbed. Where this treatment is impracticable and work is resumed on a surface, which has set, the whole surface shall be thoroughly roughened or scabbled with suitable tools so that no smooth skin of concrete that may be left from the previous work is visible. These roughened surfaces shall be thoroughly cleaned by compressed air and water jets or other approved means, brushed, and watered immediately before depositing concrete. If so ordered, the roughened surface shall be covered with cement mortar prior to placing the new concrete.

834 Movement Joints

834.1 General

Movement joints shall be formed as shown on the Drawings to permit relative movement between adjacent parts of a concrete structure, special provision being made where necessary for maintaining the water tightness of the joint. Movement joints shall include contraction joints, expansion joints, sliding joints and other special joints as may be detailed on the Drawings. The Contractor shall ensure that there is no obstruction to free movement, which the joints are intended to provide. The concrete surfaces shall be plane and smooth.

834.2 Jointing Materials

Joints shall be provided with water stops, joint fillers, sealing compound, bond-breaking compound and other jointing materials as specified or detailed on the Drawings. All such materials shall be as approved by the Supervisor's Representative and their installation shall be strictly in accordance with the manufacturer's instructions. If required by the Supervisor's Representative, the Contractor shall demonstrate that the jointing materials can be applied satisfactorily.

834.3 Contraction Joints

Contraction joints shall be treated to prevent bond between joint surfaces by the application of two coats of an approved bond-breaking paint to the joint surface first constructed and allowing the paint to dry before placing new concrete against it.

834.4 Expansion Joints

A separating strip of preformed durable resilient joint filler shall form expansion joints, which shall be continuous through the joint. No broken pieces of joint filler shall be used.

Where dowel bars are to be incorporated in expansion joints as shown on the Drawings, they shall be round mild steel bars of the diameter and length indicated. The capped end of the dowel bar shall be sawn square and bar cropping, shall not be permitted. The capped section of the bar shall be painted with two coats of an approved bond-breaking paint. The cap shall be of such a diameter as to provide a sliding fit on the bar and of length indicated on the Drawings. The cap shall be partially filled with an approved compressible filler.

834.5 Sealing Compound

Grooves shown on Drawings at the edges of joints for the placing of sealing compound shall be accurately formed. The sealing compound shall be stored, mixed and applied strictly in accordance with the manufacturer's instructions. Bituminous joint sealants shall be Plastic (for horizontal joints) and Plastijoint (for vertical joints). Polysulphide sealants shall be two part polysulphide sealants complying with BS 4254 "Two - part Polysulphide based Sealants for the Building Industry".

835 Preformed Expansion Joints

835.1 Part 1 – General

The work shall consist of furnishing and installing waterproof expansion joints in accordance with the details shown on the plans and the requirements of the specifications. Preformed sealant shall be silicone pre-coated, pre-compressed, self-expanding, sealant system.

Submittals

Standard Submittal Package – Submit typical expansion joint drawing(s) indicating pertinent dimensions, general construction, expansion joint opening dimensions and product information.

Sample of material is required at time of submittal.

All products must be certified by independent laboratory test report to be free in composition of any waxes or wax compounds using Fourier Transform Infrared Spectroscopy (FTIR) and Differential Scanning Calorimetry (DSC) testing.

All products shall be certified in writing to be: a) capable of withstanding 150°F (65°C) for 3 hours while compressed down to the minimum of movement capability dimension of the basis of design product (-25% of nominal material size) without evidence of any bleeding of impregnation medium from the material; and b) that the same material after the heat stability test and after first being cooled to room temperature shall subsequently self-expand to the maximum of movement capability dimension of the basis-of-design product (+30% of nominal material size) within 24 hours at room temperature 68°F (20°C).

Product Delivery, Storage and Handling

Deliver products to site in Manufacturer's original, intact, labeled containers. Handle and protect as necessary to prevent damage or deterioration during shipment.

Handling and storage. Store in accordance with manufacturer's installation instructions.

Quality Assurance

The General Contractor shall conduct a pre-construction meeting with all parties and trades involved in the treatment of work at and around expansion joints including, but not limited to, concrete, masonry, mechanical, electrical, plumbing and other finish trade subcontractors. All superintendents and foremen with responsibility for oversight and setting of the joint gap must attend this meeting. The General Contractor is responsible to coordinate and schedule all trades and ensure that all subcontractors understand their responsibilities in relation to expansion joints and that their work cannot impede anticipated structural movement at the expansion joints, or compromise the achievement of water tightness or life safety at expansion joints in any way.

Warranty – Manufacturer's standard warranty shall apply.

BREEAM Building Performance Requirements: The volatile organic compound (VOC) of the silicone must not exceed 50 grams/liter.

835.2 Part 2 – Product

Provide preformed, pre-compressed, self-expanding, sealant system with dual silicone pre-coated surface, water tight primary seal for expansion joints isolation joints in floors, between columns and walls as indicated on drawings designated expansion joint locations.

Sealant system shall be comprised of three components: 1) cellular polyurethane foam impregnated with hydrophobic 100% acrylic, water-based emulsion, factory coated on both faces with water-resistant silicone; 2) field-applied epoxy adhesive primer, 3) field-injected silicone sealant bands.

Material shall be capable as a dual seal of movements of +30%, -25% (55% total) of nominal material size. Standard sizes from 1/2" (12mm) to 12" (300mm). Depth of seal as recommended by manufacturer or customized as shown on details.

Silicone coating to be water/moisture resistant silicone applied to the impregnated foam sealant at a width greater than maximum allowable joint extension and which when cured and compressed shall form a bellows on two faces.

The preformed expansion joint is to be installed into manufacturer's standard field-applied epoxy adhesive.

The preformed expansion joint is to be installed slightly recessed from the surface such that when the field applied injection band of silicone is installed between the substrates and the foam and silicone bellows, the system shall be essentially flush with the substrate surface.

Select the sealant system model appropriate to the movement and design requirements at each joint location that meet the project specification or as defined by the Supervisor's Representative.

Manufacturer's Checklist must be completed by expansion joint subcontractor and returned to manufacturer at time of ordering material.

Fabrication

The preformed expansion joint must be supplied recompressed to less than the joint size, packaged in shrink-wrapped lengths (sticks).

Directional changes and terminations into horizontal plane surfaces to be provided by factory-manufactured universal-90-degree single units containing minimum 12-inch long leg and 6-inch long leg or custom leg on each side of the direction change or through field fabrication in strict accordance with installation instructions.

835.3 Part 3 – Execution

Installation

Preparation of the Work Area

The contractor shall provide properly formed and prepared expansion joint openings constructed to the exact dimensions and elevations shown on manufacturer's standard system drawings or as shown on the contract drawings. Deviations from these dimensions shall not be allowed without the written consent of the Supervisor's Representative.

The contractor shall clean the joint opening of all contaminants immediately prior to installation of expansion joint system. Repair spalled, irregular or unsound joint surfaces using accepted industry practices for repair of the substrates in question. Remove protruding roughness to ensure joint sides are smooth. Ensure that there is sufficient depth to receive the full depth of the size of the preformed expansion joint being installed. Refer to Manufacturers Installation Guide for detailed step-by-step instructions.

No drilling, or screwing, or fasteners of any type are permitted to anchor the sealant system into the substrate.

System to be installed by qualified sub-contractors only according to detailed published installation procedures and/or in accordance with job-specific installation instructions of manufacturer's field technician.

Clean and Protect

Protect the system and its components during construction. Subsequent damage to the expansion joint system shall be repaired at the general contractor's expense. After work is complete, clean exposed surfaces with suitable cleaner that shall not harm or attack the finish.

836 Expansion Joint and Access Cover System

836.1 Part 1 – General

Work Included

The work shall consist of furnishing and installing waterproof expansion joints for floor to floor application in accordance with the details shown on the plans and the requirements of the specifications therein. The expansion joint and access cover system shall be of typical wing seal design attached with elastomeric concrete header and other systems attached with thixotropic, non-sag epoxy or structural sealants that provide moisture protection at the expansion joint.

Submittals

Standard Submittal Package – Submit typical expansion joint and access cover system drawing(s) indicating pertinent dimensions, general construction, expansion joint opening dimensions and product information.

Sample of material is required at time of submittal.

All products must be certified by independent laboratory test report to be free in composition of any waxes or wax compounds using FTIR and DSC testing.

The epoxy or structural sealant should be flexible at temperatures as low as 20°F (-29°C) and retain its properties at temperatures as high as 300°F (149°C) in intermittent exposure.

Product Delivery, Storage and Handling

Deliver products to site in Manufacturer's original, intact, labeled containers. Handle and protect as necessary to prevent damage or deterioration during shipment, Handling and storage. Store in accordance with manufacturer's installation instructions.

Quality Assurance

Warranty – Manufacturer's standard warranty shall apply for all components and parts thereof for the expansion joint and access cover system.

836.2 Part 2 – Product

General

Provide wing seal designed expansion joint and access cover system with thixotropic epoxy sealant, for all floor to floor joint applications both internally (within floor levels) and external (on exposed roof slab surface), as indicated on drawings designated expansion joint locations.

The wing seal expansion joint and access cover is to be installed into manufacturer's standard field-applied epoxy adhesive.

Manufacturer's Checklist must be completed by expansion joint and access cover subcontractor and returned to manufacturer at time of ordering material.

836.3 Part 3 – Execution

Installation

Preparation of the Work Area

The contractor shall provide properly formed and prepared expansion joint openings constructed to the exact dimensions and elevations shown on manufacturer's standard system drawings or as shown on the contract drawings. Deviations from these dimensions shall not be allowed without the written consent of the Supervisor's Representative.

The contractor shall clean the joint opening of all contaminants immediately prior to installation of expansion joint and cover access system. Repair spalled, irregular or unsound joint surfaces using accepted industry practices for repair of the substrates in question. Remove protruding roughness to ensure joint sides are smooth. Ensure that there is sufficient depth to receive the full depth of the size of the preformed expansion joint being installed. Refer to Manufacturers Installation Guide for detailed step-by-step instructions.

No drilling, or screwing, or fasteners of any type are permitted to anchor the sealant system into the substrate.

System to be installed according to detailed published installation procedures and/or in accordance with job-specific installation instructions of manufacturer's field technician.

Clean and Protect

Protect the system and its components during construction. Subsequent damage to the expansion joint system shall be repaired at the general contractor's expense. After work is complete, clean exposed surfaces with suitable cleaner that shall not harm or attack the finish.

837 Preparation of Surfaces to Receive Concrete

Before concrete for reinforced concrete work is deposited on a foundation of soft ground, a screed of blinding concrete Class 10/40 of 75 mm minimum thickness shall be placed over the

ground below the underside level of the reinforced concrete to form a hard even surface on which to construct the latter.

Immediately before depositing concrete on or against a surface of masonry, brickwork, old concrete or the like, the following preparation shall be done. All loose material shall be removed and the surface washed down; all seepages of water emerging at the surfaces shall be stopped as far as possible, or suitably channeled or piped away from the work. On upward facing horizontal or near horizontal surfaces a layer of 2:1 sand-cement mortar is to be spread over the surface of the section to be concreted if so directed by the Supervisor's Representative.

838 Formwork for Non-Exposed Concrete Surfaces

Unless otherwise stated on the drawings, rough formwork may be used for all surfaces, which are not permanently exposed. Rough formwork may be constructed of plain butt-joined sawn timber but the Contractor shall ensure that all joints between boards shall be grout-tight. The finished surface shall be within the tolerances specified and full cover to reinforcement steel shall be maintained.

839 Preparation of Formwork for Concreting

Before concrete is placed, the formwork shall be thoroughly cleaned and freed from sawdust, shavings, dust or other debris. Temporary openings shall be provided to assist in removal of the rubbish.

After cleaning, the formwork shall be coated with an approved release agent, which shall not be allowed to run on to reinforcement, other embedded steelwork or concrete at any construction joint.

All formwork shall be inspected and approved by the Supervisor's Representative before concrete is placed in it, though this shall not relieve the Contractor from the requirements as to soundness, finish and tolerances of the concrete specified elsewhere.

840 Removal of Formwork

Formwork shall be removed in such a manner as shall not damage the concrete. No formwork shall be removed until the concrete has gained sufficient strength to support itself. Centers and props may be removed when the member being supported has gained sufficient strength to carry itself and the load to be supported on it with a reasonable factor of safety. Table 2 is a guide to the minimum periods, which must elapse, between the completion of the concreting operations and the removal of formwork. No formwork shall be removed without the permission of the Supervisor's Representative and such permission shall not relieve the Contractor of his responsibilities for the safety of the structure.

Minimum stripping and striking times shall be as follows unless otherwise approved by the Supervisor's Representative.

Table 2: Minimum Periods for the Removal of Formwork for Concrete works

	Ordinary Portland Cement Concrete	Rapid Hardening Portland Cement Concrete
	<u>Normal weather Hours</u>	<u>Normal weather Hours</u>
Vertical surfaces	10	8
Vertical wall surfaces under 300 mm thick	30	20
Beam sides and columns	30	20
	<u>DAYS</u>	<u>DAYS</u>
Slabs (props left under)	7	4
Removal of props to slabs	14	4
Beam soffits (props left under)	7	4

841 Cover to Reinforcement

The concrete cover to reinforcement shall be in accordance with the relevant British Standard Code of Practice or as shown on the Drawings.

The Contractor shall provide any necessary cement pads for ensuring the cover is attained and in no case shall timber packing be used.

842 Concrete Surface Finish

The concrete surface finish on upward facing horizontal or sloping faces shall be, except for blinding concrete or otherwise stated on the drawings, a "fair" surface. A "fair" surface shall be obtained by screeding and trowelling with a wood float.

Screeding shall be carried out, following compaction of the concrete, by the slicing and tamping action of a screed board running on the top edges of the formwork or screeding guides to give a dense concrete skin true to line and level.

Wood float trowelling shall be carried out after the concrete has stiffened and the film moisture has disappeared. Working should be kept to a minimum compatible with a good finish and the surface shall be true to the required profile to fine tolerance. Whenever necessary the Contractor shall provide and erect overhead covers to prevent the finished surface from being marred by raindrops or dripping water.

The surface of blinding concrete shall be that obtained by screeding as described above.

Where a "fine" surface is indicated upon the drawings this shall be obtained in a similar manner to "fair" surface save that a steel float shall be used in lieu of the wood float.

843 Monolithic Surface Hardening Compound Finish

The concrete surface finish for ground, first and second floor areas; staircase steps and landing and ramp surfaces shall be finished with a hardwearing monolithic surface hardening compound

using the dry shake method of application to ensure wearing surface bonds monolithically, to the base concrete.

All base slab concrete areas so designated shall be applied with monolithic hard wearing, abrasion resistant floor hardener tested to BS 6431-Part 20 (Wet Abrasive Method).

Typical properties for this monolithic hard wearing compound finish shall include testing to ASTM.D 4060 – Taber Abrader and BS 6431 – Part 20 (Wet Abrasive Method), alongside concrete mortar control panels. Other specific properties include:

Mohs Hardness	:	>6
Specific Gravity	:	3.1
Corrosive Elements	:	None
Sieve Analysis		
# 8 (2.5mm)	:	>98% passing
#30 (0.5mm)	:	< 5% passing

The base concrete should have a minimum cement content of 300kg/m³. The concrete mix should be designed to minimize segregation and bleeding. Free water: cement ratios of less than 0.55 are required. The concrete should have a slump of between 75 and 100mm. The base concrete should be laid and compacted in accordance with good concrete practice. Accurate finished profile and minimum laitance build up should be ensured. Particular attention should be paid to bay edges and corners to ensure full compaction. Vacuum dewatering is not recommended.

Upon application of the monolithic hardening compound very strict control is to be maintained to ensure that the correct quantity, dosage and curing technique is used at all times.

844 Concrete Surface Acrylic Sealer

The concrete surface finish for ground, first and second floor areas; staircase steps and landing and ramp surface finishes shall be sealed with a clear acrylic resin solvent based solution designed to provide a non-degrading in surface polymer seal which ultimately harden, seal and dustproof the concrete hardened finished surface, as per Clause 542.

The Sealer coat can be applied immediately after final finishing of the concrete and does not require to be removed from the surface of concrete prior to overcoating. The sealer shall provide 75% curing efficiency to BS 7542 or ASTM C309 standard when applied at 6 m²/litre.

Typical properties of the sealer shall be as follows:

Drying time at 20°C	
Touch Dry	2-4 hours
Fully Cured	24 hours
Form	Liquid
Colour	Clear
Specific Gravity	0.88
Curing Efficiency	75%
(ASTM C309)	(applied at 6m ² /litre)

The acrylic sealer shall be spray applied onto concrete immediately after surface finishing is completed. On large areas the spray operation should follow closely behind the finishing. Ensure there is no standing or free water on the concrete surface. Application is best carried out using low pressure spray equipment using a fine mist spray in a hollow fan pattern. The acrylic resin based sealer shall be sprayed directly on the fresh concrete surface in a single coat, using a back pack sprayer or for larger areas a powered barrel spray unit is recommended.

Upon application of the acrylic resin based sealer very strict control is to be maintained to ensure that the correct quantity, dosage and curing technique is used at all times.

845 Precast Concrete

Concrete members specified to be fabricated as precast concrete units shall be fabricated with concrete of the specified class placed into a grout-tight mould. If so required the mould shall be laid on a vibrating table and vibration applied while the concrete is placed.

Permanently exposed surfaces shall have a finish obtained by casting the unit in properly designed moulds of closely jointed wrought boards or steel or other suitable material. The surface shall be improved by carefully removing all fins and other projections, thoroughly washing down and filling the most noticeable surface blemishes with a cement and fine aggregate paste matching the colour of the concrete.

Surfaces which shall subsequently receive grout or concrete to complete a structural connection or other composite structural component of which the precast unit forms a part, shall be prepared as early as possible after casting. This preparation shall be carried out preferably when the concrete has set but not hardened by jetting with a fine spray of water or brushing with a stiff brush, just sufficient to remove the outer mortar skin and to expose the larger aggregate without its being disturbed. Where this treatment is impracticable, sand blasting or a needle gun should be used to remove the surface skin and laitance. Hacking is to be avoided.

With the approval of the Supervisor's Representative, the Contractor may be permitted to precast members, which were specified to be constructed in situ. In such cases, the Contractor shall carry out the work as described above but payment shall be made in the manner appropriate to the method of construction originally specified. Generally, members, which are structurally dependent on a rigid fixing with the adjoining structures, shall not be permitted to be constructed by pre casting.

Precast units shall be jointed with cement mortar as specified in Clause 448 hereof or other cement-sand proportions as shown on the Drawings, or as may be directed by the Supervisor's Representative, but mixed as dry as possible so that it is only "earth moist". The mortar shall be packed in layers between the units with steel tools until the whole of the joint is solidly filled and the exposed surfaces of the joint shall be raked out to a depth of 5 mm. and flush pointed with similar mortar but of pointing consistency.

846 Supply of Precast Concrete Units

The Contractor shall be permitted to obtain precast concrete units from outside suppliers provided that they comply with the Specification and that the Contractor obtains the Supervisor's Representative's approval for each supplier.

847 Handling and Stacking of Precast Units

The Contractor is to give the Supervisor's Representative full details of his proposed methods of handling and stacking precast concrete beams and units. The Supervisor's Representative shall examine these details and shall approve either the methods or order modifications designed to ensure that no excessive stresses are set up in the beams or units. The finally approved methods are to be adhered to at all times and the Contractor shall be deemed to have included in his rates for all measures required to handle and stack beams and units safely and without undue stressing.

848 Tolerances

Concrete work shall be executed to the tolerances specified below:

Maximum departure from horizontal position:	25mm
Maximum departure from vertical position:	25mm
Maximum surface tolerance – gradual:	12mm in 2m
Maximum surface tolerance - abrupt:	6mm
Maximum departure in dimension:	-3mm +6mm

Reinforcement bar spacing shall not deviate by more than 25mm from the specified spacing.

Cover to reinforcement shall be not less than the amount specified, and not more than 10mm more than the amount specified.

849 Cement Grout

Cement grout for general purposes shall consist of Portland cement and water mixed in the proportion of one part by volume of cement and one and a half parts by volume of water. The grout shall be used within one hour of mixing.

850 Cement Mortars

Cement mortar shall be unless otherwise specified, consist of three parts of sand to one part of Ordinary Portland cement mixed and thoroughly incorporated together. Cement lime mortar shall, unless otherwise specified, consist of three parts of sand to one part of a mixture comprising one part of cement to one part of hydrated lime. In each mortar just enough water shall be added to give a workability appropriate to its use. The above proportions are by volume. Mortar shall be used whilst freshly mixed and no softening or re-tempering shall be allowed.

851 Dry Mix Concrete

Should the Contractor wish to use dry mix concrete for any sections of the Work, he shall submit his proposals to the Supervisor's Representative for his approval. The Contractor must satisfy the Supervisor's Representative that the method he proposes to use shall produce a finished concrete of the specified strength and density.

900 BLOCKWORK & MASONRY

901 Precast Concrete Blocks

Precast concrete blocks shall be manufactured to BS 6073.

Blocks shall be either hollow or solid and the thickness of the blocks shall be as indicated in the Drawings. The blocks shall have minimum compressive strength of 3.5. N/mm².

All blocks shall have a dense, even surface and a density of not less than 1700 kg/m³.

The Contractor shall submit samples of blocks for every batch brought to the Site to the Supervisor's Representative for approval. The Contractor shall arrange strength tests required by the Supervisor's Representative to be executed by a testing authority approved by the Supervisor's Representative.

902 Mortar

Mortar for both masonry and blockwork shall be cement mortar consisting of one part of ordinary Portland cement complying to BS 12 to four parts of sand by volume, mixed with just sufficient water to make the mixture workable. No lime shall be added to the mortar.

Natural sand shall be used in cement mortar unless otherwise approved. The sand shall be obtained from sources approved by the Project.

Plasticisers, air entraining agents or other additives may be used in the mortar subject to the approval of the Supervisor's Representative.

903 Storage of Materials

Blocks shall be loaded and unloaded by hand and not tipped, and shall not be used until 4 weeks after casting unless otherwise approved by the Supervisor's Representative.

All blocks shall be handled carefully from manufacture to laying and properly stacked in position convenient for the work. They shall be kept free from standing water and protected from rain, mud and contamination by other materials.

Sand shall be stored separately on clean hard dry standing and protected from contamination.

Cement shall be stored off the ground under cover and away from damp, and in such a manner as to enable it to be used in rotation in order of delivery and in accordance with the requirements of Clause "Concrete Work ", sub-clause "Supply".

904 Mortar Mixing

All materials shall be accurately gauged by gauge boxes and mechanically mixed to a uniform consistency. Mortars shall be used within 1 hour of the addition of cement after which they shall be discarded. Re-tempering of mortar shall not be permitted, gauge boxes and mixers shall be kept clean.

905 Blockwork

All blockwork unless otherwise specified shall comply with the recommendations of BS 8000; Part 3; 1989 (Code of Practice for masonry). All surfaces on which blockwork is to be built shall be clean from any foreign matter influencing the bond between the surface and blockwork. The use of chipped or defaced blocks shall not be permitted in any face-work. All work shall be built uniform, true and level, with all perpends vertical and in line, all cross joints shall be solid, filled with mortar in every course as the work proceeds.

All blocks shall be clean before placing and shall be moistened with water for at least 3 hours before using by a method which shall ensure that each block is thoroughly and uniformly wetted.

No work shall rise more than 1000 mm above the adjoining works and such risings are to be properly racked back. No blockwork shall be carried up higher than 1500 mm in one day. Joints in walling to be plastered or rendered shall be raked out 10 mm deep to form a key. All cross (vertical) joints shall be filled by well buttering the ends of the block with mortar and then sliding it against its neighbour.

Blockwork of single block thickness shall be laid in stretcher bond, and blockwork of double block thickness in alternate courses of headers and stretchers. No broken blocks shall be accepted except where necessary for bonding. All blocks shall be cut by means of a mechanical disc cutter.

Alternate courses of load bearing block walling at intersection shall be carried through the full thickness the adjoining wall.

Course heights shall not vary throughout the building and each course shall be level and set out so that bed joints occur in line with sills, lintels and other features.

Damp-proof Courses in Walls Damp-proof courses in walls shall be bituminous damp-proof course to BS 743 weighing not less than 3.8 kg/m² overlapped 75 mm at all jointings and bedded in mortar whilst the mortar is still wet.

906 Protection

When constructing masonry or blockwork in unfavourable weather and in protecting the finished work, the Contractor shall observe the same instructions as are specified for concrete work.

All blockwork, including pointing, shall be cured by keeping the wall wet or moist with a method as approved by the Supervisor's Representative.

907 Non Load-Bearing Walls

All walls which are not load-bearing shall not be brought up to final finished level until the construction of any reinforced concrete roof slabs has been completed and the roof finishes have been installed.

908 Ties to Concrete Structures

Ties at junctions with reinforced concrete work shall be of the 'butterfly' type to BS 1243 and shall be cast into the concrete at such centres to be in line with the centre of the depth and width of mortar joints.

909 Movement Joints

Movement joints shall comply with the requirements for movement joints in concrete work as the described in these specifications.

910 Plastering and Rendering

Before plastering or rendering is carried out all joints shall be raked out to depth of 10 mm, the surface of the wall cleaned and all foreign matter removed.

External rendering shall be applied in two coats of cement/sand mortar of mix type II, Table 1 BS 5262 with a wood float finish to a minimum overall thickness of 20 mm.

Plastering to internal walls and ceiling surfaces shall be applied in two coats to a minimum overall thickness of 20 mm as follows:

- Undercoat: cement/sand - Type II, Table 2 BS 5492
- Finish: anhydrous gypsum plaster to BS 1191: Part 2, Class C with smooth finish.

Undercoats shall be thoroughly applied, straightened and scratched and brought to a true surface. Finished surfaces shall be left true, even and free from blemishes and all corners shall be finished true, vertical and even and carried out at the same time as adjacent wall surfaces.

Re-tempering or reconstitution of mixes shall not be permitted after the initial set has taken place.

1000 STRUCTURAL STEELWORK

1001 Design

The design of structural steelwork shall be in accordance with BS 449 or BS 5950, as appropriate, and BS 8110 1997: Chapter V: Part 2.

1002 Material Properties

Steel for hot rolled sections, Structural Hollow Sections, plates and bars shall comply as a minimum with the basic specification of BS EN10025, BS EN10113, BS EN10155 or BS EN10210-1.

Dimensional properties, tolerances and rolling margins shall comply with the following British Standards:

Plates	BSEN 10029
Universal beams, columns Rolled Joists, channels and Tees	BS4: part 1
Angles-BS4848: part 4	BS EN10056.2
Structural Hollow Sections	BS4848: part 2
I and H sections	BS EN10034

The surface condition of steel for fabrication shall be in accordance with the following standards:

- Steel surfaces when used shall not be more heavily pitted or rusted than Grade C of BS 7079 Part A1 (Swedish Standard SIS 05 59 00).
- Surface defects in hot rolled sections, hollow sections, flats, rounds, square bars, plates and wide flats revealed during surface preparation, which are not in accordance with the requirements of BS EN 10025, BS EN10113, BS EN10155, and BS EN10210-1, for quality of finished steel, shall be rectified in accordance with Clause 6.8 of BS EN10210-1 or BS EN10163.

Consumables for use in metal arc welding shall comply with BSEN 499, BSEN 440, BS 2901:1-5, BSEN 756, BSEN 760 or BS 7084 as appropriate.

Consumables stored in the contractor's works and on site shall be kept in a controlled atmosphere, in accordance with BS 5135.

Structural Fasteners shall be in accordance with the following standards:

- Shop and site bolts and nuts in ordinary bolt assemblies shall be grade 8.8 or 10.9 in accordance with BSEN 20898 Part 1 and BSEN 24014.
- High Strength Friction grip (HSFG) bolt assemblies shall be in accordance with BS 4395: part 2.
- Stainless steel bolts, screws, studs and nuts shall be grade A4-80 to BS 6105 unless specified otherwise.
- Holding down bolts in foundations shall be in accordance with BS 7419.
- Cup and countersunk bolts shall be in accordance with BS 4168.8 and BSEN 27721.

- Metal washers shall be made in accordance with BS 4320 Section 2 and unless otherwise specified shall be black steel washers to Form E.
- All lock nuts shall be in accordance with BS 4929: part 1.
- Where specific coatings are required to fasteners they shall be provided by the fastener manufacturer.

Proprietary Shear Studs used in composite construction shall be the headed type with the following properties after being formed:

- Minimum yield strength - 350 N/mm²
- Minimum ultimate tensile strength - 450 N/mm²
- Elongation of 15% on a gauge length of 5.65ÖA, where A is the area of the test specimen.

Protective treatment materials shall comply with the requirements of the following standards:

- Chilled iron shot and grit for blast cleaning shall be in accordance with BS 7079 Parts E3 and E4;
- Surface coatings shall be in accordance with the guidance given in BS 5493 and/or specialist advice;
- Sherardized coatings shall be in accordance with BS 4921;
- The composition of zinc in galvanizing baths shall be in accordance with BS 729.

1003 Testing

The supplier shall perform tests and provide test certificates, or obtain the manufacturers' test certificates, which shall be submitted for the materials to be used in the work.

These tests shall include the following, in accordance with BS EN10025 Cl.8, BS EN 10113.1 Cl. 8, BS EN 10155 Cl. 8, BS EN 10210-1 Cl. 9:

- Chemical analysis
- Tensile Tests
- Impact Tests
- Bend Tests
- Flattening Tests

The tests shall be carried out by an approved testing authority if appropriate and notice shall be given of the intended execution of any such tests.

If any sample fails a test, the consignment it represents may be rejected in part or in whole.

The Supplier shall make radiographic examination of butt welds in accordance with BS2600 and BS2910 and shall carry out dye-penetrant tests in accordance with BS6443. The frequency of tests shall be:

- 10% of the length of each butt welds shall be radio-graphically inspected and 10% shall be tested using penetrant.
- 5% of the length of each fillet weld shall be tested using penetrant.

1004 Shop Welding

Metal-arc welding of steel shall be in accordance with the requirements of BS5130.

Run-on/off plates shall be used during butt-welding.

Fillet welds shall be continuous to form a complete seal where two members join or abut.

Welders employed on the work shall be competent to BSEN 287-1, BSEN 287-2, BS4871 Part 1 and BS 4871 Part 3. Welding shall be carried out under the supervision of a competent welding technologist.

Welding electrodes shall comply with BSEN 499 and shall give a weld deposit with mechanical properties not less than the minimum specified for the parent metal. Hydrogen-controlled electrodes shall be used for butt-welding of steel over 25mm thick.

1005 Site Welding

All site welding shall be carried out by the electric arc process with coated electrodes and in accordance with BS5135 “Specification for the process of arc welding of carbon and carbon manganese steels”.

The welding plant shall be of modern design and of ample capacity to provide the required current to each welding point without appreciable fluctuations.

The welding procedure for making each point shall be approved by the Supervisor’s Representative before the work is started. Whenever possible all welding shall be done in the down-hand or horizontal-vertical positions. All parts to be welded shall be accurately prepared so that on assembly they shall fit closely together. After assembly and before the general welding commences the parts are to be tack-welded with small fillets welds. The tack welding must be strong enough to hold the parts together but small enough to be covered by the general welding.

Electrodes used for welding mild steel shall comply with the requirements of BSEN 499 “Covered electrodes for the manual manual-arc welding of carbon and carbon manganese steels”.

1006 Galvanizing

Lightweight gauge metalwork shall be galvanized by the hot-dip process as specified in BS3083 or BSEN 10143.

Contact between galvanized steel members and aluminum surfaces or between galvanized and un-galvanized steel members shall be prevented by means of approval insulating washers and grommets.

Galvanized steelwork shall be cleaned, degreased and etch primed before application of the specified paint treatment

1007 Erection of Steelwork

Erection of steelwork shall comply with the requirements of BS 5400 Part 6.

A detailed method statement shall be submitted by the Contractor to the Supervisor's Representative for approval prior to the placing of the beams. The statement shall include lifting details, crane locations and loading, details of temporary supports, supervision and safety precautions. The Contractor should allow sufficient time for the Supervisor's Representative to comment on his proposals and to make amendments if necessary.

Beams shall be set true to line and level during the erection process.

1008 Bolted Connections

Bolts shall be threaded only over the length of shank, which is outside the parts bolted together. The bolt shall protrude by at least two complete threads and not more than four complete threads beyond the outer faces of the tightened nut.

Holes shall not be distorted by the use of drifts.

High strength friction grip bolts shall be fitted in accordance with BS 4604 Part 2.

Load-indicating washers shall be installed in accordance with the manufacture's recommendations.

1009 Transportation and Storage

Steelwork and protective coatings shall be protected from damage during packing, handling, transportation and storage. The Contractor shall ensure that members are not subjected to greater stresses than those allowed in BS 5400 Part 6 during fabrication, transportation, storage and erection.

Stored items shall not be in contact with each other and shall be clear off the ground.

Steelwork considered beyond repair in transit shall be replaced at the Contractor's expense. The Contractor shall obtain prior approval for remedial work to damaged material.

1100 ROOF AND WALL SHEETING

1101 Coverings and Flashing

1101.1 Aluminium

Sheet aluminum shall be to BS EN 485-1 + A1, BS EN 515, BS EN 573-3, AW-1199.

1101.2 Workmanship

Fix sheet aluminium shall be in accordance with Architectural Sheet Metal Manual published by SMACNA.

Flashings shall be let into walls a minimum of 25 mm, provided with a turn back, secured with folded aluminium wedges and pointed in cement mortar. Flashings shall be lapped and single lock welted and the lower edge folded under for additional stiffness.

Aluminium in contact with mortar shall be coated with bituminous paint after bending.

1101.3 Contact of dissimilar metals

Avoid contact in the completed work between the following metals: -

- Aluminium alloys and copper alloys, nickel, lead or stainless steel.
- Iron or steel and copper alloys.
- Zinc (including galvanizing) and copper alloys or nickel.

Where unavoidable, coat contact surfaces with bituminous paint, protective tape or other approved means.

1102 Steel Sheet Roofing and Cladding

1102.1 Corrugated sheets

Steel corrugated sheets shall be hot-dipped galvanized corrugated sheets to BS 3083 and to be at least 0.6 mm thick, with corrugations 76 mm wide and 19 mm deep.

1102.2 Profiled sheets

Profiled steel sheets to BS 5427-1 shall be obtained from approved manufacturer of profile, thickness, finish and colour as specified.

1102.3 Accessories

Accessories for steel sheets shall be made from 0.6 mm (minimum) thick galvanized steel sheet or to be approved proprietary fittings. Accessories for colour coated sheets shall be obtained from the approved manufacturer of the sheets.

1102.4 Fixings

Hook bolts and nuts, drive screws, washers, self-tapping screws, roofing bolts, nuts and clips, roofing screws and sheeting clips shall be galvanized steel to **BS 1494**: Pt. 1 or electro-plated to **BS 7371-3** and of the sizes and finishes specified.

Alternatively, recommended specialist fixings from an approved manufacturer of the roofing sheets.

Bolts and screws shall be fitted with large washers compatible with sheets and shall be capable of withstanding up-lift under typhoon conditions.

Where coloured roofing sheets are used, fixing heads shall be covered with plastic caps to match the colour of the sheets.

Rivet fixings may only be used with the permission of the SO, and then only for vertical flashings.

1102.5 Workmanship

Fix steel sheeting generally in accordance with Architectural Sheet Metal Manual published by SMACNA.

Drill fixing holes in the crown of corrugations for roofing, and in the trough of corrugations for cladding. Drill holes 2 mm larger than bolts or screw, and not less than 40 mm from edges of sheets.

Remove all drilled cast material from around holes, leaving holes flat and smooth prior to any bolt or other fixing.

Make good damage to zinc coatings and galvanizing, treat cut ends of galvanized sections with two coats of metallic zinc-rich priming paint.

1102.6 Laps

Lay sloping sheets with minimum end laps of 150 mm. Vertical sheets shall be fixed with minimum laps of 75 mm. All laps shall be located over a supporting member.

1102.7 Fixing sheeting

Fix to steelworks with stainless steel self-tapping screws designed for fixing to steel. Fix to timber with self-tapping screws designed for fixing to timber.

Fixings for two rows around the perimeter of the roof, to any projecting areas, verges or open areas and at all end laps shall be at 300 mm (maximum) centres.

1102.8 Fixing accessories

Cut, fit and dress steel sheet accessories to fit corrugations or profiles and fix with approved fixings in accordance with the manufacturer's recommendations.

1102.9 Movement joints

Provide movement joints in all lengths of roofing or cladding over 45 m, with one joint for lengths up to 75 m and one for every additional 30 m. Cover with a movement joint cover fixed to sheets at one side only

1102.10 Colour coated steel sheets

Fix sheets in accordance with the manufacturer's recommendations. Sheets shall be sheared and not cut with circular saws or abrasive wheels. Make good all damages.

1102.11 Sheets to curved roofs

Sheets required to be bent to a radius for use on curved roofs shall be bent by means of a proper profiling or crimping machine.

1102.12 Waterproof joints of steel sheet roofing

Install sealants for preformed roofing panels as approved on shop drawings

1103 Aluminium Sheet Roofing and Cladding

1103.1 Profiled aluminium sheets

Aluminium corrugated and profiled sheets shall be to BS 4868. Corrugated sheets shall be at least 0.6 mm thick with corrugations 76 mm wide and 19 mm deep. Profile sheets shall be of the profile, thickness, finish and colour as specified

1103.2 Accessories for profiled aluminium sheets

Accessories for profiled aluminium sheets shall be made from aluminium flat sheet at least 0.6 mm thick and of similar finish and colour to the profiled sheets or to approved proprietary fittings. Accessories for colour coated sheets shall be obtained from the approved manufacturer of the sheets.

1103.3 Fixings

Fixings for aluminium profiled sheets as Clause 12.75.

1103.4 Generally

Fixing of aluminium sheet shall be similar to that for steel sheeting. See Clauses 12.76 to 12.83.

1103.5 Compatibility

To prevent electro-chemical corrosion, direct contact with other metals (particularly copper) shall be avoided. Fixings must be of, or compatible with, aluminium. Where unavoidable, coat contact surfaces with bituminous paint, protective tape or other approved means.

1200 CARPENTRY AND JOINERY

1201 Generally

1201.1 Generally

Timber generally shall be to BS EN 942 and to be of mature growth, properly seasoned and sawn square. Timber shall be free from wood wasp holes, large loose or dead knots, splits or other defects that will reduce its strength. Pin holes and worm holes may be permitted to a slight extent in a small number of pieces, subject to the acceptance of the Supervisors Representative, provided that there is no active infestation of the materials, that the strength of the member is not impaired and that they do not appear on the finished faces of joinery work.

1201.2 Timber for external use

- Species : Timber shall be either hardwood or softwood suitable for external use.

Approved softwood may or those cited in Table NA.1 of BS EN 942. Approved temperate hardwoods may k or those cited in Table NA.2 of BS EN 942. Submit the species to be used to the Supervisors Representative for approval.

- Preservative: Preservatives shall be environmentally friendly, healthy and safe, acceptable preservatives include Alkaline copper quaternary (ACQ) preservatives to American Wood Protection Association (AWPA) Standards or other suitably approved preservatives. Clear colourless chromate copper arsenic (CCA) to BS 4072 may be used subject to approval by the Supervisors Representative, provided that adequate precautions are taken to avoid injurious to health.

1201.3 Known Licensed Source

The minimum acceptable status of a timber source is “Known Licensed Source”. It refers to forest certification systems (except FSC) that include a chain of custody system covering the timber being purchased (be aware that not all forest systems have this element). A list of acceptable forest certification system with a chain of custody system include the followings:

- Programme for the Endorsement of Forest Certification Schemes (PEFC) – General
- PEFC – United Kingdom
- PEFC – Germany
- PEFC – Sweden
- Canadian Standards Association (CSA) (f)
- Cerflor (Brazil)
- Malaysian Timber Certification Council (MTCC)

1201.4 Storage

Store timber in a dry, well ventilated place, and protect from the weather. Stack timber in such a manner as to prevent distortion.

1201.5 **Moisture content**

Calculate moisture content at the time of fabrication by the following formula:

$$\frac{\text{Wet (or supplied) Mass} - \text{Dry}}{\text{Dry Mass}} \times 100 = \text{Moisture Content (percentage)}$$

The dry mass shall be determined by drying in an oven at a temperature of 103°C 2°C until the weight is constant.

The maximum permissible moisture content in timber to be incorporated into the work shall be as follows:

- Internal timber for use in Air Conditioned space 12%
- Internal timber generally 16%
- Timber with one face to the exterior of the building and one face to the interior (e.g.window frames) 18%
- External timber (e.g. fencing etc.) 20%

If these percentages cannot be attained due to local circumstances of supply and availability, the Supervisors Representative's attention must be drawn to the fact.

1202 **Materials**

1202.1 **Samples**

Submit samples of timber for joinery for approval where the grain shall be left exposed or where the surfaces shall be varnished or similarly treated.

1202.2 **Softwood**

Softwood for carpentry to be Pine, Cedar, or other species approved by the Supervisors Representative. All timber shall be appropriately stamped or marked to identify origin and grade. All timber shall be kiln dried and vacuum impregnated with Copper Chrome Arsenate, or as directed otherwise by the Supervisors Representative.

Pitch pine shall be best imported quality of mature growth, free from gross defects, well-seasoned and having a minimum density of 673 Kgs/m³ and an average equilibrium moisture content of 10 per cent in accordance with BS 1186 Part 1.

1202.3 **Hardwood**

Purple Heart, mahogany and green heart shall be the best quality available and must be free from gross defects. The Contractor must exercise care in selecting this timber and shall notify the Supervisor's Representative and obtain his written approval of the type and sources of the hardwoods he proposes to use.

Hardwood and hardwood products shall only be used in special circumstances under the direction of the Supervisors Representative.

Density of hardwood shall be 720 kg/m³ (minimum) at 15% moisture content.

Submit to the Supervisors Representative the following information:

- The species and country of origin.
- The name of the concessions or plantations from which these timbers originate.
- Copies of the forestry policies implemented by these concessions or plantations which confirm that the management of the timber resource is sustainable.
- Certificate from the Forest Stewardship Council (FSC) or other Approved Authority
- Hardwoods of unknown species or from unidentified sources are expressly prohibited.

1202.4 Flooring

Softwood or hardwood species used for timber flooring shall be obtained from a sustainable source as previously specified. Boarded or strip flooring shall be selected and approved hardwood, as specified, or as submitted to the Supervisors Representative for selection. Finished thickness shall be 20 mm (minimum).

1202.5 Wood block flooring

Wood block flooring shall be approved high density resin bonded fibreboard flooring or other approved hardwood as specified. Finished thickness shall be 20 mm (minimum). Blocks shall be 300 mm x 50 mm in size and colour matched.

1202.6 Parquet flooring

Wood parquet flooring shall be obtained from a sustainable source as previously specified. Each block shall be 120 mm x 25mm in size and 8 mm thick, and shall be tongued & grooved.

1202.7 Weather boarding

Hardwood weather boarding shall be 150 mm wide and tapering from 25 mm to 10mm thick and shall be:

- Sawn boarding or boarding wrot on one face and two edges with horizontal joints lapped 30 mm.
- Boarding as (a) but with wider edge rebated with joints lapped 20 mm.
- Plywood
- Plywood shall be of the following grades, as specified:
- "Grade 1 veneer" - hardwood faced, as specified, for natural finish.
- "Grade 2 veneer" - lauan faced for painting.

Generally the bonding adhesive between veneers shall be resin adhesive classified as moisture and weather resistant (M.R.) in BS 1203.

Nominal standard thicknesses of plywood shall be 3, 4, 5, 6, 9, 12, 15, 18 and 25 mm.

1202.8 **Marine plywood**

Marine plywood shall be to BS1088-1 and BS 1008-2 bonded with Type I adhesive between plies as in Subsection 1202.25

1202.9 **Blockboard**

Blockboard shall be Grade 2 veneer for painting, and bonded with Type M.R. adhesive as in Subsection 1202.25

1202.10 **Hardboard**

Hardboard shall be to BS EN 316, BS EN 622-1 and BS EN 622-2.

1202.11 **Insulating board**

Insulating board (Softboard) shall be to BS EN 316, BS EN 622-1 and BS EN 622-4.

1202.12 **Wood chipboard**

Wood chipboard shall be unsanded or sanded board to BS EN 309 and BS EN 312. Veneered chipboard shall be an approved proprietary brand to BS EN 309 and BS EN 312. All wood chipboards shall be low formaldehyde emission chipboard (Class E1) unless permitted otherwise by the Supervisors Representative, or polyurethane - based chipboard with zero formaldehyde emission. Any boarding shall be used in wet areas such as kitchens or bathrooms shall be High Moisture Resistant board to BS EN 316 and BS EN 321.

1202.13 **Medium Density Fibreboard (MDF)**

Board type shall be moisture resistant grade (MDFMR) with density in excess of 600 kg/m³ to BS EN 316 and BS EN 622-5.

1202.14 **Glass fibre**

Glass fibre insulating quilt shall be light-weight bonded mat weighing 12 kg/m³ uncompressed.

1202.15 **Semi-rigid resin bonded glass fibre slab**

Glass fibre insulating board shall be semi-rigid resin-bonded glass fibre weighing 45-48 kg/m³.

1202.16 **P.V.C. or acrylic sheet**

PVC or acrylic sheet shall be clear, translucent or coloured, as specified, and to be approved by the Supervisors Representative.

1202.17 **Laminated plastic sheet**

Laminated plastic sheet shall be to BS EN 438. Class HG (Horizontal-General Purpose) or VG (Vertical-General Purpose) as specified.

1202.18 **Acoustic tiles**

Acoustic tiles shall be of an approved proprietary brand meeting the requirements of BS EN 13964 manufactured from the following materials:

- Wood or other organic fibre insulating board to BS EN 622, 12 mm (Minimum) thick for 300 mm x 300 mm tiles and 15 mm (minimum) thick for 400 mm x 400 mm tiles.
- Mineral fibre or wool insulating board 12 mm (minimum) thick for 300 mm x 300 mm tiles and 15 mm (minimum) thick for 400 mm x 400 mm tiles.
- Approved multi-purpose, dimensionally stable building board 6 mm (minimum) thick.

Tiles shall have a plain, perforated or fissured surface with a factory applied decorative finish. The edges shall be square, bevelled, or bevelled and grooved to suit the suspension system.

Provide a certificate from the manufacturer confirming that the tiles are asbestos free.

1202.19 Proprietary suspended ceiling systems

The suspended ceiling system shall be an approved proprietary system meeting the requirements of BS EN 13964 and of one of the classes of exposure to be determined by conditions set out in Table 3.

Table 3: Classes of exposure

Class	Conditions
A	Building components generally exposed to varying relative humidity up to 70 % and varying temperature up to 25 °C but without corrosive
B	Building components frequently exposed to varying relative humidity up to 90 % and varying temperature up to 30 °C but without corrosive pollutants.
C	Building components exposed to an atmosphere with a level of humidity higher than 90 % and accompanied by a risk of condensation.
D	More severe than the above.

The suspension system shall be manufactured from one of the following materials:

- Galvanized mild steel.
- Aluminium.
- A combination of galvanized mild steel and aluminium.

Metal framing components, suspensions and connecting elements shall be protected against corrosion according to Table 4.

Table 4: Classes of corrosion protection of metal substructure components and membrane components

Class according to Table 4	Profiles, suspensions ^a , connecting elements ^a and membranes	
	Components made of steel	Components made from aluminium
A	<p>Products with a continuously hot-dip metal coating Z100, ZA095 or AZ100 according to prEN 10327^{bc}.</p> <p>Products with electroplated zinc coating flat ZE25/25 according to BS EN 10152^c.</p> <p>Continuously organic coated (coil-coated) products of corrosion protection (interior) category CPI2 for the exposed side according to BS EN 10169-3^f (e.g. coating system ZE15/15-HDP25-2T-CPI2).</p>	No additional corrosion protection required
B	<p>Products with a continuously hot-dip metal coating Z100, ZA095 or AZ100 according to prEN 10327^{bc}.</p> <p>Products with electroplated zinc coating flat according to BS EN 10152 with or without an additional organic coating^d as follows^c: ZE25/25 + 40 µ m per face^e, ZE50/50 + 20 µ m per face^e or ZE100/100 without OC.</p> <p>Continuously organic coated (coil-coated) products of corrosion protection (interior) category CPI2 for the exposed side according to BS EN 10169-3^f (e.g. coating system ZE15/15-HDP25-2T-CPI2).</p>	No additional corrosion protection required or coil coating according to BS EN 1396 : corrosion index 2a

Class according to Table 4	Profiles, suspensions ^a , connecting elements ^a and membranes	
	Components made of steel	Components made from aluminium
C	<p>Products with a continuously hot-dip metal coating Z100, ZA095 or AZ100 according to prEN 10327^{b,c} with an additional organic coating^d of 20 µ m per face.</p> <p>Products with electroplated zinc coating flat according to BS EN 10152 with an additional organic coating^d as follows^c: ZE25/25 + 60 µ m per face^e; ZE100/100 + 40 µ m per face.</p>	<p>Anodising^c</p> <p>(15 µ m < s < 25 µ m) or coil coating according to BS EN 1396: corrosion index 2a</p>
D	<p>Special measures depending on use and corrosion action.</p> <p>Minimum corrosion protection according to Class C. Additional measures as required.</p>	<p>Anodising^c</p> <p>(s > 25 µ m) or coil coating according to BS EN 1396: corrosion index 2b</p>
<ul style="list-style-type: none"> • Round steel wires used as suspensions or part of a suspension shall meet the requirements of BS EN 10244-2 (Zinc or Zinc alloy coating on steel wire). • prEN 10327 replaces BS EN 10142 (Zinc), BS EN 10214 (Zinc – Aluminium) and BS EN 10215 (Aluminium – Zinc). • Any equivalent corrosion protection leading to a similar level of protection is permitted. • Coating of exposed parts with zinc compatible organic coating according to BS EN I Supervisors Representative 12944-3 applied by a post-painting process or equivalent coil coating according to BS EN 10169-3. • Applies only to membrane components. 		

The substructure (suspension system) shall be classified in accordance with its deflection limits as given in Table 5 See para. 4.32 of BS EN 13964 for testing criteria and methodology.

Table 5: Class of deflection

Class	Maximum deflection in mm ^A
1	$L^B / 500$ and not greater than 4.0
2	$L^B / 300$
3	No limit
<ul style="list-style-type: none"> • The maximum deflection is the accumulative value of the deflection of the substructure component and the deflection of the membrane component. • L is the span in mm between the suspension components or the suspension points. 	

Aluminium sections shall be anodised where exposed. The panel grid shall be constructed of exposed tee or concealed 'T', 'Z' or other approved sections. Hangers shall be steel wires not less than 2 mm diameter, or straps, rods or combination of sections designed to facilitate the adjustment of grid levels, support the weight of the ceiling and all fittings and attachments. Fixing to soffits shall be by means of approved sockets, anchors or other fixing devices cast into the slab or approved proprietary plugs or drill-anchors.

The system shall be so designed to facilitate the removal of at least 10% of the tiles without disturbing the remainder.

Provide matching edge trim to the perimeter of suspended ceilings.

Submit samples of the panel grid complete with acoustic ceiling tiles for approval.

1202.20 **Nails**

Nails shall be steel nails to BS 1202:Pt. 1, with "bright" finish, unless otherwise specified.

Nail lengths shall be not more than the total thickness of sections to be joined less 5 mm, or not less than twice the thickness of section through which nails are driven.

Where the thickness of the outer section through which nails are being driven is less than half that of the section to which nailing is being done, the depth of penetration of the nails into the latter shall be not less than 10 diameters of the nails being used.

1202.21 **Screws**

Wood screws shall be brass, stainless steel, alloy or other non-corroding metal to AS 1476 with countersunk heads, unless otherwise specified. Steel screws shall only be used for temporary work. The proper dedicated screws shall be used for all Particle-board fixing.

Screw lengths shall be not more than the total thickness of sections to be joined, less 5 mm, or not less than one and a half times the thickness of section through which screws are driven. Where the thickness of the outer section being screwed is less than half that of the section to which screwing is being done, the depth of penetration of the screwing into the latter shall be not less than the thickness of the outer section.

Screw cups shall be brass cups or stainless steel and to BS 1494.

1202.22 **Masonry nails**

Do not use masonry nails or drive pins without approval.

1202.23 **Explosive cartridge fixings**

Obtain approval before using explosive cartridge operated fixings. All fixings shall be in accordance with the Factories and Industrial Undertakings (Cartridge-Operated fixing tools) Regulations. Use tools, normally of the indirect acting type, plus pins and cartridges which correspond with the manufacturer's specifications for that tool. A tool shall only be used by a person holding a certificate of competency specifying the maker and model of the tool on which he has been successfully trained.

1202.24 **Plugs**

Plugs for fixing to hard materials shall be proprietary plugs of plastic, soft metal, fibre or similar.

Fixing to friable materials, plasterboard and the like shall be proprietary fixings specially designed for that situation.

The use of wood plugs shall not be permitted.

1202.25 **Adhesive**

Adhesive for wood shall be as follows:

- For internal use; synthetic resin adhesive classified as moisture resistant and moderately weather-resistant (M.R.) in BS EN 204 and BS EN 301.
- For external use or internal use under very damp conditions: synthetic resin adhesive classified as Type I in BS EN 301 and tested according to BS EN 302

Adhesive for fixing laminated plastic sheet shall be synthetic resin adhesive classified as type I in BS EN 301.

Where the temperature exceeds 25 degree C, a "warm-setting" grade of adhesive shall be used.

The use of animal glues shall not be permitted.

1202.26 **Resin for MDF panels**

All urea formaldehyde bonded MDF panels and MUF mouldings shall be manufactured with low emission resins conforming to European E1 emission standard of 9mg/100g (minimum).

1202.27 **Wood preservative**

Wood preservative shall be an approved proprietary brand exterior grade where completely concealed, or not decorated and colourless, coloured or suitable for overpainting where likely to be exposed or in contact with a painted finish.

1202.28 **Wood preservative to external timber**

Wood preservative to external timber shall be applied as follow:

- | | |
|-------------------------------|---|
| Preparation | : Timber shall be free from dirt and surface moisture. |
| • Application of Preservative | : Apply by pressure impregnation in accordance with BS 8417.
Apply preservative in a manner that is not hazardous to health. Adhere strictly to the manufacturer's instructions. |
| • Cutting and Machining | : Whenever possible, all cutting, planing, boring, drilling, notching or any other machining or manual operation shall be completed prior to preservative treatment. |
| • Incising | : For certain timbers such as Douglas Fir which are difficult to impregnate, make 20 mm deep incisions coverage of 650 per m2 in the direction of the grain all in accordance with BS 144. This method shall only be used on timber sections exceeding 80 mm thickness. |
| • Creosote Application | : For timber where impregnation is not suitable and a paint finish is not required, when approved apply 2 coats of creosote in accordance with the manufacturer's instructions. |
| • Guarantee | : Obtain a guarantee of 30 years for timber components against rot, insect attack and fungal decay. |

1203 **Workmanship**

1203.1 **Generally**

Workmanship generally shall be to BS 1186:Pt. 2.

1203.2 **Timber**

Cut timber to required sizes and lengths as soon as practicable after the Works are begun, and store dry under cover so that the air can circulate freely around it.

Stack cut timber off a leveled, well-drained and maintained hard-standing ground and in such a manner as to prevent distortion.

1203.3 Dimensions

Dimensions of sections shown on the drawings are finished sizes. Allow for planing and sanding faces to finished sizes.

Check site dimensions before prefabricating joinery fittings.

1203.4 Framed joinery generally

Plane timber for joinery on all faces. Finish exposed faces to a fine glasspapered surfaces and round arrises to 1 mm radius.

1203.5 Framed joints

Faces of framed joints shall be square and shall be driven together to give a close, accurate fit.

Prepare and frame up joinery work with dry joints and store until required for fixing. Before fixing open up all joints, put together with approved glue and wedge up. Replace any sections that have warped or developed shakes or other defects.

1203.6 Running bonded joints

Running bonded joints shall be cross-tongued, using approved tongues. For work over 40 mm thick, use double tongues.

1203.7 Joinery with clear finish

Protect from damage or discolouration joinery shall be left with clear finish. Submit proposals for protection for approval.

1203.8 Prototypes

Prepare prototypes and obtain approval for repetitive fittings before starting fabrication.

1203.9 Fixing

Plug and screw or secure timber sections to the backing by approved means. Check location of buried services before fixing to walls and other surfaces.

1203.10 Nailing

Nail timber sections securely to the backing and ensure that the nails do not split the timber. Split timbers shall be removed and replaced.

Punch nail heads below timber surfaces visible in completed work.

Nail weather boarding to wood framing with not less than two corrosion proofed nails in the width of each board at each framing member.

1203.11 **Screwing**

When specified, screw timber sections to the backing including drilling pilot holes and countersinking heads flush with timber surfaces.

Screws shall be inserted full depth with a screwdriver and not hammered. Countersink screw heads 5 mm (minimum) below timber surfaces shall be left with natural finish. Glue in colour and grain matched pellets cut from matching timber. Finish off flush with face.

1203.12 **Wood preservative**

Apply wood preservative to all unexposed surfaces of timber including framing fillets etc. and backs of frames, skirtings etc.

1203.13 **Fixing plastic sheet**

Do not fix laminated plastic sheet to timber with moisture content of more than 16%.

1203.14 **Acoustic tiles**

Fix acoustic tiles and the like to timber battens or direct to sub-base by means of an approved adhesive used in accordance with the manufacturer's recommendations.

1203.15 **Suspended ceilings**

Construct suspended ceilings in accordance with BS EN 13964. Fix proprietary systems in accordance with the manufacturer's recommendations. Ensure that ceiling tiles and grids are properly set out and that all cutting is done at the perimeter unless required to be otherwise in Particular Specification. Fix all cover strips, edge trims and the like.

1203.16 **Boarded or strip flooring**

Heading joints shall be cross-tongued, and staggered not less than two board widths apart.

Cramp flooring, to ensure a tight and accurate fit along the whole length of the joint.

Fix flooring with galvanized, sheradised or cadmium-plated wire nails.

Face nail square edged flooring not more than 100 mm wide, use two nails. Stop nail heads and finish flush.

Secret-nail tongued and grooved flooring at each support with one nail placed just above the tongue and driven on skew. Punch nail heads flush.

1203.17 **Fixing battens**

On concrete, cast in or lay at 350 mm centres 50 mm x 40 mm twice splayed fixing battens pre-treated with wood preservative. Where laid on concrete bed, level in cement mortar (1:3), continuous support being provided for all batten lengths.

1203.18 **Infilling between**

Fill space between battens with lightweight concrete. Allow to dry out thoroughly.

Apply one coat of approved bitumen/rubber latex emulsion at the rate of 1 litre/m². Check and refix battens after drying-out as may be required.

1203.19 **Wood block flooring**

Ensure that the base is clean and dry. Fix blocks to screed with an approved cold bitumen/rubber emulsion adhesive. Lay to herringbone or basket pattern, as specified, with straight border two blocks (minimum) wide.

Provide 5 mm expansion gap at perimeter of areas of wood block flooring, and fill with one of the following:

- Cork strip
- Foam rubber strip

Sand surface of wood block flooring with an electric surfacing machine using sequentially graded abrasive paper to obtain a smooth surface ready to receive sealer or polish.

Machine shall be fitted with dust bag to control the release of dust.

1203.20 **Parquet flooring**

Ensure the base is clean and dry. Lay blocks on one coat of an approved cold bitumen rubber emulsion adhesive applied to the screed with a serrated trowel. Leave flooring ready to receive sealer or polish. Sand surface of parquet flooring as Subsection 1203.18

1203.21 **Door & frames general**

Door frames shall not be used as formers for door opening construction unless with the permission of the Supervisors Representative, and never when proprietary door sets are required in the Contract. In all such circumstances, templates or formers must be used. The adoption of timber doorsets may be accepted subject to the approval of Supervisors Representative.

1203.22 **Door with board finish**

Construct hardwood ledged doors with 20 mm (minimum) vertical tongued and grooved boarding in about 150 mm widths. V-jointed on face side with ledges 5 mm thicker than boarding thickness and 100 mm wide for top ledge and 175 mm wide for middle and bottom ledges. Nail boarding to ledges and screw ends of ledges to boarding.

1203.23 **Ledged and braced**

Construct hardwood ledged and braced doors as Subsection 1203.21 but with 100 mm wide diagonal braces of similar thickness to ledges. House braces to ledges and screw ends to boarding.

1203.24 **Framed, ledged and braced doors**

Construct framed, ledged and braced doors of 45 mm (minimum) thickness with 115 mm wide stile and top rail, 225 mm wide middle and bottom rail, and 100 mm wide braces. Fill in with vertical boarding as Subsection 1203.21.

1203.25 **Panelled doors**

Construct hardwood panelled doors 40 mm (minimum) thick, with 100 mm wide stiles, top rail and muntins and 200 mm wide middle and bottom rails. Flat panels shall be 20 mm thick. Groove rebate or leave open framing, as specified, for panels or glass.

1203.26 **Flush doors**

Stiles and rails generally shall be 75 mm wide. For doors exceeding 900 mm side or 2000 mm high stiles to be 100 mm wide.

Infill for hollow core doors shall be 20 mm horizontal battens at 150 mm centres. Block out for lock fixing, door closers, or other ironmongery as specified, or composition board core approved by the Supervisors Representative.

Infill for solid core doors shall be 25 mm vertical battens tightly cramped together with the covering fully bonded both sides.

Cover both sides of the door with the following as specified:

- 3.2 mm standard hardboard
- mm Plywood for painting
- mm selected Hardwood faced plywood for clear finish
- Class HG laminated plastic bonded to 5 mm plywood
- Other board finish accepted by the Supervisors Representative.

Provide 12 mm selected hardwood lipping pinned and glued to all edges.

Lipping to meeting edges of folding doors and meeting edges and heels of swinging doors shall be 25 mm thick, rebated or rounded.

When specified, fit the bottom edge of doors with a 12 mm selected hardwood removable carpet strip screwed to the lipping.

1203.27 **Cupboard doors**

Construct cupboard doors as follows, as specified:

- Plywood or blockboard lipped on all edges with selected hardwood faced with laminated plastic sheet or prepared for painting, or
- Hollow core doors as Subsection 1203.25

1203.28 **Openings in flush doors**

Frame openings with 12 mm (minimum) selected hardwood lipping. Rebate lipping for glazing, if required.

1203.29 **Glazing beads**

Provide glazing beads to match surrounding timber. Mitre at angles. Fix with screws and cups, where specified. Glazing beads shall not be less than 12 mm thick.

1204 Fire resisting timber door

Fire resisting timber doors should be flush door as described above, including frames, hinges door closers and any other hardware and shall comply with BS 476: Part 20-23.

Proprietary fire doors should be tested in accordance with BS 476 and to the approval of the Supervisors Representative. Test report shall be provided to indicate that the material, product or construction is capable of resisting the action of fire for the specified period. The test shall be carried out and the test report shall be prepared by a laboratory recognized by the relevant British Standards.

1204.1 **Smoke and intumescent seals**

Folding or swing fire doors shall incorporate proprietary smoke seals and intumescent strips where necessary to attain the requirements of BS 476:Pt. 20-23.

1204.2 **Acoustic doors**

Acoustic doors shall be either solid core doors or composite core doors with air-tight seals to all junctions with frames and recessed threshold. Seal types shall be submitted to the Supervisors Representative for approval unless specified in the Contract. Airborne sound insulation shall be tested to BS EN ISO 10140-1/2 & 5 or ASTM-E413-10 and ASTM E90-09. Field ratings shall be tested to ASTM E336-10 and ASTM E413-10. The Contractor shall guarantee both laboratory and field performance.

1204.3 **Doors and window frames**

Construct doors and window frames with properly framed joints and fix using cramps or bolts as Clauses 14.108, 14.109, 14.116 and 14.117 and secure the bottom of door frames with dowels as Clauses 14.107 and 14.115.

Lippings, particularly lippings at the closing & meeting stiles shall be profiled to ensure correct operation gaps to the satisfaction of BS 4787 Pt.1.

1204.4 **Bedding and pointing**

Bed frames in cement mortar, leaving no gaps. For external doors, rake out external face 10 mm deep, and point with an approved sealant.

1204.5 Architraves

Architraves shall be one length between angles. Mitre architraves at angle joints.

1204.6 Drawers

Construct drawers with 20 mm thick front, as specified, 15 mm thick back and sides, as specified, dovetailed and framed together and 5 mm thick bottom housed on three sides. Set drawers to slide on proprietary runners.

1300 ALUMINIUM WINDOWS, STOREFRONTS AND ENTRANCES

1301 General

1301.1 Description

Extent of Work: The extent of aluminium windows, storefronts and entrances is indicated on drawings and includes but is not limited to the provision and installation of aluminium windows, doors, panels, louvers, frames and insect screens.

1301.2 Quality Assurance

Performance and Testing: Fabricate, assemble and erect units to meet or exceed the following performance requirements:

- Thermal Movement: Fabricate components from manufacturer's stock systems which have been designed to provide for expansion and contraction resulting from ambient temperature range of 50°C.
- Wind Loading: When tested in accordance with BS 5368 Part (3) the units shall be weather-stripped for the local climatic conditions and shall be able to withstand a wind load of not less than 130miles/hr, acting inward and also acting outward, and the deflection of any member shall not exceed 1/175 of its span.
- Air Infiltration: When tested in accordance with BS 4315 air infiltration shall not exceed 0.00015 m²/s/m crack length under a wind of 40 km/hr.
- Water Infiltration: When tested in accordance with BS 4315 there shall be no water infiltration when water at 3.4 liters/m²/min. is applied under a pressure of 0.20 KA for a 15-minute test period.

Codes and Standards: Comply with the applicable requirements of the following codes and standards:

BS	British Standards
476	Specification for Fire Tests on Building Materials and Structures.
BSEN 499	Specification for Welding Consumables, Covered Electrodes for Manual Metal Arc Welding of Non-Alloy and Fine Grain Steels.
1449	Part 2: Stainless and Heat Resistant Steel Plate, Sheet and Strip.
4255	Specification for Non-Cellular Gaskets.
4315	Methods of Test for Resistance to Air and Water Penetration.
4870	Specification for Approved Testing of Welding Procedures.

4871	Specification for Approved Testing of Welders Working To Approved Welding Procedures.
4873	Specification for Aluminium Alloy Windows.
5368 Part (3)	Specification for Wind Resistance Tests.
5411 Part (3)	Eddy Current Method for Measurement of Coating Thickness of Non-Conductive Coatings on Non-Magnetic Basis Metals.
6161(7)	Accelerated Determination of Light Fastness of Coloured Anodic Oxidation Coatings Using Artificial Light.
6213	Guide to Selection of Constructional Sealants.
6459	Specification for Door Closers.
6830	Specification For Continuously Hot-Dip Aluminium/Zinc Alloy Coated Cold Rolled Carbon Steel Flat Products.

1302 Submittals

Manufacturer's Data: Submit manufacturer's specifications, recommendations and standard details for the specified products, including fabrication, finishing, accessories and other components of the work. Include certified test laboratory reports as necessary to show compliance with the requirements.

Shop Drawings: Submit shop drawings for the fabrication and installation of storefront and entrance units and associated components of the work. Include wall elevations, typical unit elevations and full size detail sections of every typical composite member. Show anchors, joint system, weather-stripping, expansion provisions and other elements not included in manufacturer's standard data, including glazing details.

1302.1 Samples

Submit samples of each required type and colour of aluminium finish on 300mm long sections and shapes and 150 mm squares of sheet aluminium as required for the units specified. Where colour or texture of finish will vary slightly for the work, include two or more pieces in each sample, to show the limits of such variations. Samples will be reviewed by the Supervisor for colour and texture only. Compliance with other requirements shall be the exclusive responsibility of the Contractor.

The Supervisor reserves the right to require samples which will show the fabrication techniques and workmanship of component parts and the design of accessories and other exposed auxiliary items for the units before fabrication of the work proceeds.

1302.2 Tests Reports

Submit written, certified test reports for the following tests required by this specification; record the dates, locations and methods of testing, and interpret the test result.

- Air infiltration tests.
- Water penetration tests.
- Wind loading tests.
- Thermal movement tests.

1303 Product Delivery, Storage and Handling

Deliver, store and handle units in a manner to prevent damage and deterioration.

Provide packaging such as cardboard or other containers, separators, banding, spreaders and paper wrappings to protect aluminum items.

Store units upright, in a protected dry area, at least 25 mm or more above ground or floor and at least 6 mm between individual pieces.

All units shall have a metal tag with type classification thereon.

1304 Material and Components

1304.1 Aluminum Windows

Provide sizes, shapes and profiles as indicated for the windows and window wall system with standard white color range.

Provide thickness as necessary to comply with the structural loading requirements and be able to withstand climatic conditions and wind loads of 130miles/hour but not less than the following:

- Principal Extrusions: 2.5 mm minimum thickness.
- Principal Formed Sheet Members: 2.5 mm minimum thickness.
- Extruded Glazing Stops and Trim: 1.6 mm minimum thickness.

Provide aluminium alloy and temper for each shape, as recommended by the manufacturer to comply with the requirements of performance, fabrication, application of finish and control of colour. Comply with BS 4873.

1304.2 Aluminium Storefronts and Entrances

Provide storefronts and entrances of the specified type and manufacturer, fabricated from extruded aluminium alloy 6063-T5 conforming to BS 4873.

Glass Framing members for storefronts shall be provided for flush glazing on all sides through site lines, and no projecting stops or face joints. The system shall provide fully resilient settings for glass and panels by use of elastomeric gaskets on both sides of the glass. Adapters, mountings, trim mouldings and face materials shall not interfere with the normal assembly and weathering of the grid framing.

Entrance door stiles and rails shall be of approved dimensions with a minimum wall thickness of 4.8 mm; weather-stripped aluminium mouldings, fitted to each door and frame, shall form continuous double-channel interlocks between the hinge and lock jambs and the closed door. Each door opening shall be double weather-stripped at jambs and head, and provided with weather-stripped extruded aluminium threshold with integral water dam. Hardware for entrance doors shall be as specified in Section 1500.

Head, jamb and mullion frames for entrance doors shall provide structural support for the doors and be tubular sections and shall be able to withstand climatic conditions with minimum wall thickness of 4.8 mm at exposed faces and sides, 6.4 mm at recessed sidewalls receiving mortised or concealed hardware, and 3.2 mm in flush glazing pockets. Glazing moldings and trim inserts shall be not less than 1.6 mm thick. External fasteners and fastening devices shall be aluminium, stainless steel or other non-corrosive finishes compatible with aluminium.

1304.3 Miscellaneous Materials

Fasteners: Where exposed, provide fasteners of aluminium or stainless steel. Where not exposed, fasteners may be cadmium or zinc plated steel. Anchors shall be aluminium or stainless steel.

Anchors, Clips and Window Accessories: Depending on strength and corrosion-inhibiting requirements, fabricate units of aluminium, non-magnetic stainless steel, or hot-dip zinc coated steel or iron.

Compression Glazing Strips and Weather-stripping: Unless otherwise indicated, and at manufacturer's option, provide moulded neoprene gaskets, moulded PVC or moulded expanded neoprene gaskets.

Sliding Weather-stripping: Unless otherwise indicated, provide approved woven pile weather-stripping of wool, polypropylene or nylon pile and resin-impregnated backing fabric, and aluminium backing strip.

Sealant: Unless otherwise indicated for sealants required within fabricated units, provide type recommended by manufacturer for joint size and movement, to remain permanently elastic, non-shrinking and non-migrating and approved by the Supervisor. Comply with Section 1301.2 for installation.

Window Cleaner's Bolts: Non-magnetic stainless steel, including reinforcing members for mullions or other components to receive bolts.

Glass and Glazing Materials: Provide glass and glazing materials which comply with requirements of Section 1400.

1305 Hardware

Provide door manufacturer's standard heavy-duty hardware units as required for operation of each door or windows. Manufacturer's recommended type for intended service required shall be finished to match window or door, unless otherwise indicated. Unless otherwise specified, comply with the applicable requirements of Section 1500 and under the "MASTER KEYING SYSTEM."

1306 Fabrication

1306.1 General

Sizes and Profiles: Required sizes for entrance and storefront units, including profile requirements shall be indicated on approved shop drawings.

Prefabrication: To greatest extent possible, complete fabrication, assembly, finishing, hardware application, and other work before shipment to project site. Disassemble components only as necessary for shipment and installation. Pre-glaze units to greatest extent possible, in coordination with installation and hardware requirements.

Sequence: Complete cutting, fitting, forming, drilling, and grinding of metal work prior to cleaning, finishing, surface treatment, and application of finishes. Remove arises from cut edges and ease edges and corners to radius of approximately 0.4 mm.

Welding: Comply with BS 639, BS 4870 and BS 4871.

Reinforcing: Install reinforcing as necessary for performance requirements; separate dissimilar metals with bituminous paint or other separator which will prevent corrosion.

Continuity: Maintain accurate relation of planes and angles, with hairline fit of contacting members.

1307 Finishes

Preparation: After fabrication, prepare aluminium surfaces and carry out anodization in compliance with BS 1615.

Finish: Unless otherwise directed, provide electrostatic polyester powder coated aluminium finish, having a film thickness of not less than 25 microns, medium matte. Apply an approved temporary protective coating of clear acrylic lacquer.

1308 Execution

1308.1 Inspection

The Contractor shall examine the substrates and the conditions under which entrance and storefront units shall be installed and correct unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Supervisor.

1309 Installation

Comply with manufacturer's specifications and recommendations for the installation of storefronts and entrances.

Set units plumb, level and true to line, without warp or rack of frames or panels. Anchor securely in place. Separate aluminium and other corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

Set sill members and other members in a bed of compound, or with joint fillers or gaskets to provide weather tight construction. Fillers and gaskets shall be installed during and after erection of components.

Refer to Section 1400 for installation of glass into the work.

Refer to Section 1500 for installation of hardware on entrance doors.

Clean aluminium surfaces promptly after installation of components, exercising care to avoid damage to the protective coating, if any. Remove excess glazing and sealant compounds, dirt and other substances.

The Contractor shall protect all components of the work from damage by other trades during and after installation and provide final cleaning using materials and methods as recommended by the manufacturer.

1400 GLAZING

1401 General

1401.1 Description of Work

Extent of Work: The extent of the glazing work is shown on drawings and in schedules and includes glazing and all associated accessories.

1401.2 Quality Assurance

Codes and Standards: Comply with the applicable requirements of the following codes and standards:

BS	British Standards
476	Fire Tests on Building Materials and Structures. Part 7:1987, Method for Classification of the Surface Spread of Flame of Products. Part 22:1987, Methods for Determination of The Fire Resistance of Non-Load Bearing Elements of Construction.
952	Glass for Glazing. Part 1:1978, Classification. Part 2:1980, Terminology for Work on Glass.
2571	Specification for General Purpose Flexible PVC Compounds for Moulding and Extrusion.
4255	Rubber Used in Preformed Gaskets for Weather Exclusion from Buildings. Part 1:1986, Specification for Non-Cellular Gaskets.
6206	Specification for Impact Performance Requirements for Flat Safety Glass and Safety Plastics for Use in Buildings.
6262	Code of Practice for Glazing for Buildings.
8000	Workmanship on Building Sites. Part 7:1980, Code of Practice for Glazing.
PD	Published Documents.
6512	Use of Elements of Structural Fire Protection with Particular Reference to the Recommendations given in BS 5588. Fire Precautions in the Design and Construction of Buildings. Part 3:1987, Guide to the Fire Performance of Glass.

1401.3 Submittals

Samples: Submit samples size 300 x 300 mm of each type of glass proposed, glazing compounds, sealants and glazing accessories.

Manufacturer's Literature: Submit manufacturer's literature containing technical and installation information.

Certificates: Submit certification from the manufacturer stating quality, thickness, type and grade.

Shop Drawings: Submit shop drawings and details of glass installation at framing members such as head, mullions, transoms, jambs and sills.

1401.4 Product Delivery, Storage and Handling

Glass: Crate glass securely and safely for delivery, handling and storage. Provide cushions at edges of glass to prevent damage. Protect glass faces from scratches and abrasions, and in a dry, well ventilated location, carefully protected at all times from soiling, atmospheric condensation and other moisture. Replace damaged or defective glass with new glass at no additional cost. Deliver each piece of glass with factory labels intact, indicating glass type, quality and thickness, and do not remove labels until installation has been accepted.

Glazing Materials: Deliver sealing materials in manufacturer's unopened containers, fully identified with trade name, colour, size, hardness, type, class and grade. Store each glazing and sealing material where they will be free from damage and in strict accordance with the manufacturer's recommendations.

1402 Products

1402.1 Glass

General

Furnish glass materials from an approved manufacturer.

Glass Materials

- External glass type G1 shall be of high performance double glazing with light gray appearance
- Maximum U-Value: UV 3.30 W/m² °C
- Maximum Shading coefficient: 0.46
- The locations for use of the various types of glasses are indicated on related Drawings and Schedules. The various types of glasses are denoted as follows:

(G1): External double glazing panel shall be made of 6mm thick tinted, reflective, laminated panel from outside with 12mm air space and 6mm thick clear panel from inside, with a tinted PVB or CIP interlayer. This type shall be capable of withstanding the local climatic conditions and a wind load of 130 miles/hour.

(G2): Internal glazing panel made of 6mm thick clear glass.

(G3): Internal glazing panel made of 8mm thick clear glass.

(G4): Internal glazing panel made of 6mm thick clear glass, for ½ hour fire rating as indicated on drawings.

(G5): Internal glazing panel made of 6mm thick clear glass, for 1 hour fire rating.

(G6): Internal glazing panel made of 6mm thick clear glass with radiation shielding.

1402.2 Glazing Sealant/ Compounds

General: Provide hardness of materials as recommended by the manufacturer for the required application and condition of installation in each case. Provide only compounds which are known (proven) to be fully compatible with surfaces contacted. Provide the following materials as required for the installation, and as approved by the Supervisor.

Polyvinyl Chloride Glazing Gaskets: Extruded, flexible PVC gaskets of the profile and hardness as required for watertight construction. Comply with BS 2571, or in another material and to standards approved by the Supervisor. If rubber is used then BS 4255 Part 1 shall apply.

Setting Blocks: Neoprene or other resilient blocks of 70-90 durometer hardness, tested for compatibility with sealants used.

Spacers: Neoprene or other resilient material of 40-50 durometer hardness, tested for compatibility with sealants used.

Cleaners, Primers and Sealants: Type recommended by sealant or gasket manufacturer.

Mirror Mastic: Type recommended by mirror manufacturer for spot application system, with less than 25% coverage and 3 mm-12 mm thickness of setting bed, with mirror supported only at lower edge.

Mirror Clips: Stainless Steel.

1403 Execution

1403.1 Inspection

The Contractor shall examine the substrates and the conditions under which glazing work shall be carried out and correct any unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Supervisor.

Weather Conditions: Do not proceed with installation of sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.

1404 Standards and Performance

Watertight and airtight installation of each piece of glass is required for all glazing of exterior units. Each installation shall withstand normal temperature changes, wind loading, impact loading for doors without failure of any kind including loss or breakage of glass, failure of

sealants or gaskets to remain watertight and air-tight, deterioration of glazing materials and other defects in the work.

Protect glass from edge damage at all times during handling, installation and other construction operations of the building.

Glazing channel dimensions as indicated are intended to provide for necessary minimum bite on the glass, minimum edge clearance and adequate sealant thicknesses, with reasonable tolerances. The Contractor shall be responsible for correct glass size for each opening, within the tolerances and necessary dimensions established.

Comply with combined recommendations of glass manufacturer and manufacturer of sealants and other materials used in glazing, except where more stringent requirements are specified, and except where manufacturer's technical representatives direct otherwise.

Comply with BS 6262, unless specifically recommended otherwise by the manufacturer of the glass and glazing materials.

Inspect each piece of glass immediately before installation, and eliminate any which have observable edge damage or face imperfections.

Install double glazed units as "sealed units" i.e. outer and inner sheets of glass to be combined in the factory by the manufacturer with a sealed void and delivered as a single unit for installation, except as otherwise specifically indicated or recommended by glass or sealant manufacturers.

1405 Preparation

Sizes: Determine glass sizes by actual field measurements of frames to receive glass. Make proper allowances for expansion, contraction and movement and provide for proper bedding and bite.

Identifications: Identify glass furnished by type when it is delivered to the site.

Glazing Procedure: Review the glazing procedure and schedule, including the method of delivering and handling glass, applying glazing materials, installing gaskets and removable stops.

1406 Installation

Employ glaziers who have had previous experience with the materials and systems being applied. Use tools and equipment recommended by the glass manufacturer. Comply with BS 8000 Part 7.

Measure all openings and cut glass accurately to fit each opening with minimum edge clearances. If glass is to be cut to size at project site deliver each piece to project at least 50 mm larger (in both dimensions) than required so as to facilitate the cutting of clean-cut edges without the necessity of seamed or nipping.

Clean glazing stops and rebates to receive glazing materials of all obstructions and deleterious substances which might impair the work. Remove protective coatings which may cause adhesion failure or interfere with bond of sealants. Comply with manufacturer's instructions for final wiping of surface immediately before application of primer and glazing compounds or tapes. Wipe metal surfaces with zylol or toluol.

Prime surfaces to receive glazing compounds in accordance with the manufacturer's recommendations, using recommended primers.

Inspect each piece of glass immediately before installation. Pieces which have significant impact damage at edges, scratches or abrasions of faces, or any other evidence of damage shall not be installed.

Locate setting blocks at the quarter points of sill, but no closer than 150 mm to corners of glass. Use blocks of proper size to support the glass in accordance with manufacturer's recommendations.

Provide spacers for all glass to separate glass from stops, except where continuous gaskets or tape are required. Locate spacers 900 mm on centres maximum inside and out, with a minimum of two (2) spacers per edge of glass or as recommended by manufacturer. Provide thickness equal to compound thickness shown. Provide width as required for minimum of 9 mm bite on glass at all 4 edges.

Set glass in a manner which produces greatest possible degree of uniformity in appearance. Face all glass, which has dissimilar faces, with matching faces in the same direction.

Glazing materials from different sources shall not be used in the same joint system unless the manufacturer of each material has stated in writing that his material is fully compatible with the other material.

Butt lap ends of sealant tape in accordance with the manufacturer's recommendations.

Tool exposed surfaces of glazing materials to provide a slight wash away from the glass. Install exposed tapes and gaskets with a slight protrusion above stops in the final compressed condition.

Clean excess sealant or compound from glass if used, and framing members immediately after application using solvents or cleaners recommended by the manufacturers.

Gasket Glazing: Miter cut and bond ends together at corners where gaskets are used for channel glazing, so that gaskets will not pull away from corners and result in voids or leaks in glazing system.

Do not attempt to cut, seam, and nip or abrade glass which is tempered or heat strengthened, including glass which is heat-treated as a result of a coating process.

If sealant is required force sealants into channel to eliminate voids and to ensure complete "wetting" or bond of sealant to glass and channel surfaces.

1407 Cleaning and Protection

Protect glass from breakage immediately upon installation. Use streamers or ribbons suitably attached to framing and held free of the glass. Warning markings, which may stain glass, glazing material, or frames shall not be applied directly to glass.

Remove and replace glass which is broken, cracked, chipped or damaged in any way and from any source, including weather, vandalism and accidents during the construction period.

Maintain glass in a reasonably clean condition during construction so that it will not become stained and will not contribute to the deterioration of glazing materials.

Wash and polish glass on both faces, not more than 4 days prior to handover. Comply with instructions and recommendations of the glass manufacturer and glazing materials manufacturer for cleaning in each case.

1500 BUILDERS HARDWARE

1501 General

1501.1 Description

The extent of builder's hardware (Ironmongery) is shown on the drawings, by the provisions of this section, and in schedules. Builder's hardware is hereby defined to include all items known commercially as builders hardware, as required for swing and sliding doors, except special types of unique and non-matching hardware specified in the same section as the door and door frame.

The required types of builder's hardware and related items include (but are not necessarily limited to) the following:

- Butts and Hinges.
- Knob Sets / Lever Handles.
- Lock cylinders and keys.
- Lock and latch sets.
- Flush Bolts
- Panic exit devices.
- Push/pull units.
- Door Closers.
- Protection plates.
- Stripping and seals.
- Key Control.
- Door stops.

Each Contractor/Manufacturer shall thoroughly review the hardware sets and schedule included hereinafter in these Specifications and submit the appropriate hardware set to suit the hospital doors function for the approval of the Supervisor.

Ironmongery to wood or steel doors, access panels, timber windows, etc., shall generally be from an internationally recognized, fully coordinated suite, in continuing production, of consistent design and finish, with a ready supply of extras and spares.

Ironmongery shall reflect the use(s) and quality of the project, facilitate building use and maintenance, prevent unauthorised access or egress, allow and direct escape from, protect against and inhibit spread of fire, smoke or other hazards, protect doors and surfaces and create desired aesthetic effects.

Standards of design and finish of door furniture shall as a minimum be equivalent to the "Allgood Mode" and/or "Allgood Modric" suites. Standards of design, finish and performance for mechanical and/or electronic items shall as a minimum be equivalent to the "Allgood Hardware" and "Allgood Secure" suites.

Alternative, fully matched and suited ranges, of not inferior quality, design, performance and finish may be accepted, subject to the Supervisor's Representative approval.

1501.2 Quality Assurance

Dimensions: Dimensions as given by the manufacturers shall be subject to production tolerances of + 0.25 mm.

Fire-Rated Openings: Provide hardware for fire-rated opening in compliance with BS 476. Provide only hardware which has been tested and approved for types and sizes of doors required.

Manufacture of doors, frames, ironmongery and other components for door assemblies shall be executed under comprehensive Quality Assurance (QA) schemes to BSENISO9002. This quality management standard is additional to individual performance requirements.

QA manuals shall require that all products and components be manufactured on machines with proper safety screens and other safety measures installed and in factories incorporating proper ventilation and dust filtering systems

The QA manual of each manufacturer of components of door assemblies which must achieve fire, smoke and/or acoustic control rating(s) shall require that every such component be of identical construction to the equivalent component as included in any performance test(s) and/or assessment(s) used to support such rating(s). Provide written confirmation thereof, with copies of the appropriate section(s) of the Quality Assurance Manual(s).

The supplier's permanent, qualified, staff shall provide full, local, technical support, properly prepare and maintain door and ironmongery schedules and master key layouts and advise on specification, installation and operation.

Codes and Standards: Comply with the applicable requirements of the following.

BS - British Standards:

BSEN179	Emergency exit devices
BS476	Fire tests on building materials and structure
BS729	Hot dip galvanised coatings
BSEN1125	Panic exit devices
BSEN1154	Door closing devices
BSEN1155	Electrically powered door holders
BSEN1158	Door co-ordinators
BS1210	Wood screws
BSEN1303	Cylinders for locks
BS1449	Steel plate, sheet and strip
BS1470-7	Wrought aluminium
BSEN1527	Sliding door gear
BSEN1634-1	Fire testing
BSEN1670	Corrosion resistance
BS1706	Electroplated coatings of cadmium and zinc
BSEN1906	Lever handles and knobs
BSEN1935	Single axis hinges

BS2870/4/5	Copper and copper alloys
BS2911	Letter plates
BS3621	Thief resistant locks
BS3827	Glossary of terms
BS4112	Hardware for domestic furniture
BS4951	Builder's hardware – lock and latch furniture (doors)
BS5378	Safety signs and colours
BS5499	Emergency signs
BS5839 Pt. 3	Fire detectors and automatic release mechanisms
BS5872	Locks and latches for doors in buildings
BS6496	Powder organic coatings for application and stoving to aluminium alloy
BS8220	Guide for security of buildings against crime
BSEN12051	Door and window bolts
BSEN12320	Padlocks and padlock fittings

1502 Submittals

Manufacturer's Data; Builders Hardware: Submit manufacturer's product data, including illustrations, for each item of hardware. Include whatever information may be necessary to show compliance with requirements, and include instructions for installation and for maintenance of operating parts and exposed finishes. Wherever needed, furnish templates to fabricators of other work which shall receive finish hardware. Transmit copy of applicable data to the Supervisor.

Hardware Schedules; Builders Hardware: Submit 5 copies of the hardware schedule in the manner and format specified. Hardware schedules are intended for coordination of the work. Review and acceptance by the Supervisor does not relieve the Contractor of his exclusive responsibility to fulfil the requirements as shown and specified.

Meet with the Supervisor or the Client and determine his requirements regarding keying of locks. Submit 5 copies of a separate key schedule, showing clearly how the Client's final instructions on keying of locks have been fulfilled. Also a master key shall be submitted.

1502.1 Samples; Builders Hardware

Prior to submittal of the final hardware schedule and prior to delivery of hardware, submit one sample of each exposed hardware unit, finished as required, and tagged with full description for coordination with the schedule. Sample board of all hardware units shall be kept at site office until completion of the project. Sample will be reviewed by the Supervisor for design, colour and texture only. Compliance with other requirements is the exclusive responsibility of the Contractor.

Units which are acceptable and remain undamaged through submittal, review and field comparison procedures may, after final check of operation, be used in the work, within limitations of keying coordination requirements.

1503 Product Packaging, Delivery, Storage and Handling

Supply ironmongery, complete with fixings and fixing instructions, in substantial, secure, protective packages, well labelled for easy identification. Major items, such as lock cases, lever furniture, cylinders and cylinder roses, bathroom turns and indicators and flush bolt sets shall be supplied in single configured sets whilst door closers, panic devices, hinges, pull handles, door stops and plates shall be individually packaged. Deliver the packaged ironmongery in substantial, protective boxes, suitable for the mode of transport, with no box weighing over 50kg.

Provide secure lock-up for hardware delivered to the Site but not yet installed. Control the handling and installation of hardware items which are not immediately replaceable, so that the completion of the work will not be delayed by hardware losses.

1504 Job Conditions

Coordination: Coordinate hardware with other work. Tag each item or package separately, with identification related to the final hardware schedule, and include basic installation instructions in the package. Furnish hardware items of proper design for use on doors and frames of the thicknesses, profile, swing, security and similar requirements indicated, as necessary for proper installation and function. Deliver individually packaged hardware items at the proper times to the proper locations (shop or project site) for installation.

Templates: Furnish hardware templates to each fabricator of doors, frames and other work to be factory-prepared for the installation of hardware. Upon request, check the shop drawings of such other work, to confirm that adequate provisions are made for the proper installation of hardware.

1505 Products

1505.1 Materials, Finishes and Fixings

Materials shall not be subject to galvanic corrosion with backgrounds or other ironmongery. Finished surfaces of one material whether extruded, rolled, cast or stamped, shall match exactly in colour and texture and all finishes visible on a door face shall be visually identical, unless otherwise specified.

Unless otherwise specified, materials shall be:

Aluminium: BS1470-7 HE9-TF alloy.

Stainless Steel: BSEN58J Grade 316 (18/10/3 molybdenum bearing grade). Lower grades will not be accepted for accessories such as lock strike plates, rebate components, etc.

Brass: BS2870/4/5 CZ121/2874 alloy

Real Bronze: Solid cast bronze of suitable alloy.

Photo-luminescent Plastics: Non-toxic, non-radioactive, green polycarbonate to DIN67510, measured value FL.2.1-280 and 2.10mcd/m² minimum luminous density one hour after excitation, to store natural or artificial light and if lights fail, radiate a bright luminosity.

Unless otherwise specified, visible finishes shall be:

Aluminium: Hand polished then anodised to BS1615, Grade AA15 and BSEN1670 Class 4 corrosion resistance.

Stainless Steel: Either No. 4 satin finish, or hand polished to a platinum like reflectance (exceeding requirements of No. 8 finish) as specified, for BSEN1670 Class 4 corrosion resistance.

Brass or Bronze with natural finishes: Satin or mirror polished then protected by transparent powder coating as specified below for BSEN1670 Class 3 corrosion resistance.

Brass with Bronze plated finish: Bronze plated and acid relieved, then protected by transparent powder coating as specified below for BSEN1670 Class 3 corrosion resistance.

Real Bronze with oxidised finish: Oxidised to Real Bronze Metal Antiqued (RBMA) patina.

Nickel or Chromium plating: To BS1224 for BSEN1670 Class 3 corrosion resistance

Gold Plating: To BS4292 for BSEN1670 Class 3 corrosion resistance

Powder Coating: Electrostatically applied, oven cured coating to BS6496, tested to BS6496 and for light fastness, detergent resistance, impact and abrasion resistance (ASTM D 522 conical mandrill and BS3900 falling ball), adhesion (BS3900,1mm crosscut) and scratch resistance (BS3900, 2000g load). Colour coatings shall be applied to polished anodised aluminium and shall provide BSEN1670 Class 4 corrosion resistance. Colours shall be selected by the Supervisor from not less than 100 ICI Colour Dimensions colours, for exact colour co-ordination of ironmongery with paints.

Surface Hygiene Coating: To inhibit the growth of a wide range of micro-organisms including: E. Coli (incl 0157), Listeria Monocytogenes, Salmonella Enteritidis, Staphylococcus Aureus (incl MRSA), Streptococcus Faecalis for a minimum of ten years in normal use providing tonal contrast to wall and door finishes to BS8300 with third party test documented evidence.

Applied electrostatically and then oven cured with a film thickness of 60-80 microns to BS6496 within ISO 9001 accredited facilities. Tested for light fastness and detergent resistance to BS6496. Adhesion to BS3900 E6 - 1mm crosscut with no detachment, scratch resistance to BS3900 E2- pass 4Kg, impact to BS3900 E3 - pass 100in/lbs., abrasion to ASTM D 522 - conical mandrill, bend to BS3900 E1- pass 3mm, humidity to BS3900 F9 - no blistering after 1000 hrs. (zinc phosphate steel), salt spray to ASTM B117 - 2-4mm creep after 1000 hours (zinc phosphate steel) and heat stability - no yellowing on continuous exposure to 130C (gloss only).

Protect iron or steel surfaces by galvanizing to BS729, zinc or cadmium plating to BS1706 or other approved methods, to BSEN1670 Class 3 corrosion resistance.

Provide suitable, matching, metric, positive drive fixings of correct types and lengths for background constructions, with visible finishes to match the item fixed.

1505.2 Fire and Smoke Control Assembles

Ironmongery to fire rated and/or smoke control assemblies must satisfy the requirements of relevant statutory and regulatory bodies and the relevant sections hereof.

Fire testing shall be executed to BSEN1634 or approved, equivalent standards. Fire tests shall be based on full-sized assemblies. In view of the extent of the expansion of metal doors and frames in a fire, only test data or assessments based on positive pressure type fire testing, such as BSEN1634 shall be considered acceptable for such assemblies.

The door leaf manufacturer shall supply fire and/or smoke control test data and/or assessments for assemblies, in latched and/or unlatched configurations as appropriate, and provide intumescent and/or cold smoke seals, as required to achieve specified ratings.

Suppliers of seals, edge protectors, ironmongery and other items shall supply test data to BSEN1634 for relevant items, to enable the door manufacturer to obtain necessary assessments and certify the performance of the complete assemblies. Data shall be for constructions similar to those used in the Works and data for other constructions, or entailing special facings, are unacceptable.

1505.3 Hinges, Pivots, and Accessories

Hinges and pivots shall be to BSEN1935 of the appropriate class for the door size, weight and duty, with heavy-duty, maintenance free, concealed bearings. Hinges to large and/or heavy use doors in public areas shall be of a concealed maintenance free bearing type to Grade 14.

Unless otherwise stated, hinges and fixing screws shall be Grade 316 stainless steel, all finished to match other hardware on the door face, including plating to match brass, bronze or other finishes, where required.

Provide hinges of the following types:

- For timber doors and frames: Jig drilled, with offset drilling patterns.

For timber doors with steel frames: Interleaf type, controlling frame gap without cut-outs or interruption of intumescent seals and with different drilling patterns for leaf and frame.

For pressed steel doors and frames: ANSI template drilled.

For assemblies of steel sections: Interleaf type, controlling frame gap, without cut-outs in sections. For outward opening external and/or security doors in areas liable to attack, provide hinges with integral security studs.

Unless otherwise specified, provide two hinges per leaf up to 1800mm high and one extra hinge for each additional 450mm height (or part thereof).

For latch less, single leaf doors to individual WC cubicles, up to 2300mm high and without closers, provide two single action rising (fall-to) or falling (fall-open) butts of aluminium or brass with manganese bronze cams and corrosion resistant pins. Stainless steel rising butts without cams are unacceptable. Unless otherwise specified, provide falling butts within Back of House toilets, locker rooms and the like, to show occupancy status but rising butts within public toilets.

Provide conductor hinges or concealed fixing, flexible metal cable loops to transfer wiring for electromagnetic fire hold closers, solenoid locks and the like between frame and door leaf.

1506 Panic Exit Devices

Horizontal bar operated panic exit devices, except to single leaf doors in service areas accessible only to maintenance staff, shall be Touch bar type. They shall be easily reversible, low projection, Touch bar type to BSEN1125 Grade 3-7-6-0-1-3-2-2-B, with secret "hold unlocked" facility and photo-luminescent "in bar" signage to BS5499. Standard units shall suit doors 800-1380mm wide and up to 3000mm high, with options for other sizes as required.

Horizontal bar operated panic exit devices to single leaf doors in service areas accessible only to maintenance staff may be standard projection, push bar type to BSEN1125 Grade 3-6-6-1-1-3-2-1-A.

Panic exit devices to pairs of doors shall not allow escape to be prevented by padlocking a chain around crossbars or other components.

In addition to the corrosion test requirements of BSEN1125, which relate to performance only, the equivalent visual requirements for significant surfaces of BSEN1670, Clause 5.7 Class 3 shall apply.

Panic exit devices shall accept an outside cylinder and/or lever or knob handle operators, local alarms, remote monitoring and/or motor operation as required.

In accordance with ABHM Code of Practice "Hardware for Timber Fire and Escape Doors" (Clause 11.3.3.1) Clauses B.2 and B.3 of BSEN1125 do not preclude the use on fire rated assemblies of devices without automatic re-latching and/or with dogging mechanism. Manufacturers of fire rated assemblies to receive such devices shall supply test data to show that latch less assemblies have been successfully fire tested.

1507 Locks and Latches:

Mortice lock suites shall be to BS5872 Category B, with:

- Replaceable forends and strike plates and rebate components if for rebated meeting edges, of materials to match door furniture, with no exposed sharp edges or corners.
- Piercing for bolting through of single sided lever or knob furniture, if required.
- Facility for full reversal of handing, without opening the case.
- If to receive lever handles, special, heavy springing against progressive lever droop (levers with sprung roses or back plates are unacceptable due to potential for damage and corrosion).
- If to receive knob handles, soft springing, with two-way action and 100mm minimum back set.

Cylinders shall be easily removable when the door is open, without dismantling trim but non-removable when closed. Cylinder fixing screws shall be concealed behind lock faceplates.

Heavy duty, modular, security locks shall be equivalent to the 72 Series, with 11mm (minimum) low friction, Grade 316 stainless steel latch bolts, 20mm (minimum) single throw deadbolts and followers with gripping action, for improved durability and security and reduced noise.

Heavy duty, high security locks and solenoid locks shall be equivalent to the 99 Series, with 19mm (minimum) throw stainless steel, three part, low friction, guided latch bolts with anti-thrust devices and/or 25mm (minimum) throw deadbolts with hardened steel rollers, as appropriate. They shall be certified by the US Underwriter's Laboratory or other approved security and fire rating body.

General duty locks shall be equivalent to the 75 Series, with 12mm (minimum) brass latch bolts and 13mm (minimum) brass deadbolts, with hardened steel rollers.

WC cubicle locks shall be mortice type, with inside thumbturn and coin operated, outside emergency release, unless door/frame details are unsuitable, when surface types are acceptable. In public areas, emergency releases shall incorporate red/white outside indicators. In dwelling areas, emergency releases shall not incorporate visual indicators.

1508 Mechanical Locking Cylinders and Keying

Cylinders shall be to BSEN1303 to match door furniture (including coloured finishes). Standard cylinder lengths shall suit doors up to 58mm thick, when used with the specified roses or back plates, with other lengths available as required and shall be under Master Key-System.

Unless otherwise stated, locks and panic exit devices shall be keyed to a system of Grand Master, Master and Sub-Master Suites without compromise to security standards and shall be construction keyed, with ten keys provided for site use. On completion, operation by a master key shall exclude all construction keys.

To allow specialist doors, such as aluminium doors, roller shutters and metal gates, to be integrated into the master key system, the door manufacturers shall provide locks to receive standard euro-profile cylinders.

Lock cylinders shall be capable of achieving required master keying systems, with adequate provision for future expansion, without compromise to security and without the need to cut keys to depths at which they become susceptible to breakage.

General lock cylinders shall be equivalent to an Advanced Series, of five-pin, integrated keyway types, with double paracentric keyways, mushroom drivers, triple grooved, anti-pick pins, hardened anti-drill pins, off-centre cams and two keys per cylinder as standard to BS1303 Grade 3.

High security lock cylinders shall be equivalent to an Advanced High Security Series, six-pin, double-locking types, offering practically infinite differs, with double paracentric keyways, mushroom drivers, triple grooved, anti-pick pins and multiple side pins, hardened anti-drill pins, off-centre cams and three keys per cylinder as standard. Keys shall be subject to a manufacturer's CARS (Computer Aided Registration System) key registration system, for which blanks are not freely available to BS1303 Grade 4.

Padlocks shall be of appropriate grades to BSEN12320, and capable of master and construction keying together with other locks.

1509 Electronic Locking Cylinders

Electronic access control cylinders shall be “Emit” or equivalent armoured, security type cylinders, with continuously changing bi-directional data codes. They shall be programmable through a configuration device attached to a laptop computer with Windows compatible software to allow:

- Establishment of a “master key” type hierarchy and “construction keying” if required
- Where required, the establishment of time profiles and audit trail reporting
- The ability by use of processor units, for transponders to also operate hard-wired access control and security systems elsewhere in the project
- Easy addition and/or deletion of users, to ensure functionality and maintain security

Batteries shall require replacement after approximately 60,000 operations.

1510 Door Furniture and Plates

Lever assemblies shall be non-sprung, to BSEN1906 incorporating four heavy duty captive MDS maintenance free, self-lubricating and corrosion resistant bearings. Roses shall project no more than 3mm from the door face, with concealed bolt through fixings.

Spindles for furniture shall be corrosion proofed, high tensile steel. Standard spindles shall suit 35-55mm thick doors.

If half sets of furniture are to operate locks, use XX9052NT or equivalent special spindles requiring no piercing of the opposite door face.

For pairs of dummy levers or knobs provide XX47460 or equivalent “Rigidisers”. For single sided dummy levers or knobs provide XX47460/XX9052NT or equivalent “Rigidisers” and special spindles requiring no piercing of the opposite door face. “Taylor” type or similar, face fixed, fix dead spindles are unacceptable, due to vulnerability to forcible damage.

Unless otherwise specified, supply pull handles with bolt through fixings and seating cups, concealed by push plates on the reverse face, or back-to-back fixings as appropriate. Face fixed pulls are acceptable only if unavoidable (e.g. if a lock case would obstruct bolts).

Unless otherwise specified, protection plates shall be 3mm thick if aluminium and 2mm thick if stainless steel or brass, with edges softened, to prevent injury to installers, users, cleaners, etc. Fix plates with suitable countersunk screws located 5mm from edges, at each corner and equally spaced, at 240mm maximum centres.

If lever handles are used on escape routes, supply special, unobtrusive, rose surrounds or insert escutcheons of photo-luminescent material as specified.

Unless otherwise specified, furniture for privacy locks shall incorporate inside thumbturn and coin operated, outside emergency release. In public areas, emergency releases shall incorporate red/white outside indicators. In dwelling areas, emergency releases shall not incorporate visual indicators.

1511 Door Controls

Door closing devices shall be cap less controlled closing types, from matching suites, with a full range of optional functions, including mechanical and electromagnetic stand open and delayed closing. Uncontrolled devices (e.g. spring hinges) are unacceptable, due to noise of operation and potential for damage to doors, frames, ironmongery, etc.

Closers for fire rated doors shall be to BSEN1154 Category of Use 4, to close a door from up to 180 degrees. In accordance with the ABHM Code of Practice “Hardware for Timber Fire and Escape Doors” (Clause 3.3.1), no closer for use on a fire rated door shall be less than Size 3.

All products to have been incorporated in successful fire tests and assessed to BS476 pt. 22 (30, 60 and 120 minutes) and BS EN 1634 (30 and 120 minutes).

Closers for healthcare projects shall comply with UK Health Technical Memorandum 59.

In addition to the corrosion test requirements of BSEN1154, which relate to performance only, the visual requirements for significant surfaces of BSEN1670, Clause 5.7 Class 3 shall apply.

Where specified, supply special function closers. If stand open is specified on non-fire rated doors, supply suitable special arms. Back check and/or delayed closing, where specified, shall be to BSEN1154.

Cap less surface closers shall suit doors of either hand and have visually pleasing, 50mm maximum projection, plain, rectangular, solid bodies of aluminium, brass or stainless steel (not removable covers), with visible surfaces, including arms, finished identically to other items on the door and with no permanent visible markings (except as required by relevant standards).

Cap less surface closers, except to service areas accessible only to maintenance staff, shall be equivalent to the 9151/6 Series, to BSEN1154 Class 4-8-2/4-1-1-3, power adjustable for doors from 300mm to 1250mm wide and 40kg to 80kg mass, or equivalent grade to Table 2 for doors of greater width/mass. They shall incorporate adjustable, hydraulic back check.

Cap less surface closers to service areas accessible only to maintenance staff shall be equivalent to the 9171/6 Series, universal arm (push- or pull-to) type, to BSEN1154 Class 4-8-3-1-1-3, for doors up to 950mm wide and 60kg mass or equivalent grades to Table 2 for doors of greater width/mass.

Transom mounted overhead concealed closers shall be to BSEN1154 Class 4-8-3-1-1-3, for doors from 850mm to 1100mm and 80kg mass, or equivalent grades to Table 2 for doors of greater width/mass.

To avoid reductions in efficiency which may result when fixing surface mounted closers on the pull side of a door, provide test data for all closers specified with parallel (pull-to) or universal (push- or pull-to) arms to show that the closer achieves the specified power classification(s) when mounted on the pull side of the door.

Door mounted overhead concealed closers shall be equivalent to the 9124 Series, to BSEN1154 Class 4-8-1/3-1-1-2, adjustable for doors from 500mm to 1100mm wide and 40kg to 80kg mass, or equivalent grades to Table 2 for doors of greater width/mass. Minimum recommended door thickness of 45mm.

Floor mounted concealed closers shall be visually pleasing, heavy duty, adjustable, hydraulic check types, with thermo-constant stabilising fluid. All floor springs should be non-handed (i.e. they are reversible). Single action straps are to be Grade 316 stainless steel, double action straps should be forged steel, both with full intumescent protection.

All floor springs for double swing doors, including plate glass assemblies, shall have micro-adjustable toe-in and positive centring, to ensure that leaves can be fully aligned in closed position.

Floor springs for main circulation routes, auditorium and other heavy use locations shall be equivalent to the Commander Series, to BSEN1154 Class 4-8-2/6-1-1-3, power adjustable for doors from 300mm to 1400mm wide and 20kg to 120kg mass, or equivalent grade to Table 2 for doors of greater width/mass. They shall incorporate adjustable, hydraulic back check and built-in levelling device.

Floor springs for medium use locations shall be equivalent to the Cavalier Series, to BSEN1154 Class 4-8-3-1-1-3, fixed power for doors up to 950mm wide and 60kg mass, or equivalent grades to Table 2 for doors of greater width/mass. They shall incorporate hydraulic back check and built-in levelling device.

Electromagnetic fire-hold closers shall be to BSEN1155 and of the same design, finish and standards as other closers. Surface type fire-hold closers shall be equivalent to the 9451/6Series, Class 3-5-4-1-1-3 and floor-mounted concealed type shall be equivalent to the Commander Series, Class 3-5-4-1-1-3. They shall allow the door to:

- Hold open electro-magnetically when set and, on receipt of a signal from a central fire alarm or other device, automatically release and properly close
- Close immediately if physically pushed to, if an integral fire officer test button is pressed, or if power fails.

Power sources for fire hold closers shall be Class II Safety Isolated Transformers to BS3535. If fire alarm systems do not incorporate clean contacts, transformers shall incorporate relay control interfaces.

All door closing devices used on fire or smoke control doors shall incorporate fire retardant fluid.

Automatic door operators shall be approved, high quality devices to BS7036, to suit the door construction, configuration, location and frequency of use and operate at 230/240vAC 50Hz. Finishes shall match other hardware on the door and units shall be frame mounted wherever possible, on the door face least susceptible to weather and/or tampering. Operators for fire rated doors shall be of suitable types which will not compromise the fire rating, linked to fire alarm systems to close automatically in case of fire. Operators shall allow adjustment of opening and closing speed, hold open time, back check and power and allow manual override, in case of power failure.

If one leaf of a pair of self-closing doors must close before the other, due to rebated styles, latch bolts, etc., supply suitable matching selectors to BSEN1158 Class 3-5-*-1-1-3 (where “*” denotes the appropriate door mass from Table 1), of types which do not obstruct ironmongery or affect fire ratings. Use sprung-arm, under-frame fixing selectors for outward opening doors and rebate or face fixing types for inward opening doors.

1512 Bolts

Bolts shall be to BSEN12051 and, unless otherwise stated, of the following minimum classifications:

- Flush bolts: Class 3-4-0-1-1-3-3, supplied in packaged kit form comprising top bolt and keep and bottom bolt and easy clean socket, suitable to secure the inactive leaf of locking pair of doors
- Barrel, tower and mortice bolts: Class 3-4-0-1-1-3-3
- Foot, drop, square spring of garage door bolts and padlock bolts: Class 3-4-0-1-1-4-4

Unless otherwise stated:

- Bottom bolts shall be 150mm minimum long
- Top bolts to doors up to 2000mm high shall be 150mm long. For taller doors, increase bolt length by 150mm for each 150mm of additional height, or part thereof. For very tall doors, automatic flush bolts may be substituted

Bolts generally shall be of a high quality, lever action, flush type, with dovetail returns to resist forcing and/or frame damage. Mount lever action flush bolts to door edges, wherever practical, for concealed fixing and to discourage misuse.

Bolts to duct doors may be of a good quality, anodised aluminium, and surface type. If doors open outwards, top bolts shall be necked to allow proper fixing.

1513 Door Stops

Provide suitable stops, where required to protect doors, ironmongery or surfaces, of concealed fixing types with robust holders matching other ironmongery on the door and rubber inserts, which are easily replaceable, using simple tools.

Select door stops according to the following order of preference:

- On individual toilet, WC or shower cubicle doors opening inwards onto walls, use buffer hat and coat hooks.
- Except within dwelling areas, where possibly use wall bumpers, mounted where door handles would strike the wall.
- If wall mounted stops are impractical, in areas with solid floors, use floor mounted stops, with expansion shield fixings.
- If wall and floor mounted stops are impractical, or where timber or carpet flooring is specified, use skirting mounted stops.
- Where there is no practical alternative, use concealed fixing, stainless steel and aluminium, overhead limit stays.

1514 Sliding Door Gear

Sliding gear shall be high quality, proprietary units of suitable type and capacity, to BSEN1527.

Flush pulls, sliding door locks, etc. shall be from the same suite as other architectural ironmongery.

1515 Sundries and Cupboard Hardware

Ironmongery to cupboards, fittings, fixtures, etc., shall suit the location and function and match architectural ironmongery in quality, design and finish.

Flush and drawer pulls shall be approved, suitably sized units from the same range as architectural ironmongery.

Drawer slides shall be heavy-duty rust proofed enamelled steel, with nylon cages and steel bearings able to bear the required load at full extension and with positive closing action.

Hat and coat hooks shall be visually pleasing. Where vulnerable to abuse, use heavy-duty hooks independently certified to withstand 1000N applied load without deformation with the fixings supplied. In psychiatric or detention facilities, use units, which collapse if improperly used and can be subsequently reset.

If required, supply suitable, approved, proprietary lockable key filing and security cabinets, suitably located, to hold one key for each lock in the works plus 25% spare capacity. For each space in the cabinet, supply four plastic key tags with key inserts and five card "key out" tabs.

1516 Spare Parts

An adequate supply of spare parts and/or replacement material for builders' hardware shall be provided at Contractor's expense to replace defective material, occurring prior to the six months follow-up inspection which will be carried out by Contractor and latch and lock manufacturers as described herein below. This shall include but not be limited to locks, doors closers, door handle sets, etc. The exact amount of such spare parts shall be agreed upon after finalization of the master system schedule.

1517 Execution

1517.1 Hardware Mounting Heights

Mount hardware units at the following locations on each door or door opening, except as otherwise specifically indicated, or required to comply with governing regulations, and except as otherwise directed by the Supervisor Representative.

- Lowest Hinge: 250 mm above floor to bottom of hinge.
- Highest Hinge: 125 mm below top of door to top of unit.
- Intermediate Hinges: Equally spaced between lowest and highest hinge units.
- Lock and Latch Sets: Knobs centered 965 mm above floor.
- Dead Lock: Cylinder and strike centered 1524 mm above floor.
- Door Push/Pull Plate: Pull centered 1143 mm above floor, also centered 120 mm from door edge, unless stile width necessitates other location.

- Arm Pull: Center arm pull 1200 mm from floor, also centered 300 mm from edge of door.
- Exit Device: Operating bar centered 1067 mm above floor.
- Bolts, Head and Sill: Operating device centered not more than 1800 mm above floor unless otherwise directed.
- Bolts, pulls and other special units: Units mounted at height recommended by manufacturer.

1517.2 Installation

Install each hardware item in compliance with the manufacturer's installations and recommendations. Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be painted or finished in another way, coordinate removal, storage and reinstallation or application of surface protection with finishing work specified in the Division 9 - Finishes. Do not install surface-mounted items until finishes have been completed on the substrate.

Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

Cut and fit threshold and floor covers to profile of door frames, with mitered corners and hair-line joints. Join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items.

Screw thresholds to substrate with No. 10 or larger screws, of the proper type for permanent anchorage and of bronze or stainless steel which will not corrode in contact with the threshold metal.

At exterior doors and elsewhere as indicated, set thresholds in a bed of either butyl rubber sealant or polyisobutylene mastic sealant to completely fill concealed voids and exclude moisture from every source. Do not plug drainage holes or block weeps. Remove excess sealant.

1517.3 Adjust and Clean

Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application made.

Final Adjustment: Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy, and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

Instruct Client Personnel in proper adjustment and maintenance of hardware and hardware finishes, during the final adjustment of hardware.

Continued Maintenance Service: Approximately six months after the acceptance of hardware in each area, the Contractor, accompanied by the representative of the latch and lock manufacturer, shall return to the project and re-adjust every item of hardware to restore proper function of doors and hardware. Consult with and instruct Client personnel in recommended additions to the maintenance procedures. Replace hardware items which have deteriorated or failed due to faulty design, materials or installation of hardware units.

1518 Hardware Set for All Building Types

The Contractor shall provide Master Key System based on the hardware schedule presented in Table 6, and Table 7 below.

1518.1 Ground Floor

Table 6: Ground Floor Hardware Schedule

Door No.	Hardware
GD-1	21
GD-2	5, 16, 24
GD-3	5, 16, 24
GD-4	1, 2, 5, 9, 10
GD-5	5, 16, 24
GD-6	5, 16, 24
GD-7	5, 16, 24
GD-8	4,5, 7
GD-9	5, 16, 24
GD-10	5, 16, 22, 23
GD-11	5, 16,7, 22, 23
GD-12	5, 16,7, 22, 23
GD-13	5, 16, 22, 23
GD-14	5, 16, 22, 23
GD-15	5, 16, 22, 23
GD-16	4,5,7
GD-17	5, 16, 24
GD-18	5, 7, 9, 10, 23, 26
GD-19	1, 5, 7, 16
GD-20	1, 5, 7, 16
GD-21	5, 7, 16, 24
GD-22	2, 7, 16, 22, 23, 26
GD-23	2, 7, 16, 22, 23, 26
GD-24	2, 7, 16, 22, 23, 26
GD-25	2, 7, 16, 22, 23, 26
GD-26	2, 7, 16, 22, 23, 26
GD-27	4, 5, 8, 15
GD-28	
GD-29	2, 7, 16, 22, 23, 26
GD-30	2, 7, 16, 22, 23, 26
GD-31	2, 7, 16, 22, 23, 26

Door No.	Hardware
GD-32	2, 7, 16, 22, 23, 26
GD-33	2, 7, 16, 22, 23, 26
GD-34	5, 7, 16, 22, 23, 26
GD-35	2, 7, 16, 22, 23, 26
GD-36	2, 7, 16, 22, 23, 26
GD-37	1, 5, 8, 16
GD-38	3, 5, 7, 16
GD-39	3, 5, 7
GD-40	4, 5, 8
GD-41	3, 5, 7, 16
GD-42	5, 7, 16, 22, 23, 24, 26
GD-43	4, 5, 7
GD-44	5, 7, 16, 22, 23, 24, 26
GD-45	5, 7, 16, 22, 23, 24, 26
GD-46	5, 7, 16, 22, 23, 24, 26
GD-47	5, 7, 16, 22, 23, 24, 26
GD-48	
GD-48	5, 7, 16, 22, 23, 24, 26
GD-50	5, 7, 16, 22, 23, 24, 26
GD-51	5, 7, 16, 22, 23, 24, 26
GD-52	4, 5, 8
GD-53	5, 7, 16, 22, 23, 24, 26
GD-54	5, 7, 16, 22, 23, 24, 26
GD-55	5, 7, 16, 22, 23, 24, 26
GD-56	5, 7, 16, 22, 23, 24, 26
GD-57	4, 5, 8
GD-58	5, 16, 24
GD-59	5, 16, 24
GD-60	5, 7, 16, 22, 23, 24, 26
GD-61	5, 7, 16, 22, 23, 24, 26
GD-62	5, 7, 16, 22, 23, 24, 26
GD-63	5, 7, 16, 22, 23, 24, 26
GD-64	5, 7, 16, 22, 23, 24, 26
GD-65	5, 7, 16, 22, 23
GD-66	3, 5, 7
GD-67	5, 7, 16, 22, 23
GD-68	3, 5, 7
GD-69	5, 7, 16, 24
GD-70	1, 2, 5, 9, 10, 12
GD-71	1, 2, 5, 16
GD-72	1, 2, 5, 16

1518.2 **First Floor**

Table 7: First Floor Hardware Schedule

Door No.	Hardware
FD-1	5,7,16,24
FD-2	2, 7, 16, 22, 23, 26
FD-3	2, 7, 16, 22, 23, 26
FD-4	2, 7, 16, 22, 23, 26
FD-5	2, 7, 16, 22, 23, 26
FD-6	4,5,8
FD-7	4,5,8
FD-8	1,5,7,16
FD-9	1,5,8,16
FD-10	4,5,8
FD-11	3,5,7
FD-12	5,7,16,24
FD-13	1,5,7,16
FD-14	1,5,7,16
FD-15	1,5,7,16
FD-16	1,2,5,16
FD-17	1,5,7,16
FD-18	1,5,8,16
FD-19	1,5,7,16
FD-20	1,5,8,16
FD-21	1,5,7,16
FD-22	1,5,7,16
FD-23	1,2,5,16
FD-24	1,2 ,5,16
FD-25	1,5,7,16
FD-26	1,5,7,16
FD-27	1,5,7,16
FD-28	1,5,7,16
FD-29	5,7,16,24
FD-30	1,5,7,16
FD-31	4,5,8
FD-32	1,5,8,16
FD-33	1,5,8,16
FD-34	4,5,8,16
FD-35	4,5,7,16
FD-36	5,7,16,24
FD-37	1,5,7,16
FD-38	1,5,7,16
FD-39	1,2,5,16
FD-40	1,5,7,16

Door No.	Hardware
FD-41	1,5,8,16
FD-42	1,5,7,16
FD-43	1,5,8,16
FD-44	1,5,7,16
FD-45	1,5,7,16
FD-46	1,2,5,16
FD-47	1,2,5,16
FD-48	1,5,7,16
FD-48	1,5,7,16
FD-50	1,5,7,16
FD-51	1,5,7,16
FD-52	5,7,16,24

1518.3 Schedule

Table 8: General Schedule Description

Item No.	Description	Finishes
1	Entrance Knobset: Latch Bolt by knob from either side except when outside knob is locked by “Push and Turn to right” action of entire inside knob. Turning key in outside knob, or rotating inside knob automatically releases outside knob	Saint Aluminum
2	Bore – in Cylinder deadbolt: locked or unlocked by key from either side. Deadbolt automatically deadlocks when fully extended.	Saint Aluminum
3	Bathroom Knobset: Latch bolt by knob either side expect when outside knob is locked by “Push and Turn to right” action of entire inside knob. Emergency release opening in outside knob. Rotating inside knob automatically releases outside knob	Saint Aluminum
4	Store room Knobset: Latch bolt by key from outside and by knob from inside. Outside knob is always rigid, inside knob is always free.	Saint Aluminum
5	1-1/2” pair 76mm x 100mm fixed pinned stainless steel butts	Saint Aluminum
6	1-1/2” pair 76mm x 100mm fixed pinned butts	Stainless steel
7	76mm projection wall mounted door stops	Stain Aluminum
8	Floor mounted door stop	Stain Aluminum
9	1 pair 152mm Flush bolts mounted on inside edge of door	Stain Aluminum
10	Easy clean flush bolt socket	Stain Aluminum
11	Double cylinder entrance lock- deadbolt thrown or retracted by key from either side. Latch retracted by thumb piece from outside or by inside knob/lever	Stain Aluminum
12	Outside and inside dummy trim-fixed thumbpiece and inside lever dummy cylinder with inside plate	Stain Aluminum
13	2 No. double ball door catch mounted on inside edge of door and door frame	Stain Aluminum

Item No.	Description	Finishes
14	1 pair 75mm x 100mm fixed pinned butts	Stain Aluminum
15	Overhead door closer from mounting on the pull side of the door	Satin Chrome
16	Overhead door closer from mounting on the push side of the door	Satin Chrome
17	“Heavy duty” sliding door hardware, track and sliding door locking mechanism	Satin Chrome
18	Indicator bolt with emergency keying and sign display “occupied” when locked	Satin Chrome
19	Male sex symbol 203mm x 203mm Aluminum	Satin Anodized Aluminum
20	Female sex symbol 203mm x 203mm Aluminum	Satin Anodized Aluminum
21	Hardware for single acting aluminum entrance doors to include locks, flush bolts, offset pivots, surface mounted door closers to be mounted on the inside face of the doors, with mill finish thresholds and weather stop for doors opening to the exterior	Stain Aluminum
22	Aluminum plush plate	Stain Aluminum
23	Push handle on aluminum	Stain Aluminum
24	Single locking panic bolt with access from push side of door	Stain Aluminum
25	Passage Lockset	Stain Aluminum
26	Aluminum kick plate	Stain Aluminum

1519 Door notes

All locks are to be cylinder locks of heavy duty commercial quality – elite or similar approved.

Knobs on all locksets and latches are to have a global shape.

All locksets are to have a basket of 70mm.

Hardware for all cupboards doors and drawers to include;

- Pivots for overlay doors
- Magnetic catches
- 100mm plastic “D shaped” pull handles
- Metal drawer slides (Knape & Vogt or similar approved”

All fire doors to be fitted to steel frames with 37.7mm pairs of stainless steel hinges.

All double doors to be fitted with astragal on one leaf of door unit.

All fire doors to be fitted with approved smoke seals to top and sides of door. Frames to carry steel right around perimeter “fire rated glass ceramic” to be used in all fire rated doors fitted with vision panels

All fire rated door hardware and locks to be stainless steel. All other doors to carry hardware and locks of satin aluminum.

1600 GYPSUM BOARD

1601 General

1601.1 Section Requirements

- Submittals: Product Data.
- Where ASTM or ANSI or AA Standards are referred to in this section, these may be replaced by E.U. member state and/or ACP State standards provided they are equivalent or superior to the U.S. Standard.

1602 Products

1602.1 Performance Requirements

Fire-Resistance-Rated Assemblies: Provide materials and construction identical to those tested in assemblies per ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

STC-Rated Assemblies: Provide materials and construction identical to those tested in assemblies per ASTM E 90 and classified per ASTM E 413 by a qualified independent testing and inspecting agency.

1602.2 Panel Products

Provide in maximum lengths available to minimize end-to-end butt joints.

Interior Gypsum Board: ASTM C 1396/C 1396M, in thickness indicated, with manufacturer's standard edges.

Exterior Gypsum Soffit Board: ASTM C 1396/C 1396M, in thickness indicated, with manufacturer's standard edges.

Water-Resistant Gypsum Backing Board: ASTM C 1396/C 1396M, in thickness indicated.

Glass-Mat, Water-Resistant Gypsum Backing Board: ASTM C 1178/C 1178M, of thickness indicated.

Cementitious Backer Units: ANSI A118.9, ASTM C 1288, or ASTM C 1325.

1602.3 Accessories

Trim Accessories: ASTM C 1047, formed from galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet. For exterior trim, use accessories formed from hot-dip galvanized-steel sheet, plastic, or rolled zinc.

- Provide cornerbead at outside corners unless otherwise indicated.
- Provide LC-bead (J-bead) at exposed panel edges.
- Provide control joints where indicated.

Aluminum Accessories: Extruded-aluminum accessories indicated with Class II, clear anodic finish; AA-C12C22A31.

Joint-Treatment Materials: ASTM C 475/C 475M.

- Joint Tape: Paper unless otherwise recommended by panel manufacturer.
- Joint Compounds: Setting-type taping compound and drying-type, ready-mixed, compounds for topping.
- Skim Coat: For final coat of Level 5 finish, use high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.
- Cementitious Backer Unit Joint-Treatment Materials: Products recommended by cementitious backer unit manufacturer.

Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

Adhesive shall have a VOC content of 50 g/L or less. Adhesive shall comply with Green Seal's GS-36 and with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

Acoustical sealant for Exposed and Concealed Joints: Nonsag, paintable, nonstaining latex sealant complying with ASTM C 834.

- Sealants shall have a VOC content of 250 g/L or less.
- Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Source Using Small-Attenuation Blankets: ASTM C 665, Type 1 (unfaced).
- Sound-Attenuation Blankets: ASTM C 665, Type I (unfaced).
- Textured Finish: Polystyrene aggregate ceiling finish where indicated.
- Textured Finish: Aggregate finish where indicated.
- Textured Finish: Acoustical finish where indicated.

1602.4 **Execution**

Install gypsum board to comply with ASTM C 840.

- Isolate gypsum board assemblies from abutting structural and masonry work. Provide edge trim and acoustical sealant.
- Single-Layer Fastening Methods: Fasten gypsum panels to supports with screws.
- Multilayer Fastening Methods: Fasten base layers with screws, and face layers to base layers with adhesive and supplementary fasteners.

Install cementitious backer units to comply with ANSI A108.11.

Fire-Resistance-Rated Assemblies: Comply with requirements of listed assemblies.

Finishing Gypsum Board: ASTM C 840.

- At concealed areas, unless a higher level of finish is required for fire-resistance-rated assemblies, provide Level 1 finish: Embed tape at joints.
- At substrates for tile, provide Level 2 finish: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges.
- Unless otherwise indicated, provide Level 4 finish: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges.
- Where indicated, provide Level 5 finish: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges. Apply skim coat to entire surface.

Glass-Mat, Water-Resistant Backing Panels: Finish according to manufacturer's written instructions.

Cementitious Backer Units: Finish according to manufacturer's written instructions.

Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture free of starved spots or other evidence of thin application or of application patterns.

1700 FLOOR, WALL & CEILING FINISHES

1701 General

Where a manufacturer's name or the proprietary name of an article appears in this section, it is given as an indication to tendering contractors of the standard and description required and contractors may quote for any manufacturer's article, provided it is of the standard and description specified and approved by the Supervisor's Representative in writing, prior to inclusion into the works.

1702 Porcelain/Ceramic Tiles (non-skid)

Porcelain/Ceramic tiles shall be unglazed, non-skid to BS 6431 Parts 2 & 6, and shall be laid in accordance with BS 5385. Tiles shall be laid with cement based tile adhesive to BS 5980, possessing Class AA water resistance with additive. Joints between tiles shall be a constant width 3 mm wide. Floor tiles shall be grouted with epoxy grout. The joints shall be completely filled. The manufacturer's printed instructions must be strictly adhered to. Unless specified otherwise, glazed tiles shall comply with BS 1281. They shall be laid on a bed of cement mortar (1:4) and pointed afterwards with accurate and straight joints.

1703 Glazed Wall Tiles

Glazed wall tiles shall be of sizes and thicknesses specified and shall be accurately fixed to floated backing with cement and sand (1:5) and grouted with white cement. Alternatively, tiles may be fixed with an approved tile adhesive and grouted with white cement. All tiles shall be of the cushion-edge type. All external angles shall be rounded edge tiles of radius approved by the Architect. Tiles shall be in accordance with BS 1281 and BS 5385, Part 1.

1704 Granolithic Paving

All granolithic paving to be carried out in accordance with CP 204. The mix is to be cement/sand/aggregate 1:1:2 by weight aggregate, size 5 - 10mm, laid monolithically 25mm thick with an approved hardener.

1705 Cement/Sand Screed

Screeds shall be laid in accordance with CP 204.

Mix screeds of cement and sand (1:4) and lay to the thickness described. Finish screeded beds with a rough surface to receive ceramic tiles and a steel trowelled surface to receive vinyl asbestos tiles, ceramic tiles when fixed with approved adhesive and floor paint. Thoroughly brush clean surfaces to receive screeds of all foreign matter and well soak prior to laying screed

Provide an adequate bond between screeds and in-situ concrete by the use of an approved concrete bonding agent or by well hacking, wetting and applying cement grout immediately prior to laying the screed.

Beds shall be laid in bays not exceeding 375 square feet (35 square metres). Edges of adjoining bays shall be well hacked and wetted prior to laying the next day. Immediately the beds are laid, they shall be cured and protected for at least five days to

prevent damage or shrinkage of any kind. The method of curing is to be approved by the Supervisor's Representative.

Ensure that the levels of floors within any one area and between adjoining areas are constant unless specifically described or shown to be otherwise. Make up for any variations in the thickness of precast or pre-moulded floor finishings and irregularities in the surface of the structural base by adjusting the thickness of the screed as necessary.

1706 Laying of Tiles

Tiles shall be laid with continuous joints and bedded in a cement and sand (1: 6) screed or backing not less than 30 mm thick and pointed or grouted with cement slurry to match the tiles. Tiles shall be accurately cut and fitted to all doors, thresholds, wall openings, projections, etc. The finished floor shall be perfectly true, level or to the falls specified and cleaned off on completion of the work to the satisfaction of the Supervisor's Representative.

1707 Protection of Tiling

After the tiles have been laid, the floor shall be covered immediately to give complete protection from dirt and damage during all subsequent stages of the work.

The Contractor shall be required at his own expense to remove any tiles which have been stained or damaged before completion of the work and replace them with new ones.

1708 Rendering

Mix rendering of cement and sand (1: 4) including a plasticiser additive at the rate as detailed in the manufacturer's printed instructions.

Proportion materials by measure and not by estimation and provide proper approved measuring boxes for this purpose. Make up mix on site in a close boarded wood platform with upstand edges.

Where approved mechanical batch mixers are employed, rotate each batch in the drum at least two minutes and use immediately thereafter. Mix only quantities which can be used at once and reject rendering which has begun to set before being required.

Carefully float all work and finish to the stated thicknesses with surfaces perfectly flat to stand the straight edge every way, free from all cracks and leave perfectly clean. External angles shall be true and slightly rounded.

1709 Plasterboard

Gypsum wall board to BS 1230 Part 1 type 1 shall be taper edged boards fixed with plasterboard screws or flat head nails as BS 8212 Clause 6.3. Boards shall be as manufactured by British Gypsum Limited and shall be installed in accordance with BS 8212 and the manufacturers printed instructions.

Wall boards shall be joined by applying jointing compound to the depression between the boards, firmly embedding the jointing tape, covering it with the jointing compound and striking off flush.

Finishing compound shall be applied over the joint and feathered out approx. 50mm. This process shall be repeated and feathered out a further 50mm beyond the first application, finished flush and smooth. Nail holes shall be filled and finished flush.

1710 Suspended Ceiling

The suspended ceiling system shall be acoustical non-combustible mineral fibreboard with standard type suspension hung directly from concrete soffits.

The suspended ceiling system shall be installed in accordance with CP 290 by skilled workmen. The suspension systems shall be supported by No. 12 gauge steel hanger wires secured to the concrete soffit and the exposed grid framing shall be securely fixed to the hangers.

The lay-in panels shall be set loose within the grid and care shall be taken not to stain or damage the panels on the exposed face or on the edges. The installation must be carried out in accordance with the Manufacturer's written instructions, all to the satisfaction of the Supervisor's Representative.

The panels shall have factory applied washable white vinyl latex paint finish.

The suspension system shall be exposed grid type with electro-galvanised steel framing finished on exposed surface with low sheen satin white enamel.

1711 Spares

The Contractor is to supply the Supervisor at practical completion of the works with the following spares:

- Floor and Wall tiles - 2% of quantity
- Suspended ceilings: - 10 box tiles

1712 Resilient Sheet Flooring

1712.1 Section Requirements

Submittals: Product Data and Samples.

BS EN ISO 10581:2013 Resilient floor coverings. Homogenous poly (vinyl chloride) floor covering.

Where ASTM standards are referred to in this section, these may be replaced by E.U. member state and/or ACP State standards provided they are equivalent or superior to the U.S. Standard.

Extra Materials: Deliver to Owner at least 10 linear feet (3 linear m), in roll form and in full roll width, for each type and color of resilient sheet flooring installed.

1713 Products

1713.1 Unbacked Vinyl Sheet Flooring

Unbacked Sheet Vinyl Floor Covering: BS 8203:2001++A1:2009 or ASTM F 1913, 0.080 inch (2.0 mm) thick.

Wearing Surface: Smooth.

Sheet Width: As standard with manufacturer 6 feet (1.8 m) or 6.6 feet (2.0 m).

Retain "Seamless-Installation Method" Paragraph below for seamless installation. Generally, manufacturers prefer the appearance and performance of seamless installations produced using heat-welded seams or chemically bonded seams. See "General Comments" Article in the Evaluations for a discussion of seamless installation.

Seamless-Installation Method: Chemically bonded.

1713.2 Vinyl Sheet Flooring With Backing

Vinyl Sheet Floor Covering with Backing: ASTM F 1303, Type I, minimum binder content of 90 percent; Type II, minimum binder content of 34 percent, Grade 1.

- Overall Thickness: As standard with manufacturer.
- Interlayer Material: Foamed plastic.
- Backing Class: Class A (fibrous), Class B (non-foamed plastic), Class C (foamed plastic).

Wearing Surface: Smooth (homogeneous)

- Sheet Width: As standard with manufacturer in nominal widths of 5 feet (1.5 m), 6 feet (1.8 m), 6.6 feet (2.0 m) or 12 feet (3.6 m).
- Retain "Seamless-Installation Method" Paragraph below for seamless installation. Generally, manufacturers prefer the appearance and performance of seamless installations produced using heat-welded seams or chemically bonded seams. See "General Comments" Article in the Evaluations for a discussion of seamless installation.
- Seamless-Installation Method: Chemically bonded.

1713.3 Installation Accessories

Trowelable Leveling and Patching Compounds: Latex-modified, Portland cement or blended-hydraulic-cement-based formulation provided or approved by flooring manufacturer for applications indicated.

Adhesives: Water-resistant type recommended by manufacturer to suit floor covering and substrate conditions indicated.

- Low-Emitting Materials: Adhesives shall have a VOC content of [50] g/L or less.
- "Low-Emitting Materials" Subparagraph below is based on ICC 700, "National Green Building Standard."
- Low-Emitting Materials: Adhesives shall comply with Green Seal's GS-36 and with the testing and product requirements of the California Department of Public

Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

Heat-Welding Bead: Solid-strand product of floor covering manufacturer.

Chemical-Bonding Compound: Manufacturer's product for chemically bonding seams.

- First "Low-Emitting Materials" Subparagraph below is based on LEED. VOC content limit is that for PVC welding compounds.
- Low-Emitting Materials: Chemical-bonding compound shall have a VOC content of 510 g/L or less.
- "Low-Emitting Materials" Subparagraph below is based on ICC 700, "National Green Building Standard."
- Low-Emitting Materials: Chemical-bonding compound shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

Integral-Flash-Cove-Base Accessories: 1 inch (25 mm) radius cove strip and square metal, vinyl, or rubber cap; both provided or approved by floor covering manufacturer. Retain "Floor Polish" Paragraph below for use with most floor coverings. Liquid floor polish is generally used instead of paste wax. See "Maintenance Procedures" Article in the Evaluations for additional information.

Floor Polish: Protective liquid floor polish products as recommended by manufacturer.

1714 Execution

Prepare concrete substrates according to ASTM F 710. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.

Unroll sheet floor coverings and allow them to stabilize before cutting and fitting.

Maintain uniformity of resilient sheet flooring direction, and match edges for color shading at seams.

Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches (150 mm) away from parallel joints in substrates.

Seamless Installation:

- Heat-Welded Seams: Comply with ASTM F 1516.
- Chemically Bonded Seams: Bond seams with chemical-bonding compound to permanently fuse sections into a seamless flooring.

Integral Flash Cove Base: Cove floor coverings 6 inches (150 mm) up vertical surfaces. Support on cove strip and butt against cap strip.

Before retaining "Floor Polish" Paragraph below, verify manufacturer's floor polish recommendations. Generally, floor polish is used with most vinyl products.

Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor covering before applying liquid floor polish.

- Apply two coat(s)

1800 SANITARY APPLIANCES

1801 Generally

All plumbing work shall be in compliance with the Water Authority's requirements and Waterworks Regulations.

1801.1 Scope of Work

This Section covers all sanitary appliances supplied by the Contractor and the installation of all sanitary appliances, including those supplied by the Employer.

1802 Materials

1802.1 Generally

Inspect pipes and fittings inside and out before fixing. Reject any which are defective.

Certain standard sanitary appliances may be supplied by the Employer, as scheduled on the drawings. These may include brackets, waste fittings, traps, taps, valves, chains and plugs & all fittings which relate to fixtures.

Provide all other sanitary appliances as specified. Submit samples of all sanitary fittings for approval.

- All sanitary fittings unless specified otherwise shall be white, from an approved manufacturer, generally ensuite and complete with all necessary fittings.
- Wastes, outlets and overflows to BS EN 274, exposed surfaces shall be either chromium plated or other non-chromium plated alternatives subject to approval by the Supervisor's Representative. Cr-Ni coating shall comply with BS EN
- 248.
- Taps and combination tap assemblies to BS EN 200, exposed surfaces shall be either chromium plated or other non-chromium plated alternatives subject to approval by the Supervisor's Representative. Cr-Ni coating shall comply with BS EN 248.

1802.2 Baths

Baths shall be vitreous enameled sheet steel to BS 1390 with adjustable feet for 75 mm seal trap holed at end for and including combined waste and overflow to BS EN 274 complete with plug and chain if applicable and chromium plated brass taps to BS EN 200.

1802.3 Shower trays

Shower trays shall be prefabricated to BS EN 251 and BS EN 14527-2006+A1 made from glazed ceramic or resin-stone with solid surface. Any solid surface shall comply with BS EN ISO 19712-1, BS EN ISO 19712-2 & 3.

1802.4 Shower fittings

Shower fittings shall be either chromium plated brass or other non-chromium plated alternatives subject to approval by the Supervisors Representative, and approved easy clean valve, thermostatic valve or as specified fitted with one of the following:

- Concealed or exposed shower fittings for lever with flexible hose 1500 to 1800 mm long c/w chrome plated sliding bar and head.
- Time-delayed control for adjust 15 sec. to 30 sec. cold or mixer.
- Self-cleansing swivel-jointed rose with an adjustable spray.

1802.5 Taps

Taps shall be:

- Sensor tap shall conform to BS EN 816. Operating pressure between 0.3 – 10 bar. Flow rate not more than 6 litres per min. Max. Water temp. 80 degree. Aerator. Self-cleaning. Turn-off control pre-set 0 – 3sec.
- Sensor mixer or cold.
- Self – closing tap for time delay function.
- Bib tap.

1802.6 Ceramic Wash basins

Ceramic wash basins shall be to BS 1188 and shall be made from vitreous china to BS 3402 of the following types as specified:

- Under counter basin with overflow.
- Wall hung basin with or without pedestal as specified.
- Semi-recessed basin with or without overflow as specified.
- Counter top basin with or without overflow as specified.

1802.7 Solid surfacing wash basins

Solid surfacing wash basin shall comply with BS ISO 19712-1, BS ISO 19712-2 & 3 with drain, with or without overflow as specified and to size and configuration shown on the drawings.

1802.8 Kitchen sinks

Sinks shall be to BS EN 695 and BS EN 13310 and to the size and configuration shown on the drawings with overflow and sound deadening pads under the sink and drainers.

Sinks shall be provided with an effective means of attaching a bonding conductor which shall be accessible to the electrician after the sink has been installed.

1802.9 Stainless steel sinks

Stainless steel grade 304 or grade 316 as specified in Clause 17.09, minimum thickness 0.8 to 0.9 mm for Grade 304 and 1.5 to 1.6 mm for grade 316, with satin finish.

1802.10 Solid surfacing sinks

Solid surface shall comply with BS ISO 19712-1, BS ISO 19712-2 & 3.

1802.11 Close-coupled suites, one piece and independent W.C.s

Close-coupled suites, one-piece and independent W.C. pans with integral trap shall be vitreous china to BS 3402 and with horizontal outlet to BS EN 997, white plastic single ring seat and cover with plastic fixing bolts all to BS 1254.

1802.12 **Flushing cistern**

7.5L flushing cistern to BS 7357, 9L and dual flushing type cisterns to BS 1125, complete with flushing apparatus, discharge pipe, ball valve and overflow, of one of the following types as specified:

- Low level plastic.
- High level plastic.
- Low level vitreous china.
- Close coupled vitreous china.

Sensor valve where specified for automatic flushing shall conform to BS EN 12164's Operating pressure shall be 0.5 – 10 bar rinse. Time-off control approx. 10 sec. and remote adjust from 1.5 – 30 sec. Dry battery operation shall be 6V Lithium 2 CR5. A/C operation shall be 220 - 230/50Hz step down to 6V.

Sensor fittings shall be suitable for use in salt water application.

1802.13 **Urinals**

Wall hung urinals to BS EN 13407. Vitreous china bowl type to BS 5520 with 50 mm diameter of waste outlet, complete with vitreous china automatic flushing cistern to BS 1876, chromium plated flush pipes and spreaders to suit the number of appliances. The discharge volume shall be not more than 4.5 litres for every basin or stall, or for every metre of a trough urinal.

Sensor valve shall conform to DZR brass to BS EN 12164's CW602N. Operating pressure shall be 0.3 – 10 bar rinse. Time-off control approx. 9 sec. and remote adjust from 7 -22 sec. Dry battery operation shall be 6V Lithium 2 CR5. A/C operate shall be 220-230/50Hz step down to 6V.

Sensor fittings shall be suitable for use in salt water application.

1802.14 **Storage**

Store appliances under cover and keep dry. Separate with dust sheets or polythene sheets when not in manufacturer's own packing.

Store all metal sinks etc. on a level surface to prevent twisting. Prevent contact with cement or lime.

1802.15 **Traps**

Traps shall have 75 mm seal, unless otherwise specified.

Cast iron traps shall be to BS EN 274.

Plastic waste traps shall be to BS EN 274-1; 274-2 and BS EN 274-3 or to be of an approved proprietary brand.

1802.16 **Silicone Sealant**

Silicone sealants shall be to BS EN ISO 11600 +A1.

Type F Class 25 in white colour or to match sanitary fixtures and to BS EN ISO 846.

1803 Workmanship

1803.1 Fixing generally

Provide all necessary jointing compound, mortar, lead plugs and other accessory materials. Cut and pin, or plug and screw brackets, and make all necessary connections to water supply services, overflows, wastes and ventilating pipes.

All sanitary appliances shall be adequately supported when being fixed. Where build-in types of brackets are used, the tails of such supports shall be built into the wall at least 75 mm and where wall fixing types are used, the wall finish shall have been arranged to make provision for them.

All fittings shall be pointed as necessary with the following:

- White or coloured cement.
- White or coloured silicone sealant. All fittings shall be de-greased and dried before the application of sealant.

Install discharge pipes and water supply pipes before fixing the appliances. Retain protective coverings during and after fixing when practicable and clean off when required.

Replace any appliances which are chipped or scratched either before or after fixing.

1803.2 Waste outlets

Bed waste outlets to wash basins, sinks, baths and showers in proprietary jointing compound.

1803.3 Fixing taps

Fix taps to make a water tight seal with the sanitary appliance. Place hot tap to left of cold tap as viewed by the user. Ensure that Hot/Cold markings are correctly applied and located.

1803.4 Connections

Provide connectors for service and waste pipes.

1803.5 Fixing wash basins

Wash basins shall be supported on one of the following as specified:

- Pair of concealed painted steel brackets.
- Pair of porcelain enameled towel rail brackets.
- Set of porcelain enameled or chromium plated legs and brackets.
- Approved proprietary brackets to suit the basins.
- Counter top as shown on drawings or manufacturer's details.

Water tight seal between the walls and the basins shall be made by using silicone sealant.

1803.6 **Fixing W.C. pans**

Fix W.C. pans as follows:

Pedestal type

- Bed W.C. pans on concrete floors in white lead putty or other non-hardening compound. If cement mortar is used for bedding, it shall be not richer than 1:6, and a thin layer shall be applied only to that part of the pedestal which is in contact with the floor. Fix with No. 14 SG round-headed brass screws 70 mm long with domed plastic inserts in colour to match to fixture.
- Joint W.C. pans to soil or drain pipes with approved PVC W.C. pan connectors to BS 5627 or other approved type.

Wall hung type

- Fix wall hung type WC pans to load bearing walls or support frame by non-ferrous fixing bolts. Water tight seal between the walls and the edge of the W.C. pans shall be made by appropriate sealant.

1803.7 **Fixing urinals**

Stall type:

- Bed outlet to waste connector in proprietary jointing compound.
- Bed base and overlap facing in cement and sand mortar 1:3.

1803.8 **Fixing Baths**

Supports for the bath shall be adjustable to permit the bath to be properly levelled when installed. Bearing plates shall be provided under bath feet. A permanent watertight seal between the wall and the edge of the bath shall be made by using silicone sealant.

Ensure that all bath surfaces are properly protected up to completion stage.

1900 INTERNAL FITTINGS AND FIXTURES

1901 Demountable Partitions

1901.1 Construction of the system

The system shall be simple and strong in construction, readily adaptable to suit different office layouts and be capable of being assembled and erected with high speed and efficiency. It shall include a range of module types incorporating varying proportions of solid panels and glazed areas ranging from full height (floor to ceiling) solid panel to full height glass (including low and half height screens).

1901.2 Partitions

The partitions shall be fully demountable and provide maximum recovery of components including panel finishes and involve minimum amount of effort, time and disturbances of wall, floor and ceiling when alteration and resiting either in part or in whole is required. Any module shall be capable of being demounted and replaced with one of a different type or with a door.

Completed partitions shall be free from exposed bolts, nuts, nail heads and rivets. The overall thickness of a completed partition shall not be more than 100 mm.

1901.3 Module

The partitions shall be constructed of standard module units so assembled that individual units can be easily dismantled without disturbance to adjoining units and the partition cavity may be exposed from one face without disturbing the opposite face.

Module design of varying door heights and low level screens shall also be available in addition to the capability of the design to readily accommodate special size doors, doors with vision panels or louvers, double action doors, etc.

1901.4 Accommodation for building services items

The system shall have suitable room and sufficient provision within the thickness of the partition to accommodate normal electrical, telephone and computer network wiring and conduits, and also the related fittings including electrical switches, power points and network nodes, etc.

1901.5 Approval

Any particular system proposed shall be subject to the approval of the Supervisors Representative, samples and details of the system shall be submitted for approval if required by the Supervisors Representative.

1902 Materials

1902.1 Framework

The framework shall be either galvanized and coated rolled steel sections to BS EN 10162 or anodized extruded aluminium sections to BS EN 515, BS EN 573-3 and BS EN 755-1 to 9, BS EN 12020-1 and BS EN 12020-2 or a combination of both. All sections shall be of a size and shape which shall give adequate strength to the framing.

Galvanized steel sections shall be not less than 0.56 mm thick. All framework (vertical and horizontal studs and furring channels) shall have suitably placed holes formed of an appropriate size to facilitate installation of electrical and computer network and wiring.

1902.2 Lining panels

Panels shall be of 12.50 mm (minimum thickness) gypsum plasterboard or plywood or chipboard and shall be securely fixed to both sides of the partition.

- Gypsum plasterboard shall comply A3 with BS EN 520:2004+A1 and consist of a core of set gypsum plaster in accordance with BS EN 13279-1 and 13279-2 sandwiched between two layers of heavy paper.
- Plywood shall be Grade 2 lauan plywood for internal use as specified in Clause 13.12.
- Chipboard shall comply with BS EN 309 and BS EN 312.

1902.3 Doors

Doors shall be 45 mm thick hollow or 50 mm solid core flush doors covered with selected hardwood veneer or laminated plastic sheet on both sides and hung to rebated timber frames.

Appropriate number and types of door hinges shall be provided depending on the size and weight of doors used.

When specified, hardwood louvre and frame shall be fitted to the door.

1902.4 Glass for glazed panel

Glass for glazed panel shall be 6 mm thick minimum, of the qualities specified in BS 952, free from bubbles, smoke vanes, air holes, scratches and other defects and cut to fit the openings, with due allowance made for expansion, and securely fixed to the trim sections by approved fixing materials and method as well as manufacturer's instructions.

1902.5 Washable matt-finished vinyl cloth

Washable matt-finished vinyl cloth for panel facing shall be either plain or textured fabric-backed vinyl cloth of approved quality applied in one full width (minimum 1200 mm) to each panel with approved adhesive prior to installation in accordance with the manufacturer's instructions. Samples with at least 5 choices of colour showing the surface texture and pattern shall be submitted for the Supervisors Representative's approval.

1902.6 Hessian fabric

Hessian fabric shall be interior design, wall lining quality, close weave to a colour chosen by the Supervisors Representative fixed in full widths with approved adhesive. A sample panel shall be made up for the Supervisors Representative's approval before use.

1902.7 Skirtings

Skirtings shall be 75-100 mm high of baked enamel steel or anodised extruded aluminium sections of minimum 10 mm thick.

1902.8 Pinboards

Pinboards shall be of 13 mm softboard to comply with BS EN 316, BS EN 622-1 and BS EN 622-4, finished with Hessian wall paper to be approved by the Supervisors Representative.

1902.9 Finishings and Colours, generally

Colours of finishings, anodic frame coatings, plastic stops of cover strips, together with fabrics and all other finishings shall be to the requirements of the Supervisors Representative.

1903 Workmanship

1903.1 Studdings

Vertical studdings shall be in one continuous length extending from floor to ceiling and shall be positioned at maximum 600 mm centres for partitions not exceeding 3.5m high and at maximum 400 mm for partitions exceeding 3.5 m high. Joints and fixing within the framing shall be performed in such a manner that shall, when erected, produce a rigid and stable and yet fully demountable framing. The vertical and horizontal stud channels shall be able to support the various fittings to the system such as glazing panels, doors and shelving as required.

1903.2 Fixing

Floor channels shall be securely fixed of maximum 600 mm centres by means of:

- 12 mm concrete nails to concrete or screed floor.
- No.6 self-tapping screws to steel or chipboard floor.
- No. 6 wood screws to timber floor.

Ceiling channels shall be securely fixed of maximum 600 mm centres by means of:

- No. 6 self-tapping screws to the rigid suspension system along the metal grid of suspended ceiling.
- No. 6 self-tapping screws and approved plastic plugs to concrete ceiling soffit.
- No. 6 wood screws to timber or plywood ceiling.

Wall channels shall be securely fixed of 750 mm centres by means of:

- No. 6 self-tapping screws and approved plastic plugs to concrete or brick walls.
- No. 6 wood screws to timber or plywood.

Ceiling and wall channels shall be fitted with an applied foam plastic gasket to form a light and sound seal. Partitions other than full height shall be provided with either floor to ceiling stabilizer posts or buttress panels to ensure adequate rigidity and stability.

Full height panels (floor to structural ceiling) shall generally be applied in one piece. Where ceiling height exceeds 2700 mm and/or where building access restrict the size

of panels, then a horizontal aluminium channel trim joint shall be permitted. Such joint shall line up with door head level.

Top edge of panels shall be securely fitted into the ceiling channel and bottom edges retained by the skirting fixing. Vertical edges of panels shall be retained to the vertical studs by means of continuous clip or screw fixed aluminium cover strips or by other approved method. Vertical panel edges at wall junctions shall be fitted into the wall channel. Centre of panels shall be fixed to the framing by means of suitable stud adhesive, spot applied at maximum 600 mm centres or by other approved method.

The covering 'tee' bar shall be held continuously by friction and not by clips.

1903.3 Door frames

Timber door frames shall be securely fixed to the partition framework with diagonal braces on each side to stabilize mid-height point of the frame.

Door frames at corners and tee junctions shall be positioned so as to allow sufficient clearance between back of door and the intersecting partition to allow the mounting of a surface mounted door closer and enable the door to open a full 90° without the closer body striking the intersecting partition face.

1903.4 Glazed panels

Glass panels shall be securely fixed into the system by means of extruded aluminium vertical and horizontal trim section with vinyl strips, and so designed that the glass panels may be removed and replaced without dismantling the panel trim or framework. The system shall be capable of providing double glazing. All exposed edges and corners of glass screens shall be rounded and polished.

1903.5 Skirtings

Skirtings shall be securely fixed to the partition framing by approved fixing materials and method. External corners in skirtings shall be formed from a continuous length. Mitred out or butted corners shall not be permitted.

1903.6 Finishes

Gypsum plasterboard panels shall be faced with an approved fabric vinyl cloth as described in Subsection 1902.5. When required to be painted, gypsum plasterboard panels shall be prepared and two coats of paint applied.

Plywood and chipboard surfaces may either be painted or faced with laminated plastic sheet or with 3.2 mm selected hardwood veneer. When required to be painted, plywood, chipboard and hardwood surfaces shall be knotted, primed, stopped and two coats of paint applied.

1903.7 Sound Insulation

Where additional sound insulation is required, a layer of 50 mm thick fibreglass quilt or plastic foam slabs of an approved proprietary brand shall be placed close butt jointed within the partition framing. Detailing may vary depending on the proprietary system

employed and the sound reduction factor specified. Airborne sound insulation shall be tested to BS EN ISO10140-1/2 & 5 or ASTM-E413 and ASTM E90.

1903.8 Alteration and Resiting

During alterations to and re-installation of existing partitions, every care and precaution shall be exercised to avoid unnecessary waste and damage of the partition components and the erection and fixing to be executed in a workmanlike manner as previously described.

When partition components shall be transported from one building to another or to Government Store, they shall be adequately protected and every care and precaution shall be taken during loading, unloading and during the course of transportation to avoid damages to components.

1903.9 Make good disturbed areas

Immediately upon completion of the Works and before handing over, clean up all partitions and doors and also floor, ceiling and walls upon which partition work has been carried out.

All disturbance to the floor, ceiling and wall structure and/or finishes during the course of partition work shall be made good to match existing.

1904 LOWER LEVEL DEMOUNTABLE PARTITION (OPEN PLAN OFFICE LAYOUTS)

1904.1 Generally

The system shall be simple and strong in construction, readily adaptable to suit different office layouts and be capable of being assembled and erected with high speed and efficiency.

The system shall also be fully demountable and shall provide maximum recovery of components including panel finishes and involve minimum amount of effort, time, and disturbances on wall and floor finishes when alterations and repositioning either in part or in whole are required. Any module shall be capable of being dismantled and replaced by one of the different types of panels in the series.

Completed partitions shall be free from exposed bolts, nuts, nail heads, screws heads and rivets.

1904.2 Module

The partitions shall be constructed of standard module units, so assembled that individual panel can easily be dismantled or attached at a connection point being spanned by a component without removing components from adjacent panels and without upsetting the integrity of the system.

1904.3 Accommodation for building services items

The system shall have suitable room and sufficient provision within the thickness of the partitions to accommodate normal electrical, communication and computer network wiring, and also the related fittings including electrical switches, power points and network nodes, etc.

1904.4 Panels frames and posts

Panels, frames and posts shall be anodized extruded aluminium sections or equivalent. All panel post sections shall be of a size and shape which shall give adequate strength to the panel framing. The aluminium frames or equivalent shall contain fastening devices to accept a variety of decorative inserts including glass panels, veneer, fabric, and acoustic materials, etc. Cut sections of panel posts shall be covered with plastic top caps and be flushed with panel tops. Joints and fixings for the panels shall be performed to produce a rigid, stable and fully demountable system.

1904.5 Screen Panels

The nominal thickness of the screen panels shall be within the range of 38 mm to 50 mm thick overall. Panel sizes shall vary from 1020 mm to 1650 mm high overall and shall be available in such widths that, when used in conjunction with connectors, a centreline to centreline dimension shall be 600 mm, 900 mm, 1000 mm, 1200 mm or as specified.

Screen panels shall be covered with fabric and foam layer on both sides. Centre cores shall be kiln-dried wood frames covered both sides with pinboard or plywood boarding.

Each screen panel shall be finished and protected on all exposed edges with impact resistant anodized aluminium moulding or equivalent. Round corners shall be used for all exposed edges.

The tops of panels shall be suitably protected with anodized aluminium sections or equivalent against cleaning and maintenance equipment and against damages during changes.

1904.6 Hanging Components

Screen panels shall be designed and constructed for hanging components such as work tops, shelf units and storage components, etc. All hang-on components shall be fixed securely by a locking mechanism but can be slot-fixed into patented panel posts by support brackets or metal clips.

The screen panel assembly shall be capable of carrying a total of load 454 kg minimum.

1904.7 Screen Fabric

Total thickness of the fabric shall be at least 3 mm. The fabric and the foam layer shall comply with the flammability standard BS 7176 2007+A1 or its international equivalent if polyurethane foam material is adopted. For other materials, fabric and form shall have the surface spread of flame of Class 1. The fabric shall be available with a reasonable choice of colours, and shall be specially designed for covering office screens

1904.8 Wall mounted rails

Wall mounted rails shall be of metal construction with sufficient strength and shall be suitable for mounting panels to walls with connectors to ensure continuous connections and stability of the panel system.

1904.9 Panel connector

The panel connector assembly shall be a single piece unit, able to connect two, three or four panels together. It shall be in metal construction and finished with paint coating. Self-adjusting mechanism shall be provided with the connector to take up any tolerance variations to ensure tight connections and to adjust to various heights of panel at each joint.

Panel connector assembly shall be designed to carry vertical load of 454 kg minimum.

1904.10 Support legs

Support legs shall be bronze anodized aluminum or equivalent. Ends of support legs shall be clipped and locked securely into the bases of screen panels. They shall be adjustable for levelling without disengaging from the internal components of the screen panels.

1904.11 Skirting

Skirting shall be 10 mm thick (minimum) anodized extruded aluminium section or equivalent. Mitred or butted corners shall not be permitted.

1904.12 **Samples**

Samples of fabric, foam, hinges and anodized aluminium section with the support of valid testing certificates for fabric and foam shall be submitted for the approval of the Supervisors Representative. Mock up sample of the system shall be provided if required.

1905 VENETIAN BLINDS

1905.1 Generally

The materials used to manufacture slim-line venetian blinds shall comply with BS 3415 and shall be free from visible defects e.g. dents, scratches, etc.

Blinds shall be installed in accordance with manufacturer's instructions.

1905.2 Materials

Headrail

Headrail shall be enamel coated galvanized steel section to BS EN 10162 of sufficient strength and thickness to support the completed blind without visible sagging or twisting.

Brackets

Blinds shall be supplied with galvanized steel fixing brackets able to support the blind and retain it securely.

Slats

The blinds shall be constructed with enamel coated flexible aluminium slats of 25 mm wide and 0.18 mm thick (finished thickness) 5% tolerance in thickness. The material and profile of any slat in the assembled blind shall be such as to provide the strength and flexibility in accordance with BS 3415.

Slat widths within a blind shall be consistent to within + 0.2 mm or - 0.5 mm. Slats shall have radiused ends or corners and shall be free from burrs and sharp edges.

Bottom rail

The bottom rail shall be constructed from enamel coated galvanised steel section to BS EN 10162 rigid throughout its length in the mounted blind. The ends of the bottom rail shall be enclosed with plastic end-caps.

Ladder tapes/cords

Ladder tapes or cords shall be constructed from polyester fibre.

Samples

Technical pamphlets and a sample of the venetian blind shall be submitted for the approval of the Supervisors Representative.

1905.3 Workmanship

Headrail

The headrail shall not deviate from the horizontal by more than + 5 mm when the blind is mounted beneath a plane surface, and no part of the operating mechanism, within the headrail, shall make contact with that surface.

Unless specifically intended for installation within a recess or box, the ends of the headrail shall be closed off by plastic end caps.

Fixing brackets

Brackets shall be pre-bored to allow for end or top or face fixing. A minimum of 2 No. for blinds with widths not exceeding 1200 mm and 1 additional bracket for every increment of 600 mm in width. It shall be possible to remove the headrail from the brackets when they are fixed.

Fixing slats

Holes and slots cut into each slat shall be positioned symmetrically across the width of the slat and their width shall not exceed the width of the cord passing through them by more than 3 mm to minimize light penetration of the finished blind, consistent with satisfactory operation. The holes and slots in slats of the same blind shall align to within 1 mm, to minimize abrasion of cords and tapes passing through them.

In a finished, assembled blind, the slats shall be capable of tilting through an angle of not less than 70° to the horizontal in each direction and each slat shall overlap the adjoining slat by at least 10% of the slat width in each of the fully closed positions at any point of drop of the blind. The top slat shall be within 5 mm of the headrail in the fully closed position.

Unless specifically designed to clear an obstruction at the point of installation, the length of any slat shall be within 2 mm of the overall width of the blind, and the alignment of slat ends at any position of the blind, shall not deviate from vertical by more than 2 mm.

Bottom rail

Unless specifically designed to clear an obstruction at the point of installation, the length of the bottom rail including end-caps shall be within 3 mm of the overall width of the blind.

Tape or cord securing points shall be in alignment to within 3 mm with the holes for these in the slats. Tape or cord anchorage shall withstand a force of 400 N applied directly to the tape or cord.

Control action

The rise and fall control mechanism shall ensure quick release and a smooth raising and lowering action at any position, with no fluctuation greater than 10% in the graduation of the force required to raise or lower the blind completely.

A cord locking control mechanism shall be released by drawing the control cord across the face of the blind and shall be locked when the cord is in a vertical position. The cord locking system shall be so designed that it shall not be possible to drop a blind accidentally.

Lift cords of 2 mm diameter shall have a breaking force of not less than 400 N when tested in accordance with the method given in section 9 of BS EN ISO 2307.

Cords shall be secured together so as to prevent horizontal misalignment of the blind by pulling the individual rise and fall cords

Tilt control

The tilt control shall be able to hold the suspended slats securely in any tilted position.

Control rods ("wand") shall have a breaking force of not less than 400 N when tested in accordance with the method given in section 9 of BS EN ISO2307 and the "wand" shall be of solid core transparent plastic rods.

Ladder tape/cord

When tested in accordance with the method given in section 9 of BS EN ISO 2307, vertical sections or supports of the tape or cord shall have a breaking strength of not less than 250 N; and the horizontal sections or cross-web of the tape or cord shall have a breaking strength of not less than 50 N. The cross web shall be securely joined to the vertical supports and shall withstand a force of not less than 50 N without separation. The interval between tapes in a finished blind shall be such that the horizontal deflection of the slats between ladders does not exceed 3 mm.

Tapes shall be distributed symmetrically across the blind width, and shall be provided at 225 mm from edge of blind and at 650 mm (maximum) centres.

Vertical blinds

Vertical blind louvres shall be made of 100 mm wide glass fibre slats or impregnated fabric of a colour and quality approved by the Supervisors Representative and shall be installed complete with all necessary accessory materials in accordance with the manufacturer's instructions.

The vertical blinds shall enable operation and rotation of slats in 180° upon a vertical axis to both sides by drawing of an endless cord or a chromium plated ball chain.

2000 LOCKERS

2001 Compartments

Locker compartment shall have minimum internal dimensions of 260 mm (height) x 250 mm (width) x 450 mm (depth).

Multi-tier lockers shall comprise a maximum of six-tier compartments and shall not be more than 2000 mm in overall height including the supporting frame or base.

Stacks of lockers may be connected together to form a block.

2002 Material and construction

Sides, back and shelves of locker shall be manufactured from 24 SWG cold rolled galvanized steel sheet jointed together to form the locker housing.

Door frames shall be manufactured from 20 SWG cold rolled galvanized steel sheets.

Doors and reinforced ribs shall be manufactured from 24 SWG cold rolled galvanized steel sheet. Doors shall be reinforced top and bottom with vertical rib for rigidity and security; and shall be mounted in a formed framework to the front of the locker housing.

All components shall be finished with baked enamel of colour as specified prior to final assembly.

2003 Door fittings

Doors shall be fixed with door buffers for quietness. Door hinges shall be concealed self-closing type. PVC number plate with engraved numbers shall be fixed on each door.

2004 Ventilation

Lockers shall be designed to allow free internal air circulation using perforated door and/or back panel, without impairing the security of locker compartments.

2005 Safety

Lockers shall be free from any sharp points, edges and corners.

2006 Door lock

Door lock may be one of the following:

- Cylinder spring bolt lock with large cylinder and 2 keys.
- Cylinder refund locks with detachable lockset, entirely made of stainless steel, controlled by master key.

The lock mechanism shall be securely protected to interlock with the frame upright.

2007 Cubicle systems

2007.1 Cubicle systems generally

Cubicle systems to consist of panels with light weight core material and high performance surface veneer which shall be impervious to water, easily cleaned and with a durable finish.

Panels shall be designed to be bolted or screwed together and may be raised on posts or wall brackets above floor level, floor mounted, or suspended from above.

2007.2 Construction

Panels, doors and pilasters of cubicle system shall be either:

- Metal construction of baked enamel or vinyl finish constructed with hot-dipped galvanized steel sheets formed and bonded with a cellular honeycomb core, or polyurethane core, or other approved light weight core materials. Edges shall be tack welded around the perimeter and sealed with interlocking molding. Molding corners shall be welded to each other and to face sheets and ground smooth to form a rigid frame around the component.
- Plastic construction fabricated of high pressure laminate on cores of particle board or plywood. Composition core shall be multi-ply to resist warping and assure surface smoothness. Face laminate shall overlap edge laminate to assure water run-off and enhance adhesive bonding.
- Solid Laminate for all components min. 12mm thick.

Doors and panels supplied under sub paragraphs (a) and (b) above shall be completely moisture resistant and 20mm thick (minimum) and pilasters shall be 32mm thick (minimum).

2007.3 Door fittings

Doors shall be fixed with stainless steel or chromium-plated self-closing hinges which shall be adjustable to allow the door to open to different degrees.

Door latch shall be slide latch indicator bolt or concealed latch knob with indicator, or other proprietary product approved by the Supervisors Representative. Locking devices shall have emergency release mechanism.

Buffer hook also serving as clothes hook shall be fixed to each door.

Door stop and door keeper with full height rubber strip shall be fixed to the lock side of the pilaster.

2007.4 Fixing of cubicle systems

Cubicle system may be floor supported, wall mounted, overhead braced or ceiling hung. Overhead braced compartments shall be braced with anti-grip headrail.

Panels and headrails shall be screw-fixed to wall and pilaster with stainless steel brackets or aluminium channels.

Edges of pilaster shall be screw-fixed to wall with stainless steel brackets or aluminium channels.

Ceiling mounted pilaster shall be fixed to the overhead structural members by means of stainless steel inverted stirrup brackets and adjustable threaded stud and shall be covered with stainless steel plinth or other approved coverings.

Base of pilaster shall be screw-fixed to the floor by means of stainless steel inverted stirrup brackets with adjusting devices for levelling during installation and permanent height adjustment of the partitions. Connection between base of pilaster and floor shall be covered with stainless steel plinth or other approved coverings.

2008 Folding/sliding partitions

2008.1 Folding Partitions generally

Partitions shall be continuously hinged and suspended with swivel hanger either at the end of alternating panels or centrally hung for all panels of a maximum height of 4500 mm. Tracks or guides, where used shall be flush with the floor finish and all ironmongery fittings are to have matched finishes.

2008.2 Panels

Panel construction shall be either:

- 45 mm thick (minimum) and not exceeding 900 mm in width for end hung partitions or not exceeding 1200 mm for centrally hung partitions, consisting of hardwood frame and selected hardwood edging with plywood facing finished with either veneers, plastic laminate, vinyl cloth or paint as specified. When specified, panels shall be infilled with mineral wool.
- Proprietary partition panels of aluminium or steel framing with particle board or steel faces. Thickness, width and height of panels shall be in accordance with manufacturer's recommendations.

2008.3 Vertical seals

Vertical sound seals between panels shall be tongue and groove configuration incorporated with vinyl acoustical seals.

2008.4 Horizontal as generally seals

Horizontal seals, both top and bottom shall be twin-finger contact type vinyl strips sweep seals fixed to the top and bottom edges of the panels.

2008.5 Pass doors

Pass door shall be either a swing access door of a maximum height of 3000 mm, provided by the end leaf of a hinged unit consisting of an odd number of leaves or an independently hung leaf.

Alternatively, pass doors can be wicket doors required no thresholds and finish to match the partition panels.

Pass doors shall be fixed with stainless steel hinges and furnished with mortice latches with flush lever handles on both sides of the doors.

2008.6 Suspension system

Suspension system shall consist of heavy duty extruded aluminium or hot-dipped galvanised steel track to BS EN 10143 connected to the structural support by bolts or threaded rods.

Brackets shall be aluminium alloy pressure die castings or other approved bracket types, spaced at centres not exceeding 900 mm and shall be reduced to 600 mm centres for heavy doors.

Hangers shall be steel ball bearing type (lubricated for life) or proprietary trolley assembly: both shall be with vertical adjustment.

Panels shall be continuously hinged with stainless steel butt hinges fitted 3 in height on partition up to 3000 mm.

2100 COLD FLUID-APPLIED WATERPROOFING

2101 General

2101.1 Section Requirements

Submittals: Product Data.

Installer Qualifications: Installer who is approved by manufacturer.

Warranties: Manufacturer's standard written warranty, signed by manufacturer agreeing to promptly repair or replace products that fail in materials or workmanship for the period of **five (5)** years.

Where ASTM standards are referred to in this section, these may be replaced by E.U. member state and/or ACP State standards provided they are equivalent or superior to the U.S. Standard.

2102 Products

2102.1 Waterproofing Materials

Retain one of or all options in "Polyurethane Waterproofing" Paragraph below if manufacturers can confirm compliance.

Polyurethane Waterproofing: DIN EN 1928 / DIN EN 4102 or ASTM C 836/C 836M and coal-tar free.

Primer: Manufacturer's standard primer, sealer, or surface conditioner.

Sheet Flashing: 50-mil- (1.3-mm-) minimum, nonstaining, uncured sheet neoprene.

- Adhesive: Manufacturer's recommended contact adhesive.

Joint Reinforcing Strip: Manufacturer's recommended fiberglass mesh or polyester fabric.

Joint Sealant: Multicomponent polyurethane sealant, compatible with waterproofing, and as recommended by manufacturer for substrate and joint conditions.

Protection Course: Semi rigid sheet with reinforced asphaltic core, 1/8 inch (3 mm) thick; Fan-folded, extruded-polystyrene board insulation or Molded-polystyrene insulation board 1 inch (25 mm) thick.

Molded-Sheet Drainage Panels: Permeable geotextile laminated to a three-dimensional, molded-plastic-sheet drainage core.

Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV or Type VI, fabricated with shiplap or channel edges and with one side having grooved drainage channels.

2103 Preparation

Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

Mask off adjoining surfaces not receiving waterproofing.

Close off deck drains and other deck penetrations.

Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.

Remove projections, and fill honeycomb, aggregate pockets, holes, and other voids.

Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners according to waterproofing manufacturer's written instructions and to recommendations in ASTM C 898/C 898M and ASTM C 1471.

Install sheet flashing and bond to deck and wall substrates where required according to waterproofing manufacturer's written instructions.

2104 Waterproofing Application

Retain first option in first paragraph below for plaza and horizontal decks; retain third option for vertical surfaces such as planters and foundation walls.

Apply waterproofing according to manufacturer's written instructions and to recommendations in ASTM C 898/C 898M and ASTM C 1471.

2104.1 Unreinforced Waterproofing Applications

Apply one or more coats of waterproofing to obtain a dry film thickness of 90 mils (2.25 mm).

2104.2 Reinforced Waterproofing Applications

Apply first coat of waterproofing, embed membrane-reinforcing fabric, and apply second coat of waterproofing to completely saturate reinforcing fabric and to obtain a dry film total thickness of 120 mils (3 mm).

Install protection course over waterproofing membrane. Use adhesive or tape applied according to manufacturer's written instructions. Do not penetrate waterproofing. Retain subparagraph below if molded-sheet drainage panels are used.

Lap edges and ends of geotextile to maintain continuity.

2200 CRYSTALLINE WATERPROOFING

2201 General

2201.1 Section Requirements

Submittals: Product Data.

Ambient Conditions: Proceed with waterproofing work only when temperature is maintained at 40 deg. F (4.4 deg. C) or above during work and cure period and when space is well ventilated and kept free of water.

Where ASTM standards are referred to in this section, these may be replaced by E.U. member state and/or ACP State standards provided they are equivalent or superior to the U.S. Standard.

2202 Products

2202.1 Waterproofing Materials

Crystalline Waterproofing: Packaged blend of Portland cement, treated sand, and chemicals that, when mixed with water and applied, penetrates into concrete and concrete unit masonry and develops crystalline growth within substrate capillaries to produce a waterproof substrate.

Water Permeability: Maximum zero for water at 30 feet (9 m) when tested according to CE CRD-C 48.

Compressive Strength: Minimum 4000 psi (27.6 MPa) at 28 days when tested according to ASTM C 109/C 109M.

2202.2 Accessory Materials

Patching Compound: Cementitious repair mortar, crack filler, or sealant recommended by waterproofing manufacturer.

Portland cement: ASTM C 150, Type I.

Sand: ASTM C 144.

Polymer Admixture for Protective Topping: Polymer bonding agent and admixture designed to improve adhesion to prepared substrates and not to create a vapor barrier.

2202.3 Mixes

Crystalline Waterproofing: Add prepackaged dry ingredients to water according to manufacturer's written instructions. Mix together with mechanical mixer or by hand to required consistency.

Protective Topping: Measure, batch, and mix Portland cement and sand in the proportion of 1:3 and water gauged with a polymer.

2203 Preparation

Repair damaged or unsatisfactory substrate with patching compound according to manufacturer's written instructions.

Surface Preparation: Comply with waterproofing manufacturer's written instructions to remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.

2204 Application

General: Comply with waterproofing manufacturer's written instructions for application and curing.

Saturate surface with water for several hours prior to application and maintain damp condition until applying waterproofing. Remove standing water.

Number of Coats: Two (2).

Retain either brush or spray application in "Application Method" Subparagraph below unless Contractor has option.

Application Method: Brush or Spray. Apply to ensure that each coat fills voids and is in full contact with substrate or previous coat.

Dampen surface between coats.

Final Coat Finish: Brushed or Spray textured.

Curing: Moist-cure waterproofing for three days.

Protective Topping: Apply 25.4mm (1-inch) thick protective topping over floor surfaces.

2300 ELECTRICAL WORKS

2301 General

2301.1 Regulations and Standards

The electrical installation shall comply with all relevant statutory regulations and standards current at date of tender, unless otherwise indicated within this Specification. In general the following shall apply:

- The IEE Regulations for Electrical Installations, 16th Edition.
- The Health and Safety at Work Act, etc.
- Factories Act (UK)
- British Standards (BS)
- British Standards Codes of Practice (CP)
- International Electrotechnical Commission (IEC)
- Regulations under the Electricity Acts of Saint Lucia.

If no standard is specified, the relevant British Standard or, in the absence of such standard, International standard shall apply.

2301.2 Abbreviations of Electrical Terms

For the purpose of this Specification the following abbreviations of electrical terms have been used:

L1	-	red phase
L2	-	yellow phase
L3	-	blue phase
N	-	neutral
ac	-	alternating current
dc	-	direct current
A	-	amp
mA	-	milliamp
V	-	volt
kW	-	kilowatt
kWH	-	kilowatt hour
kVAr	-	kilovar
kVA	-	kilovolt amp
MVA	-	megavolt amp
Hz	-	hertz (cycles per second)
SP	-	single pole
SPN	-	single pole and neutral
DP	-	double pole
TP	-	triple pole
TPN	-	triple pole and neutral
SPSwN-		Single pole and switched neutral
TPSwN-		triple pole and switched neutral

MCB	-	miniature circuit breaker
MCCB	-	moulded case circuit breaker
RCD	-	residual current device
MCC	-	motor control centre

2302 Polarity

The polarity of all electrical apparatus used for the Works specified shall be arranged as follows:

- for two pole apparatus the phase of 'live' pole at the top (or left hand side) and the neutral or 'earthed' pole at the bottom (or right hand side),
- for three or four pole apparatus the phases in order of red, yellow, blue and neutral reading from top to bottom or left to right in the case of vertical and horizontal lay outs respectively and as viewed from the front.

All non-flexible cables shall be so connected between main switchboards, distribution boards, plant and accessories so that the correct sequence or phase colours are preserved throughout the system.

All non-flexible cable cores shall be identified with phase colours for three and four wire circuits. Single phase circuits shall be red and black.

2303 Voltages and Frequencies

Unless otherwise indicated in the Particular Specification, all apparatus and wiring shall be suitable for use with the Saint Lucia Standard Electrical Power Supply, which conforms to the EC standard of 3 phase, 4 wire, 230/400 volt, 50 Hz earthed neutral supply. The supply waveform shall be a sine wave.

Supplies for control, tripping, alarm and indication circuits shall be 24 V dc. Circuit breaker spring charging motors shall also operate at 24 V dc.

Control voltage within motor starters shall be 240 V ac. Extension of 240 V circuits outside the starter shall not be permitted except for the circuit to the emergency stop button, where fitted.

Tap changer motors and electrical panel heating and lighting shall operate at 230 V, single phase. All equipment operating at 230 V shall be fully shrouded and clearly labelled.

Where 230 V lighting and heating is used within a panel which otherwise contains equipment with a nominal operating voltage of 24 V, the 220 V equipment shall be insulated, sheathed and protected in accordance with standard practice for installing such equipment in buildings. No live terminals shall be accessible without the use of tools, no single-insulated wires shall be used, and no 220 V cables shall share cable trays or other routes with 24 V circuits.

All references to voltages shall relate to the nominal, or rated value of the supply.

2304 Units of Measurement

All information shall be in metric SI units. Where plant design exist in imperial units, the dimensions and tolerances of lay outs and terminal points shall be presented in SI units to a degree of accuracy which permits the precise matching of existing components.

2305 Electricity Supplies

The Contractor shall liaise with the relevant Utility Company to undertake any testing and inspection necessary for the electricity supplies to be connected when required. On completion of the tests and inspections, not less than two weeks prior to the power supply being required, the Contractor shall supply to the Supervisor's Representative a copy of his Electrical Installation Completion Certificate and of the test certificates.

2306 Electrical Safety

The Contractor shall be responsible for the electrical safety of all equipment supplied and installed. Whilst any equipment is being installed or tested, the Contractor shall ensure that all necessary precautions are taken to safeguard personnel working on site. If necessary, this shall include erecting warning notices and fencing off areas which are considered to pose a risk.

The Contractor shall be responsible for ensuring that the electrical installation is carried out by competent personnel and that the work is carried out in accordance with standard procedures and test requirements. Before any piece of apparatus is energised it shall be thoroughly examined for the presence of dirt, water or other foreign bodies.

2307 Electrical Motors

Electrical motors shall comply with BS 4999 and BS 5000, or equivalent.

Motors shall be three phase squirrel cage induction type. They shall be capable of withstanding without damage an overload equivalent to 150% of full load torque for 15 seconds.

The motor rating shall be not less than 105% of the maximum power demand of the driven plant when operating in its normal range. For motors above 15 kW, the input power factor over the normal operating range shall not fall below 0.85 lagging.

The motor terminal box shall allow adequate clearance for an air termination of the specified cable, cable lugs and glands.

Motors of 15 kW and above shall be fitted with anti-condensation heaters. The heaters shall be separately fused and energised when the main circuit contractor is open.

A motor rating plate shall be fitted to every motor giving the following information:

- manufacturer's name
- motor type and serial number
- power rating
- current, voltage and winding connection

- supply frequency
- duty power factor
- duty speed
- class of insulation
- IP rating
- maximum number of starts per hour

Unless otherwise specified the motors shall be capable of starting at least 5 times, equally disposed in any one hour at maximum ambient temperature.

Motor insulation shall be rated to thermal class F and temperature rise shall not exceed the limits of class B.

The degree of protection of the motor enclosure shall be as follows:

- Outside in temperate climates IP 55;
- Where hosing down may take place IP 55;
- Inside adjacent to water carrying equipment or in uncontrolled environment IP 44;
- Inside in controlled environment IP 22.

All motors shall be provided with a frame earth terminal of sufficient size to take full fault current.

All motors operated on an HV supply, and all motors rated at 250 kW or greater shall incorporate winding temperature protection in the form of six thermistor (or thermocouple) temperature detectors embedded in the stator windings. The temperature detectors shall be wired to a connection box mounted on the motor frame. The box shall be dedicated to the connection of the temperature devices and shall not be used for any other purpose. The box shall incorporate over-voltage protection devices.

All motor rotating parts together with their couplings shall either be enclosed within the motor frame or be fitted with guards, removable only by the use of tools, to prevent accidental contact.

2400 TRANSFORMERS

2401 Voltage Transformers

Voltage transformers shall comply with the latest Standards. The secondary winding shall produce an output line voltage of 240 V, three phase. The accuracy class and VA rating shall be as specified or shall match the requirements of all connected instruments and relays.

The primary circuit shall be protected by HRC fuses having a short-circuit rating of not less than that of the switchgear. The connections between the fuses and the switchgear primary conductors shall be of sufficient cross section and be supported to withstand the short-circuit rating of the switchgear.

The secondary circuit shall be protected by HRC fuses mounted as close as possible to the secondary terminals. Fuses shall be accessible without the need for isolating the switchgear.

Isolatable voltage transformers shall have the facility for padlocking in the service position. Safety shutters shall automatically cover the busbar spouts when the transformer is withdrawn. Shutters shall have the facility for padlocking in the closed position.

2402 Current Transformers

Current transformers shall comply with the latest Standards and shall be of the wound-primary or bar-primary type according to ratio required. All current transformers shall have a short-time current rating of not less than that of the switch panel in which they are incorporated. For bar-primary current transformers this rating shall be for a period of 3 seconds. For wound-primary patterns the rating shall preferably be for a period of 3 seconds but may be reduced to not less than 0.5 second subject to the Supervisor's Representative's approval.

Identification labels shall be fitted giving type, ratio, rating, output and serial numbers.

Current transformers shall be of Class 1 accuracy for use with measuring instruments and Class 10P for use with protective relays.

Class 5P shall be used for combined overcurrent and earth fault protection of the inverse time overcurrent type.

The secondary windings of each set of star-connected three phase current transformers shall be earthed at one point only, via a bolted link.

Separate sets of CTs shall be used for metering and protection.

Shorting links shall be provided at test blocks.

2403 Control Transformers

Unless otherwise specified all contactor control circuit supplies shall be obtained from the 240 V secondary winding of a single phase integral control transformer.

Transformers shall be of the double wound pattern in accordance with the latest Standards and shall have an earth screen between primary and secondary windings. One leg of the secondary winding shall be earthed. The primary winding shall be protected by cartridge fuses, and the secondary winding shall be protected by a fuse and link.

A spare control transformer shall be provided with each new switchboard.

2404 Protective Relays

Protective relays shall be mounted on the front of the switchgear or relay panel in such a position that operation and maintenance can be conveniently carried out. Auxiliary relays may be mounted inside a cubicle provided that they are readily accessible.

Each relay shall be contained in a dust proof case with a clear front cover. All metal bases and frames shall be earthed except where there are technical reasons where this is impracticable.

All relay contacts shall be capable of making the maximum current which can occur in the circuit without causing damage to the contacts.

Relays shall have provision for testing the operation and calibration without disconnecting the permanent wiring.

Flush, draw out type relays are preferred. Each relay shall have an indicator device to show when the relay has operated and if necessary, which phase element. Each indicator shall be hand resettable. Resetting devices shall not require the removal or opening of the relay. It shall not be possible to operate the relay without opening the case.

Where solid state relays are specified, these shall be of the module type comprising a number of plug in elements allowing interchange of functions. Each of the protection elements shall have adjustable controls for current and time settings as required. Solid state relays of a particular type shall have interchangeable protective elements with other similar relays supplied under this Contract.

All relays shall be provided with a name plate giving manufacturer, type, and serial number, year of manufacture, ratings and connection diagram.

All relays using a DC auxiliary supply shall operate down to 60% of the nominal voltage and up to boost charge voltage of the battery.

Protection relays shall comply with the latest Standards where appropriate and shall conform to the following provisions:

2404.1 Generator or Transformer Biased Differential Protection

The protective relay system shall be suitable for generators or two or three winding transformers. The relay shall not operate due to magnetising or line switching current surges or tap change ratio changes provided on the transformer, nor for through fault currents.

2404.2 Transformer Restricted Earth Fault Protection

These relays shall be instantaneous in operation, consistent with normal operating due to transient switching currents. Each relay shall be capable of being set to operate under service conditions with primary currents likely to occur on site by means of relay adjustment.

2404.3 Overcurrent and Earth Fault Protection

Relays shall be of the attracted armature or rotating disc type having instantaneous, inverse or very inverse definite minimum time, directional or non-directional characteristics as specified.

2404.4 Under Frequency Relays

The setting range shall be variable between -10% and + 2% from the rated frequency. Two different settings shall be provided to give alarm and trip facilities. A low pass filter unit shall be fitted where the harmonic distortion exceed 5% of the fundamental.

2404.5 Under and Over-voltage Relays

Variable settings shall be provided as required together with a 0 to 5 second time delay.

2404.6 DC Trip Relays

Relays shall be suitable for operating with the voltage reduced to 60% of normal.

2404.7 Motor Thermal Relays

Relays for motor protection shall give protection against overload, stalling, current unbalance, and single phasing. The relay shall have variable current settings and overload tripping time.

2405 Motor Starters

2405.1 Motor Starters - Low Voltage

Motor starters shall be of the "direct on line" (DOL), Autotransformer, and Soft Starter or Star-Delta type as specified in the "Specific Requirements".

All starters shall comply with the latest Standards.

- Utilisation category AC3
- Co-ordination type C
- Intermittent duty class 0.3
- Mechanical endurance 3 million

The starter shall have motor circuit HRC fuses or MCCB's or motor circuit protector type moulded case circuit breakers to protect each contactor and overload unit against short circuit conditions. The contactor shall not be used for short circuit protection.

The starter shall incorporate the following features:

Fault rated, door interlocked, fused switch or MCCB with mechanical operating handle, ON/OFF indication and pad-lockable OFF facility. The fused switch or MCCB shall be fitted with not less than one "make" and one "break" spare auxiliary contacts in addition to those used within the starter circuitry;

Thermal overload device with inherent temperature compensation and single phasing protection, time lagging to cover the starting period, and overload setting adjustment. Operation of the device shall open the main contactor circuit and this shall be locked out until reset via a door mounted hand operated reset push button.

For motors up to 30 kW direct connected thermal overload devices integral with the motor contactor shall be accepted. For motors rated at over 30 kW the overload devices shall be separately mounted. For motors of 100 kW and above the starters shall be equipped with motor protection relays which provide thermal imaging type overload detection, earth leakage protection, instantaneous overcurrent protection, and phase current unbalance protection;

Local/remote and/or manual/auto (or manual/off/auto) control selector switch as required by the application; Triple-pole air break contactor complying with the latest Standards and with inherent under voltage release;

Fault reset push button;

HRC cartridge fuse(s) and wiring via main contactor N/C auxiliary contacts to supply the motor anti-condensation heaters;

HRC cartridge fuses for control and indication circuit protection;

Ammeter and single CT (fitted to blue phase) for 3 phase motors between 2.5 kW and 25 kW. Ammeters shall be fitted on all phase for motors larger than 25 kW. Where power factor correction capacitors are fitted, the ammeter shall read uncorrected current;

Pilot lights to indicate:

Power available	White
Running	Red
Stopped	Green
Motor tripped alarm	Amber
Flow failed alarm	Amber
Winding temp alarm	Amber (motors>250 kW)
General alarms	Amber

Individual alarm lights shall be provided for each fault condition. They shall remain in the alarm condition until the protective device is manually reset.

- Hours run counter;
- Start push button, operable in local or manual modes only;
- Stop push button of the latching, mushroom-headed type, coloured red and latching in the stop position. The push button shall be of the twist to reset type. The stop push button shall be operational in all control modes. The starter circuitry shall also provide connections for an emergency stop push button located at the plant. This shall be connected in series with the starter mounted stop button to directly break the main contactor control supply.
- Power factor correction capacitors shall be supplied when necessary, to correct the power factor of the motor to a minimum of 0.95 lagging. Where the motor rating is 50 kW or greater, the capacitors shall be separately switched. In this case the capacitors shall be fitted with discharge devices.
- Power factor correction capacitors shall comply with the latest Standards and shall be of the polypropylene film and aluminium foil type and be "self-heating".
- For motors of rating 250 kW or greater, winding temperature detector relay to the latest Standards arranged to continuously monitor three temperature detectors.

Lamp test push button.

Panel anti-condensation heater, fuses and thermostat.

Control relays as required.

Flow failed protection relay.

All necessary links, wiring, terminals, terminations, and insulated barriers.

2405.2 Motor Starters - High Voltage

High voltage motor starters shall comply with IEC 694 and shall be fully compartmentalised to avoid the possibility of fault propagation (metal clad).

Contactors shall be operated by 240 V DC (full-wave rectified AC) derived from a transformer-rectifier in each starter. Contactors shall be vacuum or air as specified. Operation of vacuum contactors shall be such that current is broken at, or very near to zero current to minimise current chopping.

All HV starters shall be equipped with motor protection relays which provide thermal imaging type overload detection, earth leakage protection, instantaneous overcurrent protection, and phase current unbalance protection.

Each starter shall comprise:

- bus bar;
- switch disconnecter (suitable for switching stalled motor current);
- on-load circuit earthing switch;
- HRC fuses;
- vacuum contactor;
- motor protection relay;
- control transformer;
- ammeter and phase selector switch;
- Controls as specified.

The contactor or contactor and fuse assembly shall be withdrawable with positions for 'service', 'test' and 'disconnected'. Removal from the 'service' position shall automatically apply the circuit earth.

Facilities shall be provided for operation of the starter in the 'test' position.

Fuses shall be fitted with striker pins. An associated tripping mechanism shall ensure the de-energization of the vacuum contactor on the operation of any fuse.

Contactors shall be rated for utilisation category, AC4 and duty Class 0.3. Surge suppressors shall be fitted when recommended by the motor manufacturer. However, as a general rule they shall be fitted when motors are less than 600 kW.

The motor current ammeter physical size shall be in keeping with the size of the starter and shall have an adjustable and sealable red pointer to indicate full load current.

The control transformer shall be double wound, single phase. The windings shall be encapsulated with an earthed metal screen between the windings. The motor protection relay shall be solid state and provide protection for:

The relay shall be of the self-supervisory type with continuous monitoring of hardware and software.

The relay shall be hand resettable and give clear indication of the reason for operation.

Where specified starters shall be provided with power factor connection capacitors to raise the power factor to 0.95 lagging when operating at the duty point.

The starter cable box shall provide provision for the connection of a power factor correction capacitor supply cable such that the capacitor current does not pass through the motor protection relay.

Provision shall be made to supply a motor anti-condensation heater from each motor starter. The heater shall be energised via the cubicle isolator and controlled by a normally closed auxiliary contact on the main contractor. The heater circuit shall be protected by an internal circuit breaker.

2406 Circuit Breakers

2406.1 High Voltage Circuit Breakers

Circuit breakers shall be vacuum or SF6 type as specified. The equipment shall comply with the latest Standards as appropriate and be fully rated for the ambient conditions specified.

Circuit breakers shall be capable of clearing any fault condition which may occur on the system without damage to equipment or personnel.

Circuit breakers of the same pattern and rating shall be interchangeable.

Vacuum circuit breakers shall comprise separate vacuum interrupters designed to prevent welding of contacts and sharp current chopping during fault interruption or switching or motor loads.

All circuit breakers shall be provided with operating mechanisms as detailed in the specification, the selection being from the following types:

- independent manual spring;
- hand charged spring with electrical or manual release;
- motor charged spring with electrical release;

All operating mechanisms shall have mechanical 'ON' and 'OFF' indicators and a manual trip device fitted with means for locking. Hand charged and motor charged spring mechanisms shall have mechanical indicators to show 'SPRINGS CHARGED' and 'SPRINGS DISCHARGED'.

The operating mechanisms of hand charged and motor charged spring types shall be arranged so that release of the springs to close the circuit breaker can only be achieved by a deliberate action. It shall not be possible for vibration or mechanical shocks to release the charged springs. Motor charged spring mechanisms shall be arranged so that charging is initiated automatically following a discharge. The necessary limit stops and switches for the automatic control of the charging shall form an integral part of the mechanism. The facility shall be provided to hand charge a motor charged spring mechanism.

Spring operated mechanisms shall be provided with volt-free contacts to give indication that the springs are charged.

To facilitate maintenance and the adjustment of contacts, it shall be possible to 'slow-close' the circuit breaker but this operation shall only be possible in the fully withdrawn position. Any operating handle or lever necessary shall be supplied.

All circuit breakers shall be provided with interlocks to ensure that:

- The circuit breaker cannot be racked into or out of the service or earth position whilst it is closed. Attempts to rack out a closed circuit breaker shall not cause it to trip;
- The circuit breaker can only be closed when fully engaged in the service, earth, or fully isolated positions;
- The circuit breaker cannot be closed in the service position without completing the auxiliary circuits between the fixed and moving portions;
- The circuit breaker cannot be 'slow-closed' except in the fully isolated position;
- With hand charged or motor charged spring mechanisms, the springs cannot be discharged until they have been fully charged or until the means for charging has been fully removed and disconnected;
- When the circuit breaker is closed in the earth position, tripping can be effected only by the manual device on the operating mechanism;
- Where mechanical key interlocking is employed, tripping of a closed circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism.

Circuit and/or busbar earthing shall be by the transfer circuit-breaker method without the requirements of any loose attachments. The earthing operation shall be completed by the closing of the circuit breaker by its normal operating means using local control. Selection of either circuit or busbar earthing shall be possible only after the circuit breaker has been fully isolated. Mechanical key interlocks shall remain operative when the circuit breaker is in either earthing position.

Facilities shall be provided on all incoming and feeder circuit breakers for earthing the circuit side. On at least one circuit breaker panel in any section of busbars, facilities shall be provided for busbar earthing.

A set of safety shutters shall be provided to cover each three phase group of stationary isolating contacts. The shutters shall be opened automatically by a positive drive from the circuit breaker moving portion and when closed shall prevent access to the stationary isolating contacts. When the circuit breaker is withdrawn each set shall be capable of being individually operated and of being padlocked in the closed position.

Shutters in bus-section units shall be coloured red and shall be labelled with a large white arrow pointing in the direction of the section of busbars to which the contacts are connected.

Circuit breaker moving portions shall be fitted with positive guides to ensure correct alignment of the isolating contacts in both the service and the earth positions.

2406.2 Low Voltage Circuit Breakers

All 415V circuit breakers for incoming circuits, and bus section circuits on 415V switchboards and interconnector circuits shall be of the air break metal clad type complying with the requirements of the latest Standards.

Circuit breakers shall switch three phase poles. The neutral pole shall either be switched or established through a bolted link. Access to the link shall not be possible when the equipment is in the "Service Position".

Provision shall be made for easy access to the circuit breaker contacts for maintenance purposes.

Arc chutes shall be so arranged that the emission of hot gasses shall not damage any part of the equipment.

2406.3 Moulded Case Circuit Breakers

Moulded case circuit breakers (MCCBs) shall be manufactured to the latest Standards.

MCCBs shall have thermal overload and adjustable magnetic short circuit tripping devices with a trip-free mechanism to ensure that the contacts cannot be held closed against a fault. Contacts shall be silver tungsten tipped and shall operate with a wiping, arc resisting material and incorporate arc chutes based on the de-ionising principle.

MCCBs shall have a factory calibrated and sealed trip unit, interchangeable with similar units for varying the rating of the circuit breaker.

Where dust and damp proof enclosures are to be used, then the circuit breakers shall be fully enclosed in a case with a gasketed door. Circuit breakers mounted in a composite control panel shall be segregated from other equipment and have a matching purpose-made

cover plate. Where possible, circuit breakers shall be mounted vertically and be arranged so that one breaker can be removed without interfering with other circuit breakers. The switch dolly and protruding face shall be engraved with the circuit rating and the ON and OFF positions.

Tripping due to overload or short-circuit shall be clearly indicated by the handle automatically assuming a position midway between the manual ON and OFF positions. To reset from the 'tripped' position, the dolly shall first pass through the OFF position. All phase poles shall operate simultaneously.

MCCB's used for short circuit protection (only) in motor starters shall provide instantaneous short circuit protection by means of an adjustable magnetic element on each pole. The adjustment knob(s) shall have the end and mid-setting points marked and adjustment shall follow a linear scale so that each point has a significant value within calibration tolerances. MCCB's shall not be used to provide thermal protection or switching of motors.

MCCB's shall be ambient temperature compensated. Compensation shall allow the breaker to carry rated current between 25°C and 50°C with tripping characteristics that are approximately the same throughout this temperature range.

2406.4 Miniature Circuit Breakers

Miniature circuit breakers (MCBs) shall be manufactured and tested to the latest Standards.

MCBs shall have a short circuit rating of at least M4 and shall be Type 3 with a breaking capacity of 4.5 kA at 220/380 V unless otherwise specified.

The fault capacity of the MCB shall be not less than that of the switchboard. If this is not the case, back up HRC fuses shall be fitted. MCB's for dc circuits shall provide a double break (one pole protected plus one switched).

2406.5 Earth Leakage Circuit Breakers

Earth leakage circuit breakers (ELCBs) shall be of the current operated type complete with current balance transformer, test push button, trip coil and thermal overloads. They shall be double pole for single phase and four pole for three phases and neutral circuits. ELCBs shall comply with the requirements of the latest Standards.

The out of balance current shall not exceed 30 mA for circuit breakers up to 60 amp rating and 500 mA for above this rating.

Current operated ELCBs shall not be used where the product of the operating current and the earth loop impedance exceeds 40.

2407 Fused-Switches and Disconnecter Combination Devices

2407.1 General

Fused switch disconnectors, switch-disconnectors and disconnectors, shall be rated at 500 V and shall be to the latest Standards.

Fuse switch disconnectors shall be of the air break triple pole or single pole and neutral type. They shall have not more than one fuse in any one pole. The neutral shall be either switched or taken through a removable link. If a switched neutral is required, the neutral shall be arranged to make first and break. A separate brass earth terminal shall be provided.

Operating mechanisms shall be of the independent spring type and fitted with mechanical ON and OFF indicators. Operating handles shall be of semi-flush or telescopic pattern to reduce front projection to a minimum.

Disconnectors shall be identical to fuse-switches but the fuse links shall be replaced by hard drawn high conductivity copper links.

Facilities for locking the operating handles by padlock shall be provided.

All switch-disconnectors shall be rated to make the full short circuit current of the system. Units used on distribution circuits shall be rated to break full load current and units used in motor starters shall be rated to break stalled motor current.

2407.2 Fuses and Links

Fuses shall comply with the latest Standards as appropriate.

Fuses and links shall be provided to enable any circuit to be isolated as necessary for maintenance and test purposes without isolating the whole panel. All fuses shall be of the cartridge type. Fuse carriers and solid link carriers and bases shall be made of plastic moulded insulating materials; ceramic materials shall not be accepted. Accessible live connections shall be effectively shrouded and it shall be possible to change fuses and remove links with the circuit alive without danger of contact with live metal. The fuses shall be rated to give maximum protection to the apparatus in circuit and the rating shall be inscribed on the fuse label.

Earthing and neutral links in main supply circuits shall be solid copper bolted pattern.

Fuses and links functionally associated with the same circuit shall be mounted side by side.

2407.3 Circuit Protective Conductors

An independent Circuit Protective Conductor shall be provided for each circuit and may comprise one or any of the following as appropriate:

- a separate core within a multicore cable;

- a separate conductor installed within a conduit or trunking. Steel conduit or trunking shall not be used as a circuit protective conductor;
- the metal sheath of an armoured cable. The sheath shall be bonded to the metalwork of the apparatus and to the apparatus earth bar if any;
- the copper sheath of a mineral insulated copper sheathed cable;
- an independent insulated copper conductor run adjacent to the circuit it protects.

Circuit protective conductors associated with the main circuits supplying switchboards and large electrical loads, i.e. motors in excess of 75 kW shall form a separate core of a multicore cable feeding the device or shall be an independent insulated copper conductor run adjacent to the supply cable. The size of the circuit protective conductor shall be calculated in such a manner as not to take into consideration the contribution of any other parallel or fortuitous earth paths.

The armouring of the supply cable shall not form the sole means of earthing a switchboard or large electrical load.

Where the cable armouring or sheath is used as the circuit protective conductor it shall be securely bonded at both ends to the metalwork of the apparatus and to an earth bar. Particular care shall be taken to ensure continuity across items of apparatus situated within a cable run and should the design of such items of apparatus not give adequate and lasting continuity through its structural body then additional earthing clips and conductors shall be provided to independently bond the cable sheaths together. Similarly additional earthing clips shall be provided to bond the cable sheaths/armour to any piece of apparatus fitted with a special earth terminal should the earth connection for the termination gland be inadequate. Any additional earthing clips shall be fitted within the apparatus wherever possible.

2408 Distribution

2408.1 Local Control Stations

Local control stations shall be of heavy duty construction and where appropriate, constructed in accordance with safety and general construction equipment with the Section entitled 'Switchboard, Cubicle and Enclosure Construction'. Local control stations shall be mounted directly onto the plant to be controlled, or be provided with a floor mounting tubular pedestal with provisions to accommodate the incoming cables.

Small covers shall be secured by screws or bolts and be totally removable. In larger sizes and where instruments are to be fitted, the covers shall be provided with heavy duty hinges.

The bottom face shall be arranged to accept, with adequate space for the use of spanners, gland terminations for the number of cables required.

Terminals shall be provided for interconnections arranged vertically at the side for easy access, and marked with identification numbers/letters corresponding with the associated diagrams.

Pendant type local control stations for cranes, hoists, etc. shall be of moulded neoprene or equivalent heavy, flexible, high impact strength materials. The station shall be connected by a long moulded-in cable strengthening sleeve, to minimise the possibility of cable fracture at the bending point. The enclosure shall be self-coloured in safety yellow.

2408.2 Marshalling Boxes

Marshalling boxes shall be constructed of sheet steel with ample space for routing and terminating cables and cores.

Enclosure protection shall be the same as that for switchboards i.e.

- Outdoor IP65
- Indoor IP54

Every marshalling box shall be provided with the following:

- undrilled gland plate arranged for bottom entry;
- anti-condensation heater with thermostat and fuse;
- padlocking facility and padlock;
- earthing bar with terminal holes;
- door-switch operated internal light with fuse;
- labels for front door, fuses, terminal blocks, and terminals;
- transparent plastic covers on terminal blocks operating at greater than 24V;

2409 Power Transformers

2409.1 General

Transformers shall be sized for continuous operation at the maximum rating at the ambient conditions specified.

The transformer load factor shall be taken as 80% for normal operation.

The core construction shall be built up of on-aging, low loss and high permeability, cold rolled, grain oriented silicon steel. Lifting eyes or lugs shall be provided for removal of the core assembly.

The cores shall be earthed at one point only with a readily accessible removable connection which may be conveniently opened to check the core insulation.

The windings shall be double wound connection Dy11.

Transformers shall be supplied complete with oil level indicator with drain cock, sample cock, oil change valves, jacking pads, pulling lugs, Buchholz relay, and thermometer pocket with thermometer, and earthing terminal.

Transformers rated above 150 kVA shall be fitted with separate oil and winding temperature gauges.

Transformers rated above 250 kVA shall be provided with offload tap changers manually operated by a lockable wheel or handle. The tapplings shall be provided on the HV windings at +22% and 5% of the no load primary voltage.

Cable boxes with wiping or screwed glands shall be provided for the cables specified. A non-magnetic gland plate shall be fitted for single core cables and insulated glands provided for 400 mm² cables and above. It shall be possible to remove the cable boxes without breaking the cable seal or draining the oil. Disconnecting link boxes shall be fitted on the high and low voltage sides of the transformer for cable pressure testing.

2409.2 Insulators and Bushings

Porcelain insulators and bushings shall comply with the requirements of the latest Standard as appropriate.

Porcelain for insulating purposes shall comply with the requirements of the latest Standards. Each porcelain insulator shall bear the manufacturer's mark and batch identification, which shall be applied before firing. The clamping surfaces of all porcelain insulators shall be accurately ground and shall be free of glaze.

2409.3 Insulating Oil

Insulating oil shall comply with the requirements of the latest Standards. Insulating oil shall be provided by the Contractor for all oil-filled apparatus and 10% excess shall be provided for topping up purposes in sealed drums.

If equipment is to be filled with oil at Site, the Contractor shall provide oil for filtration equipment of suitable capacity.

The Contractor shall supply a schedule of insulating oils and greases which the Contractor recommends for use with his equipment.

2410 Earthing

2410.1 General

Earthing systems shall comply with the latest Code of Practice and IEE Wiring Regulations (16th Edition).

The metalwork of all items of electrical plant, electrical system neutral points, power and control cable armouring and screens, and extraneous metalwork including structural steelwork, pipework, fences and gates, shall be connected to the earthing installation.

Earth continuity in non-electrical plant shall normally be achieved via metal to metal faces, pipe flanges, metal hinges, and metal fixings. Earth straps to bond pipework sections shall be supplied where earth resistance is high or there is risk of corrosion or similar which could in the future increase resistance and affect earth continuity.

Perimeter fences shall be either bonded to the earthing system. Metal gates shall be bonded to the fence using flexible connections.

2410.2 Installation

The earthing installation shall comprise an earth terminal, earth busbars, circuit earthing conductors, equipotential bonding conductors, and main earthing conductor and earth electrodes. The circuit earthing and equipotential bonding conductors shall be of the radial, grid or ring form as dictated by the plant lay out.

The earthing installation shall be protected from mechanical damage and corrosion.

Joints in tape conductors shall be riveted and soldered, brazed, clamped, bolted or exothermically welded. Non-corrosive flux shall be used for soldered joints. Clamped and bolted type joints shall be tinned and shall only be used above ground.

The interconnection of conductors below ground shall be by means of exothermic welding or brazing. Compression type lugs shall be provided for the termination of cables.

Earthing conductors shall be buried directly in the ground or secured to building structures, cable racks and trays using propriety fixings.

Where the soil is aggressive to copper, buried earthing conductors and joints shall be protected by an approved serving.

An equipotential bond shall be provided to all buried metal pipework at the point of entry into a building or chamber where electrical apparatus is installed. Electrical continuity across all pipe joints within the structure shall be ensured. Normally the connection of the pipe flanges shall suffice, but where pipework incorporates a compression coupling (e.g. Viking-Johnson coupling), a bond shall be provided to any otherwise isolated section.

Cable armouring and screens shall be bonded to earth at both ends unless otherwise specified. Cable armour shall not be used as the sole earth protective conductor.

2410.3 Conductors

Circuit and main earthing and equipotential bonding conductors shall be high conductivity copper tape or 1000 V grade PVC insulated multi-stranded cable. PVC cable insulation shall be striped green/yellow. Cable lengths shall be continuous and intermediate jointing is not permitted.

The main bonding conductor shall be not less than 16mm² and supplementary bonding of non-electrical plant not less than 10 mm². All connections shall be made using compression

type cable lugs, taped on completion to completely seal the lug and any bare copper from the atmosphere.

The surface to which earthing bonds are fixed shall be cleaned free from paint and other non-conducting material and coated with petroleum jelly.

2410.4 Earth Electrodes

Earth electrodes where used shall be solid copper or copper clad high tensile steel rods with a copper plate thickness of not less than 0.25mm. The outer diameter shall be not less than 16mm. The rod shall penetrate a minimum of one metre below ground level. Where multiple rods are used they shall be separated by a distance of not less than the driven length.

Earth rods shall have hardened tips and caps and be extendable.

Where soil conditions make the use of rod type electrodes impracticable a grid configuration may be used comprising horizontally buried bare high conductivity copper tape of dimensions 15mm x 4mm minimum. Tape shall be buried at a minimum depth of 600mm.

Each earth rod shall be provided with a clamp fabricated from non-ferrous metal for the connection of the earthing conductor. The connection shall be made in a concrete inspection chamber set flush with the finished ground level. The inspection chamber shall be permanently marked "Electrical Earth".

Marker posts and plates shall be provided to mark the position of the electrodes and buried connections. The markers shall be similar to those provided for cable routes.

2410.5 Main Earth Bar

Where specified, a main earth bar shall be installed in a convenient location. This shall comprise a high conductivity copper bar of sectional area at least that of the main earthing conductor. The earth bar shall be wall mounted, supported on insulators. The earth bar shall be complete with disconnecting links for test purposes, and connection points for the outgoing and incoming earth cables and tapes.

Earth studs shall have a minimum size of M8.

2410.6 Main Earth Terminal

A main earth terminal shall be installed in an approved location adjacent to the incoming supply to a building. This shall be labelled and comprise a 50 mm x 6 mm minimum cross section copper bar supported on porcelain barrel type insulators and wall mounted.

The bar shall be of sufficient length to accommodate bolted earth bonding connections from transformers, major items of plant and electrical switchgear, building structural steelwork, concrete reinforcement, the earth electrode system and the lightning protection system.

The earthing conductor shall be clearly marked as such and shall be accessible for disconnection to facilitate testing of the earth electrode system.

For small installations an earthing terminal comprising a single brass stud of 12 mm minimum diameter shall be acceptable with the approval of the Supervisor's Representative.

2410.7 Tests at Site

On completion of the earthing installation the Contractor shall measure the resistance of each electrode installation and of each complete earthing system to the general body of the ground. All other tests stipulated in the Reference Standards, shall also be carried out.

The resistance to earth of each complete earthing network shall not exceed one ohm.

2411 Neutral Earthing Resistors (Transformers and Generators)

2411.1 General

The resistors shall comply with the relevant parts of the latest Standards and shall be formed from continuous grids or strips of chrome aluminium steel or equivalent material.

2411.2 Material Temperature

The material shall have a temperature coefficient of less than 1.2% increase in resistance per 100°C rise over the operating temperature range, a high resilience against breakage and be free from any flaw likely to cause local overheating. The resistors shall be assembled into standard units having an inherent inductance of less than 10 degrees phase shift between current and voltage when operating on a 50 Hz supply.

2411.3 Temperature Switch

A temperature switch shall be provided within the resistor enclosure to detect uncleared earth faults or faults within the resistor.

2411.4 Interconnections

Interconnections between tiers shall be of plated copper connectors bolted to stainless steel terminals.

2411.5 Resistance

The resistance units shall be clamped securely in tiers by mica insulated bolts so as to prevent loops or grids coming into contact due to short-circuit forces. The resistance tiers shall be mounted in a box formation between pressed steel and frames, adequate allowance being made for any thermal expansion.

The resistance units shall be mounted in drip proof enclosures with protective classification of IP23. All protective and supporting steelwork shall be plated with zinc.

2411.6 Terminals

Terminals shall be provided for the connection of external cables and these shall support the cables or interconnecting copper work firmly holding them well clear of other parts. Cables shall not be run above hot resistance material.

2411.7 Air Break Isolators

An air break isolator and a current transformer of suitable rating shall be provided for mounting in the same enclosure with each neutral earthing resistor.

2412 Lighting Protection

Where buildings or sections of the plant are to be protected against lightning or static charges, an earthing system shall be provided. The installations shall be carried out in accordance with the latest Standard.

The down connectors shall be of hard drawn high conductivity copper of 25mm x 3mm section. The tape shall be fixed to the outside of the structure by means of stand-off saddles. Where indicated, connections shall be made to the concrete reinforcing. The route of the tapes and the fixings shall be approved by the Supervisor's Representative before installation.

Where the conductors specified shall be PVC insulated to prevent corrosion and to blend with the building fabric.

A test link shall be installed in each down conductor adjacent to the earth rod at a height of 1200 mm above ground level. The overall resistance of the earth termination system to earth shall not exceed 10 ohms. If this requirement is not met the number of earth electrodes shall be increased or they shall be interconnected until a value of 10 Ω is attained. After this resistance value is obtained, the lightning protection system shall be bonded to the main earthing system.

Earth rods and connection chambers provided for the lightning protection system shall be in accordance with the requirements of rods for the earthing system.

2413 Cables and wires

2413.1 General

Cables and wires shall be supplied by an approved manufacturer and where possible the same manufacturer shall be used for all cables and wires. Each drum or coil of cable shall be accompanied by a certificate stating the manufacturer's name, rating of cable, result and date of tests. Cables manufactured more than 12 months before delivery shall not be accepted.

All cables shall be delivered with cable ends effectively sealed. When a cable is cut from a drum both ends shall be immediately sealed to prevent ingress of moisture. Cables shall not be transported to site in loose coils but a number of short lengths of cable may be transported on the same drum. The Contractor shall be wholly responsible for the purchase and/or hire costs of all cable drums and for the removal of these drums from site after use.

Cables and wires shall be adequately rated for current carrying capacity under normal and short time fault conditions at the specified voltage.

The Contractor shall ensure that cable and wires associated with the power distribution and control systems throughout the Works are adequately rated for their use. When assessing the rating and cross section of any cable or wire, the following factors shall be taken into account:

- Maximum voltage drop permissible;
- Type and magnitude of load;
- Fault level and duration related to circuit protection relays and fuses;
- Overcurrent setting of relays;
- Route length and disposition of cables;
- Ambient temperature;
- Method of laying;

The design current of any circuit shall exceed the full load current of the supplied device by at least 10%. The voltage drop for any circuit from origin of the installation (i.e. supply authority's terminals) and the load under steady state conditions shall not exceed 4% of the nominal voltage. Under motor starting conditions the corresponding voltage drop shall not affect the operation of the motor controls or the ability of the motor to start and run effectively and in any event shall not exceed 10%. The Contractor when sizing cables for the remote operation of shunt trip coils shall take due account of the voltage drop caused by the momentary current surge taken at the instant of energization.

The Contractor shall submit cable schedules for approval detailing ratings, sizes, lengths, method of installation and function of all individual cables.

2413.2 Cable Types

Cables complying with BS, IEC, or approved equivalent standards shall be accepted provided that all cables which are supplied for a specific operating voltage are to the same

national standard. Each cable shall be in accordance with a standard which relates to its application.

(Standards specified in the following Sections indicate the type of cables which may be used in the design. If the Contractor wishes to use cables to an alternative standard then details of current carrying capacity, derating factors, etc., shall be submitted to the Supervisor's Representative for approval.

2413.3 High Voltage Power

XLPE/SWA/PVC - semi-conducting conductor screen, cross linked polyethylene insulation, stranded copper conductors, core screen of semi-conducting compound, semi-conducting tape, and metallic layer, extruded PVC bedding, galvanised steel wire armoured, flame retardant red PVC sheathed overall, suitable for use on an earthed system of the voltage specified. Cables shall comply with the latest Standards.

2413.4 Medium/Low Voltage Power Cables

XLPE/SWA/PVC - cross linked low density, polyethylene insulated, stranded copper conductors, extruded PVC bedding, galvanised steel wire armoured, flame retardant black PVC sheathed overall, suitable for use on an earthed system at a rated voltage of 0.6/1kV or 1.9/3.3kV as specified. Conductor temperature shall not exceed 90°C for continuous operation and 250°C for short circuit. Cables shall comply with the latest Standards.

PVC/SWA/PVC - PVC insulated, extruded PVC bedding, galvanised steel wire armoured, flame retardant black PVC sheathed overall, stranded copper conductors suitable for operation on a system at a rated voltage of 0.6/1kV. Conductor temperature shall not exceed 70°C for continuous operation. Cables shall comply with the latest Standards.

PVC/PVC - PVC insulated, extruded PVC bedding, flame retardant PVC sheathed overall, stranded copper conductors suitable for operation on a system at a rated voltage of 0.6/1kV. Maximum conductor temperature shall not exceed 70°C. Cables shall comply with the latest Standards.

PVC - PVC insulated single core copper conductor rated at 450/750 V. Insulation shall be phase coloured. Conductor temperature shall not exceed 70°C for continuous operation. Cables shall comply with the latest Standards.

Copper conductors shall be used throughout. Cores of cross-sectional area greater than 1.5 mm² shall be stranded. Lighting wiring shall be of a minimum cross-section of 1.5 mm². Small power and control cables shall be of a minimum cross-section of 1.5 mm².

2413.5 Flexible Cables and Cords

General purpose-PVC insulated stranded copper conductors white PVC sheathed overall, rated at 300/500 V in accordance with the latest Standards.

2413.6 Analogue signal cables

Cables shall be PVC or polyethylene insulated, twisted pair laid with individual or collective screen, tape bound with extruded PVC bedding, galvanised steel wire armouring and overall PVC sheath. Conductors shall be multistrand copper, 24/0.2 mm (0.75 mm²) or as specified. Solid cores shall not be permitted. The cables shall be rated at 300/500 V and shall comply with the latest Standards.

Cables with a collective screen only are permitted for use where the signal is a high level carrier (e.g. 4-20 mA dc) and the route length is not greater than 30 m. Where the route length exceeds 30 m or the signal is low level (e.g. from a strain gauge) cables shall have both individual and collective screens.

2413.7 Digital signal and control cables

Where the signal is based on a supply not greater than 24 V dc and the maximum ON-state loop current does not exceed 20 mA, then analogue type cables shall be used. Where the voltage and/or current exceeds these limits the cables shall comply with one of the following specifications:

- PVC/SWA/PVC - PVC insulated, extruded PVC bedding, galvanised steel Wire armoured, flame retardant black PVC sheathed overall, stranded copper conductors suitable for operation on a system at a rated voltage of 0.6/1kV. Conductor temperature shall not exceed 70°C for continuous operation. Cables shall comply with the latest Standards.
- PVC/PVC - PVC insulated, extruded PVC bedding, flame retardant PVC sheathed overall, stranded copper conductors suitable for operation on a system at a rated voltage of 0.6/1kV. Conductor temperature shall not exceed 70°C for continuous operation. Cables shall comply with the latest Standards.
- Internal wiring of control panels shall be of a minimum cross-section of 1.0 mm², flexible and stranded.

Instrumentation and control cabling shall be of a minimum cross-section 1.5 mm² for outdoor use and 1.0 mm² for indoor use.

2413.8 Cable Labelling

At each end of each cable, in a uniform and visible position a label shall be fixed on the cable to indicate the site cable number and route, and the number and size of conductors. Labels shall be made of PVC, brass, aluminium, lead or copper strip, engraved and retained by suitable non-rusting or non-corroding binding wire passing through two fixing holes, one at either end of the label. If the cable gland is not normally visible, then the label shall be fixed inside the panel by means of screws.

Three phase power cable cores shall be identified A, B, C or colour coded red, yellow, blue so that the correct three phase sequence is preserved throughout the system. Single phase power cable cores shall be colour coded red, black.

Control cables shall have individual cores identified by means of suitable permanent ferrules bearing the same number at both ends.

Each cable and core shall bear the same number at both ends of the cable and core respectively.

Terminals shall bear permanent identification as follows:

- Power terminations- colour, number or letter
- Control terminations- letter or number or both

2414 Cable Installation

2414.1 General

Non-sheathed single insulated wire shall only be installed in galvanised steel conduit or trunking.

Cables with sheaths but without any form of armouring shall only be installed in protected indoor locations such as floor ducts, conduits, or covered cables trays and ladders.

Cables with underground quality PVC sheaths and steel wire armouring may be installed in all locations including being direct buried in the ground, pulled into underground ducts or clipped direct to a surface or uncovered cable tray.

Single core cables shall not be used unless absolutely necessary (e.g. feeder cables from transformers to switchboards). Where the installation method requires armouring this shall be of the non-magnetic type formed from hard drawn aluminium strip or wire. No single core cables shall be direct buried in the ground.

Where cables are run together in the same tray, trench or conduit they shall be suitably derated or spaced to maintain current rating. Crossovers shall be avoided where possible. Large power cables (e.g. those carrying in excess of 50 A), and signal cables shall be run separately to minimise interference.

Where a number of cables are terminated in equipment, they shall finally approach the equipment from a common direction. Top and bottom entry methods shall not be mixed in the same panel.

Cables shall be complete with all saddles, cleats, hangers, brackets, trays, ladders, ties, nuts, bolts, screws, washers, packing, ducts, sand, concrete covers, marker tape and route marker posts as may be necessary to complete the installation.

Marker tape shall be placed in the ground above cables laid underground either direct buried or in ducts. The tape shall be 150 mm wide, yellow with black printing "DANGER-ELECTRIC CABLES".

All cables of less than a complete drum length shall be installed without joints except where approved by the Supervisor's Representative.

Unless unavoidable, cables shall not be installed in areas of direct sunlight. Where it is necessary, sunshields constructed to the approval of the Supervisor's Representative shall be supplied and installed.

Cables shall be installed in such a way that the minimum bending radii are not reduced when installed or during installation. Cables shall not be installed in ambient temperatures below that recommended by the cable manufacturer.

Cables grouped together shall have an insulation capable of withstanding the highest voltage present in the group.

Cables shall be laid in a manner such that any electrical interference between cables have no detrimental effect on the life and operation of equipment installed within the installation. As a general rule the following minimum clearances shall be adhered to where ever practical:

- There shall be a minimum separation of 600 mm between HV power and all other cables and 300 mm between all other categories. These separations are minimum and special circumstances such as the presence of high current flows, or harmonic content may necessitate larger separation distances.
- Where practical a separate cable support system shall be provided for power and non-power cables. Where this is not practical a separation of 150 mm shall be maintained between power and non-power cables when run on the same support system.
- In order to make economic use of the cable support system, cables shall be arranged in groups of 50 mm maximum overall diameter. These groups shall be securely tied to the cable support system at intervals not exceeding 900 mm for horizontal runs and 300 mm intervals on vertical runs.
- In order to make the most economic use of cable ladder/tray and duct capacity, multicore cabling shall be utilised in order to connect instrumentation groups by using suitably located sub-distribution junction boxes. The junction boxes shall be suitable for the area in which they are to be installed and for the type of circuit. They shall be readily accessible for maintenance and clearly labelled junction boxes shall be constructed of steel or GRP and provide degree of protection IP 55.

- Separate cables shall be used for digital and analogue signals at all times.

Digital and analogue signals shall be segregated within junction boxes.

2414.2 Submissions by the Contractor

Submissions which the Contractor is required to make in relation to the cable installation shall include, where relevant, the following:

- Drawings and Schedules;
- Block diagrams to show control cabling systems with each cable and terminal equipment being identified as in the cable schedules.
- Cable route and layout drawings

For those items which are underground these drawings shall include the following:

- Route plans for all cables, cable ducts, and cable trenches;
- Sectional views of all cable ducts, trenches etc. for each different section throughout the route;
- The position of all marker posts, joints, draw pits etc.

Route plans and section views for all cable trays and cable runs.

Cable schedules, which shall detail the cable number, type, voltage, size, route, length, and number of cores. Control cable schedules shall detail the connected and spare core numbers, diagram numbers of connected equipment, core ferrule and terminal reference numbers.

2414.3 Data and Calculations

- Manufacturers catalogues and data sheets for all cables and fittings.
- Cable sizing calculations
- Test certificates for all witnessed and routine tests carried out at the manufacturer's works and at site.

2414.4 Installation Direct in the Ground

Power cables of rated voltage up to 1000 V shall be buried at a depth of 500 mm to the cable centre.

Power cables of rated voltage above 1000 V up to and including 12 kV shall be buried at a depth of 1000 mm to the cable centre. The depth of laying shall only be varied due to the presence of other cables or services. The laying of cables at excessive depth shall not be accepted. Unless unavoidable, cables shall not be routed below pipes.

On cross roads the cable shall be run through a uPVC duct as specified hereafter.

The bottom of excavated trenches shall be free of sharp stones and other obstacles and shall be covered with sand or fine sifted soil compacted to a depth of 50mm.

Cables shall be unrolled from the drums in such a manner as to avoid loops and kinks, and care shall be taken when laying or pulling into ducts to avoid damage to the outer sheath by drawing over sharp obstacles, edges, or stones. Cables pulled in either by machine or by hand shall be pulled in using rollers to prevent contact between the cable and the ground.

Cables shall be snaked into the trenches to avoid tension in the cables during backfilling or from subsequent settlement. Trenches shall be provided with a layer of 75mm of sifted soil before laying of the cable. After laying, cables shall be covered to a minimum depth of 75mm of compacted sand or sifted soil and shall have a layer of protective concrete cable tiles laid above. The tiles shall overlap the cables at both sides with minimal 50mm

Where cables of different voltages are laid together at the same depth, vertical cable tiles shall be used to segregate the cables.

Control, instrumentation and communication cables shall be laid not closer than 1000 mm to high voltage cables.

2414.5 Installation in Underground Ducts

Underground ducts shall be constructed of impact resistant uPVC and shall be laid at a minimum depth of 500 mm (to the duct centre). The duct shall be surrounded by not less than 75 mm of sieved sand on all sides. At road crossings, uPVC ducts of minimum diameter 100 mm shall be laid at a minimum depth of 1000 mm (to the duct centre). The duct shall be surrounded by not less than 150 mm of concrete on all sides.

When installing cables in ducts the following measures shall be observed:

- cables shall be pulled in a straight line;
- rollers shall be positioned at the ends of the ducts both at the drawing in and drawing out points over which the cables are to be drawn;
- uPVC ducts and cables sheaths shall be coated with an approved lubricant;
- the maximum distance between draw-pits shall be the guaranteed minimum length of cable on each drum, making allowance for jointing;
- adequate space shall be allowed in each draw-pit for the installation and jointing of cables;
- the pulling rope shall be guided by rollers;
- only one large cable shall be drawn into each duct;
- Where more than one small cable is to be pulled into the duct, all cables shall be pulled in simultaneously.
- Whenever a duct is laid in the ground, a draw wire or man-made fibre rope shall be pulled in and at least 1000 mm excess length shall be left at each end.

2414.6 Sealing Cable Entries into Buildings

Where cables pass in or out of duct entries into or within buildings, these entries together with any spare ducts shall be effectively sealed against the ingress of moisture. The sealing method shall have a fire resistance of not less than 30 minutes.

2414.7 Marking of Underground Cables

The location of all underground cables shall be identified by:

- engraved plates fixed to the exterior surface of the walls of buildings 300 mm above ground level, directly above the point where cables pass through the wall;
- marker posts on road verges, etc. at intervals of not more than 100 m and at all junctions and changes of direction along the route;
- marker posts at 10 m intervals within an enclosed site and at all junctions and changes of direction along the route.

Marker posts shall be of concrete, not less than 200 mm high and shall have an enameled metal plate affixed giving the details of the cable the below including the depth and voltage rating. A drawing or sample of a typical marker post shall be submitted to the Supervisor's Representative for approval.

2414.8 Installation in Cable Trunking

Cable trunking shall be manufactured from hot dipped galvanised mild steel of thickness not less than 1.25 mm. The trunking shall have two return flanges for rigidity. Where necessary, additional strengthening straps shall be fitted internally. The cover shall overlap the trunking and be made of the same gauge steel. All bends, tees and intersections shall be of the gusset type and shall, wherever possible, be purpose made by the manufacturer and of a matching design to the main trunking. Retaining straps shall be fitted to hold cables within the trunking when the cover is removed. Barriers formed from continuous sheet steel with the bottom edge welded to the trunking shall be installed where it is necessary to segregate cables.

The size of the trunking shall be adequate for the number of cables to be installed together with 50% spare capacity. Trunking shall have minimum dimensions of 50 mm x 50 mm. Internal connecting sleeves shall be fitted across joints in the trunking and earth continuity ensured by bonding each section of trunking to a continuous earth wire.

Non-flammable fire barriers shall be inserted where the trunking passes through walls or floors.

Conduit connections to trunking shall be made by flanged couplers and internal brass bushes.

Trunking shall be supported at intervals not greater than 2 m horizontally or 2.5 m vertically.

Crossings over expansion joints shall be made in flexible conduit.

Whenever trunking is cut or drilled the bared sections shall immediately be given a coat of zinc rich cold galvanising paint.

Cable and trunking runs shall be determined by the Contractor and agreed by the Supervisor's Representative before any work is started. A clearance of not less than 150 mm shall be maintained between the trunking and plumbing or mechanical services.

Trunking systems erected outside a building shall be weatherproof.

2414.9 Installation in Troughs and Trenches

Where the building structure incorporates purpose built covered trench systems, power distribution cables may be laid on the floor of the trench. Control and instrumentation cables shall be segregated and installed on cable trays or ladders fixed to the walls of the trench.

Where the building structure incorporates general service trenches containing pipework, chemical lines and other services, all cabling shall be segregated from other services and run on cable tray or ladder fixed to the trench walls. Crossovers shall be kept to a minimum and cabling shall be taking above wet service pipework.

2414.10 Cable Tray and Ladder

Cable trays and ladders shall be of hot dip galvanised perforated steel or PVC coated of thickness not less than 1 mm for trays up to 100 mm width, not less than 1.25 mm for trays from 100 mm to 150 mm width, and not less than 1.5 mm for trays from 150mm to 300mm width. Cable tray and supports shall be manufactured in accordance with the latest Standards.

Cable tray and ladder supports shall be of ample strength to maintain rigid support to the fully laden cable tray along its entire length. All brackets and tray work shall be suitable for withstanding the normal weight of the cables fixed to it together with a temporary weight of 125 kg.

Wherever possible, cable trays shall be installed in full lengths without cutting. Where tray is cut or drilled the bared sections shall be dressed and immediately be given a coat of zinc-rich cold galvanising paint. Similarly for PVC coated trays, the bared sections shall be immediately sprayed using a PVC aerosol.

2414.11 Installation in Buildings

Cables to be run on walls, ceilings, or other structures shall be supported on tray or ladder racks, or enclosed in conduit or trunking.

All cables shall be neatly run vertically or horizontally parallel to adjacent walls, beams or other structural members.

Cable hangers, cleats, saddles, brackets and similar supporting devices shall be of an approved type and of adequate strength for the cables they are supporting. They shall be treated to withstand site conditions without corroding. Self-locking plastic buckle clips and strapping shall not be used

Hangers shall be spaced according to recommendations in the IEE Wiring Regulations. Allowance shall be made for expansion and contraction of the cables.

2414.12 Cable Installation in Conduit

Conduits shall be either galvanised heavy gauge steel screwed type or light-gauge steel non-screwed type steel. Accessories shall either be malleable cast iron or pressed steel.

A space factor of 40% shall not be exceeded, and in any case conduit of less than 20 mm diameter shall not be permitted. The tubing is to be perfectly smooth inside and out and free from imperfections. Both ends of every length of tubing shall be reamed with all sharp edges removed before erection.

Where conduits converge, adapter boxes shall be used. Conduits shall be connected by means of male brass bushes and couplings. Where conduits are greater than 25 mm, straight through joint boxes shall be of the trough type.

Where conduit or fittings are attached to equipment casings, the material of the casing shall be tapped for a depth of not less than 10 mm or male bushes and flanged couplings may be used.

Hexagonal lock nuts shall be used at running joints and shall seat firmly and evenly onto mating faces. Lock nuts shall not be used at non-running joints.

All junction boxes, draw-in boxes, and inspection fittings shall be placed so that the cables can be inspected, withdrawn and re-wired during the life of the installation.

Generally not more than two bends or offsets or one coupling shall be permitted without a suitable inspection accessory. Fish wires shall not be left in conduits during erection. The whole of the installation shall be arranged for a loop-in type of system with joints being carried out at switches, isolators or appliance fittings.

Ends of conduits which are liable to be left open for any length of time during building operations shall be plugged to prevent the ingress of dirt and covers shall be fitted on all boxes.

Generally, conduits shall not cross expansion joints of buildings. Where they cannot be installed in any other manner, a galvanised flexible conduit shall be used across the expansion joint. A total of 150 mm movement shall be allowed.

2414.13 Surface Installation

Surface conduits shall be secured and fixed by means of distance spacing saddles or clips which allow the conduits to be taken directly into accessories without sets or bends. Conduits shall be run in a square and symmetrical manner. Runs shall be properly ventilated and allow for drainage of condensation. All surface conduit runs shall be marked

out for approval by the Supervisor's Representative before the installation is carried out. Where large multiple parallel conduit runs occur, galvanised trunking may be used instead.

Conduits installed on structural steelwork shall be secured by girder clips, drilled and tapped to the metalwork. Power driven fixings shall be used only with the approval of the Supervisor's Representative. Any drilling or access which is required through any structural member of the building shall be agreed with the Supervisor's Representative before carrying out the work.

Exposed threads and plates where galvanising has been damaged shall be cleaned and then painted with two coats of an approved metallic zinc based paint. This treatment shall be applied as the work proceeds.

2414.14 Concealed Installation

Concealed conduits shall be securely fixed to prevent movement before laying of screed, floating of plaster, casting of columns or other building operations necessary after the conduit installation. Crampets or similar fixings shall be used for attaching the conduit to blockwork, etc. Building nails shall not be accepted.

At least 15 mm shall be allowed for finishes over the conduit. Where this cover cannot be maintained then expanded metal shall be fitted over the conduit. Conduit cast into reinforced concrete floors shall be fixed to the steel reinforcing. Concrete shall be prevented from entering conduit boxes when being poured. Where possible, the conduit boxes shall be fixed to shuttering to give a flush finish.

Conduit installed in voids, false ceilings, and other concealed routes shall be installed as specified for surface conduits. Draw-in wires shall not be pulled into the conduits during erection. Wiring shall be carried out after the false ceiling or permanent ducts have been completed. Conduit installed in floors shall be sealed against ingress of moisture.

The conduit installation shall be inspected by the Supervisor's Representative before the building operation conceals the work.

2414.15 Flexible Conduits

Flexible conduit shall be of the waterproof galvanised type of PVC wire-wound type with cadmium plated mild steel couplings. Lengths of flexible conduit shall be sufficient to permit withdrawal, adjustment or movement of the equipment to which it is attached and shall have a minimum length of 300 mm. Flexible conduit shall not be used as a means of providing earth continuity. A single earth conductor of adequate size shall be installed external to the conduit complete with earth terminations.

Where conversion from rigid conduit to flexible metallic conduit is to be made, the rigid conduit shall terminate in a trough type box. The flexible conduit shall extend from this box to the equipment, the earth continuity cable shall be secured to the box and to the piece of equipment. The use of lid facing screws, etc. shall not be permitted. Adapters shall incorporate a grub screw or a gland to prevent the flexible conduit becoming loose.

2414.16 **PVC Conduit**

Where galvanised conduit is liable to corrosion, PVC conduit shall be installed.

PVC conduit shall be of the oval or round high impact non-flame propagating type as specified and self-extinguishing. Surface and concealed installations shall be generally as described for steel conduit.

PVC conduit fittings shall all be white unless specified otherwise.

Jointing shall be carried out using a PVC solvent and socketed accessories. Expansion couplers shall be fitted in straight surface rings every 12 m. The free end shall be sealed with non-setting mastic to form a waterproof seal.

Purpose made bends may be used providing that the cable bending radius is maintained. Cracked or crinkled conduit shall be rejected.

The conduit shall be suitable for use in ambient temperatures of between -5°C and 60°C and shall not be installed in areas that receive direct sunlight. A separate protective conductor (earth continuity conductor) shall be installed.

Adaptable boxes and accessories shall be made from heat resistant insulating material. The minimum wall thickness of boxes having a nominal internal depth of 16 mm or less shall be 1.5 mm. For deeper boxes the minimum wall thickness shall be 1.5 mm. For deeper boxes the minimum wall thickness shall be 2 mm. All boxes which are intended to support luminaries or other heat sources shall have either external fixing lugs riveted to the metal fixing inserts or utilise steel insert clips.

2414.17 **Metal Cable Trunking**

Cable trunking shall be manufactured from mild steel of not less than 1.25 mm and shall be hot dipped galvanised. The Contractor shall ensure that the size of the trunking is adequate for the number of cables to be installed together with 50% spare capacity and shall in any case be 50 mm x 50 mm minimum size.

Segregation of cables shall be carried out if required using continuous sheet steel barriers with the bottom edge welded to the trunking.

The trunking shall have two return flanges for rigidity. Where necessary, additional strengthening straps shall be fitted internally. The cover shall overlap the trunking and be made of the same gauge. Fixing screws for covers shall be recessed and be of the self-retaining 'quick fix' type. All bends, tees and intersections shall be of the gusset type and shall, wherever possible, be purpose made by the manufacturer and of a matching design to the main trunking.

Cables shall be retained in the trunking when the cover is removed by means of straps. Internal connecting sleeves shall be fitted across joints in the trunking and earth continuity ensured by bonding each section of trunking to a continuous earth wire.

Non-flammable fire barriers shall be inserted where the trunking passes through walls or floors. Conduit connections to trunking shall be made by flanged couplings and male bushes.

Trunking shall be supported at intervals not greater than 2 m horizontally or 2.5 m vertically. Crossings over expansion joints shall be made in flexible conduit.

Should it be necessary to cut or drill a section of trunking or a trunking fitting the bared ends shall immediately be given a coat of zinc rich cold galvanising paint.

Cable and conduit/trunking runs shall be determined by the Contractor and agreed by the Supervisor's Representative before any work is started. The run shall be at least 150 mm clear of plumbing and mechanical services.

Conduit/trunking systems erected outside a building shall be weatherproof.

2414.18 Installation of Mineral Insulated Metal Sheathed Cables

Before any length of MIMS cables is installed it shall be tested for insulation resistance and if below the manufacturer's required standard it shall be warmed by a suitable means to expel any moisture. Should this prove ineffective the cable ends shall be cut back until a satisfactory insulation value is obtained. If for any reason a cable has to be left unconnected for a period of time, it shall be adequately supported and the end made off with a dummy pot to prevent mechanical damage and the ingress of moisture.

All terminal ends of the cables shall be sealed to prevent the entry of moisture, and at all terminations pot type seals shall be fitted complete with a PVC shroud. Where the cables terminate at equipment sufficient allowance shall be made in the length of the cable to enable glands with tails to be withdrawn from the equipment without damage to the cable. Where the equipment is subject to vibration, adequate anti-vibration loops shall be left in the cable run.

Combined neoprene sleeving shall be used for the insulation and protection of the cores of the cables from the points at which they leave the seal to the terminals of the equipment served. The sleeving shall be marked with the appropriate cable size and reference.

Where cable glands are exposed to onerous atmospheric conditions and in all instances where they are screwed into aluminium or zinc based alloy fittings, either inside or outside the building, cadmium plated cable glands shall be used.

Care shall be taken to ensure that all seals for MIMS cable are made in an approved manner as laid down by the cable manufacturer. Insulation tests shall be carried out immediately the joint has been made and again 24 hours later. Readings below 200 m Ohms shall not be accepted.

Where MIMS cables pass through concrete, blockwork or brickwork, walls, floors, etc. they shall be suitably protected by a length of conduit throughout the concealed length. MIMS cables shall not be installed directly in concrete, blockwork or brickwork, walls, flooring, etc.

Where a number of MIMS cables are scheduled to be installed in a multiple cable run, the cables shall be fixed to perforated cable tray, by means of single or multi-way copper or aluminium strip saddles complete with two fixing holes and PVC finish.

2415 Cable Terminations and Joints

2415.1 Power Cable

Power cables shall be terminated in suitable boxes arranged for bolting to switchgear, motor starters and motors. Each cable entry into a terminal box shall be made through a suitable gland.

Boxes shall be of adequate proportions to accommodate all cable fittings including stress cones or other means of insulation grading. Boxes shall be open able for inspection without disturbing the gland plate, cable or termination.

Where air insulated terminations are used, the cable crutch shall be protected by a heat-shrink trifurcating sleeve.

Cores shall have either crimped lugs or sleeves to match either post terminals or bolted clamp terminals.

Glands for armoured cables shall provide a positive armour clamp to the box or switchgear coating. This clamp shall completely support the cable weight so that no tension is applied to the termination. The clamp shall also provide earth continuity and be of adequate size to withstand the full fault current of the system for one second.

Where single core glands are required, these shall be non-magnetic. The gland plate shall also be of a non-magnetic material. Removable connections for bonding across the gland insulation shall be provided. The gland insulation shall withstand a test of 2 kV ac for one minute.

Glands shall seal the inner and outer cable sheaths against ingress or dirt and moisture and provide mechanical support. All glands shall be provided with an earthing tag.

Where cable glands are exposed to the weather these shall be protected by heat shrink or purpose moulded sleeves covering the gland continuously from the cable sheath to the gland neck.

Where the apparatus enclosure classification requires sealed cable gland entries, sealing shall be achieved by using threaded cable gland holes and polytetrafluoroethylene (PTFE) tape.

2415.2 Multicore or Control Cable Terminations

A sufficient number of terminals shall be provided to terminate all cable cores. For control and auxiliary wiring an additional 20% of this number shall be provided as spares.

Terminal blocks for terminating up to and including 35mm² cable shall securely clamp the conductor, without damage, between two plates by means of a captive screw; pinch screw type terminal blocks shall not be used.

For cables above 35mm², stud or bolted terminals shall be used, each cable core being fitted with a suitable lug.

Not more than one core of internal or external wiring shall be connected on any one terminal. Where duplication of terminal blocks is necessary, purpose made solid links shall be incorporated in the design of the terminal blocks.

Terminals which remain energised when the main equipment is isolated shall be suitably screened and labelled.

Terminal blocks for different voltages or circuit type shall be segregated into groups and distinctively labelled.

Plant which has to be dismantled for maintenance shall have multicore cable terminations made of through glands onto an adaptable box. The box shall have terminal blocks, and connections shall be made to the equipment by single core wires and flexible waterproof plastic conduit. A separate earth core shall link the box to the equipment.

2415.3 Joints

Through joints shall only be allowed on long cable runs outside buildings. Where such joints are necessary in thermoplastic and elastomeric cables, the cables shall be jointed with epoxy or acrylic resin cold setting compound, which has been premeasured and pre-packed ready for use. The boxes shall be of split, moulded plastic type with filling vents for compound. Bonding straps shall be fitted with armour clamps across the joint and inspected by the Supervisor's Representative prior to filling the box with compound. Wrapped pressure type joints shall not be accepted.

Conductor cores shall be jointed number-to-number or colour-to-colour.

2416 Small Power and Lighting Installations

2416.1 Distribution Boards

Distribution boards shall be of folded sheet steel enclosed construction, braced to form a rigid structure. Doors shall be lockable, hinged and gasketed to give a damp and dustproof enclosure. The degree of protection shall be IP43 (indoors and IP55 (outdoors).

The busbars shall be mounted on non-hygroscopic insulators, completely shrouded or PVC insulated, coloured to denote the appropriate phase. The current rating of the busbars shall be not less than the sum of the maximum current rating of all outgoing circuits. A neutral bar shall be provided with a separate terminal for each circuit.

A separate earth terminal block shall be provided with a separate terminal for each circuit. Distribution boards shall have a fault rating at least that of the system for one second. Removable top and bottom undrilled gland plates shall be provided with a brass earthing stud.

A switch fuse or isolator shall be connected on the incoming side of the board. The device shall be triple pole and neutral with overcurrent protection.

Each outgoing circuit including spare ways shall be protected by an HRC fuse or miniature circuit breaker (MCB). HRC fuse bases and carriers shall be of non-hygroscopic insulation.

Barriers shall be fitted over all live parts and spaces between phases. Each distribution board shall have a permanent circuit identification chart mounted on the inside of the front door.

Boards for use on dc systems shall be double pole types with fuses on the incomer.

2416.2 Bulk Switching Contactors

Bulk switching contactors (e.g. for large lighting or heating loads controlled from a single switch) shall be of the air break electromagnetic type. The contactors shall be continuously rated for the duty specified, shall have an utilisation category AC1, and an intermittent duty class 0.3 with the characteristic mechanical endurance of that class. The current ratings specified shall be eight hour rated duty.

Contactors shall be single or triple pole as required, each type with a neutral terminal. Contactors shall be fitted with a continuously rated operating coil having both terminals brought out.

Enclosures shall be similar to those of distribution boards and shall have a degree of protection not less than IP52.

2416.3 Socket Outlets

Domestic pattern socket outlets shall comply with the latest Standards. Industrial pattern socket outlets shall comply with the latest Standards.

In areas having plaster, tiled or other decorative finish, socket outlets shall be fitted flush with the finished area. In all other areas fittings shall, unless otherwise specified, be surface mounted.

2416.4 Lighting Switches

Internal lighting switches shall be supplied complete with box, cover plate and fixing screws. They shall be surface mounted metal clad type with aluminium or steel finished box.

At multi-switch positions, the switches shall be contained in multi-gang boxes.

External lighting switches shall be of the metal clad, galvanised and weatherproof pattern with rotary action. They shall be surface mounted.

2416.5 Internal Lighting

Lighting shall be complete with all supports, suspensions, flexible cables, pendants and plugs. They shall be connected to the main circuit wiring with heat resisting flexible cables of a minimum core size of 24/0.20 mm.

Protective classification shall be IP42.

The earthing of all lighting shall be by a separate core in the connecting flex or cable, securely bonding the earth terminal on the fitting to that of the interconnecting cables.

Where adjacent lighting are connected to different phases of the supply, a label shall be fitted internally, warning of the presence of the phase-to-phase voltage.

Lighting shall not transmit load to suspended ceilings unless the ceiling and lighting is of integrated design with the appropriate supports.

Where high bay discharge lighting are suspended from the structural ceiling, the connection between the fitting and fixed wiring shall be by plug and socket.

Lamp holders for flexible pendants shall be of the all-insulated skirted pattern with cord grips.

The fixings, connection boxes and other parts of the lighting shall be erected at times to suit the building programme. The glassware, diffusers, shades, lamps and tubes shall not be fitted until all building work is complete. Fittings shall be left clean inside and outside and ready for use.

2416.6 Types of Lighting

Fluorescent

Diffusers shall be of flame retardant extruded acrylic or GRP material. They shall be either opal or prismatic pattern as specified.

A gasket shall be fitted between the diffuser and the body to form an effective seal.

The lighting comply with the latest Standards.

Incandescent Lights

Recessed down lighter lights shall be constructed from an aluminium alloy reflector and housing with adequate top ventilation holes. An adjustable position, porcelain BS lamp holder shall be incorporated, pre-wired with heat resistant cable. Re-lamping shall be from below only.

Surface incandescent lights shall be of the white opal glass type suitable for wall or ceiling mountings.

External Lighting

All external lights shall be of the totally enclosed fully weatherproof pattern with vandal-proof polycarbonate diffusers having a minimum degree of protection IP55.

Security lighting systems shall be designed to be inaccessible to intruders.

Bulkhead lights shall have a cast aluminium alloy body, polycarbonate diffuser, and gasket and porcelain lamp holder.

Emergency Lighting

Emergency lighting lights shall be of the self-contained or slave type as specified.

The lights shall be fully automatic in operation, providing instant illumination in the event of a mains failure. The battery capacity shall be sufficient to operate all lights connected to the emergency lighting system for a period of 3 hours.

2416.7 Lamps

All lamp holders shall be fitted with a lamp of a type and size specified by the manufacturer or as stated on the drawings.

Fluorescent Lamps (Designations MCFE/U and MCFA/U)

Fluorescent lamps shall comply with the latest Standards. Unless otherwise specified, lamps shall be coloured 'white' for industrial use and 'warm white' for commercial and domestic lighting. Lamp caps shall be of the bi-pin type. The guaranteed minimum life shall be not less than 3000 hours.

Metal strip lamps (MCFE/U) shall be used in glass reinforced polyester lights or where the metalwork is not within 20 mm of the lamp.

Incandescent Lamps

Incandescent lamps shall comply with the latest Standards. General lighting service lamps shall have a coiled coil up to 150 W and single coil above this wattage. The lamps shall have standard bayonet cap and have an internally frosted glass envelope.

General lighting service lamps used for emergency lighting or lamps operating at a voltage different from the normal mains voltage, shall be fitted with an Edison screw cap. Lamps rated at 300 W and above shall have a Goliath Edison screw cap.

Guaranteed minimum life shall be not less than 2000 hours for lamps rated at 300 W and above and 1000 hours below 300 W.

2416.8 Low and Extra Low Voltage Supply Transformers

Low and extra low voltage supply transformers shall comply with the latest Standards and shall, unless otherwise specified, be of the single phase type. Transformers shall be supplied complete with fixing bracket.

The rated output voltage and VA shall be as specified.

2417 Electric Hand-Lamps

Electric hand-lamps shall be suitable for 25 V operational and shall be complete with specified length of TRS flexible cable, lamp and galvanised wire guard. Electric hand lamps shall comply with the latest Standards. The hand lamp cable shall, unless otherwise specified, be terminated in a plug complying with the latest Standards.

When used with a portable supply transformer, the cable may be permanently connected to the output terminals via a suitable compression gland.

The hand-lamp shall be complete with a reeling drum or wall brackets or both for the neat storage of the cable when not in use.

- Automatic Earth Proving Supply Points
- Where supplies are taken to portable tools or machinery at 230/400 volts the supply point shall incorporate a device for continuously monitoring the effectiveness of the earth connections to the appliance.
- The apparatus shall comprise a metal cased totally enclosed damp and dust proof unit incorporating a double pole or triple pole hand operated circuit-breaker, relay, low voltage transformer and non-linear resistor together with a socket outlet facilitating the connection of a flexible cable having two separate earth cores in addition to the supply cores. In addition to the mains operated no-volt trip and relay, a current operated earth leakage trip shall be incorporated.
- The plug and socket arrangements for the outgoing lead shall be suitable for the system of protection and shall not be interchangeable with other types.
- Earth proving supply points shall be to the latest Standards.

2417.1 Time Switches

Time switches shall be of the synchronous motor wound clockwork type with a 30 hours spring reserve. The time switch shall incorporate a test ON/OFF switch which shall not interfere with the time clock and auto winding mechanism.

2417.2 Wiring

Internal wiring shall be carried out using single core PVC insulated cable installed in surface run conduit or trunking and shall be fixed to walls of structured steelwork.

The copper conductor size shall be not less than 1.5 mm² for circuits feeding lighting or fixed apparatus or less than 2.5 mm² for socket outlet circuits.

No conduit serving a single phase socket outlet, lighting point or switch shall contain more than one supply phase.

2417.3 Batteries and chargers

Battery units shall comprise a floor standing or wall mounted front access type steel cabinet accommodating batteries, battery charger and distribution facilities.

Batteries

Unless otherwise specified, batteries shall be of the high performance nickel-cadmium type having cells housed in translucent, high impact plastic containers. The containers shall be fitted with vented filler plugs. High and low electrolyte levels shall be permanently marked on the container.

Cell terminals shall be of the bolted type. The terminal polarity shall be permanently marked.

Battery cells shall be arranged so that each is accessible for test and inspection. Cells shall be located in the lower section of the cabinet and shall be not less than 300 mm above floor level.

Batteries shall be supplied complete with all necessary connections. The connections between tiers, and cells and disconnection links and fuses shall be of the multi-stranded plastic insulated type.

The nominal battery voltage shall be 24V unless technical considerations otherwise dictate. The battery capacity shall be adequate to supply all connected loads for a minimum period of 8 hours.

At the end of the 8 hour period the battery shall have sufficient capacity to complete the operations listed below, at the end of which the battery voltage shall not have fallen below 90% nominal value with the standing loads connected:

- two closing operations on all automatic circuit breakers;
- two tripping operations on all circuit breakers;
- charging of one D.C. motor wound circuit breaker closing spring.

Detailed calculations and loading data used to determine the battery capacity shall be submitted to the Supervisor's Representative at an early stage in the Contract.

Battery charger

The battery charger shall be of the solid state design incorporating 'Float' and 'Boost' charging facilities. In the 'Float' charge mode, the charger shall automatically maintain the battery in a fully charged condition whilst supplying its rated current. In the 'Boost' charge mode the charger shall be capable of fully charging the battery from a fully discharged state in a period not exceeding 7 hours.

Boost mode is not required for standby batteries for fire detection, emergency lighting or intruder alarm systems.

The charger output voltage regulation shall not exceed +2% for load variations of 0 to 100% with A.C. supply voltage variations of +6%.

The charging characteristics shall minimise battery water loss.

The charger shall be equipped with the following:

- Incoming supply On/Off switch;
- Supply On indication;
- Output voltmeter;
- Output ammeter;
- Float/Boost charge selector switch;
- Charger Failed alarm relay
- Charger Failed indication

The minimum requirement for the 'Charger Failed' alarm shall be the detection of A.C supply or D.C. output failure. The alarm relay shall not operate under a transient A.C supply failure condition.

An individual pair of volt-free contacts for 'Charger Failed' shall be provided. The contact shall be wired to terminals.

Double pole moulded case or miniature circuit breakers shall be provided as required.

2500 PHOTOVOLTAIC COLLECTORS

2501 General

2501.1 Section Requirements

Submittals:

Product Data: For each type of product.

Shop Drawings: For photovoltaic (PV) modules.

Warranty: Manufacturer agrees to repair or replace components of PV modules that fail in materials or workmanship within specified warranty period of ten (10) years from date of Substantial Completion.

Based on Saint Lucia's sustainable energy legislation, the maximum allowable output for a photovoltaic (PV) solar system is 25 kilo-Watts [25 kW].

Where NFPA, NEMA or American standards are referred to in this section, these may be replaced by E.U. member state and/or ACP State standards provided they are equivalent or superior to the U.S. Standard.

2502 Products

2502.1 Performance Requirements

Nationally Recognized Testing Laboratory Listing: Entire assembly shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for electrical and fire safety, Class A according to IEC 61730 and UL 1703. Safety Class: II. FM approved for NFPA 70, Class 1, Division 2, Group C and Group D hazardous locations.

Certifications:

IEC 61225

IEC 61730-1/2

IEC 62716

ISO 9001

ISO 14001

OHSAS 18001

UL 1703

2502.2 System Description

Grid-Tied PV System: An array of 84 modules to generate a total nominal 25 kilo-Watts [25 kW] connected via a utility meter to the electrical utility.

Front Panel:

Glass: High transmission tempered with antireflective coating.

0.125-inch- (3.2-mm-) thick glass.

Backing Material:

Tempered glass.

0.125-inch- (3.2-mm-) thick glass; black or dark shaded colour.

Bypass Diode Protection: Internal.

Junction Box:

IP67 with 3 bypass diodes.

Output Cabling:

Quick, multiconnect, polarized connectors.

Two-Conductor Harness: No traditional return wire is needed from the end of a row back to the source combiner.

Size: 2 x 1000mm

Maximum Series Fuse Rating (A): 20

2502.3 Capacities and Characteristics

Minimum Electrical Characteristics:

Rated Open Circuit Voltage (Voc): 39.8

Maximum System Voltage (V): 1000

Maximum Power at Voltage (Vpm): 32

Rated Short-Circuit Current (Isc) (A): 8.05

Open Circuit Voltage VOC (V): 36.9

Maximum Power at Standard Test Conditions Defined in IEC 61215 (Pmax): 220 watts.

Normal Operating Temperature Characteristics (NOTC):

Temperature at Nominal Operating Cell Temperature: $45.0 \pm 2^{\circ}\text{C}$

Temperature Coefficient (NOTC Pmax): -0.41% /K

Temperature Coefficient (NOTC Voc): -0.29% /K

Temperature Coefficient (NOTC Isc): 0.04% /K

2502.4 Module Framing

PV laminates mounted in anodized extruded-aluminum frames.

Entire assembly UL listed for electrical and fire safety, Class A according to UL 1703, complying with IEC 61730.

Finish: Anodized aluminum.

2502.5 Array Construction

Framing:

Material: Extruded aluminum.

Maximum System Weight: Less than 4 lb. /sq. ft. (19.53 kg/sq. m).

Minimum Distance to Connectors: 39.4 inches (1000 mm).

Roof Mounting:

Wind-tunnel tested to 150-mph (241-km/h) wind.

Service Life: 25 years.

Freestanding system.

2502.6 Charge Controller

Charge controllers shall have the following:

Digital display.

Data logging.

Remote interface.

External sensors.

Temperature compensation.

2502.7 **Inverter**

Control Type: Maximum-power-point-tracker (MPPT) control.

Operating Conditions:

Operating Ambient Temperatures: Minus 4 to plus 122 deg F (20 to 50 deg C).

Relative Humidity: Zero to 95 percent, noncondensing.

Charge controllers shall have the following:

Overcurrent protection.

Generator input breaker box.

Automatic transfer relay.

Digital display.

Transformer.

Disconnect switch.

Surge overload protection.

Enclosure: NEMA 250, Type 3R; enclosure material to be galvanized steel.

Protective Functions:

AC over/under voltage.

AC over/under frequency.

Ground over current.

Over temperature.

AC and dc overcurrent.

DC over voltage.

Disconnects:

Retain subparagraphs below to suit Project.

Low-voltage disconnect.

Low-voltage reconnect.

High-temperature disconnect.

High-temperature reconnect.

Regulatory Approvals:

IEEE 1547.1.

IEEE 1547.3.

UL 1741.

2502.8 **Mounting Structures**

Roof Mount: Extruded aluminum, four rails, tilt legs, and roof standoffs.

2503 Execution

2503.1 Installation

Examine roofs, supports, and supporting structures for suitable conditions where PV system shall be installed. Do not begin installation until mounting surfaces have been properly prepared.

Install arrays per manufacturer's written instructions.

Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

Perform tests and inspections with the assistance of a factory-authorized service

2600 MECHANICALWORKS – PARTICULAR SPECIFICATIONS

2601 Design Criteria

All systems have been designed to the scheduled criteria, and the Contractor is to advise of any areas where the systems deviate from this performance level. The following design criteria represent standard good practice National Diagnostic Facility facilities, as agreed with the client and outlined in HBN and CIBSE guidelines.

External Conditions:

Winter design Minimum recorded external temperature 18.9°C- Space heating not required.

Summer design 30°C db / 25.5°C wb – Daily range 5°C.

2601.1 Internal Conditions

AREA	SUMMER°C	COMMENTS
Kitchen	26	Uncontrolled
Internal Seating	24	
Toilet Areas	26	Uncontrolled
Circulation Areas & Corridors	26	Uncontrolled

Note: Generally, all temperatures are dry resultant temperatures and are subject to a +/- 2K swing. No humidity control has been designed, although it is generally expected to be within 30-70% RH range.

2601.2 Fresh Air Provision

AREA	Litres/second
Occupied Areas	12

2601.3 Ventilation Rates

AREA	AIR CHANGES / HR	GENERAL METHOD
Toilet Areas	10 air changes / hr.	Mechanical extract ventilation

2601.4 Internal Noise Levels

AREA	NR LEVEL
Kitchen	50
Internal Seating Area	45
Toilets	50
Circulation Areas & Corridors	50

2601.5 External Noise Level

All external plant and discharge noise levels from ventilation plant shall be selected and provided with the necessary attenuation to achieve a noise level of NR35 within the adjacent Outpatient and patient rooms.

2602 General Description of Works

2602.1 Scope of Work

The Work covered by this Contract and referred to in this document as the Contract Works shall include the preparation of installation drawings, the supply, delivery, installation and erection, calibration, testing and commissioning and preparation of As Built Drawings and maintenance manuals of the Supervisors Representative services listed here all in accordance with the Conditions of Contract, Specification, Drawings and all other related documents:

- Ventilation
- Comfort Cooling
- Water Services
- Gas
- Above Ground Drainage (Soil and Waste)

The scope of work shall include connections to existing services within the new Hospital.

Works and studied any relevant existing records.

2602.2 Builder's Work Holes

The Contractor shall be responsible for the sizing, setting out and the provision of all builder's work holes.

2603 Ventilation

This section of the Specification details the complete ventilation installation including extract fans, dampers, grilles, attenuators, ductwork etc., all in accordance with the Specification and relevant drawings.

2603.1 Extract Fans

Kitchen Extract Fan

The kitchen extract fan reference EF1 shall be positioned as indicated on the relevant drawing and be capable of the scheduled duty.

The fan shall be fully cased two stage axial flow type supplied complete with mounting feet and anti-vibration mountings and installed in accordance with the manufacturer's recommendations.

The fan impellers shall be high efficiency aerofoil section blade with purposely toothed hub and clamp plate for adjustable pitch angle.

The fan motors shall be totally enclosed air stream rated class F insulation. Motors shall be provided with sealed for life bearings, temperature overheat protection and be suitable for speed control. The fan motors shall be pre-wired to an externally mounted terminal box.

The fan casing shall be constructed of galvanised steel with integral drilled inlet and discharge flanged connections. The fan inlet and discharge shall be provided with flexible connections.

The fan motors shall be suitable for a 400/3/50 electrical supply.

Toilet Extract Fan

The toilet extract fan reference EF2 shall be positioned as indicated on the relevant drawing and be capable of the scheduled duty.

The toilet extract fan shall be in-line duct mounted twin fan with removable casing panel for access to the fans.

The fan and motor assemblies shall be fully isolated from the unit casing with anti-vibration mountings and flexible connections on the fan discharges.

The fan casing shall be constructed of galvanised steel with integral inlet and discharge duct spigot connections. The unit inlet and discharge shall be provided with flexible connections.

The fan discharge outlets shall be provided with back draught flaps complete with micro switch and air flow switches.

The fan motors shall be pre-wired to an externally mounted terminal box.

The fan motors shall be suitable for a 230/1/50 electrical supply.

2603.2 Extract Fan General

All extract fans shall be as manufactured by the manufacturers used on the existing new hospital as listed in the Appendices.

2603.3 Ductwork

All galvanised sheet metal ductwork shall be low pressure class A and constructed in accordance with HVCA specification DW144 with a minimum thickness 0.7mm. Alternatively ductwork may be constructed in accordance with SMACNA "Low Pressure Duct Construction Standards.

All non-metallic ductwork shall be constructed in accordance with HVCA specification DW154 and EN 13403.

2603.4 Flexible Connections and Ducts

Flexible connections shall be fitted to each fan intake and discharge connection.

Flexible connections shall be provided by the selected fan manufacturer of the length recommended by the manufacturer. To ensure effective vibration isolation the distance between the flanges or spigots where the flexible connector is to be installed shall be at least 25mm less than overall length of connector when stretched. Where connecting to fan flanges each flexible connector shall incorporate a mild steel backing flange to ensure an air tight seal. Where connecting to a fan or duct spigot the connector shall be secured by worm drive clips of minimum 10mm wide and galvanised finish.

All material shall conform to BS 476 Part 7, Class 7 spread of flame and Part 8.

An earthing strap shall be fitted across each flexible connection to provide electrical bonding. This shall be arranged to avoid fracture, or vibration leading to fracture.

Flexible ducts shall be provided at the final connections to ventilation terminal plenum boxes. The flexible ducts shall meet the requirements of DW/144, meet the above fire rating and have a smooth internal bore.

2603.5 Grilles

The Contractor shall supply and install grilles of the scheduled size, type and positioned as indicated on the relevant drawings. The final locations of the grilles shall be as indicated on the Architect's ceiling plans.

All grilles shall be installed in accordance with the manufacturer's recommendations and shall be suitable for concealed fixing with cores removable for cleaning. All grilles shall be fitted with an opposed blade damper and shall be finished stove enamel white or colour to be advised by the Architect.

All grilles shall be as manufactured by the manufacturers used on the existing new hospital as listed in the Appendices.

2603.6 Fire Dampers

Fire dampers shall be provided where ducts pass through fire barriers.

Fire dampers shall comply with BS 476, CP413 and shall be of the type with the blades outside of the airstream.

Fire dampers shall be constructed in accordance with DW 144 and shall be installed with HEVAC/HVCA mounting frame.

Fire dampers shall be as manufactured by the manufacturers used on the existing new hospital as listed in the Appendices.

2603.7 Balancing Dampers

Control and balancing dampers shall be installed as shown on the drawings.

The dampers shall be constructed in accordance with DW 144 and be stainless steel aerofoil/opposed blades with synthetic blade end bearings. The damper blades shall be housed in a galvanised mild steel frame having either integral peripheral flanges or spigot plates on either side as dictated by the connecting ductwork arrangement. The totally enclosed hard wearing and free running precise movement opposed blade mechanism shall be positioned outside of the airstream for protection against damage.

The dampers shall be fitted with a manually operated lockable quadrant control.

Balancing dampers shall be as manufactured by the manufacturers used on the existing new hospital as listed in the Appendices.

2603.8 Attenuators

The contractor shall select the attenuators to achieve the desired Acoustic Criteria in each area served.

Each attenuator shall contain sound absorbing splitters consisting of a formed galvanised sheet metal section containing sound absorbing material. The sound absorbing material shall be inert, non-hygroscopic, non-flammable, rot proof and vermin proof. The sound absorbing material shall be secured in the prefabricated section and faced with galvanised steel perforated plate. The sound absorbing material of attenuators on supply and recirculation units shall be wrapped in melinex.

The specified air handling plant has been selected on the basis of a maximum pressure drop of 50Pa for each attenuator. The static pressure drop of any required attenuators must be considered when finalising the selected air handling plant external resistance.

2603.9 Thermal and Acoustic Insulation

All supply, return and fresh air ductwork shall be thermally insulated in accordance with Part 3 Section 3 of the Specification.

2603.10 Testing and Commissioning

The Contractor shall include to test and commission the systems in accordance with the requirements of Part 3 Section 2 and 8 of the Specification.

All ductwork shall be pressure tested in accordance with DW143 and meet the requirements of DW144 Class A.

2603.11 Identification and Labelling

All ductwork shall be identified with plant reference, system description and direction of air flow in accordance with DW 144 and as instructed by the Supervisors Representative.

The identification shall be at a minimum of 5.0m spacing, at each take-off and either side of all walls.

All items of plant shall be identified by engraved white Perspex labels with red nomenclature securely fixed to or adjacent to the relevant item of plant.

2604 Comfort Cooling

The Contractor shall supply, install, test & commission the new comfort cooling system described hereinafter.

The system shall be VRF multi split system.

2604.1 External Air Cooled Condensing Unit

The external air cooled condensing units shall include inverter driven compressors to facilitate 100% control, wrap around coil for improved efficiency and low noise fans.

The units inverter controlled hermetic scroll compressor shall be capable of controlling the compressor in 1Hz increments.

Extra sub-cooling shall be provided by a Heat Interchange Circuit (HIC), which allows better refrigerant distribution and control with electronic expansion valves.

The refrigeration process of the external units shall be maintained by pressure and temperature sensors controlling solenoid valves, check valves and bypass valves. The heating or cooling mode of the condensing unit will be controlled by a 4 way valve which will reverse the cycle of the refrigerant to change the mode of the condensing unit.

Each external unit will require a 400V AC 3 phase & neutral mains supply and have a starting current of no more than 15 amps. Control will be via a 30V DC signal generated by the external unit.

Each external air cooled condensing unit shall be matched with the associated indoor units to provide the cooling requirements indicated on the Schedule.

2604.2 Indoor Units General

Each indoor unit will have a heat exchanger which shall be constructed from copper tubing with aluminium fins. The flow of refrigerant through the heat exchanger will be controlled by a linear expansion valve. This valve will be controlled by two pipe thermistors and a return air thermistor and shall be capable of controlling the variable capacity of the indoor unit between 25% and 100%.

Each indoor unit will require a 230V AC mains supply. Control will be via the 30V DC signal from the condensing unit.

The units will be manufactured with compact flat panel design and front grille opening for ease of cleaning.

Airflow passage will ensure minimum noise generation, suppress condensation and prevent mixing with secondary air. A synthetic fibre washable filter and filter casement shall be provided. Each unit will be provided with a condensate drain lift pump as standard.

2604.3 Remote controllers

The controllers shall be wall mounted manufactured in ABS plastic with a LCD display and standard colour.

The controller will be capable of altering the following functions on indoor units (within a group):

- On/Off
- Operating mode
- Set point
- Fan speed
- Timer settings
- Test run

The controller shall also be capable of displaying the following items:

- On/Off
- Operating mode
- Set point
- Return air temperature
- Fan speed
- Timer settings
- Filter
- Fault diagnosis
- Test run

Set point range shall be limited to prevent tampering.

All remote controller functions can be locked off or all remote controller functions can be locked except On/Off.

Automatic switch off timer options shall turn off the unit after 30 min to 4 hours.

2604.4 Control Wiring

All control wiring shall be carried out in 2-core 1.5mm² PVC shielded cabling with colour coding and tagged with ID number at 3 metre intervals as per schematics provided by the manufacturer for ease of identification and maintenance.

Any control or communication wiring shall not be run next to power wiring. A minimum space of 100mm between both control and power cables shall apply.

2604.5 Installation General

The fixing of all comfort cooling equipment, installation of all refrigerant pipework and full commissioning shall be performed by a specialist refrigerant installer who shall be authorised to install the selected equipment.

2604.6 Refrigerant Pipework

All pipework to be carried out in refrigerant quality soft/medium drawn copper tubing to BS2871 Part 2: 1972 and complete with the appropriate headers and joints.

The Pipework installation shall be carried out by an Approved Refrigerant Supervisor's Representative and accordance to BSEN 378 2000 Specification (or latest version if updated) and the manufacturer's design and installation instructions.

Longest possible lengths of copper pipe should be utilised to minimise joints on site.

Appropriate refrigeration installation tools must be utilised. Dry Nitrogen must be utilised at all times in the system during brazing.

All pipework (suction and liquid lines) to be insulated with slip on close cell elastomeric pipe insulation (as manufactured by Armaflex or equal and approved) with a fire performance class 0 of the 1985 building regulations, having a wall thickness of not less than 13mm.

After installation of pipework, and prior to sealing of insulation joints and starting of equipment, pipework should be pressure tested to 28Kg/cm² (430psi), held for 24 hours and checked for leaks, vacuumed/dehydrated to (-752mm Hg) 2 torr, and held at that setting for 12 hours (minimum).

Refrigerant (R410A) charge weight must be calculated, to the actual installed length of pipework in accordance with the manufacturer's recommendations.

The charging should be carried out with an appropriate charging station.

Pipework shall be properly fixed and supported at a minimum of 1.5 metres centres and where required should be run on galvanised trays. All pipework to be labelled with ID number (condensing unit's ref.) at 3 metre intervals.

Joints in copper pipe shall be brazed. Brazing shall be carried out to the requirements of the HVCA Code of Practice – Brazing and Bronze Welding of Copper Pipe and Sheet.

2604.7 Condensate Pipework

A condensate drain shall be installed from each internal unit. The drain shall be installed and insulated all as per the standard specification. Minimum size of condensate pipes to be 25mm copper or plastic, insulated and pumped or by gravity from each wall mounted unit, drains to run 1:80 min falls.

2604.8 Commissioning

The systems shall be commissioned in accordance with the manufacturer's installation handbook.

2605 Water Services

The contractor shall supply, install, test & commission the new water services systems described hereinafter.

2605.1 Scope of Works

The water services to the Cafeteria shall be connected to existing services within the Main Hospital as indicated on the relevant drawing.

Cold, hot and potable water services shall be distributed via the ground floor ceiling void to serve the sanitary fittings and equipment on the ground and first floor.

2605.2 Pipework

All distribution pipework within the building shall be half hard copper pipework to BS EN 1057 – R250 (Table 1)

2605.3 Jointing and Fittings

Joints in copper pipework 54mm nominal bore or less shall be capillary type fittings to BS 864, Part 2 except for final connections to taps, etc.

The use of lead/tin solder in the integral ring of capillary fittings or in the feeding of end feed fittings is prohibited.

Compression fittings may be used where it is impracticable to install capillary type, but only with the approval of the Supervisors Representative.

Small branch connections from large mains may be silver solder brazing fittings or formed and brazed where specifically approved by the Supervisors Representative.

All materials used in the water system shall be non-dezincifiable.

2605.4 Valves

Valves shall be provided within the main distribution pipework as indicated on the relevant drawings.

Valve shall also be provided at each take-off from the main distribution pipework and at the connection to each sanitary fitting and item of equipment.

Valves shall be as manufactured by the manufacturers used on the existing new hospital as listed in the Appendices.

Isolating valves 50mm nominal bore or less shall be in accordance with BS 5154 and constructed of gunmetal/bronze wedge gate valve pattern non rising stem, with ends screwed to BS21 taper pipe thread. All valves shall be installed with a union connector adjacent on the dead site of the valve.

Regulating valves 50mm nominal bore and below installed on hot water service return shall be double regulating valves with ends screwed to BS21 taper pipe thread.

Valves concealed within ceiling voids, roof voids and ducts shall comply with BS1010.

Valves at connections to sanitary fittings and equipment shall be handle operated ball valves. Valves exposed to view shall be chromium plated.

Drain valves shall be of gunmetal construction to BS 2879 bush pattern, screw down with loose handle and hose connection.

Non return/check valves 50mm nominal bore and below shall be copper alloy construction, swing pattern to BS 5154 with ends screwed to BS21 taper pipe thread.

All valves shall comply with local water authorities requirements with parts in contact with water constructed from non-dezincifiable materials.

All hot water service outlets other than taps to kitchen sinks shall be provided with Type 3 thermostatic mixing valves to provide a blended water temperature of 41°C. Where taps provide Type 3 mixing additional thermostatic mixing valves will not be required.

2605.5 Expansion and Contraction

Provision for expansion and contraction of the pipework shall be as specified in Part 3 Section 1 of the Specification.

2605.6 Termination

The Contractor shall include for connecting to all sanitary fittings and equipment.

2605.7 Thermal Insulation

Thermal insulation shall comply with Part 3 Section 3 of the Specification.

Thermal insulation within ceiling voids and ducts shall be finished as described in Section 3 of this Specification.

2605.8 Labelling and Identification

Pipework shall be identified as defined in Part 3 Section 3 of the Specification.

2605.9 Testing

Testing shall be carried out in accordance with Part 3 Section 1 of the Specification. The operating pressure of the system shall be assumed to be 6 bar.

2605.10 Chlorination

After testing of pipework and prior to making the connection to the existing mains, the installation shall be satisfactorily cleansed and chlorinated in accordance with BS 6700.

Before chlorination all pipework, valves and fittings shall be thoroughly flushed out to remove dirty water, debris, etc. The flushed water shall discharge to the foul water drainage.

2605.11 Water Authority

The installation shall be to the entire satisfaction of the local Water Authority and Supervisors Representatives and in accordance with the relevant Codes of Practice.

The complete system shall fully comply with all current statutory Legionella standards.

2606 LP GAS

2606.1 Scope of Works

The complete installation shall comply with LPG Code of Practice 24.

LP gas storage cylinders are to be located within an external compound adjacent to the new Cafeteria.

The LP gas supply to the catering equipment shall be routed via externally mounted pipework and the Kitchen ceiling void terminating with a manual isolation valve at the cooking area.

The LP gas installation shall include 2 stage pressure regulating valves and a gas proving system.

2606.2 Pipework and Jointing

Pipework shall be heavy weight black mild steel to BS EN 10255.

Pipework of 50mm nominal bore or less shall be screwed and socketed with unions at valves and equipment and for ease of installation and dismantling.

Fittings shall be malleable cast iron reinforced pattern screwed BS 21 and shall comply with BS 143 and BS 1256 part 1.

Flexible hoses shall conform to BS 3212. LPGA Code of Practice recommends that they should be a maximum of 1 metre in length. They should however be long enough to ensure they provide sufficient flexibility without putting strain on any connections.

Hose joints shall be made properly, either factory made or by using a crimp type connection. Jubilee clips must not be used on hoses of an internal diameter if less than 8mm or where the operating pressure is greater than 50mbar and should not be over tightened. Hoses should be located so they are not liable to damage by heat or any other method. Where switch-over systems are used, a non-return valve i.e. flash-back arrestor, must be fitted to prevent back pressure and gas escape when changing cylinders.

2606.3 Gas Proving System

A combined gas proving and ventilation interlock system shall be provided with the panel located as indicated on the relevant drawing.

The system shall include the following:

- Monitoring of low gas pressure across the gas solenoid valve – gas solenoid valve to close in event of low pressure.
- Monitoring of high gas pressure – gas solenoid valve to close in event of high pressure.
- Ventilation interlock – gas solenoid valve to close in event of loss of kitchen extract air flow.
- Quick proving time from switch on to ready for use.
- Interface with fire alarm system – gas solenoid valve to close in event of fire alarm.
- Fire test isolation mode – once test is completed panel to revert to normal operation and be included in fire alarm activation.
- Emergency gas isolation button located adjacent to the door from the Kitchen to the Seating Area.

The complete gas proving system shall be tested and commissioned in accordance with the system manufacturer's requirements.

2606.4 Pipework Testing

Pipework soundness testing shall be carried out by a competent person in accordance with LPGA Code of Practice 22.

Prior to any use all hose joints shall be leak tested using soap and water.

2607 Soil and Waste Drainage

The section of the Specification covers the complete foul drainage above ground installation from sanitary fitting and equipment outlets to point of connection to below ground installation and termination of soil vent pipes all as indicated on the relevant drawings.

2607.1 General

- Sanitary fittings shall be as per Architect's Specification.

- Waste pipework shall be PVC-U to BS EN 1329.
- Discharge stack and branch pipework shall be PVC-U to BS EN 1329.
- Discharge pipework from dishwasher shall be cast iron pipes with fittings to BS EN 877.
- Separate ventilation pipes shall be BS EN 1329.
- Accessories shall include traps, WC pan connections and access pipes.
- Below ground drainage shall be as per Civil Supervisors Representative's Specification.

2607.2 System Performance

Collection and Distribution of Foul Water

- General: Quick, quiet and complete, self-cleansing in normal use, without blockage, cross-flow, back-fall, leakage, odours, noise nuisance or risk to health.
- Pressure fluctuations in pipework (maximum): ± 38 mm water gauge.
- Water seal retained in traps (minimum): 25 mm.

2607.3 PVC-U Pipework

Standard: To BS EN 1329-1, Kitemark certified.

Weather resistance, connectors to WC pans, opening dimensions of access fittings, design of swept fittings, standoff dimensions of pipe and fitting brackets and requirements for adaptors and plugs: To BS 4514.

Brackets: Plastic one-piece pipe bracket.

Fixings: Stainless steel screws.

Size: to suit pipe

Accessories: Bends, offsets, junctions, access pipes, weathering slate, vent cowl etc.

WC Pan Connector.

2607.4 Fire Seals

Installation: In accordance with manufacturer's recommendations

2607.5 Installation Generally

Standard: To BS EN 12056-5.

Components: From the same manufacturer for each type of pipework.

Electrolytic corrosion: Avoid contact between dissimilar metals where corrosion may occur.

Plastics and galvanized steel pipes: Do not bend.

Allowance for thermal and building movement: Provide and maintain clearance as fixing and jointing proceeds.

Concealed or inaccessible surfaces: Decorate before starting work specified in this section.

Protection

Purpose made temporary caps: Fit to prevent ingress of debris.

Access covers, cleaning eyes and blanking plates: Fit as the work

2607.6 Pipe Routes

General: The shortest practical, with as few bends as possible.

Bends in wet portion of soil stacks: Not permitted.

Routes not shown on drawings: Submit proposals before commencing

2607.7 Fixing Pipework

Pipework: Fix securely plumb and/ or true to line. Fix discharge stack pipes at or close below socket collar or coupling.

Branches and low gradient sections: Fix with uniform and adequate falls to drain efficiently.

Externally socketed pipes and fittings: Fix with sockets facing upstream.

Additional supports: Provide as necessary to support junctions and changes in direction.

Vertical pipes: Provide a load bearing support not less than every storey level. Tighten fixings as work proceeds so that every storey is self-supporting.

Wall and floor penetrations: Isolate pipework from structure, e.g. with pipe sleeves.

Masking plates: Fix at penetrations if visible in the finished work.

Expansion joint sockets: Fix rigidly to the building.

Fixings: Allow the pipe to slide.

2607.8 Fixing Vertical Pipework

Bracket fixings: Plugged and screwed into masonry

Distance between bracket fixing centres (maximum):

32-50	1200mm
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65-110	1800mm
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To be confirmed with manufacturer

2607.9 Fixing Low Gradient Pipework

Bracket fixings: Bolted to concrete

Distance between bracket fixing centres (maximum):

32-40	500mm
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50	600mm
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65-110	900mm
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To be confirmed by manufacturer

2607.10 Jointing Pipework

Joint with materials, fittings and techniques that will make effective and durable connections.

Jointing differing pipework systems: With adaptors intended for the purpose.

Cut ends of pipes: Clean and square. Remove burrs and swarf. Chamfer pipe ends before inserting into ring seal sockets.

Jointing or mating surfaces: Clean and, where necessary, lubricate immediately before assembly.

Junctions: Form with fittings intended for the purpose.

Jointing material: Do not allow it to project into bore of pipes and fittings.

Surplus flux, solvent jointing materials and cement: Remove from joints.

2607.11 **Jointing Pipework –PVC-U**

Jointing: Solvent welded

Welded pipes shall also include lubricated seal joints at no more than 1.8m spacing to allow for movement.

2607.12 **Identification of Internal Foul Drainage Pipework**

Markings: To BS 1710.

Type: Self-adhesive tape

Wording: Foul Drainage

Type: Integral lettering on pipe wall, self-adhesive bands or identification clips.

Locations: At 500 mm centres, junctions and both sides of slabs, valves, appliances, bulkheads and wall penetrations.

2607.13 **Access for Testing and Maintenance**

General: Install pipework with adequate clearance to permit testing, cleaning and maintenance, including painting where necessary.

Access fittings and rodding eyes: Position to avoid obstruction.

2607.14 **Testing Generally**

Dates for testing: Give notice.

Inform CA sufficiently in advance to give him reasonable opportunity to observe tests.

Preparation:

Pipework: Securely fixed and free from obstruction and debris.

Traps: Filled with clean water.

Testing:

Supply clean water, assistance and apparatus.

Do not use smoke to trace leaks.

Records: Submit a record of tests.

2607.15 **Pipework Air Tightness Test**

Preparation

Open ends of pipework: Temporarily seal using plugs.

Test apparatus: Connect a 'U' tube water gauge and air pump to pipework via a plug or through trap of an appliance.

Testing: Pump air into pipework until gauge registers 38 mm.

Required performance: Pressure of 38 mm is to be maintained without loss for at least three minutes.

2607.16 Siphonage and Back Pressure Tests

Method

WC pans: Test by flushing.

Other appliances: Test by filling to overflow level, then removing the plug.

Number of tests: Test each appliance three times. Recharge traps before each test.

Self siphonage testing: Test each appliance individually.

2607.17 Pre-handover Checks

Temporary caps: Remove.

Permanent blanking caps, access covers, rodding eyes, floor gratings and the like: Secure complete with fixings.

2608 Controls

The Contractor shall supply, install, test and commission the new controls systems described hereinafter.

2608.1 Motor Controls

Motor controls and all electrical equipment shall comply with Part 3 section 6 of the Specification.

The Kitchen and Dishwasher extract fans shall be provided with local starters sized to suit the motor power and located adjacent to each fan within the purpose built enclosure on the first floor Staff Seating Area.

The Toilet extract fan unit shall be provided with a duty share/changeover panel located adjacent to unit within the purpose built enclosure on the first floor Staff Seating Area.

All necessary relays and volt free contacts shall be provided to allow items of plant to be controlled from the existing Building Management System (BMS).

Provision shall be made for stopping each fan from an isolator located adjacent to the fan starter or unit panel.

Provision shall be made for stopping all fans from a remote combined gas proving and ventilation panel and isolation button located adjacent to the door from the Kitchen to the Seating Area.

2608.2 Labels

Labels shall be provided adjacent to each component of motor controls and shall be of rear engraved Perspex filled black.

The nomenclature of each label shall be agreed with the Supervisor's Representative prior to manufacture.

2608.3 Drawings and Wiring Diagrams

Two sets of wiring diagrams shall be passed to the Supervisor's Representative for comment prior to placing orders. The diagrams shall also include wiring to all external controls and components. The drawings and diagrams shall be available at a time to meet the Contract programme allowing the Supervisor's Representative a minimum of 2 weeks to pass comment.

On completion of the Contract all drawings and wiring diagrams shall be amended to suit the final installation and copies shall be included in the Operating and Maintenance Manuals as detailed in Part 1 of the Specification.

2608.4 Commissioning

The Contractor shall fully commission the controls systems on completion of the installation and demonstrate to the Supervisor's Representative the operation of all controls. The Contractor shall fully instruct the Client's Maintenance Supervisors Representatives on the principles of operation of the control system and the use of the adjustments incorporated within the control system. These instructions shall be carried out at times to be agreed with the Client.

2609 Gas chamber (laboratory fume hoods)

2609.1 Reference Standards

BS EN 14175-7:2012 – Fume cupboards for high heat and acidic load.

Where ANSI or ASHRAE standards are referred to in this section, these may be replaced by E.U. member state and/or ACP State standards provided they are equivalent or superior to the U.S. Standard.

2609.2 General Description

All new hoods shall meet testing criteria established by the American Society of Heating, Refrigerating, and Air Conditioning Supervisors Representatives, Inc. (ASHRAE) in ANSI/ASHRAE 110-1995, "Method of Testing Performance of laboratory Fume Hoods" or "Gas Chambers" All laboratory fume hoods (i.e. standard, bench, distillation, walk-in) shall have proper aerodynamic design to minimize eddy currents and assure against air movement from the hood into the laboratory. The design shall include airfoil sides and an aerodynamic sill with a 1-inch air gap between the sill and the hood floor. An "air by-pass" shall be present on all hoods to control the range of the face velocity as the hood sash is raised and lowered. The face velocity at any sash position should never exceed three times the "open face" velocity. It is necessary to keep the air velocities within this range to reduce eddy currents around the edges of the hood face.

2609.3 Location

All new fume hoods shall be an integral part of the laboratory design and all laboratory renovations shall also rectify improper hood locations.

Fume hoods shall be located in a room so that air currents generated in the room shall not interfere with the hood's ability to capture and eliminate vapours, mists, and airborne particles. Therefore, hoods shall be located as far away as possible from:

- Doors
- Supply air diffusers
- Windows which can be opened
- Heavy traffic areas
- Other location exhaust ventilation devices

Room air current velocities at the face of the hood should not exceed twenty linear feet per minute (LFM) from any source and should be as close to zero as practicable.

2609.4 Hood Design and Construction

In general, all fume hoods should be constructed and contain materials that shall permit their planned use to be carried out safely; therefore, their intended use must be known.

Sides

Hood sidewalls shall be 3 ½ - 6 ½ inches (88 – 165 mm) wide, and shall be properly formed to present a smooth airfoil to the inflowing air. The hood interior lining shall be flush with the sides. These features shall, over the range of the hood's designed air face velocity, prevent significant eddy currents from circulating air from inside the hood through the plane of the face of the hood.

Sill

A radiused stainless steel sill is required. It shall be installed at the bottom of the hood opening and extend back under the sash. An open area of approximately 1 inch shall be present under the sill to direct air across the work surface at all sash positions.

Sash

The sash may be vertically or horizontally tracked. Horizontal sash hoods shall have a device to lock the sash in its tracks. Removal of the sash must only be possible with special tools or keys. Glass used in the sash shall be at least 7/32 inches (5.5 mm) thick combination sheet. The sash shall be securely enclosed in a complete frame, welded and ground smooth at the corners. Stainless steel or a baked-on epoxy coat is to be used for the sash frame. Vertical sashes shall be counter-balanced with sash weights, suspended from each side of the sash and shall be easily operated. The sash frame must be held in a stainless steel track and have plastic guides.

Interior

The interior lining of the hood must be resistant to the materials and chemicals to which it shall be exposed. Stainless steel is acceptable; suitable compositions, including transite, must be painted or coated with impervious sealer such as epoxy paint.

Use of perchloric acid, hydrofluoric acid, and radioisotopes require special consideration as detailed in those sections.

Exterior

Cold rolled steel shall be used for the hood exterior. All parts shall be joined together with screws to allow for dismantling and access for service. After fabrication and before final assembly, all component parts shall be given an acid, alkali and solvent resistant finish on both exterior and interior surfaces.

Frame

A full rigid frame shall support the interior and exterior walls of the fume hood.

Working Surface

The working surface shall be molded epoxy or stainless steel. It shall be recessed not less than ¼ inch (6 mm) deep and have a raised area on all sides. The raised area across the front of the hood shall be at least three inches wide.

Hood Fixtures and Services

The user shall specify utility service needs. Electric service shall be located on the exterior of the hood. Plumbing fixtures shall be brass, chrome-plated, or acid and organic vapor resistant plastic. All fixtures shall have color-coded end caps. All controls for plumbing services shall be located on the hood exterior.

Lighting

Hoods shall be equipped with sufficient fluorescent or incandescent lighting. The light fixture shall be easily accessible from the outside of the hood, shall be shielded from the hood interior by a laminated or tempered glass panel, and shall be vapor sealed.

Air By-Pass Mechanism

All hoods shall be equipped with an air by-pass mechanism located above the hood face opening. It shall provide an effective sight-tight barrier between the user and the hood interior. By-pass louvers shall be directed upward away from the front of the hood and provide an effective barrier and deflector for flying debris from inside the hood. The by-pass shall control the face velocity as the sash is lowered. The velocity of the air at any sash position shall never exceed three times the open face velocity. The air by-pass shall begin to operate when the sash is one-third to one-half closed.

Plenum and Slot Arrangement

A plenum shall be located in the rear of all fume hoods. It must have at least two but no more than three slots. The lower slot shall be furnished at the working surface level and be locked at 2 to 2 ½ inches or have the baffle removed entirely. The upper slot shall be located

in the upper section of the hood. The opening shall be set at 3/8 to 1/2 inch maximum. A middle slot, if furnished, shall be fixed and have an opening no greater than 2 inches.

2609.5 Exhaust Motors

Exhaust motors and duct systems for hoods are to be sized and designed to provide an average hood face velocity of 80-100 LFM, as measured at the face, with the sash wide open. Deviations in this value shall not be greater than 20% at any point across the hood face. To assure this standard, the designer must work closely with the duct installer to determine the effects of duct routing on motor sizing.

Exhaust motors shall be located on the roof, or in an adequately ventilated fan loft. Exhaust motors shall be located to allow access for maintenance.

2609.6 Face Velocity Control System

The fume hood shall be equipped with a device to measure and monitor airflow. At a minimum, the system shall have a visual indicator of the hood face velocity. Additionally, adjustable low flow/caution alarm set points with audible buzzer or alarm are recommended.

2609.7 Duct Design and Construction

Ducts shall be constructed of materials compatible with the chemicals being used in the hood. Circular ductwork is preferable to other shapes as it reduces friction loss and is easier to seal.

Ducts are usually constructed of galvanized sheet steel, riveted and sealed. If reactive chemicals shall be used, ducts shall be constructed of a non-reactive stainless steel, unplasticized PVC, or have an inorganic ceramic coating.

Ductwork shall take the straightest route to the roof, minimizing bends and horizontal runs. Increased distances and bends create resistance to airflow and require exhaust motors. When elbows are necessary, they shall have proper centerline radius (1½ times the diameter of the ducts) to minimize eddying and resistance to air flow. All elbows shall have removable wear plates when operations shall involve heavy dust concentrations. Ductwork shall not enter the exhaust motor on an elbow. Exhaust motors shall be located on the roof so that a negative pressure shall be maintained in the ductwork and prevent escape of toxic material through holes and cracks in the duct.

HEPA or charcoal filters are not required for most routine uses of fume hoods. Where filters are required, the housing shall be located in the fan room or roof before the blower. The filter housing shall be located to allow for easy filter changing by the bag-in/bag-out technique. Exhaust fans shall be sized accordingly to handle the increased pressure drop across the filter.

Any deviation from the original specifications required in the routing of ductwork during installation shall be considered by an Supervisor's Representative to assure that the change shall not alter the designed performance of the hood.

2609.8 Discharge

The discharge point must be at a proper height above the highest point of the roof or parapet (10-15 ft.) (3.05 – 4.57 m) to reduce air streaming effects of the building. Air shall be discharged vertically with at least 3500 feet per minute (17.78 meter/second) stack discharge velocity. The discharge stack should be located in the prevailing downwind direction of the air intake point.

The discharge stack shall be uncapped, straight, and cylindrical. The discharge duct shall overlap the fan ductwork 6 inches (150 mm) (and have a 1 inch (25 mm) greater diameter, to provide for rain drip discharge. Deflecting weather caps are prohibited on discharge stacks, as they reduce the effective stack height, reduce air velocity, and are not effective rain shields, and increase final cost.

2609.9 Special Hoods

Perchloric Acid Hood

To safely contain perchloric acid, work requirements in addition to the standard design for fume hoods are specified under this section.

Construction:

Materials of construction for the hood and ductwork shall be non-reactive, acid resistant and relatively impervious. Type 316 stainless steel, with welded joints, is preferred. Unplasticized PVC or an inorganic ceramic coating such as porcelain is acceptable.

All interior surfaces of the hood and ductwork shall be smooth and seamless, and constructed for easy cleaning. The work surface shall be smooth and watertight with a minimum of ½ inch (25 mm) dished front and sides and an integral trough at the rear to collect wash-down water. The hood shall be designed to allow easy visual inspection of all interior surfaces.

Ductwork and Exhaust Fans:

Each perchloric acid hood shall have an individual exhaust system (i.e. individual duct to individual fan). The ductwork shall go straight from the hood to the roof with no horizontal runs or sharp turns. “Wash-down” facilities shall be built into the hood and ductwork. An air ejector system or an exhaust fan may be used. An air ejector exhaust system eliminates the possibility of acid reaction with fan components and allows for ease of cleaning. If a fan is used, the blades shall be made of acid resistant metal or a metal protected by an inorganic coating. Fluorocarbon grease shall be used to lubricate the fan.

Hydrofluoric Acid Hoods

Hydrofluoric acid is a highly corrosive agent. Consequently, standard laboratory fume hood construction materials shall be substituted with materials resistant to hydrofluoric

acid attack. For hydrofluoric acid, the standard fume hood design shall be supplemented by the following specifications on construction and materials.

Construction

The hood and ductwork shall be constructed of non-reactive materials that are resistant to hydrofluoric acid attack and are relatively impervious. A Portland Cement hood interior or other suitable material is recommended. The hood shall be constructed to allow easy visual inspection of all interior surfaces. A transparent plastic sash and PVC ductwork is required.

Ductwork and Exhaust Fans:

Ductwork shall be constructed from PVC or equivalent material. Horizontal runs and bends in ductwork must be kept to a minimum. The motor and blower housing shall not have exposed metallic parts.

Radioisotope Hoods

In addition to meeting the standard design specifications for fume hoods, the interior of all radioisotope hoods shall be stainless steel or molded epoxy resin and must form a smooth integral unit. All interior screws shall be countersunk and joints sealed and smooth for ease of decontamination.

2610 Building Management System (BMS)

The Contractor under this section shall include to provide an additional outstation to serve the new plant located within the Cafeteria and connect the outstation to the existing Building Management System (BMS) head end located within the Hospital Supervisors Representative's office to provide the specified control and alarm functions.

The new outstation shall be located within the purpose built fan enclosure on the first floor Staff Seating Area.

2610.1 Wiring

Wiring shall be provided as follows:-

Power supply to the outstation will be provided by the Electrical Services Contractor.

The Building Management System specialist shall wire from the outstation to all field control and monitoring devices. The BMS specialist shall include to connect the new outstation to the existing BMS network.

The BMS specialist shall include and provide all wireways for the controls and BMS installation.

2610.2 Commissioning

The Building Management System specialist shall fully commission the new installation and provide a minimum of a day's training for the Client's maintenance Supervisor's Representative to instruct on the principles of operation of the BMS system and the use of the control adjustments and fault monitoring facilities.

2610.3 Graphics

The Building Management System Specialist shall generate graphic screens for the new Cafeteria plant to be added to the existing head end to be used by the Client's maintenance Supervisors Representative.

2611 Wiring To Mechanical Plant and Equipment

This section of the Specification covers the wiring and connections to all items of mechanical plant and equipment.

This shall include all power and controls wiring from the motor controls to all items of plant and controls.

2611.1 Wiring

The installation of wiring shall be through galvanised trunking or conduit runs to suit the locations of the motor controls and items of mechanical plant and equipment. The installation shall be in accordance with and comply with the requirements of BS 7671 "requirements for electrical installations – IEE wiring regulations sixteenth edition".

Conduit runs shall terminate within 450mm of each item of mechanical plant and equipment with a conduit/adaptable box. Final connections shall be made with flexible cable or conduit.

Local isolators shall be installed within the conduit runs, the isolators being mounted either on a metal frame fixed to the floor or wall adjacent to the item of plant or equipment.

All wiring shall be carried out using single core PVC cable sized to suit the equipment loads.

2611.2 Local Isolators

The Contractor shall include for the complete installation of isolators local to each item of plant or equipment. The isolators shall be of the metal clad type and manufactured in accordance with BS 5419: 1977. The operating handles shall be of the type suitable for locking in the off position.

Each switch or isolator shall be labelled as to its function and source of supply.

2611.3 Final Connections

The Contractor shall include for the complete installation of final connections to all items of plant and equipment included in the tender drawings and specification.

Each final connection shall include a protective conductor. The connections to plant or equipment item shall be made using PVC coated flexible conduit such as Kopex with an earth protective conductor.

2611.4 Wiring for BMS

The provision and wiring of the plant BMS system is covered by Part 2 Section 9 of the Specification. This section of the Specification includes for the provision of wire ways and conduits to the various items of equipment.

2700 MECHANIAL WORKS – GENERAL SPECIFICATIONS

2701 Pipework Fittings and Valves

This section of the Specification sets out the standards methods and processes to be adopted for the supply and erection of pipework, fittings, valves and cocks. It shall be read in conjunction with each and every other relevant Section of this Specification and the requirement of BS Code of Practice CP341. 300-307 shall be incorporated unless otherwise specified.

Special requirements particular to any service have been indicated in the relevant Sections of the Specification or on the drawings and in the event of any conflicting requirement the subject shall be referred to the Supervisor's Representative for clarification.

Standard Specification (M&E) No. 3 issued by the Department of the Environment shall be taken to be incorporated as an indication of normal practice unless any Section of this Specification indicates otherwise.

2701.1 Pipework

Pipework shall be of the grade and specification as described in the relevant section of the Specification for the various services.

Pipework shall be free of burrs, rust, scale and other defects and shall be thoroughly cleaned before erection.

Pipework which is unduly marked by tools, flattened or otherwise distorted or damaged will be rejected by the Supervisor's Representative.

Open ends left during the progress of the work shall be blanked off with purpose made metal or plastic plugs, caps or blank counter flanges.

A coat of heat resisting corrosion resistant paint shall be applied to all black pipework and on all welds. Exposed threads on galvanised pipework shall be painted with zinc rich paint immediately after erection.

Pipework shall be run to follow the contours of the building and shall be sloped for the purpose of venting and draining. The Contractor shall allow in his tender for bending pipework around all projections and recesses and for all off-sets due to varying thicknesses of walls, floors, ceilings and other structural works or other services, whether such changes in direction of piping are indicated on the drawings or not.

All pipe routes shall be checked against the Architect's and Structural Supervisor's Representative's drawings.

All piping shall be erected to present a neat and orderly appearance, arranged parallel to or at right angles to structural members of the building.

All pipework, valves, fittings and equipment forming the pipework installation shall be erected so that they can be easily dismantled, and accessible for repair and replacement.

Joints shall not be made in the thickness of any wall, floor or ceiling, and pipework shall not be embedded in brickwork or concrete unless specially ordered.

Vertical pipework must be fitted plumb and parallel to all other pipework wherever practical.

Where pipework passes through walls, floors and ceilings, tubular pipe sleeves must be fitted. The internal diameter of the sleeve shall in no case exceed the outside diameter of the pipework enclosed by more than 15mm and shall project 3mm beyond the finished surfaces of the wall. Sleeves shall be of the same materials as the service pipe.

Sleeves in a vertical position shall project 10mm above finished floor level, except that, where washing down of floors, etc., is likely to be carried out the sleeves shall project 35mm.

Where necessary to allow for expansion or contraction, oversize sleeves may be permitted and the attention of the Supervisor's Representative must be drawn to the proposed masking plates insulating material.

Sleeves shall normally be packed, after erection and building in, with suitable fibrous insulation or equal insulating material.

Where pipes pass through walls, floors and ceilings exposed to view they shall be fitted with wall and floor plates of the telescopic pattern. Chrome plated or equal approved finish.

2701.2 Pipework Fittings

Wherever practical, made bends and sets shall be used in preference to fittings. Bends and sets in pipework shall be cold drawn by a hydraulic bending machine for sizes up to 50mm bore. Larger sizes shall be fire made, and the radius shall be not less than three times the pipe diameter. Where bends or sets are to be formed on galvanised pipework such pipework shall be galvanised after the forming is completed.

Curved or long sweep bends and branches shall be used as far as practicable.

Long sweep branches with gradual reductions for reduced diameters shall be used where two runs connect together.

Exception to the above being only where air pipes or air bottles, drain or dirt pockets, are taken off, or air venting requirements dictate, in which case square connections and fittings shall be used.

Attention is drawn to BS 806 with reference to spacing of branch connections and the consideration affecting reinforcement. The distance between any two adjacent branches shall not be less than the sum of the outside diameters of the branches.

Reduction in sizes of pipe lines shall be affected by either of the following approved methods:-

- By factory made reducing pieces manufactured at the tube or fitting manufacturer's works.
- By properly hot swaging down the larger pipes to the smaller diameter.

Reducers on runs which are not vertical shall be of the eccentric type.

Where branch joints, welded joints, bosses, vent and drain pockets are made, special care shall be taken to ensure that there is no obstruction or possible cause of obstruction and to see the full bore is maintained in all directions.

Fittings for steel shall be of malleable iron, black or galvanised MS as specified or shall be of the butt welding type as appropriate.

Fittings for copper tube shall be to BS 864 Part 2 with integral solder ring

2701.3 Pipework Jointing

All black pipe flanges shall be screwed or of the "slip-on" welding type and conform to BS 4504. Flanges on galvanised pipe shall be screwed, galvanised and all exposed threads shall be painted with a zinc rich paint immediately after flange is screwed on. Where pipework is to be galvanised after fabrication, welded flanges shall be used. All flanges shall be machined right across the jointing face and on the edges.

Mild steel flanges which weld to pipework shall be drilled with a slight taper in their bore and be provided with a shaped boss to facilitate welding. Flanges shall be welded neck and bore.

Long neck welding flanges may be used but the practice of burning out the threads of a screwing flange will not be permitted.

All pipework flanges shall, when in position, forming a pair, be flush with one another all around. Flanges shall, depending on the flange material, be bolted together with bronze or bright mild steel bolts and nuts complete with washers. Bolts shall not project more than one and a half threads through the nuts. Where high tensile or other special bolts or nuts are required for arduous application approved identification of such requirement will be required at each such flange.

Joints between flanges shall normally be made with Taylor's brass corrugated rings, Klingerrite or other approved jointing material, purpose made and not cut from sheets on site. Unusual or corrosive services may require special, approved material.

Joint rings shall be fixed concentric with the pipe bore and the Contractor shall ensure that they do not obstruct any of the pipe bore.

Screwed joints in water and steam pipework shall have taper threads to BS 21 and shall be made with approved jointing tape, or with best quality hemp and jointing paste. The amount of hemp and paste used in jointing shall be kept to a minimum and all excess shall be removed. Where excessive use of hemp is observed the Contractor will be required to remove the length of pipe and fittings involved and replace same with new materials.

Screwed joints in pipework conveying oil shall be made with approved appropriate tape or with a compound or glycerine and litharge and shall be completely oil tight. Fittings shall provide rodding facilities on all pipework for oil above 75 seconds viscosity.

Joints in copper pipework shall be by means of capillary fittings of the integral solder ring type or by brazing, using the correct forming tools (e.g. Allen Tools). Couplings shall be fitted strictly in accordance with the manufacturer's recommendations, particular attention being given to cleanliness, cleaning of excess flux after joint has been made, lack of distortion of the pipe and ensuring full insertion depth. All capillary fittings shall be of the same manufacturer.

On brazed joints brazing couplings shall be used where joints are visible. Elsewhere or where particularly specified, these may be made by properly belling or swaging one pipe to allow insertion of the other. All brazed joints shall be made by using an approved filler rods and appropriate fluxes.

Caulking of joints will not be permitted, except on joints particularly designed for such jointing.

Flanges on copper pipework shall be bronze welded at the neck and the tube ends shall be expanded at the flange face.

All unions on steel pipework shall be Navy Pattern of malleable "iron" with bronze seats and taper threads, black or galvanised as applicable.

2701.4 Welding

All welding must be executed by first class certified welders, working under skilled supervision. They shall be competent and experienced in the particular class of work for a period of not less than 12 months for in this specification and shall hold a current approved certificate.

The welding shall be carried out by "Oxy-Acetylene" or "Electric Arc Process." In the case of the former, welding of pipes up to 400mm bore shall, in all respects, comply with the requirements and recommendations contained in "Recommended Practice of Oxyacetylene Welding in Mild Steel Pipe Lines" as issued by the Heating Ventilation and Domestic Supervisors Representatives National Joint Council or the appropriate BS. For the

"Electrical Arc Process" all works, methods, equipment and materials shall comply with the recommendations and requirement of the appropriate British Standards Specification.

Prior to welding, the pipe ends shall be aligned and secure in positions by a suitable bolted clamp with jack screws for the maintenance of the proper gap at the bottom of the welding groove. The groove shall then be tack welded in several places as to retain the pipe ends in their correct position during the welding operation.

The bore at the ends of adjacent pipes should preferably match exactly but in no case shall they differ in diameter by more than the allowance shown in the following table and alignment shall be within the limits shown.

Normal Bore Internal Diameter (mm)	Difference in Out of Alignment (mm)	Maximum Parallel (mm)
Up to 100	1.0	0.5
Over 100 up to 250	2.0	1.0

All welds shall be reinforced on the external surfaces, the reinforcement running smoothly at each end of the weld. Welds which show undercutting will not be approved.

The Supervisor's Representative reserves the right to instruct the Contractor to cut out selected sections of piping or other works which include welds, and subject these sections to test at the National Physical Laboratory, or other approved body, at the expense of the Contractor.

Such samples tests proving unsatisfactory, the Contractor shall immediately take all necessary steps with the approval of the Supervisors Representative, to examine and make good all welds, until the same meets with the requirements of the relevant BS Specification or other approved Specification.

2701.5 Expansion and Contraction

The Contractor shall ensure that adequate provision is made for the expansion and contraction of all pipe lines.

The setting out of pipework shall take into account the advantages of natural flexibility. Attention shall be given to the details of arrangement of pipe supports, branch connections and restraints imposed by structure or other services.

The tender drawings indicate major expansion compensating devices and the cost of these shall be included in the tender together with an allowance for all guides and anchors.

Where the natural flexibility of the pipework is insufficient, the expansion shall be taken up with expansion bellows, joints, compensators and/or loops and shall be anchored and guided in accordance with the manufacturer's recommendations.

Expansion loops or bends shall be of one piece and made at the tube fitting manufacturer's works. If the total length of tube in the loop or bend is such as to prohibit this, welds may be made in the long arms as near the centre as possible. No welds will be permitted in the crown of the bend or in the short arms, and any seams shall be arranged at the side of the bends.

All loops or bends shall be flanged, and arranged to vent and drain naturally.

All expansion loops, bends or joints shall be erected on cold draw, and to be nearly the full extent of same, and shall not be assembled before pipes are anchored.

In the eventuality of the recommendation being not immediately possible, necessary distance pieces shall be inserted, and attention is drawn to the need in some cases to temporarily fit make-up pieces for testing purposes.

The Contractor shall provide, for all pipework, the necessary anchors which shall be adequate strength to resist the maximum stresses.

Anchors shall preferably be welded to the pipework.

The Contractor shall also provide and fix in position, ready for building in, all cleats, brackets and steelwork required for anchor points. The proposed method of anchorage shall be submitted to the Supervisor's Representative for his approval together with corresponding calculations and details of thrust loadings.

Where necessary to prevent long pipe runs from buckling and to ensure alignment of pipes and free movement on joints, all necessary pipe "guides" are to be provided. These shall be constructed to prevent radial motion and carefully installed so that axial movements are not hampered.

(For maximum recommended distances of pipe guides refer to Table under "Pipe Supports").

With a view to reducing strain due to expansion on plant or equipment of any description, the Sub-Contractor shall ensure that the connecting pipes are suitably set and include such expansion bends or loops as required, the fixed point being taken as the piece of plant or equipment. The connections shall be so supported that no strain is placed on the equipment.

Failure to comply with the instructions in this Section, by the Contractor, shall make him fully responsible for any damage resulting there from.

2701.6 Pipework Supports

All pipework shall be adequately supported on hangers, or on brackets with fixed or adjustable rollers according to position, in order to permit free movement due to expansion

and contraction, and the amount of such movement shall be proportioned throughout the system by the provision of anchors at suitable points.

It is desirable that positions of support should be arranged as near as possible to pipe joints.

Support in ducts, ceiling voids and trenches shall be so spaced as to allow access to any pipe or joint without disturbing the remainder.

Mains in ducts or trenches shall be carried on purpose made racks, with adjustable supports on brackets, and so fixed that mains cannot leave such supports during expansion or contraction (see pipe guides).

Where a common pipe hanger is used, provision must be made for unequal expansion.

Contact of dissimilar metals that may cause corrosion must be avoided, i.e. supports in contact with steel pipe shall be of a similar metal, galvanised pipe shall have galvanised supports, copper pipe shall have copper or copper alloy supports or plastic lining inserts if other metal support are used.

Valves of 75mm bore or over or similar equipment shall be separately supported to avoid strain on the connections.

The Contractor shall provide all pipe supports required which shall include all necessary steel supporting brackets, girder clip assemblies, rollers with adjustable and non-adjustable roller carriages, standard steel support rods or hangers with eyes, standard cast iron washers and rockers, pipe clips (Claw, pear or round pattern) pipe rings, etc., he shall include all welding, drilling nuts, bolts, and washers together with the welding or bolting to steel structural works. Fixings to steel structural works shall be made only with the Supervisors Representative's approval.

All supports referred to shall be to the Supervisors Representative's approval and satisfaction.

Pipe hangers or supports shall be constructed to provide vertical adjustment and enable free movements of pipework in radial or longitudinal direction. All hangers or supports rods shall have welded or forged eyes with screw adjustments which shall be so fabricated that all threads shall be true and complete threads. Turn buckles or adjusting nuts shall have the full length of thread in service, and the amount of adjustment shall be plainly visible at all times. All screw or equivalent adjustment shall be provided with locking features. All hangers shall be provided with spherical rockers and washers.

Hangers or supports, other than spring hangers, shall be based on the weight of the pipe, fittings and valves, the weight of the medium transported or the medium used for testing, whichever is heavier, and the weight of the insulation covering used. Allowance shall also be made for the weight imposed during erection or maintenance.

Supports shall be sufficiently close together so that the sag of the pipe is within limits that will permit draining of the supported pipe and prevent excessive bending stresses from concentrated loads between supports. The pipe suspension shall be such as to prevent excessive stress, excessive variation in supporting force and possible resonance with imposed variations. The fabrication and installation of excess stress of strain. Supports, whether of the rigid or spring type shall be capable of taking the entire piping load imposed by the expansion or contraction.

All lines shall be suitably sway braced to prevent undue or unwanted movements or vibration, but such sway bracing shall not interfere with the proper thermal movement of the piping. An approved vibration dampener that provides an instant counteracting force shall be provided where required to control the piping. All parts of the supporting equipment shall be fabricated and assembled so that they will not be disengaged by movement of the supported pipe.

Particular consideration shall be given to connections to plant such as compressors, pumps, steam generators, etc. Anti-vibration bellows are to be positioned as near as possible to the equipment and the pipework anchored immediately behind the bellows.

The size of the clamp supporting any chilled water pipe, shall be equal to the outside diameter of the pipe insulation. At the point of support, the pipe shall be held by a concentric spacer or necklace of timber or plastic blocks or similar. See Section 4.3.

Supports on pipework above 50mm within plant rooms shall incorporate spring hangers having a minimum deflection of 15mm.

2701.7 Support Spacing

Recommended spacing for pipe supports shall be generally as described in the following tables:

Table 9: Supports for Steel Pipework

Size of Tube (mm)	Intervals for Horizontal Runs		Intervals for Vertical Runs Bare or Lagged (m)
	Bare (m)	Lagged (m)	
15	2.0	1.8	2.4
20	2.4	2.0	3.0
25	2.7	2.4	3.0
32	2.7	2.4	3.0
40	3.0	2.4	3.7
50	3.4	2.7	4.6
65	3.7	3.0	4.6
80	3.7	3.0	4.6
100	4.1	3.0	4.6
125	4.4	3.7	5.5
150	4.8	4.5	5.5

Size of Tube (mm)	Intervals for Horizontal Runs		Intervals for Vertical Runs Bare or Lagged (m)
	Bare (m)	Lagged (m)	
200	5.1	4.5	8.5
250	5.8	5.0	9.0
300	6.1	5.0	10.0

Table 10: Supports for Copper pipework

Size of Tube (mm)	Intervals for Horizontal Runs		Intervals for Vertical Runs Bare or Lagged (m)
	Bare (m)	Lagged (m)	
15	1.4	1.2	1.8
22	1.4	1.2	1.8
28	1.7	1.5	2.4
35	1.7	1.5	3.0
42	2.0	1.8	3.0
54	2.0	1.8	3.7
67	2.0	1.8	3.7
76.1	2.4	2.0	3.7
108	2.7	2.4	3.7
133	3.0	2.7	3.7
159	3.0	2.7	3.7

Note: The above figures are only recommended figures and shall be at all times checked by the Contractor to be in accordance with all Sections of the Specification and drawings and shall varied to suit particular installation conditions.

For all other materials or grades or pipework the spacing of supports and guides shall take into account the nature of the pipework, together with the factors described in Sections in this section of the Specification and the effects of temperature of the pipework or of adjacent equipment or pipework. Plastic pipework shall be continuously supported on timber battens

2701.8 Air Venting

The Contractor shall ensure that all pipework is installed to ensure a slight rise or fall in direction as may be required to provide venting and/or draining of the systems.

To this effect the Contractor shall provide at all high points as shown on drawings, and/or as may be found necessary to satisfy site conditions, proper air vents. These air vents shall be made up as follows:

2701.9 Air Bottles

A vent pipe tapping taken off the top of the main, or equipment, and connected to an air bottle. The vent pipe tapping shall be of mains size up to 50mm bore and shall remain at 50mm bore for larger mains. These vent pipes shall be connected to air bottles, which, for low and medium temperature pipework, shall consist of 250mm lengths of 50mm bore tube fitted with blank ends and a 6mm air cock. For high temperature pipework the bottles shall be 300mm lengths of 50mm bore tube for pipework up to and including 75mm and 400mm lengths of 100mm bore tube for pipework above 75mm. They shall be of welded construction.

Where the air bottle or pocket is not readily accessible a 15mm bore air release pipe shall be provided from each air bottle or pocket, arranged to terminate with valve in a position of easy access and at approximately 1.0m above floor or ground level, or at such level as may be required or indicated by the Supervisors Representative.

On low and medium temperature pipework the air release pipe shall be fitted with needle seated key operated clock. On high temperature pipework it shall be fitted with a needle seated globe valve arranged for key operation and fitted with a sunken plug.

Automatic air vents shall be used only where indicated or where agreed. They shall have gunmetal or brass bodies and non-ferrous or stainless steel floats and guides and non-corrodible valves and seats. Each automatic air vent shall be fitted with a lockshield valve and union. Air release pipes shall be run to discharge at a suitable visible point.

All air vent and release pipes shall be installed in such a manner as to prevent freezing.

2701.10 Draining

The Contractor shall provide for each section of the system, and as required by site conditions, suitable drain connections at all low points, whether shown on the drawings or not.

On low or medium pressure systems these shall comprise standard hose union drain cocks with detachable keys.

On high temperature hot water systems they shall comprise a needle seated, key operated globe valve.

On open circuit systems they shall be screw down pattern to BS 2879.

All drain and drip points at pumps, cooler coils, safety valves and cocks and other equipment shall be provided with drain lines discharging into tundishes adjacent to the equipment. Where necessary, to prevent back suction, drains from equipment shall be trapped.

The tundishes shall be adequately sized for the expected discharge and shall be constructed from copper or stainless steel sheet. A rolled top trim shall be formed to stiffen the tundish

and hinged lid shall be provided to allow for examination of the drip pipes without disturbing the drain lines. The tundishes shall discharge into light gauge stainless steel or copper pipes run to convenient floor grilles or sumps.

Drain cocks are to be fitted on the dead side of the valves on the main branches, to assist draining down.

2701.11 Scale or Dirt Pockets

The Contractor shall provide a scale or dirt pocket on the return from any air heater, or other similar plant or equipment, at a low point adjacent to the plant or equipment.

The scale or dirt pocket shall be the same size as the pipe and shall be not less than 150mm long or deep. They shall be fitted with welded on flange and bolted black companion flange arranged to allow easy removal for cleaning. Alternatively, on low and medium temperature systems, pockets of 50mm bore or smaller, may be fitted with screwed plugs and caps.

On closed systems blow down pockets shall be provided at the base of all main risers, at low points in plant rooms and at the end of long horizontal runs to allow for the removal of aerobic sludge.

The pockets shall be the same bore as the pipework up to a maximum of 50mm bore and shall be a minimum of 600mm long. On low temperature pipework the pockets shall terminate with a plug cock. On high temperature pipework they shall terminate with parallel slide valves. Two shall be provided with each pocket, one being nearest the branch with the second terminating the pocket and a minimum of 600mm from the adjoining valve. All valves shall be operated by a removable key. The valves shall be the same diameter as the pocket and shall be fitted with blank counter flanges or screwed plugs as appropriate.

2701.12 Combined Temperature and Pressure Test Points

Combined temperature and pressure test points shall be provided at all points on the drawing or wherever required to enable satisfactory testing and balancing on completion, e.g. in flow and return mains across calorifiers, mixing and diverting valves, flow and return headers, etc.

Test points are in addition to any permanent gauges called for, and shall be installed in such a position to allow easy access and use.

Combined test plugs shall be as those manufactured by Messrs Binder Supervisors Representative. Each test plug shall have a suitable core and be complete with a screw on cap. The Contractor shall supply to the Site Supervisor's Representative 2 no. pressure gauges complete with adaptors and 2 no. thermometers, of each necessary range, suitable for use with these plugs.

2701.13 **Valves and Cocks General**

Valves and cocks shall be provided where indicated on the drawings and elsewhere as specified or considered to be necessary, to provide for isolating sections of the circuits, items of equipment, regulation of flow quantities and balancing.

All valves and cocks shall be located and installed to allow ease of operation and servicing. Where valves and cocks are concealed behind access panels or similar, they shall, wherever practical, be grouped for ease of access and to reduce the number of panels required.

All seats, discs and packing shall be completely suitable for the operating conditions, temperatures and pressures, to provide efficient service with the minimum of necessary maintenance.

Valves and cocks in areas where unauthorised interference with settings is possible, or where such interference could be a source of danger, shall be fitted with key operated spindles and with dust covers. Alternatively, on large valves they shall be securely locked by means of padlock, in the correctly set position. Wheeled valves on hot services shall be fitted with "cool" pattern wheels.

Spare gland packing shall be provided and left in the care of the Site Supervisors Representative. This shall be of the appropriate grade and of sufficient quantity to repack each gland.

All screwed valves and cocks shall be fitted with a union on the "dead" side of the valve or cock.

Valves or cocks on mains water services and other cold water services shall be subject to Local Authority requirements, and stamped accordingly.

Valves and cocks exposed in rooms shall be provided with easy clean bonnets.

Valves in plant rooms shall be fitted with open and shut indicators.

The Contractor shall provide and handover two of each type and size of the following:

- Air cock keys.
- Drain cock levers.
- Lockshield valve keys.
- Levers for any other valves and cocks, provided in the Contract.

All valves and cocks shall be constructed throughout including spindles, in materials free from de-zincification and this shall be clearly specified on all orders to manufacturers.

2701.14 **Parallel Slide Valves**

Parallel slide valves shall be constructed in accordance with BS 5151 and BS 5157 and with such requirements of BS 1952 as are appropriate. The valves shall be of the outside

screw pattern with non-rising hand wheel and with bolted bonnet and gland. A sliding crosshead shall be provided.

Valves shall be manufactured from bronze, cast iron or cast steel, according to the pressure/temperature conditions for the system. Ends shall be flanged to BS 4504 or screwed to BS 21 with taper thread, as appropriate.

2701.15 Globe Valves

Globe valves shall comply with the requirements of BS 5152 or BS 5154 and shall be suitable for the working pressure and temperature described elsewhere in this Specification.

The valves shall be provided with renewable seats and shall have a gland capable of being repacked under pressure.

Valves shall be provided with ends screwed to BS 21 with taper threads or flanged to the appropriate table of BS 4504 as required by the application and service.

2701.16 Gate and Check Valves

Gate valves shall be of the non-rising stem type with inside screw.

Cast iron gate valves shall comply with BS 5150 when fitted in closed circuits or BS 5163 when fitted in open circuit.

Gunmetal gate valves shall comply with BS 1952 or BS 5154 and shall be provided with ends flanged to BS 4504 or screwed female ends to BS 21 with taper threads as appropriate to their location and service.

Copper alloy check valves shall comply with BS 5154 and shall be suitable for horizontal or vertical pipe line mountings as appropriate. They shall be provided with flanged or screwed ends as described above to suit their location and service.

Cast iron check valves shall comply with BS 5153, shall generally be in accordance with (4) above and shall be provided with flanged ends to BS 4504.

2701.17 Double Regulating Valves and Orifice Valves

These valves shall be of the "Y" type or oblique pattern. Valves shall be bronze/gunmetal or cast iron. End shall be flanged to BS 4504 or screwed to BS 21 as appropriate.

Each valve shall have a double regulating feature with a graduated indicator.

Each valve shall be fitted with a pressure test point on either side of the valve seat.

2701.18 **Butterfly Valves**

Butterfly valves shall comply with the requirements of BS 5155 and shall be constructed for insertion between flanges.

The valves shall be provided with a rubber, PVC or PTFE moulded liner depending on the service and shall have a lever operated, moulded disc mounted in self-lubricating bearings.

Where the valves are subject to unauthorised interference the lever shall be either removable or lockable.

2701.19 **Strainers**

Pipeline strainers shall be of the angle pattern containing a mesh cage, having a free area of not less than the pipe bore, retained in position by a locking ring independent of the access plug.

Flow through the strainers shall be internal to external to provide for flushing without removing the cage.

2701.20 **Cleaning and Flushing Pipework**

All pipes, valves and fittings shall be thoroughly cleaned of rust, scale and other foreign matter before erection. All pipework systems shall be washed through and thoroughly cleansed as each section is completed. The operation shall be repeated using the water treatment specialist recommended cleansing agent as each system is completed and before being put into service. This shall be performed in the presence of the Supervisors Representative's representative and to his satisfaction.

After washing out and testing and before connecting to the incoming mains, all cold water mains services, tank services, hose reel services, etc., shall be cleansed by chlorination in accordance with BS 6700: 1987.

All closed circuit systems shall be run for sufficient time to allow aerobic sludge to form and collect at the blow down points. The system shall be shut down and the blow down points cleaned out. This process shall be repeated until all sludge is cleared and suitable water treatment added to the systems.

Any particular cleaning or flushing process other than described above will be referred to in the Particular Specification.

2701.21 **Testing Pipework**

Upon completion of a section, or sections, of the pipework installation and/or as may be directed by the Supervisors Representative, the Contractor shall, without extra charge carry out a hydraulic test. The test pressure shall normally be twice the working pressure and shall be maintained for the duration of two hours or such period as is required to permit full inspection of the installation during which time the pressure gauge shall not vary. (See elsewhere in this Specification for additional or alternative requirements).

When the pipework installation is completed, the contractor shall, without extra charge, carry out a further hydraulic test normally at 1½ times the working pressure for a period of one hour, or such other time as shall be deemed necessary to enable complete and full inspection of the works.

The above tests shall be witnessed by the Supervisors Representative, and any defects shall immediately be made good. Test certificates shall be issued to the Supervisor's Representative in triplicate.

2701.22 De-zincification

All valves, stop cocks and fittings installed in copper pipe shall have all parts that are in contact with the water, constructed of high quality leaded gunmetal or other non-de-zincifiable alloy Electrolytic Action.

All necessary precautions shall be included to prevent electrolytic action between copper pipework and steel tanks and equipment, etc., i.e. cooling towers. Where applicable insulating joint rings, jointing material etc., shall be used.

2702 Thermal and Acoustic Insulation

This section of the Specification sets out the standards, methods and processes to be adopted for the supply and installation of thermal and acoustic insulation and shall be read in conjunction with each and every other relevant section of this Specification.

Special requirements particular to any service will be indicated in the relevant section of the Specification or on the drawings and in the event of any conflicting requirement the subject shall be referred to the Supervisor's Representative for clarification.

Attention is drawn to health hazards to personnel handling insulated materials, including asbestos and some plastic materials, cleaners, solvents, etc.

Precautions set out by the Asbestos Research Council and the Asbestos Industry Regulations shall be strictly observed at all times.

Similarly, adequate precautions shall be taken against any hazard to health involved in the use of any solvent cleaner or material in connection with insulation and the manufacturer of any such materials must be consulted in this connection.

Unless otherwise specified, thermal insulation work, materials, methods and processes shall be in accordance with British Standard Code of Practices.

Regardless of the finishing material the vapour sealing on all cold services shall be fully maintained.

The Contractor shall obtain competitive quotations for the thermal insulation which shall comply with this section and other relevant clauses.

2702.1 Insulation Materials

All insulation materials shall be non-corrosive to ferrous and non-ferrous metals. They shall be fire resistant and non-combustible, water repellent, sterile, free from odour and offer no sustenance to vermin. Insulation materials and also methods and materials used for application of insulation shall be to the approval of the Local Authority and to the Fire Officer, the materials shall be classified as non-combustible when tested in accordance with BS 476 part 4 and shall have a Class 0 surface spread of flame as defined in the UK Building Regulations, Approved Document B, Appendix A, Paragraph A12 (b).

Insulation materials shall have a Euroclass of either A1, A2 or B. Should have a FIGRA RCT of less than 1.0 and should not have a potential to flashover.

Insulation material should have the relevant certification undertaken in line with the required EU method, indicating that fibres are not classified under the CHIP 98 Regulations and EU Directive 97/69/EC

2702.2 Rigid Phenolic Foam

Phenolic pipe or duct insulation un-faced or faced shall achieve a minimum Class 0 rating to the Building regulations. The insulant shall be free from CFC's and HCFC's during manufacture and/pr. insulation. Refer to CIBSE Guidance Note CN1.2000.

Phenolic foam pipe insulation (except in support areas) shall have a nominal density of 35kg/m³ and a thermal conductivity value not exceeding 0.018 W/mK at mean temperature 10°C.

Insulation for circular/flat oval ductwork shall be as for rectangular ductwork, except that the laminate will be back slotted to accommodate the curvature of the surface to be insulated.

2702.3 Mineral Wool

Mineral wool pipe insulation (except in support areas) shall have a nominal density not less than 120kg/m³, with a factory applied facing which is a laminate of close mesh reinforcement between two layers of foil, including integral lap for fixing and have a thermal conductivity of 0.037 W/mK at a mean temperature of 50°C. The whole to comply with BS 5422 (Table1) and BS 5970 water vapour permeance and Building Regulations Class 0 definition. Fixing to be in accordance with manufacturer's instructions, by peeling protective tape from self-adhesive lap and pressing lap smoothly over joint. Where adjacent sections abut, approved 75mm wide aluminium tape to be used to maintain integrity of the vapour barrier.

Mineral wool duct insulation shall have a nominal density of 45 kg/m³, having a factory applied reinforced aluminium foil facing, and have a thermal conductivity of 0.040 W/mK at a mean temperature of 50°C. Complying with BS 5970 water vapour permeance and Building Regulations class 0 definition, Joints to be securely taped with 75mm minimum wide soft aluminium self-adhesive tape. The insulation on the underside of the ducting to

be additionally secured by means of suitable insulation hangers, at recommended centres of 300 mm. the whole to be further supported by means of 19-22 swg x 50 mm mesh galvanised wire netting. Where a vapour barrier is required, care to be taken when applying wire mesh support to avoid damaging aluminium foil. Where support pins/hangers puncture the foil, they should be sealed using aluminium foil tape to maintain the vapour barrier. Where a vapour barrier is required, provision should be made to exposed slab edges to carry the aluminium foil to the adjoining slab.

For high velocity and circular ductwork, insulation to have nominal density of 45 kg/m³, having a factory applied reinforced aluminium foil facing, and to have a thermal conductivity of 0.043 W/mK at a mean temperature of 50°.

2702.4 Insulation Application

Application shall be carried out by skilled ladders under close supervision by the insulation specialist firm. All materials must be used in accordance with the manufacturer's/suppliers recommendations as to sequence application, method of installation, etc.

Specified thicknesses shall be maintained and a neat and attractive finish shall be provided to suit the location.

Before application of insulation all mild steel surfaces are to be thoroughly cleaned and treated with a corrosion inhibiting paint.

The insulation material shall be applied in correct sequence and to the thicknesses specified with adequate time for drying out where appropriate.

All necessary supporting and reinforcing of the insulation and finishes shall be incorporated.

Surfacing, finishing or similar shall not be taken into account when determining the thickness of insulation.

All finishing coats shall be properly finished smooth neat and straight.

Painting of insulation where required shall be carried out by the Main Contractor unless otherwise specified elsewhere.

All external insulation shall be fully weatherproofed. The insulation shall be of the same specification thickness and finish as the relevant service, wrapped with two-ply roofing felt with overlaps of not less than 50mm and arranged so as to shed water. The laps shall be sealed with a suitable bitumastic adhesive. Felt to be wrapped with 25mm x 0.9mm galvanised wire mesh drawn tightly with 0.9mm galvanised lacing wire and finished with two coats of black bituminous varnish paint.

All fibrous particles remaining after cutting fabrication shall be removed by suction cleaning. The whole of the insulation covering shall be left clean on completion of the work.

2702.5 Thermal Insulation for Pipework

Thermal insulation applied to pipework shall be fixed in close contact with the pipe. Two or more pipes shall not be lagged together without specific instructions in writing from the Supervisor's Representative.

Thicknesses of insulation shall be in accordance with the tables at the end of this section.

Insulation shall be notched to fit around pipe hangers.

All external pipework shall be electric trace heated and the insulation sized to cover the pipe and heating tape.

All ends of insulation not butted to each other shall have aluminium end capping.

The insulation on chilled water and cold water services shall be covered with a continuous vapour barrier.

External runs of heating and chilled water pipework and in the roof plant rooms shall be electrically traced to give 10 watts per meter run. The trace heating shall be thermostatically controlled to maintain the water temperature between 2°C and 5°C. The electric wiring serving the trace heating cables shall be fully protected and run in adequately supported conduit. The point at which connections to the heating tape are made shall be enclosed in weatherproof cases strapped to the pipe.

2702.6 Colour Code

All installations shall be colour coded and be complete with service labels and direction of flow arrows, to conform to BS 1710 and RAL classification with the instructions of the Supervisor's Representative.

2702.7 Acoustic Insulation

Acoustic insulation shall be provided where indicated on the drawings.

2702.8 Insulation Thicknesses

Thicknesses of insulation for pipework and flat surfaces shall (together with approved coverings) be as specified and are the minimum for the particular service and conductivity. For intermediate conductivities, the minimum thickness is to be determined by interpolation

Table 11: Insulation Thickness and Finish/Coverings for Specific Services

Service	Location	Insulation Material	Thickness mm (Min.)	Finish/Coverings
Heat Calorifiers	Any area	RF/GF/CS	100	Aluminium Sheet
Low pressure HWS Calorifiers	Any area	RF/GF/CS PF	75 45	Aluminium Sheet Aluminium Sheet
HWS Cylinders	e.g. Residential	Domestic Sectional to BS 5615	75	
Condensate Receivers	Any area	RF/GF/CS	100	Aluminium Sheet
Chilled Water Tanks	Any area	PF	40	Aluminium Sheet and Vapour Barrier
Hotwells	Plant Plant	RF/GF/CS	100	Reinforced Aluminium Kraft Foil
F & E Cisterns	Any area Any area	RF/GF/PF PF	40 25	Reinforced Aluminium Kraft Foil
Cold Water Storage Cisterns	Any internal area Outdoor: to be detailed elsewhere	PF	40	Reinforced Aluminium Kraft Foil
Valves & Flanges	Any area	RF/GF/PF CS	As for Pipework	
Expansion Bellows	Any area	RF/GF/PF CS	As for Pipework	
Ducting Flanges	Any area	RF/GF/PF	As for Pipework	
Boiler Flue Ducting Smoke Boxes Grit Arresters ID Fans	Plant	CS	100	Aluminium Sheet Aluminium Sheet
	Plant	RF/GF	100 plus 25mm air gap	

CS – Calcium Silicate RF – Rock Fibre
 GF – Glass Fibre PF – Phenolic Foam (CFC Free)
 + Phenolic Foam not to be used on steam services

Table 12: Combination of Insulation and Covering for Various Services

SERVICES	LOCATIONS	THERMAL INSULATION						COVERING				
		01	02	03	04	05	06	A	B	C	D	
STEAM CONDENSATE HTHW AND MTHW	Plantrooms	X		X				X	X			
	Ducts	X						X	X			
	Cavities	X		X				X				
	Occupied	X						X	X			
	Outdoor	X		X				X	X	X	X	
LTHW DHW	Plantrooms	X		X		X	X	X	X			
	Ducts	X				X	X	X	X			
	Cavities	X		X		X	X	X				
	Occupied	X				X	X	X	X			
	Outdoor	X		X		X	X		X			
CWS AND CHILLED WATER	Plantrooms					X	X	X	X			
	Ducts					X	X	X	X			
	Cavities					X	X	X				
	Occupied					X	X	X	X			
	Outdoor					X	X	X	X			
AIR CONDITIONING SUPPLY AND PLENUM DUCTS	Plantrooms	X				X	X	X	X			
	Ducts	X				X	X	X	X			
	Cavities	X				X	X	X				
	Occupied	X				X	X	X	X			
	Outdoor	X				X	X	X	X	X		
FLUE GAS DUCTING See for fixing	Plantrooms	X	X		X				X			
	Ducts	X							X			
	Cavities	X	X						X			
	Occupied	X							X			
	Outdoor	X	X		X				X			
HEATING OIL PIPE LINES	Plantrooms	X		X					X			
	Ducts	X							X			
	Cavities	X		X								
	Occupied	X							X			
	Outdoor	X		X					X		X	

MINIMUM THICKNESS (MM) OF INSULATION FOR STEEL PIPEWORK WITH HOT FACE TEMPERATURE OF 175°C (i.e. On steam or HTHW services)

Internal Diameter Of Steel Pipe (mm)	Thermal Conductivity of the Insulation Materials (W/mK)			
	0.03	0.04	0.05	0.06
	Insulation Thickness (mm)			
15	25	40	70	110
20	25	50	75	110
25	30	50	80	120
32	30	50	80	130
40	35	60	90	130
50	40	60	90	130
65	40	70	100	140
80	40	70	100	140
90	50	70	100	140
100	50	75	110	140
125	50	75	110	150
150	50	80	110	150
200	60	80	120	150
250	60	90	120	160
300	70	90	120	160
350	70	100	130	160
400	75	100	130	170

MINIMUM THICKNESS (MM) OF INSULATION FOR STEEL PIPEWORK WITH
HOT FACE TEMPERATURE OF 80°C (i.e. On steam or LTHW services)

Internal Diameter Of Steel Pipe (mm)	Thermal Conductivity of the Insulation Materials (W/mK)				
	0.02	0.03	0.04	0.05	0.06
	Insulation Thickness (mm)				
15	15	20	35	50	80
20	15	25	35	60	90
25	15	25	40	60	90
32	15	25	40	70	90
40	15	30	40	70	90
50	15	30	50	70	90
65	20	30	50	70	90
80	20	35	50	70	90
90	20	35	50	75	90
100	20	35	50	75	90
125	25	35	60	75	100
150	25	40	60	75	100
200	25	40	60	75	100
250	25	40	60	75	100
300	25	40	60	75	100
350	25	40	60	75	100
400	25	40	60	75	100

MINIMUM THICKNESS (MM) OF INSULATION FOR STEEL PIPEWORK WITH HOT FACE TEMPERATURE OF 100°C (i.e. MTHW services)

Internal Diameter Of Steel Pipe (mm)	Thermal Conductivity of the Insulation Materials (W/mK)				
	0.02	0.03	0.04	0.05	0.06
	Insulation Thickness (mm)				
15	15	20	35	50	80
20	15	20	40	60	90
25	15	25	40	60	90
32	15	30	40	70	100
40	15	30	50	70	100
50	15	30	50	70	100
65	20	30	50	75	100
80	20	35	50	75	100
90	20	35	50	75	100
100	20	40	60	75	100
125	25	40	60	80	110
150	25	40	60	80	110
200	30	40	60	90	110
250	30	50	70	90	110
300	30	50	70	90	10
350	30	50	75	90	120
400	30	50	75	100	120

MINIMUM THICKNESS (mm) OF INSULATION FOR COPPER PIPEWORK WITH HOT FACE TEMPERATURE OF 60°C (i.e. DHW services)

External Diameter Of Copper Pipe (mm)	Thermal Conductivity of the Insulation Materials (W/mK)				
	0.02	0.03	0.04	0.05	0.06
	Insulation Thickness (mm)				
22	15	15	30	40	75
28	15	20	30	50	75
35	15	20	35	50	80
42	15	25	35	50	80
54	15	25	40	60	80
76.1	15	30	40	60	90
108	20	35	50	70	90

MINIMUM THICKNESS (mm) OF INSULATION REQUIRED TO PREVENT CONDENSATION ON STEEL PIPEWORK WITH A SURFACE TEMPERATURE OF 10°C (i.e. on steam or MCW services)

Internal Diameter Of Steel Pipe (mm)	Thermal Conductivity of the Insulation Materials (W/mK)			
	0.02	0.03	0.04	0.05
	Insulation Thickness (mm)			
15	10	15	19	20
20	13	15	19	25
25	13	19	20	25
32	13	19	25	30
40	13	19	25	30
50	13	19	25	30
65	13	19	25	30
80	15	19	25	35
90	15	20	30	35
100	15	20	30	35

MINIMUM THICKNESS (mm) OF INSULATION REQUIRED TO PREVENT CONDENSATION ON COPPER PIPEWORK WITH A SURFACE TEMPERATURE OF 10°C (i.e. MCW services)

External Diameter Of Copper Pipe (mm)	Thermal Conductivity of the Insulation Materials (W/mK)			
	0.02	0.03	0.04	0.05
	Insulation Thickness (mm)			
22	10	15	19	20
28	13	19	20	25
35	13	19	20	25
42	13	19	25	25
54	13	19	25	30
76.1	15	20	30	35
108	15	20	30	35

MINIMUM THICKNESS (mm) OF INSULATION REQUIRED TO PREVENT CONDENSATION ON STEEL PIPEWORK WITH A SURFACE TEMPERATURE OF 5°C (i.e. Chilled water services)

Internal Diameter Of Steel Pipe (mm)	Thermal Conductivity of the Insulation Materials (W/mK)			
	0.02	0.03	0.04	0.05
	Insulation Thickness (mm)			
15	15	19	25	30
20	15	20	25	30
25	15	25	30	35
32	15	25	30	35
40	19	25	30	40
50	19	25	35	40
65	19	30	35	50
80	19	30	35	50
90	20	30	40	50
100	20	30	40	50

2703 Low Temperature Hot Water (LTHW) Heating Thermal Insulation

2703.1 Pipework

Thickness of insulation as described in this specification.

Rigid Phenolic foam (minimum density 35 kg/m³) or Mineral wool (minimum density 120 kg/m³) preformed rigid sections with factory applied facing which is a laminate of close mesh reinforced between two layers of foil including integral wrap.

Fixing to be in accordance with manufacturer's instructions, by peeling protective tape from self-adhesive lap and pressing lap smoothly over joint. Where adjacent sections abut, approved 75mm wide aluminium tape to be used to seal joints.

2703.2 Bends and Tees

Bends shall be covered with plain sections of the same specification and thickness as the pipework, mitred to fit and held in place with adhesive or masking tape. The bend shall then be wrapped with 50mm self-adhesive canvas tape for a distance of 150mm from the tee, with a minimum overlap of 25% of the tape width.

Tees shall be made from rigid sections of the same specification and thickness as the pipework, mitred together, the mating cut surfaces being liberally coated with Atlas Foster Safetee Ductfas 81-99. The joint shall be wrapped with 50mm wide self-adhesive canvas tape for a distance of 150mm from the tee, with a minimum overlap of 25% of the tape width.

2703.3 Valves

All isolating, regulating and control valves 25mm bore and over to be fitted with aluminium removable boxes, complete with quick release fasteners, and packed tight with insulation of the same specification and thickness as pipework. These boxes shall be so designed as to leave the valve gland visible.

All isolating, regulating and control valves 20mm bore and below to be insulated with oversize sections of the same specification and thickness as the pipework, carefully cut, mitred where necessary and taped in position. The oversize sections shall overlap the pipework insulation by 100mm each side of the valve. The finish shall be as specified for pipework. Valve glands must remain visible.

Concealed in False Ceilings, Vertical and Horizontal Duct, Casing, Shafts, Voids, Floor and Walls

Regulating and control valves to be insulated as specified in accordance with Section 3 of this Specification.

2703.4 Flanges and Unions

All flanges on pipework 65mm and over to be insulated with aluminium removable boxes complete with quick release fasteners and packed tight with insulation of the same specification and thickness as pipework.

All flanges on pipework 50mm and below and all unions to be insulated in oversize sections of the same specification and thickness as the pipework, carefully cut, mitred where necessary and taped in position. The oversize sections shall overlap the pipework insulation by 100mm each side of the flange or union. The finish shall be as specified for pipework.

Concealed in False Ceilings, Vertical and Horizontal Ducts

All flanges and unions to be insulated as specified in Clause 3.3.2.4 (1(b)) above.

2703.5 Expansion Bellows

All bellows 80mm nominal bore and over to be fitted with aluminium removable boxes, complete with quick release fasteners packed tight with insulation of the same specification and thickness as the pipework. The length of the box and the arrangement of the packing shall be so that the movement of the bellows is not restricted in any way.

All bellows 65mm nominal bore and below with the exception of those fitted in the continuous convector casings, to be insulated with oversize sections of the same Specification and thickness as the pipework. The sections shall be applied over the flanges of the bellows, clear of the bolts and be secured by self-adhesive tape. The finish shall be as specified for pipework.

2703.6 Calorifiers

The Calorifiers shall be insulated with plain rigid bevelled lags of mineral wool or glass fibre 50mm thick, minimum density 80 kg/m³ to suit the calorifier temperature. The bevelled lags shall be fixed to the calorifier using Atlas Foster Safetee Ductfas adhesive 81-99 and further secured by aluminium bands.

The insulation shall then be covered in sheet aluminium, 1mm thick shaped and fitted to give a neat appearance each joint to be lapped by at least 50mm and secured with rivets or self-tapping screws at intervals not exceeding 50mm. All fittings to be left exposed and neatly flanged in.

End chests on calorifiers to have purpose made flexible mattress covers.

2703.7 External Pipework

External pipework and fittings shall be insulated as described above and have a weatherproof finish as specified in this Specification.

2704 Domestic Hot Water Service Thermal Insulation

The thickness of insulation as described in this Specification.

All pipework within the thickness of the partition walls is not to be insulated.

All pipework exposed within the occupied space serving sinks, etc., is not to be insulated.

2704.1 Pipework, Pipework Fittings, Valves, Flanges and Unions

Insulation to be as specified for LTHW Heating Thermal Insulation.

2705 Cold Water Services Thermal Insulation

Thickness of insulation as described in this Specification.

This Specification includes cold water down service, mains water service, and de-ionised water.

All pipework within the thickness of partition walls is not to be insulated.

All pipework exposed within the occupied space serving the sinks, etc., is not to be insulated.

2705.1 Pipework

Rigid Phenolic foam (minimum density 35 kg/m³) or Mineral wool (minimum density 80kg/m³) preformed rigid sections with factory applied 22 micron thick reinforced aluminium foil facing fully bonded to the insulation or class '0' nitrile rubber flexible sections. Insulation to be a close fit to the pipe, all joints in the facing to be sealed with 50mm wide self-adhesive foil tape.

The insulation is to be continuous through all pipe support clips.

In viewable areas within buildings or areas subject to mechanical damage, the foil faced insulation shall be coated with a brush application in Childers CP50 coating or Atlas Foster Sealfas 30-36, 170g (6oz) shall be smoothed into the wet film and lapped, followed by a second coat of the same sealant.

2705.2 Pipework Fittings

Bends shall be covered with plain sections of the same specification and thickness as the pipework, mitred to fit and held in place with adhesive or masking tape. The bend shall then be wrapped with 50mm wide aluminium faced self-adhesive tape with a minimum overlap of 25% of the tape width. Finally, the bend shall be wrapped with 50mm wide self-adhesive canvas type overlapped as above.

Bends within plant room to be finished with Childers CP50 coating or Atlas Foster coating 30-36 brushed on.

Tees shall be covered with rigid sections of the same specification and thickness as the pipework, mitred together. The mating out surface being liberally coated with Atlas Foster Safatee Ductfas 81-99. The joint shall then be wrapped with 50mm wide aluminium faced self-adhesive tape for a distance of 150mm from the tee, with a minimum overlap of 25% of the tape width. Finally, the completely insulated tee shall be wrapped with 50mm wide self-adhesive canvas tape overlapped as above.

Tees within plant room to be finished with a coat of Atlas Foster Coating 30-36 brushed on.

2705.3 Valves

Insulation to be as specified for LTHW Heating, Thermal Insulation, Clause 3.3.2.3 "Valves," except that the valves shall be first coated with 25mm thickness of "Densofil" and covered with "Denysl F R" tape.

2705.4 Flanges and Unions

Insulation to be as specified for LTHW Heating Thermal Insulation, Clause 3.3.4.2.4 "Flanges and Unions" except that flanges and unions shall first be coated with 25mm thickness of "Densofil" and covered with "Denysl F R" tape.

All tanks storing cold water are to be painted with two coats of an approved anti-corrosion paint after erection of the tank.

2706 Chilled Water Thermal Insulation

2706.1 Insulation Thickness

Thickness of insulation as below:

Nominal bore of Pipe (mm)	Radial thickness of Insulation (mm)
50 and below	38
65 and above	50

2706.2 Pipework

Insulation as specified for Cold Water Services Thermal Insulation Clause 3.3.4.2.

To maintain the vapour barrier on pipework a high density Phenolic foam insert, with metal spreader plate, thickness as insulation shall be placed between the pipe and the support. This should be approximately 100mm wide and placed on centrally to the support. The vapour seal to this must be strictly maintained. The insulation shall be fixed hard up against the H.D. foam.

The joints between pipe support inserts and insulation are to be covered and sealed with self-adhesive faced tape 100mm wide.

2706.3 Pipework Fittings, Valves, Flanges and Unions

Insulation as specified for Cold Water Services Thermal Insulation in this Specification

2706.4 Circulating Pumps

Chilled water circulating pumps shall not be insulated but it will be necessary to fully protect them against the effects of condensation by two coats of approved anti-condensation paint.

2706.5 External Pipework

External pipework and fittings shall be insulated as described and have a weatherproof finish as described in this Specification.

2707 High Pressure Hot Water Thermal Insulation

2707.1 Pipework

Thickness of insulation as described in this Specification.

Pipework shall be insulated as described in this Specification, but with the exclusion of Phenolic pipe.

2707.2 Pipework Fittings, Valves, Flanges and Unions

A 6mm circumferential gap shall be arranged in the HPHW pipework preformed insulation at least every 3.6m of straight run. This gap shall be provided also at the same position in any protective covering on the insulation.

The gaps shall be covered with 100mm wide bands of woven glass cloth secured by 1.6mm U (16 SWG) galvanised wire ties

2708 Steam and Condense Thermal Insulation

2708.1 Pipework

Thickness of insulation as described in this Specification.

Pipework with the exception of the lengths of pipework which are shown on the drawings as cooling legs shall be insulated as described in this Specification for LTHW heating, but with the exclusion of Phenolic foam.

2708.2 Valves

Valves, with the exception of those valves incorporated in trap sets and drain sets shall be insulated as described in this Specification for LTHW Heating (exclude Phenolic foam.)

Steam traps shall not be insulated.

2708.3 Flanges and Unions

Flanges and unions, with the exception of those unions incorporated in trap sets and drain sets shall be insulated as described in this Specification for LTHW Heating (exclude Phenolic foam.)

2708.4 Expansion and Contraction Gaps

Expansion and contraction gaps shall be provided as described in this Specification for HPHW pipework.

2708.5 Boiler Blowdown Pipe

The blowdown pipework shall be insulated and protected as specified for the steam pipework, on the sections of the pipe which are above floor level. The vent pipe from the blowdown tank shall be similarly insulated.

2708.6 Steam Boiler Flue

The steam boiler flue shall be insulated with rigid slabs or bevelled lags or mineral wool 100mm thick, 160 kg/m³ density to be suitable for a temperature of 300°C.

The slabs shall be applied directly to the flue and be secured in position by means of aluminium bands 50mm minimum width x 1.62mm minimum thickness at not more than

600mm centres. Any corners of the insulation slabs shall be protected by full length angle section of the same material as the banding.

The slabs shall be finished with aluminium sheeting 0.91mm thick. The sheeting to be bent round the insulation with 50mm longitudinal and end laps, secured by cadmium plated self-taping screws of suitable size, spaced at 100mm centres, longitudinally.

2708.7 Hotwell Tank

The steel hotwell tank shall be insulated on the sides, top and underneath with plain rigid slabs of mineral wool 40mm thick, minimum density 80 kg/m³ to suit a hotwell temperature of 70°C.

The slabs shall be stuck to the tank using Childers KP31 G.P. Adhesive or Atlas Foster Safatee Ductfas Adhesive 81099 and further secured with aluminium bands which will also form the foundation for the finishing sheeting. The insulation shall then be covered in sheet aluminium, 1mm thick, shaped and fitted to give a neat appearance, each joint to be lapped, to prevent entry of water, by at least 50mm and secured with rivets or self-taping screws at intervals not exceeding 100mm. Overlaps to be sealed with Atlas Foster Metal Sealant 96-64.

Where manholes occur the covers shall be insulated also, such that the cover can be removed when required.

2709 Ductwork Thermal Insulation

2709.1 Insulation Application

Externally applied insulation shall be applied in close contact with the ductwork, but attachment shall not rely entirely on adhesives.

Insulation shall be cut around test holes, access doors, damper quadrants, etc., where the vapour seal is cut the vapour sealing finish should be continued on and sealed with an adhesive to the ductwork. Access panels of above 0.06m² shall be provided with separate insulating pads. All unavoidable penetrations of the vapour barrier and all terminations of insulation to be sealed with Childers Sealant CP76 or Foamseal 30-45.

All supports to be constructed as to allow sufficient space for the insulation and the application of vapour sealing. Vapour sealing is to be carried continuously across all joints, angles, etc. All supports for rectangular ductwork insulated with vapour sealed finish are to be constructed with a hard wood insulator attached to the top surface of the bearer. This insulator is to be approximately the same thickness as the insulation, its length is to be the width of the duct; and is to be a minimum of 25mm wider on either side of the support bearer. The insulation is to be carefully butt jointed to this timber insulator with all butt joints being sealed with Childers Sealant CP76 or Foamseal 30-45 and the vapour seal

being lapped and sealed with Childers CP50 or Sealfas 30-36 to cover both the bottom and exposed ends of the hardwood.

Circulating ductwork with vapour seal finish shall have a purpose made H.D. foam collar inside of all of the supporting hanger, of approximately the same thickness as the insulation and the minimum of 25mm wider either side of the support. Sealing and finish shall be as for rectangular ductwork item (3) above.

Vertical supports for both circular and rectangular ductwork finished with insulation and vapour seal shall have a hardwood insert between any metal supports to avoid a direct metal to metal contact. The insulation shall be butted to the angle and sealed with Childers Sealant CP76 or Foamseal 30-45 and the vapour seal finish carried out, then lapped and sealed to the metal/timber support.

The insulation shall be stopped approximately 25mm either side of fire dampers with the exposed end of insulation to be sealed with Childers Sealant CP76 or Foamseal 30-45, the vapour seal covering then to be taken over the end and sealed to the ductwork.

All the humidifiers are to be insulated as per rectangular supply ductwork in plant room areas. With the addition of all exposed ends of insulation to be sealed with Foamseal 30-45 before the final application of canvas finish. All observation panels must be left clear.

2710 Ductwork in Plant rooms and Exposed Plant Areas

All rectangular supply ductwork in the plant areas to be insulated with 30mm thick aluminium foil faced Phenolic foam laminate (40kg/m³ density) or 50mm thick aluminium foil faced mineral wool slab (80 kg/m³) The insulation shall be cut to fit so that the top and bottom pieces overlap the side slabs and all joints shall be tightly butted. Insulation to be bonded to all faces with Childers KP31 Adhesive or Ductfas Adhesive 81.99. Insulation on inverted surfaces or on sides of ducts exceeding 600mm depth shall be additionally mechanically supported. All butt joints in the foil facing to be sealed with 100mm wide self-adhesive aluminium foil tape.

All circular or flat oval supply ductwork in the plant areas to be insulated 30mm thick aluminium foil faced Phenolic foam laminate (40kg/m³ density – back slotted) or 50mm thick aluminium foil faced mineral wool slab (80kg/m³ density – lamella) The insulation to be fully bonded to the ducting with Childers KP31 G.P. Adhesive or Foster Ductfas Adhesive 81-22. All joints in the facing or protrusions through the facing to be sealed with 100mm wide self-adhesive aluminium foil tape. Insulation to be additionally secured with 12mm wide aluminium or plastic strapping with attaching seals applied as circumferential bands at 300mm centres.

Final finish shall be as previously described in this Specification above.

All external ductwork shall be insulated in accordance with Sections of this Specification and the canvas finish shall be omitted and replaced by the following:

Surface of foil facing to receive a trowel hand application of a polymeric emulsion mastic such as Childers CP55.

Whilst wet, a reinforcing No.10 glass cloth membrane to be worked into the mastic and smoothed to remove air pockets and wrinkles. Allow to dry.

Surface to receive a second trowel/hand application of the same mastic, but in a different colour to ensure complete specification.

N.B. Insulation and weatherproofing to top sides of external rectangular ducting shall be laid to falls to avoid “ponding.”

2711 Ductwork in Ceiling Voids/Ceiling Zone and Vertical Ducts

All rectangular, circular and flat oval ducting shall be generally insulated in accordance with the sections of this Specification, except that the insulation thicknesses shall be reduced to 25mm for Phenolic foam and 40mm for mineral wool. In addition, the canvas and coating shall be omitted so that the foil facing will constitute the final finish.

2712 Heater and Cooler Batteries

All external faces of ventilation/air conditioning heater and cooler batteries shall be insulated with 50mm thick aluminium faced flexible insulation held in place by Childers KP31 G.P. Adhesive or Ductfas adhesive 81-22. These shall be finished in 20 gauge aluminium sheeting all overlapped and secured by pop rivets and firmly attached.

2713 Ductwork Acoustic Insulation Application

Acoustic insulation shall be provided where indicated on the drawings.

The ductwork shall be insulated as specified for ductwork within plant room. The insulation to then be wrapped with 25mm x 0.9mm galvanised wire mesh drawn tightly with 0.9mm galvanised lacing wire and finished with 25 minimum Keenes cement trowelled to a smooth and even finish. A second layer of 25mm x 0.9mm galvanised wire mesh is to be wrapped around the ductwork when half the thickness of the Keenes cement has been applied.

2714 Insulated Pipe Supports

At the support positions, the insulation and vapour seal shall be continuous and shall not be punctured by support. The insulation at the support shall be a Phenolic foam material of sufficient density to withstand the bearing loads transmitted from the pipe to the support, and shall extend on either side of the support. The higher density Phenolic foam shall be capable of working within the range -180°C to +120°C.

The load bearing insulation at the support shall be capable of withstanding the maximum loads generally by a pipe supported at the centres shown in table

Variations: Centres greater than those shown in Table 13 shall be referred to the manufacturer to establish the length and density of the insulated support block.

Table 13: Variations Guideline

O.D of pipe (mm)	21	27	34	42	48	60	76	89	114	140	168	220	273	324	356	406	457
Maximum support of Centres (Metres) of Kooltherm K-Blocks			2		4					6				4			

The insulation at the supports shall be a K-Block as supplied by Kooltherm Insulation products Limited or equal and approved. K-Blocks shall be faced with a factory applied class “0” reinforced aluminium foil, and fitted with a bonded spreader plate in the bottom section for all pipework sizes 48mm nominal bore and above. The vapour seal shall be completed by the use of an overlap and factory applied double sided adhesive tape.

At all support positions, other than those where the insulated pipe support block is surrounded by a clip or saddle in intermittent contact with the block, a block designed to accept the loads generated by the pipe shall be presented to the Supervisor’s Representative for approval e.g. of the type Kooltherm Insulation Productions K-Block and Kooltherm sketch 106/2a for use with Roller or Flat beam support.

In all cases where Roller supports are used, the length of the insulation and the wearing plate where fitted shall extend beyond the limits of the pipe movement.

2715 Electrical Requirements for Mechanical

2715.1 Motor Control boards

Motor control boards shall be suitable for operation on a 3 phase, 4 wire, 50Hz, 415 volt supply and shall have a continuous rating of not less than the assigned full load rating of the equipment and shall have a short time rating suitable for the design fault level of the board.

The motor control boards shall comply with the requirements of BS 5486 Parts 1 and 2. Unless otherwise stated in this Specification, or on the drawings the boards shall be Form 2 classification.

The motor control board shall mean the composite panel as a whole which shall include all motor starters, switches, fuses, control and ancillary equipment all internal wiring and all other items as particularly specified.

The boards shall be of the indoor type, cubicle pattern, metal clad, flash front and back, comprising separate sections or compartment as required.

Board shall be arranged so that the installation, connections, etc., of the cables and all maintenance work and testing can be carried out safely and readily from the front of the board.

All boards shall be constructed of first grade sheet steel, adequately stiffened and braced to provide a rigid construction. The complete steelwork shall be cleaned and degreased, rust-proofed and unfinished with successive coats of primer, undercoat and stove enamel to give a high quality finish.

The degree of protection provided by the boards, shall be IP 41 according to BS 5420. Where possible, all components shall be constructed of non-hygroscopic and non-inflammable materials

Cover fixing screws shall have a bright zinc finish.

All motor control boards shall be arranged so that they can be readily extended at either end should this be required. Where the boards incorporate spare cubicles or compartments for the future possible installation of additional units they shall be arranged so that the installation and connection of the units can be easily carried out from the front of the board.

All units shall be fitted with labels engraved to show the circuit reference or designation. Labels shall also be fitted where necessary to indicate the function of any internally mounted item of equipment.

All items of equipment, instruments etc. mounted on the front face of the board, shall be of the flush mounting type and shall be arranged in a neat and symmetrical manner. Hinged doors, with locking devices, shall be provided.

Compartments housing items of heat emitting apparatus shall be adequately ventilated.

Where boards control items of plant served by different incoming supplies, they shall be divided into separate sections, electrically isolated from each other. The electrical supply to each board or electrically separate section, shall be controlled by a main switch mechanically coupled to prevent the door of the switch compartment being opened until the switch is in the "OFF" position.

All compartments used in the construction of motor control boards e.g. switches, fuse switches, contactors, etc., shall comply with the relevant specification clauses.

A continuous accessible earth bar, rigidly supported, shall be run along the length of the board. Branch connections from this earth bar shall be provided to the framework of the board, gland plates, and to all equipment forming part of the board. The earth bar shall be so placed that cable sheaths armouring can be readily connected to it. All earth connections shall be arranged so that disconnection of any one item shall not affect the earthing of any other item. The earth shall be connected via a protective conductor to the main earth plant.

Busbar and Connection

Busbars shall be HD HC copper, carried out suitable insulators, shielded and rigidly cleated and supported. Neutral bars and connections shall be of the same cross sectional area as the phase busbar and connections.

The busbars and also the busbar connections of each circuit shall be capable of carrying the required through fault current and shall be capable of carrying their normal rated current continuously without damage or overheating

All busbars and busbar connections shall comply with the requirements of BS 159.

Busbars, poles, interconnection cables, etc., shall be colour coded.

Contactor Starters

All motors shall be controlled by contactor starters which shall be of the following types:

Motor Rating	Starter Type	Protection
Up to 4kW	D.O.L	Adjustable thermal O/L with single phase prevention and under voltage protection
4+ to 18.5kW	Star/Delta	Adjustable thermal O/L with single phase prevention and under voltage protection
18.5+ to 55kW	Stator /Rotor	Auto Transfer or thermal O/L Adjustable with single phase prevention and under voltage protection
55+ kW and above	Stator /Rotor	Auto Transfer or P& B Golds thermal relay

All starters for motors of above 55kW shall be provided with combined thermal overload relays and “single phase preventer” arranged for current transformer operation complete with instantaneous relay trip circuit with hand reset buttons.

If, for any reason, the above methods of starting could cause undue "run-up" time for a particular motor, then alternative methods of starting may be employed. Similarly solid state equipment may be employed in place of the above methods of starting to limit starting/stopping currents. Full details of alternative proposals shall be provided at the time of tendering, together with starting/running currents.

The requirements for under voltage protection may be dispensed with if the starting of motor is controlled by automatic devices.

All starters shall be provided with integral manual "start" and "stop/reset" push buttons. The "stop/reset" button shall be coloured red and shall be shrouded to prevent inadvertent operation. The "start" push button shall be coloured green.

Indicating lamps as follows shall be fitted to all contactor starters. Lamps indicating a "running" condition shall be fitted with a white lens. A green lens shall be fitted to lamps indicating an "off" position. Trip lamps shall be fitted with red lens. If indication lamps are not mounted directly adjacent to the associated starter they shall be clearly labelled with the circuit designation. Lamps shall be of a type and rating to give maximum lamp life.

All starters shall be suitable for the particular duty and for the number of operations necessary and shall, unless otherwise specified, be of the automatic contactor type.

All contactor starter circuits shall be protected with HRC fuses.

Contactor starters shall be provided with the necessary number of auxiliary contacts required for the control, indication and alarm system circuits.

Provision shall be made in all contactor starts for the connection of remotely located emergency stop buttons. If emergency stop buttons are subsequently not required for any particularly item of plant, links shall be inserted across the associated terminals on the terminal board assembly.

All contactor coils shall be suitable for operation from a 240 volt single phase AC supply.

All contactor starters shall be provided with integral switches. They shall be arranged so that access to the current carrying parts of the switch cannot be obtained until the switch is in the "OFF" position. The switches shall have mechanical "ON/OFF" indication, with provision for padlocking in the "ON/OFF" positions. The switches shall also comply with one of the following requirements:

- They shall be of the off-load type mechanically and electrically interlocked with the contactor starter to prevent breaking of current by the isolator contacts or;
- They shall be of the load breaking (stalled motor) type.

Switches and Fuse Switches

Switches and fuse switches shall be of the on-load type complying with BS 5419.

All units shall have a quick make and break action and shall have a provision for padlocking in the "off" position." They shall be arranged so that access to the current carrying parts of the switch cannot be obtained until the switch is in the "off" position. Mechanical "on/off" indication shall be provided.

The moving contact assemblies on fuse switch units shall be arranged so that they can be completely withdrawn for maintenance purposes.

All fixed contacts shall be adequately shrouded.

The neutral connection in TP&N and SP&N units shall be in the form of a bolted link.

The busbars, poles, etc., shall be marked with the appropriate phase colours.

Fuses, Bridges and Bases

All fuses shall be HRC cartridge type, Class "P" and "Q1" to BS 88.

Fuse bridges and bases shall be of an approved non-hygroscopic insulant suitable for the reception of the HRC fuses.

Each HRC fuse shall be of the appropriate current rating and fusing factor in order that adequate protection and discrimination is provided in the circuit.

All fuses, wherever fitted, shall be of the same manufacture.

All separately mounted fuse shall have engraved labels giving current rating and category fitted adjacent to the fuse carrier.

Indicative Instruments and CT's

Each incoming supply cubicle/unit shall be provided with an ammeter and voltmeter. Ammeters shall be provided with a selector switch to enable the current loading of each phase and the neutral to be selected. A voltmeter selector switch shall also be provided to enable three voltage between phases and between each phase and neutral to be selected.

Indicating instruments/selector switches shall be provided on other circuits as particularly specified.

All indicating instruments shall be mounted at or near eye level.

Ammeters and voltmeter shall be the MI type, flush monitoring in square bezel cases with clearly marked scales of a suitable rating accuracy, complying with BS 89.

Instrument protective fuses shall be the HRC type to BS 88 with a class "Q" fusing factor.

Current transformers shall comply with BS 3938 and shall be of a suitable class, rating and accuracy.

Isolation of Supplies

Where a component is utilised to house relays and other control devices and no provision can be made for isolating the electrical supplies to these items, a warning label shall be fixed on the door of the compartment to indicate the maximum voltage present.

In the event of any control gear or ancillary apparatus contained within a cubicle being energised from a supply other than the motor circuit, the associated isolator shall incorporate auxiliary contacts such that when the contactor starter is isolator, the auxiliary supply to the control gear and ancillary apparatus is also isolated on all poles. Where this arrangement is not possible, due to the limitations on the number of auxiliary contacts that can be provided on the isolating switch or other technical reasons, a warning label shall indicate the maximum voltage present. As an added safety requirement, all live terminals shall be adequately shielded.

Controls and Control Systems

Hand/Off/Auto switches shall be provided for all items of plant provided by remote control devices. With the switch in the "auto" position, the motor shall operate automatically under the dictates of any control devices.

The operation of the switch in the "hand" position shall override any control devices those which are necessary for the safe operation of any plant.

The control positions shall be clearly indicated and each switch and push button shall be clearly labelled with the circuit designation.

Where necessary, the motors fed from each motor control board shall be sequence interlocked for starting in order to obviate the large starting current that would otherwise occur if the motors started simultaneously.

Interlocked, isolating switches shall be provided as necessary for each separate control system.

Duty selector switches shall be provided for the control of duplicate motors where one is selected for normal duty and other for standby. The standby motor shall be arranged for automatic starting in the event of a failure of the duty motor.

Fuses of suitable rating shall be installed to afford protection of the various sections of the control system.

Panel Wiring and Terminations

The control board shall be supplied complete with all necessary internal power and control wiring.

All incoming and outgoing cables and wiring shall be connected to terminal boards mounted at the top of the control boards.

Each wire shall be separately terminated with an approved type of crimped terminal to suit the terminal stud and wire used. A sufficient number of spare terminals shall be included on each terminal board. Terminal boards shall have separate terminals for incoming and outgoing wires. Not more than two wires shall be connected to any open terminal.

All internal panel wiring shall be run in a square and symmetrical manner and shall be securely fixed with PVC strips or other suitable means.

Wiring shall have identification ferrules fitted at each end, marked with circuit references and numbers so as to correspond with the appropriate terminal marking. The wiring and schematic diagrams of the internal panel wiring shall show the reference number allocated to each cable connection and terminal.

Sufficient terminals shall be provided on each control board to enable wiring from external equipment to be brought back to the control equipment. No form of "looping in" shall be allowed any external equipment.

Any terminals which are connected to another control board or remotely mounted device and which can be made live from this source shall be shrouded by means of transparent cover and clearly labelled in red "live terminals."

Marshalling compartments, housing terminal block assemblies, shall be provided as necessary for the control wiring systems.

Cable Terminations

All cables shall enter the top of the control board for connection to the main auxiliary terminal boards. The boards shall be arranged so that the installation and connection of the cables can be carried out from the front of the boards.

Detachable blank undrilled gland plates shall be fitted in all cubicles for terminating MICC and PVC SWS cables. The gland plates shall be located above the terminal boards. Where more than one gland is provided in a cubicle they shall be arranged so that they are not vertically in line with one another.

2715.2 Loose Mounted Equipment

Contactors Starters

All loose mounted contactor starters assemblies shall generally comply with the requirements detailed in the clause relating to contactor starters mounted in motor control boards.

They shall be mounted in self-contained wall or floor mounting metal enclosure which shall comply with the constructional requirements applicable to the motor control boards.

The complete contactor starter assemblies shall include the contactor starter and necessary protection "start" and "stop/reset" push buttons, indicating lamps, integral switches with necessary auxiliary contacts, hand/off/auto and duty selector switches where necessary, control equipment and wiring. HRC fuses are not required to be provided in these assemblies. Designation labels shall be fitted to each starter.

Undrilled cable gland plates shall be provided in each starter assemblies.

Emergency Stop buttons

Where motors are located more than 2 metres away or are not visible from the contactor starter position, emergency stop buttons shall be installed adjacent to the motor.

The stop buttons shall have mushroom type heads, coloured red, with auto lock buttons so that the buttons remains in the "off" position after it has been pressed. The whole assembly shall be mounted in an iron box or metal enclosure.

A label shall be fitted to each stop button to indicate its function.

2715.3 Motors

All motor shall be wound for the pressure of the supply stated.

In general, all motors above 746 watt shall be three phase unless otherwise stated.

Motors of 746 watt and below shall be either three phase or single phase, three phase being preferred.

Motor shall be rated for continuous duty but this shall not preclude the motors being suitable for intermittent usage. They shall comply with the requirements of BS 2048, BS 4999 and BS 5000 as appropriate and shall be of the sizes and types to drive the equipment under normal conditions of service without overloading.

Thermal insulation shall be Class "E", "B" or "F" as specified in BS 2757 to suit the particular application. The use of Class "Y" or "A" is excluded.

Motor enclosures shall comply with BS 4999, Part 20. The degree of protection shall be IP44, or as otherwise indicated, with the exception of condensate pumps which shall be IP55.

Test Certificates for complete motor tests, as prescribed in the relevant British Standards, shall be submitted to the Supervisor's Representative before the installation of the motors. The compliance of the motors with the manufacturing type tests shall not relieve the Sub-Contractor of his responsibility of providing motors capable of operating the driven equipment under actual conditions of loading.

All motors shall be fitted with a rating plate inscribed with the motor data, including connection details. These plates shall be of durable and non-corrodible material.

2715.4 P F Correction

In order to improve the overall power factor of the system, the Sub-Contractor shall supply individual power factor correction capacitors to each motor having a rating in excess of 4kW. These capacitors shall be mounted on or adjacent to the motors.

These capacitors shall be directly connected across the motor input terminals and shall be rated to correct the power factor to 0.95 lagging at 75% full load, subject to the kVAR rating of the capacitor not exceeding the no-load magnetising kVAR of the motor.

Consideration shall be given on large motor drives, which operate under variable load conditions, to the provisions of automatic PF correction equipment to correct the PF to 0.95 lagging under all load conditions.

2715.5 Radio Interference Suppression

All apparatus including such items as contactor starters, contactors and fluorescent fitting chokes, where the normal operation is such that interruption of the low frequency or of direct electric currents occur, shall be fitted with means of suppressing the interference frequencies so caused.

The standards of interference suppression required are to be in accordance with BS 800 and subject to the modification hereinafter described.

Details of the equipment and methods to be used in determining the level of radio interference shall be as specified in BS 727.

BS 800 shall be modified insofar as whenever reference is made to the frequency range 200 kHz to 1605 kHz to the same condition shall apply over the range 200 kHz to 30MHz and wherever reference is made to the frequency range 40MHz to 70MHz the same condition shall apply over the range 30MHz to 150MHz.

2715.6 Circuit Labels

All units shall be fitted with labels engraved to show the circuit reference or designation. Labels shall also be fitted where necessary to indicate the function of any internally mounted items of equipment.

All labels shall be of Traffolyte with black engraving on a white background.

2715.7 Conditions of Services

All apparatus shall be rated for continuous service i.e. 24 hours per day, 7 days per week throughout the year, except for the necessary minimum maintenance periods. This requirement shall not preclude the apparatus being equally suitable for intermittent usage where a requirement arises to suit the application such as the frequent starting and stopping of motors expressed as starts per hour or similar.

All installations must be suitable for operation under the climatic and environmental conditions applicable to the building and the site.

2716 Testing and Commissioning

2716.1 Introduction

The work will be tested and commissioned when completed.

This section of the Specification is written to give the Contractor an idea of what allowance should be made in his tender to cover the cost of commissioning and testing.

Although the Supervisor's Representative will be inspecting the Works and witness a sample of the testing and commissioning, this in no way relieves the contractor from his responsibilities to ensure that the work is effectively and adequately supervised by his own staff. The contractor shall employ specialist commissioning staff to commission the works.

2716.2 Commissioning

Commissioning shall be carried out in accordance with approved Codes, those issued by CIBSE being adopted where appropriate.

At the end of the Contract, the Contractor shall satisfy himself that the installation is 100% complete. He shall ensure that all manufacturers' information is available and that all equipment functions as intended.

2716.3 Tests

Tests shall be carried out during the progress of the works as requested by the Site Supervisors Representative.

A Certificate of all hydraulic tests conducted on site shall be forwarded to the Supervisor's Representative to the following particulars.

- Apparatus under hydraulic test.
- Test pressure in kilo Pascals (kPa).
- Duration of test.
- Result of test.

Each certificate shall be signed by the Contractor, and countersigned by the Supervisor's Representative or his representative who witnessed the test.

Each system shall be adjusted and balanced to the design terminal water and air flow rates and temperatures.

Balancing shall aim at the minimum closure of valves and dampers to minimise power consumption and noise generation and fans or pumps shall be suitably adjusted in speed to deliver the design flow without throttling.

Records shall be made of the flow rates obtained compared with the design flow rates and the settings of all valves and dampers which produced these flow rates. Temperatures and pressure changes shall be recorded at each item of plant and terminal device.

Further balancing may be required when the systems are under load and to suit occupied conditions. Any revisions to damper and valve settings shall also be recorded and a complete record made of the operating conditions finally required.

The tolerances for regulation air flow given on page 23 of the CIBSE air distribution commissioning code shall be revised to read as follows:

Flow rate at terminals all in the same room	+ 15%
With overall room flow rate	+ 10%
Flow rate at single terminal in room.	+ 10%
Flow rate of plant.	+ 5%

Note: This will require the tolerances of individual terminals must be averaged out to produce the plant tolerance i.e. terminals cannot all be at same maximum tolerance.

2800 ELEVATOR

2801 Specifications and Dimensions

The specifications and dimensions for the elevator are shall be as follows;

Specification	Description
GENERAL	
Manufacturer:	
Model:	
Governing Code:	Mercosur International Code BM207, based on EN8-1 safety regulations for the construction and installation of lift
Type:	Machine Room Less Passenger
Power Supply: Main:	415v – ph – 50hz
Lighting Supply:	240v – 1ph – 50hz
Capacity:	630 kg / 8 persons
Speed:	1.0 m/s
Travel:	7.2 m
Pit Depth:	1200mm
Overhead Height:	3650mm
Stops/No. of Openings:	3 – Front 3 / Rear None
Floor Openings:	G, 1, 2
Door Opening Size:	900mm x 2100mm
Door Type:	2 Panel Side Opening
Car Inside Dimensions:	1100mm (w) x 1400mm (d) x 2200mm (h)
CABIN	
Cabin Model:	New Export Stainless Steel
Dimensions:	1100mm (w) x 1400mm (d) x 2200mm (h)
Wall Decoration:	Brushed Stainless Steel
Half Height Mirror:	Rea Wall
Front Return Wall Finish	Brushed Stainless Steel
Flooring:	Platform recessed for ceramic tiles (by others)
Ceiling/Lighting:	Stainless Steel with LED Lighting
Handrail:	Qty. 1, Finish, location: rear wall
Ventilation Fan:	In ceiling
DOORS	
Car Door Model:	
Opening Type:	Fully automatic 2 panels side sliding doors
Door Size:	900 mm (w) x 2130 (h)
Finish:	Brushed stainless steel
Car Door Sill:	Anodized aluminum
Protection System:	40 Beam Light Curtain
Landing Door Model:	
Qty.	3
Door Type:	2 panels sliding doors

Specification	Description
Opening:	Right hand
Door Size:	900 mm (w) x 2130 (h)
Landing Door Sills:	Anodized aluminum
Door Frames:	Wide jamb
FIXTURES	
Car Operating Panel (COP)	
Arrangement:	Vertical
Push Buttons:	High protection micro touch with Braille symbols
Position Indicators:	Digital dot matrix
Emergency Light:	1 hour
Overload Indicator:	Full load indicator and audible
Finish:	Brushed stainless steel
Landing Operating Panel (LOP)	
Finish:	Brushed stainless steel
Push Buttons:	High protection micro touch with Braille symbols
Position Indicator:	Digital dot matrix all floors
Finish:	Brushed stainless steel
FUNCTIONS	
Controller Model:	ACS Microprocessor
Operation:	Down collective
Control Cabinet Finish:	Brushed stainless steel
Machine:	Permanent-magnet synchronous gearless
Motor Drive:	Frequency Inverter VVVF
FEATURES	
Automatic Rescue Drive: In the event of a power outage, elevator returns to nearest landing and doors open	
Voice annunciation	Nudging (Door anti-nuisance)
Overload device	Intercom (2 way communication)
Firemen service	Sleep mode
Automatic cut off fan and cabin light	

2802 Supply & Installation

Supply of the elevator should include a manufacturer's warranty of twelve (12) months for the replacement of any defective parts. Installation of the elevator shall be strictly in accordance with the manufacturer's specifications and installation requirements.

The Contractor is to ensure that the following requirements are met for the functionality of the elevator:

- A telephone line installed for the elevator controller for cabin intercom communication
- Three (3) phase power supply with disconnect switch to the elevator controller

The Contract shall make available the following to facilitate the installation and commissioning of the elevator;

- A dry and secure storage area on site for storage of the elevator equipment during the works
- Single phase power supply in close proximity of the elevator shaft for use by Regional Elevator for the installation works.

All necessary protection and safety measures shall be adopted during the installation of the elevator.

2900 CHAN LINK FENCES AND GATES

2901 Standards

Where ASTM standards are referred to in this section, these may be replaced by E.U. member state and/or ACP State standards provided they are equivalent or superior to the U.S. Standard.

2902 Fence Components

Retain one of two "Fabric" paragraphs below. 2-1/8-inch (54-mm) mesh is typical for residential fences, 2-inch (50-mm) mesh for commercial, and 1-3/4-inch (44-mm) mesh for tennis courts and swimming pools.

Fabric: Metallic-coated steel, 1-3/4 inch (44 mm) mesh, 0.120 inch- (3 mm) diameter wire with polymer coating.

Polymer Coating: ASTM F 668, Class 2a or 2b.

Color: Dark green.

Usually retain first option in "Selvage" Subparagraph below for fences 60 inches (1500 mm) or less in height.

Selvage: Knuckled on both selvages.

Fabric: Aluminum, ASTM F 1183, 2 inch (50 mm) mesh, 0.148 inch (3.76 mm) diameter wire.

Usually retain first option in "Selvage" Subparagraph below for fences 60 inches (1500 mm) or less in height.

Selvage: Knuckled on both selvages.

Posts and Rails: Aluminum pipe complying with ASTM F 1043 requirements for heavy industrial fence, and color coated to match fabric.

Tension Wire: Metallic-coated steel, ASTM A 817 and ASTM A 824.

Fittings and Accessories: ASTM F 626, color coated to match fabric, and as follows:

Post and Line Caps: Provide watertight cap for each post. Provide line post caps with loop to receive tension wire or top rail.

Post Brace Assembly: Same material as top rail with 3/8-inch (9.5 mm) diameter rod and adjustable tightener.

Retain "Bottom and Center Rail" Subparagraph below if required.

Bottom and Center Rail: Same material as top rail with cap on each end.

Gate Posts, Swing Gates, and Accessories: ASTM F 900, same metal and finish as posts and rails, with galvanized hardware and accessories.

Privacy Slats: PVC, UV-light stabilized, not less than 0.023 inch (0.58 mm) thick, sized to fit mesh specified for direction indicated.

2903 Installation

Install fence to comply with BS 1722: Part 1 or ASTM F 567 or equivalent European Standard.

Excavation: Drill post holes 8 inches (200 mm) in diameter and 18 inches (450mm) to 23.62 inches (600 mm) in depth, equally spaced, but not more than 10 feet (3.05 m) apart.

Setting Posts: Set posts in holes approximately 4 inches (102 mm) above bottom of excavation. Align posts vertically and align tops. Pour concrete footings with tops 2 inches

(50.8 mm) above grade, trowelled to a crown to shed water 2 inches (50.8 mm) below grade.

3000 GABIONS AND MATTRESSES

3001 General

Gabion: A retaining wall system designed for mass gravity retaining wall applications. Gabion units are delivered flat packed ready for site assembly, where they are filled with rock and stacked on one another to form flexible, permeable, monolithic structures such as retaining walls and channel linings.

- **Gabion Type:** BBA (Roads and Bridges) Certified double twist hexagonal woven mesh gabions.
- **Mesh Type:** 80x100mm aperture in accordance with BSEN10223-3 (Figs. 1&2).
- **Mesh Wire:** 3.0mm diameter steel wire in accordance with BSEN 10218-2 and BSEN 10223-3.
- **Selvedge Wire:** 3.4mm diameter steel wire in accordance with BSEN 10218-2 and BSEN 10223-3.
- **Wire tensile strength:** The wire used in the manufacture of the gabion has a tensile strength between 350-500 N/mm² in accordance with BSEN 10223-3.
- **Corrosion Protection:** Zinc/Galfan galvanised 245g/m² to BSEN 10244-2 Table 3; CLASS A.

Adhesion of galvanising: The adhesion of the galvanised coating to the wire is such that when the wire is wrapped six turns around a mandrel having four times the diameter of the wire, it does not flake or crack when rubbing it with the bare fingers in accordance with BSEN10244-1.

Additional Coating: In polluted environments, where a long design life is required, where soils or water are acidic, in salt or fresh water or where the risk of corrosion is present, a PVC coated galvanised wire product, or a non-flammable HDPE coated galvanised wire product, is necessary. Flammable HDPE or HDPE coated products that are not self-extinguishing are not acceptable due to fire hazard potential. PVC or Non-flammable HDPE coating has a nominal wall thickness of 0.5mm.

Gabion Certification: Manufacturer's (not supplier's) Certification is to be provided to project Supervisor's Representative / project contractor and is required to demonstrate gabions are BBA (Roads and Bridges) Certified and manufactured in an ISO9001 Certified facility.

Gabion Unit Assembly: Gabions are constructed from a continuous mesh panel with each side of unit integral with the body of the gabion and not attached separately using loose spiral connections. Each gabion unit has its own base and lid to ensure sufficient structural strength. Lids or bases must not be shared between consecutive layers of gabions, due to this creating a weaker structure.

Typical Gabion sizes for 3.0mm diameter galvanized wires:

Mesh size (mm)	Length (m)	Width (m)	Height (m)
80x100	1	1	1
80x100	1.5	1	0.5
80x100	1.5	1	1
80x100	2	0.5	0.5
80x100	2	1	0.5
80x100	2	1	1
80x100	3	1	0.5
80x100	3	1	1

NB: Other gabions sizes are available.

3002 Stone Filling

Stone filling for gabions shall consist of hard durable rock free from weathered or decomposed parts. The minimum dimension of each stone shall not be less than half its maximum dimension. For mattresses the stone shall be 150 to 80mm, for baskets the stone shall be 200mm to 100mm. The stone shall be obtained from a source approved by the Supervisor's Representative. No stone shall be smaller than the size of the gabion mesh. In carrying out the filling, selected pieces of stone of elongated shape shall be placed with their flatter and elongated faces in contact with the mesh wherever possible.

3003 Construction

For complete installation instructions or for special assembly details consult manufacturer's installation instructions.

The empty gabions shall be placed to line and level as shown on the Drawings or as directed by the Supervisor's Representative and then stretched so that the gabions retain their shape on being filled. Diaphragms shall be provided at no more than 1 meter intervals for baskets and not more than 600mm intervals for mattresses. The gabions shall be filled with approved stone as specified above, either by hand or using mechanical equipment as approved by the Supervisor's Representative. No basket or mattress forming part of an intended continuous line of gabions shall be completely filled until an adjacent basket or mattress has been half filled, unless otherwise directed, in order not to cause displacements from bulging during filling.

For baskets at least two horizontal connecting wires shall be tied between front and back of the gabion in each 1 meter compartment, at a height of 330mm and 660mm from the

bottom as the stone fill reaches these levels. Additional tie wires shall be provided if necessary and in no case shall the gabion basket bulge by more than 40mm. Where a continuous line of gabions is required, adjacent gabions shall be securely tied together at the top and bottom of the gabions with tying wire.

Particular care shall be taken to ensure tightness of mesh, well packed filling with minimum voids and secure lacing.

The gabions shall be filled to a level just sufficient to require the lid to be forced into place with a bar. The lid and all joints between basket and between diaphragms and basket shall each be tied down with a continuous running wire

Where gabions are to be shaped, the shape shall be formed by folding the mesh internally and tying it with a continuous running wire.

All tying wire shall be galvanised, PVC coated and of the same gauge as the gabion mesh wire specified above.

3100 GEOTEXTILES (GEOMATERIALS)

3101 General

3101.1 Scope of Work

The Contractor shall place all geomaterials in the areas shown on the drawings and as instructed by the Supervisor's Representative and in accordance with the following specification.

3101.2 Contractor's Obligations

The Contractor shall be fully responsible for the supply of all equipment, materials and services and for the complete co-ordination of all the activities for the successful installation of the geomaterial foundation. The Contractor shall bear full and sole responsibility for the supply, installation and performance of the geomaterial supplied by him.

3101.3 Consent

The Contractor shall submit geomaterial samples and data sheets to the Supervisor's Representative for inspection and review, and shall not proceed with procurement of any geomaterial or equipment until the consent of the Supervisor's Representative is given. Samples of approved geomaterial shall be retained on Site for reference throughout the construction period.

The Supervisor's Representative may instruct tests to be carried out on the geomaterial to demonstrate its compliance with this Specification. An independent certificated laboratory approved by the Supervisor's Representative shall carry out the tests. Notwithstanding the foregoing, the Supervisor's Representative may require observe tests on the proposed material prior to approval of the laboratory being granted.

The Contractor shall permit the Supervisor's Representative to take random samples of geomaterials from the Site for further check tests at all times.

3101.4 Testing

Tests to check the properties of the geomaterial shall comply with the methods of testing set out in the following standards or acceptable equivalent standards:

BS EN ISO 10319	Geotextiles- Wide-width Tensile Test
BS EN ISO 12236	Geotextiles and Geotextile-related Products- Static Puncture Test (CBR Test)
BS EN 918	Geotextiles and Geotextile-related Products- Dynamic Perforation Test (Cone Drop Test)
BS EN 964 & BS EN ISO 9863	Geotextiles and Geotextile -related Products, Determination of Thickness at Specified Pressures
BS 2471	Methods of Test for Textiles - Woven Fabrics – Mass per Unit Length and Mass per Unit Area
ASTM D4533	Test Method for Trapezoid Tearing Strength of Geotextiles.

3101.5 Ordering

The geomaterials shall be ordered in advance of the site trials and in good time for incorporation into the Works.

3101.6 Delivery and Storage

All geomaterials shall be delivered to site in the wrapping applied by the manufacturer or, as a minimum, 50 micron black Polyethylene wrapping. Any damage to the wrapping shall be repaired immediately by the Contractor at his own cost. The rolls shall be stored in a well-aired area and protected from direct sunlight. The wrapping shall only be removed immediately prior to use. Each roll shall have an individual roll number and have a roll label with the following details:

- Name and address of manufacturer
- Roll number
- Name and type of product
- Length and width of the roll
- Unit weight
- Raw materials
- Method of manufacture

3101.7 Handling

The geomaterial shall be handled with due care, following all of the manufacturer's recommendations such that it is undamaged for incorporation into the Works. All damage, including physical damage, or where the geomaterial has been exposed to chemical contamination, shall be reported to the Supervisor's Representative. The Supervisor's Representative shall have the power to instruct the removal of the damaged or contaminated portion of the geomaterial or in cases of severe damage or contamination, the rejection of the entire roll.

3101.8 Method Statement

Thirty (30) days prior to commencement of the installation of the geomaterial in the Works and before any site trials are carried out, the Contractor shall submit to the Supervisor's Representative for his consent, a method statement for the successful installation of the geomaterial and its incorporation into the Works. The method statement shall list all plant, labour, methods, activities and sequencing of operations required for laying the geomaterial.

Any alternative method to that previously approved shall be subject to the consent of the Supervisor's Representative. Notwithstanding the above, the Supervisor's Representative's consent to the Method Statement shall not absolve the Contractor of his duties or obligations under the Contract.

3101.9 Site Trials

Prior to commencement of full-scale installation of the geomaterial, the Contractor shall demonstrate his working method described in the Method Statement by conducting a site trial in the presence of the Supervisor's Representative. The trial shall consist of laying a minimum of 20m of geomaterial and the full layer of rip-rap. The site trial may be conducted on the Site and be incorporated in the Works at the discretion of the Supervisor's Representative and following a successful trial.

Providing that upon completion of the trial, the work and working method are acceptable to the Supervisor's Representative they shall be designated the "standard" for the installation of geomaterial and the Method Statement shall be modified to suit the results of the Site trial. All subsequent work shall comply with the established "Standard."

The Contractor may submit revisions to the approved "standard" but shall not modify his working methods until additional trials have been conducted in the presence of the Supervisor's Representative and the Supervisor's Representative's consent has been given.

3101.10 Preparation for Installation

The Contractor shall notify the Supervisor's Representative whenever installation of the geomaterial foundation is to be carried out. The Contractor shall also permit and afford all facilities for the Supervisor's Representative to inspect the laying of the geomaterial and placement of the bedding layer. The Contractor shall replace or repair any geomaterial damaged during installation and shall remove and replace any bedding stones that do not conform to Specification.

3101.11 Installation above Water

The installation of the geomaterial foundation shall be carried out by experienced personnel with suitable equipment, to the "Standard" established during the Site Trials. The geomaterial shall be laid in such a manner as not to damage the geomaterial or unduly disturb the formation.

The formation to receive the geomaterial foundation shall be free from debris and material greater than 100mm in size. The formation shall be generally free of any mounds or hollows and shall not exceed a gradient of 2% different from that shown on the Drawings. The Contractor shall not proceed with the installation of the geomaterial until the Supervisor's Representative has granted specific consent for the sections concerned.

The geomaterial shall be laid on the prepared formation without wrinkles, gaps, folds, slack, stressing or deformation. The geomaterial shall be laid line to line and to the level of the formation and there shall be no gaps or voids under the geomaterial or bulges in the surface and to the tolerances in formation above. The Contractor shall follow the manufacturer's recommendations for overlapping or sewing of the geomaterial, subject to the consent of the Supervisor's Representative and following a successful Site Trial.

3101.12 Installation under Water

Experienced personnel shall carry out the installation of the geomaterial foundation with suitable equipment to the "Standard" established during the Site Trials. The geomaterial shall be laid in such a manner as not to damage the geomaterial or unduly disturb the formation.

The formation to receive the geomaterial foundation shall be free from debris and material greater than 100mm in size. The formation shall be generally free of any mounds or hollows and shall not exceed a gradient of 2% different from that shown on the Drawings. The Contractor shall not proceed with the installation for the geomaterial until the Supervisor's Representative has inspected the formation and the Supervisor's Representative has granted specific consent for the sections concerned.

The geomaterial shall be laid on the prepared formation without wrinkles, gaps, folds, slack, stressing or deformation. The geomaterial shall be laid line to line and to the level of the formation and there shall be no gaps or voids under the geomaterial or bulges in the surface and to the tolerances in formation above. The Contractor shall follow the manufacturer's recommendations for overlapping or sewing of the geomaterial, subject to the consent of the Supervisor's Representative and following a successful Site Trial.

The Contractor shall secure the geotextile to the river bed by the method agreed in the Site Trial and place a 0.5 metre thick layer of the rip-rap material onto the geomaterial as soon as possible after sufficient geomaterial has been laid, subject to the consent of the Supervisor's Representative.

3101.13 Geometrical Type 1

Location

To be placed under all imported stone bed protection

Type 1: Needle-punched Geofabric

The main functions of a geotextile used beneath Rip-rap are filtration and separation. The geotextile shall be manufactured under factory production control guidelines set out within EN 13253; Geotextiles and geotextile related products – characteristics required for use in erosion control works (coastal protection, bank revetments). The manufacturer must be able to supply accompanying CE documentation upon request. The functional characteristics and relevant test methods to this specific condition of use are identified below.

The geotextile shall have the following properties shown in Table 14.

Table 14: Geotextile Properties

Physical Properties:				
Polymer type:	Prime quality virgin polypropylene fibre containing 1% carbon black by weight.			
Fabric construction	Needle punched nonwoven fabric manufactured from mechanically entangled staple fibre.			
	Approved test method	Units	Typical Mean value	Allowable tolerance to 95% confidence limits
Thickness @ 2kPa:	EN ISO 9863-1: 2005	mm	4.3	n/a
Mechanical Properties:				
Static puncture strength (CBR)	EN ISO 12236	kN	2	-10%
Push-through displacement	EN ISO 12236	mm	78	n/a*
Tensile strength	EN ISO 10319	kN/m	15	-10%
Tensile extension	EN ISO 10319	%	100	+/-30%
Cone drop perforation hole diameter	BS EN 13433	mm		+3mm
Filtration Properties:				
Water flow normal to the plane of the	EN ISO 11058	l/s/m ²	80	-30%

geotextile @50mm head				
Characteristic opening size: 90% finer [O90]	EN ISO 12956	m		+/-30
<i>Indicates property not used for quality control as part of harmonised testing within EN 13253</i>				

2.4 Durability (according to annex B: EN 13253):			
Resistance to weathering (UV) @ 50MJ/m2 radiant exposure	EN 12224	Retained Strength	>80%
Resistance to Oxidation (150 years)	EN 12225	Retained Strength after 84 days	>80%
Microbiological Resistance	EN 12225	Retained Strength	>80%
Resistance to liquids	EN 14030	Retained Strength	>80%
<i>Durability test data can be supplied by the manufacturer – test frequency must not exceed 3 years.</i>			

Geotextiles shall be delivered to site in packaging, which will protect the product from damage during handling, storage. Packaging must be suitable to protect the product from UV degradation. Product must be kept in appropriate packaging until such time that it is required for installation.

The geotextile shall be clearly and indelibly marked with the product name along the edge of the roll at regular intervals no greater than 5mts. The labelling shall clearly identify the product supplied in accordance with EN ISO 10320: Geotextile and Geotextile related products – Identification on site.

The geotextile manufacturer shall provide production test certificates on mechanical properties at the rate of one set of tests per 6,000m2 delivered to site and a minimum of one set per contract. Test methods employed shall be in accordance above specification and the reporting laboratory should be accredited by UKAS to carry out the required tests. Certificates relevant to a batch of geotextile shall be furnished to the Supervisor's Representative prior to that batch of Geotextile being incorporated in the works.

The rolls of geotextile shall be stored on level ground and stacked not more than five rolls high and no other materials shall be stacked on top of the geotextiles.

The geotextile shall be laid and installed in the positions and to the line and levels described on the drawings. Construction plant must not operate directly on the geotextile.

Joints shall be formed by overlapping by a minimum of 1metre. A reduction in overlap to 0.3m may be considered by the Supervisor's Representative where the sub-layer is firm and above water level.

On site quality control should be performed in accordance with CEN/TR 15019.

- Test specimens should be taken every 30,000 m² , with a minimum of 1 test above 1000 m²
- For sampling EN 963 should be applied, i.e. samples should be taken not less than 5m from the end of the roll in machine direction and over the whole width in the cross machine direction. The location of the sample should be described exactly.
- For evaluation of conformance, statistical procedure should be used in line with section 5.2 of CEN/TR 15019: 2004.

The following definitions shall apply when considering test results:

- A set of test results shall be those results derived from specimens cut from one sample.
- The mean value for any set of test results shall be the arithmetic mean of that set of results.
- The characteristic value is the value below which not more than 5% of the test results may be expected to fall. This represents the value at 1.645 standard deviations below the mean value.

3200 GLASS FUSED TANK

3201 General

3201.1 Scope of Work

Supply and erect cylindrical Glass-Fused-to-Steel bolted water storage tank(s), including foundation, tank cover, tank structure and appurtenances as shown on the Supervisors Representative's drawings and described herein.

All labour, materials, plant, equipment and tools, as required for the construction of the storage tank shall be included.

3201.2 Definitions

Capacity: The net volume that may be removed from a tank filled just to the top capacity level and emptied to the bottom capacity level. The bottom capacity level if not specified by the purchaser, shall be the water level in the tank shell when the tank is emptied through the specified discharge pipe.

Constructor: The party that furnishes the work and materials for placement or installation. Also referred to as the bidder at tender stage.

Manufacturer: The party that manufactures, fabricates, or produces materials or products.

Purchaser: The person, company, or organisation that purchases any materials or work to be performed. Also referred to as the Supervisor's Representative at tender stage.

Reservoir: A flat-bottom cylindrical tank having a shell height equal to or smaller than its diameter.

Standpipe: A flat-bottomed cylindrical tank having a shell height greater than its diameter.

Tank: A standpipe or reservoir used for water storage.

3201.3 Responsibilities of Parties

Manufacturer's responsibility: The Manufacturer shall furnish a tank structure free of defective materials, including coatings.

Bidder's responsibility: The Bidder shall offer new tank structures as supplied from a Manufacturer specialising in the design, fabrication and erection of factory applied Glass-Fused-to-Steel, bolted sectional tank systems. The Manufacturer shall own and operate its own production plant, fabricate and glass coat the tank plates at one location so as to provide full quality control responsibility over product.

Purchaser's responsibility: The Purchaser shall allow access to the structures at the request of the Manufacturer or the Bidder for the purpose of inspection, if required.

3201.4 Submittal Drawings, Calculations and Specifications

Construction shall be governed by the Owner's plans and specifications showing general dimensions and construction details, after approval by the Supervisor's Representative of submittal drawings prepared by the Manufacturer. There shall be no deviation from these drawings and specifications, except upon written order or approval from the Supervisors Representative. As a minimum, the submittal drawings shall show:

- Dimensions, description of materials and other pertinent information.
- Joint and foundation attachment details.
- Tank assembly (general arrangement drawing) with positions of appurtenances.
- Details of appurtenances.
- Roof details (if applicable).
- Floor details (if applicable).

The Bidder is required to furnish, for the review and approval by the Supervisor's Representative, 4 No sets of construction drawings for all work not shown in complete detail on the bidding drawings. A complete set of structural calculations shall be provided for the tank structure. All such submissions shall be authorised by the Supervisor's Representative.

When approved, two sets of such prints and submittal information will be returned to the Contractor marked "APPROVED FOR CONSTRUCTION" and these drawings will then govern the scope of work detailed thereon. The approval by the Supervisor's Representative of the Manufacturer's drawings shall be on approval relating only to their general conformity with the bidding drawings and specifications and shall not guarantee detailed dimensions and quantities, which remains the Contractor's responsibility.

The Manufacturer's standard published warranty shall be included with the submittal information.

The Contractor is to include the Manufacturer's standard Inspection and Maintenance Manual upon receipt of approved drawings.

3201.5 Prequalification

The Supervisor's Representative 's selection of factory applied Glass-Fused-to-Steel bolted sectional tank construction for this facility has been based upon the design criteria, construction methods specified, and optimum coating for resistance to internal and external tank surface corrosion. Deviations from the specified design, construction or coating details shall not be permitted.

All standards of design, fabrication, erection, product quality and long term performance as outlined in this specification are to be adhered to with no deviation.

Manufacturer's wishing to pre-qualify shall submit the following to the Supervisor's Representative for consideration:

- Typical structure drawings.
- List of tank materials, ancillary equipment and tank coating specifications.
- List of five (5) tanks presently in service for a similar duty, or size and character specified herein, operating satisfactorily for a minimum of five (5) years, including reference name, location, duty and year of supply.

Only bids from Manufacturers who have successfully pre-qualified will be considered.

The Supervisor's Representative shall fully consider the life time cost implications of the diverse range of tank sheet coatings and finishes available and reserves the right to evaluate all bids based on life time costs (i.e. long term operation, tank shut down time, coating and maintenance costs). Values to be used in this evaluation will be at the discretion of the Supervisors Representative, as detailed in this specification and bid tabulation form. As a minimum the Supervisor's Representative shall consider such cost implications over a 30-year operational period. The Supervisor's Representative will add all such costs, dependent upon the type of tank offered, to the Bidder's bid price to determine the effective low bid for purposes of making the award.

3202 Glass Fuse Water Tank

3202.1 Tank Size

The tank shall have a nominal diameter of 6.00 m (19.68 ft.), with a nominal shell height of 5.20 m (17 ft.).

3202.2 Tank Capacity

Tank capacity shall be 147 m³ (32,335 US Gallons) with 4.25 m (13.94 ft.) water depth.

3202.3 Design Standards

The tank materials, design, fabrication and erection of the tank shall conform to the 'AWWA STANDARD FOR FACTORY-COATED BOLTED STEEL TANKS FOR WATER STORAGE' – ANSI/AWWA D103-97.

The Glass-Fused-to-Steel coating system shall fully conform to Section 10.4 of ANSI/AWWA D103, latest revision.

The tank and all materials in contact with the stored water shall be certified and listed by the National Sanitation Foundation (NSF) to meet ANSI/NSF Additives Standard 61.

3202.4 Design Loads

Specific Gravity _____.

Design (guaranteed) Freeboard 0.30 m (12 inches).

Wind speed 69.3 m/s (155 mph) – AWWA D103 Standard is 100mph (44.7m/s).

Allowable Soil Bearing Capacity 450 KPa (65 psf) – To be furnished in Supervisors Representative's Soils Report.

Earthquake Seismic Zone 4 - In accordance with AWWA D103, latest revision (Zones 0, 1, 2A, 2B, 3 or 4).

Site Amplification Factor 1.0 - In accordance with AWWA D103, latest revision (Soil Profiles A, B, C or D).

Use (Importance) Factor 1.0 - In accordance with AWWA D103, latest revision (Typically 1.25 unless otherwise specified).

3202.5 Materials

Structure Bolts

Bolts used in tank lap joints shall be ½" – 13 UNC-2A rolled thread, conforming to ASTM A325 and A490.

Bolt Strengths

ASTM A325 Compliant Bolts:

Minimum Tensile Strength – 120,000 psi (827 MPa)

Minimum Proof Load – 85,000 psi (586 MPa)

Minimum Allowable Shear Stress with threads excluded from the shear plane - 30,000 psi (207 MPa)

ASTM A490 Compliant Bolts

Minimum Tensile Strength – 150,000 psi (1034 MPa)

Minimum Proof Load – 120,000 psi (827 MPa)

Minimum Allowable Shear Stress with threads excluded from the shear plane - 37,500 psi (259 MPa)

Bolt finish to be hot dipped galvanised coating.

Bolt Head Encapsulation

All structure bolts shall have ultraviolet resistant polypropylene encapsulation of the bolt head.

Bolt head encapsulation shall be certified to meet ANSI/NSF standard 61 for indirect additives.

All lap joint bolts shall be properly selected such that threaded portions of the bolts will not be exposed to the shear plane between tank sheets.

All bolts for the tank shell and optional Glass-Fused-to-Steel roof shall be installed such that the head portion is located inside the tank, and the nut and washer are on the exterior.

Bolt lengths shall be selected to achieve a neat and uniform appearance. Excessive threads extending beyond the nut after torquing will not be permitted.

The torque values (as set down in the Manufacturer's Construction Guide) shall not be exceeded during tank construction.

All lap joint bolts shall be designed to prevent rotating during tightening.

Plates and Sheets

Plates and sheets used in the construction of tank shell, optional steel floor and optional steel roof shall comply with the minimum requirements of Section 2.4 of AWWA D103-97.

All steel plates and sheets shall be sourced from reputable international steel mills, and produced by a hot rolling process.

Raw materials delivered to the Manufacturer's plant shall be tested/inspected to ensure compliance with the Manufacturer's requirements for strength and chemical composition.

Typical Test Certificates and Certificates of Conformity shall be available for the Supervisors Representative's inspection if required. Such Certificates shall be requested at the time of issue of the Purchase Order.

Mild strength steel shall conform to ASTM A1011 SS Grade 33.

High strength steel shall conform to ASTM A1011 Grade 55 Class 1 or ASTM A1011 Grade 60 class 1.

When multiple vertical bolt line sheets and plates are used, the effective net section area shall not be taken as greater than 85% of the gross area, as required by AWWA D103-97, Section 3.5.2.

The annealing effect created from the glass coated firing process shall be considered in determining steel ultimate and yield strengths.

Structural Shapes

Material shall conform to the minimum requirements of ASTM A36.

Horizontal Wind Stiffeners

Where a roof is specified within the scope of supply, the top stiffener shall provide a flat, horizontal, continuous surface at tank rim level.

Where an open topped tank is specified within the scope of supply a variation of top stiffeners may be utilised (internal and external) to suit the specific application.

Wind stiffeners shall be steel, hot dipped galvanised, rolled steel angle or web truss types.

Sealant

The sealant shall be used to seal lap joints, bolt connections and sheet edges.

The sealant shall cure to a rubber-like consistency and have excellent adhesion to the glass coating, have low shrinkage and be suitable for interior and exterior exposure.

The sealant shall be a one component, moisture cured, polyurethane compound.

EPDM or Neoprene gaskets and tape type sealer shall not be used other than for shell access manway door.

The sealant shall be suitable for contact with potable water and be compliant to NSF Standard 61 for indirect additives.

3202.6 Glass Coating

Surface Preparation

Sheets shall be steel grit-blasted to a silver grey finish on both sides to remove mill scale and surface oxidation.

Grit blasting shall be performed to the equivalent of SSPC SP10, as required by AWWA D103-97, Section 10.4.1.

The surface anchor pattern shall be in the range of 0.02mm (1.0 mil) to 0.10mm (4.0 mils), with a target value of 0.06mm (2.4 mils).

Cleaning

Immediately after fabrication and grit blasting and prior to application of the coating materials, all sheets shall be thoroughly cleaned by an alkali wash.

Following the alkali wash all sheets shall be rinsed in hot water containing a nitrite based rust inhibitor.

The rust inhibition process shall be followed by heat drying to ensure the sheets are clean and dry ready to be coated.

Coating

All sheets shall receive a coat of catalytic nickel oxide based pre-coat to both sides, as required by AWWA D103-97, Section 10.4.2.1. The pre-coat application weight is controlled and measured and sheets that do not meet the required specification, in accordance with the Manufacturer's specified parameters, shall be rejected at this point.

All pre-coated panels shall be heat dried to ensure that a moisture free surface has been achieved before the final coating is applied.

A coat of cobalt rich glass slip shall be continuously applied to both sides of the sheet followed by heat drying.

The coated panels shall be visually inspected and sheets with spray or glass defects shall be rejected at this point.

The thickness of the coating system shall be measured using an electronic instrument; the instrument shall have a valid calibration record. Interior and exterior dry film coating thicknesses shall be between 0.15mm (6.0 mils) and 0.48mm (19.0 mils) as required by AWWA D103-97, Section 10.4.2.2. Sheets that are not within the Manufacturer's specified parameters shall be rejected at this point.

After inspection sheets shall be fired through the furnace at approximately 850°C (1562°F) in accordance with the Manufacturer's approved procedures and as required by AWWA D103-97, Section 10.4.2.3.

Tank internal sheet colour shall be as specified by the Manufacturer. Tank external sheet colour shall be Blue (Munsell 5PB 2/4, RAL 5013, BS 4900 20 C 40) or Green (Munsell 2.5GY 2/2, RAL 6006, BS 4900 12 B 29).

Sample tests shall be carried out by the Manufacturer to ensure that enamel materials meet the physical properties and chemical resistance characteristics as published in the Manufacturer's specification.

Inspection

Inspection procedures shall be carried out within the Manufacturer's plant under ISO 9001:2000 Quality Systems.

Colour Measurement

A colorimeter shall be used to measure the external sheet surfaces. Electronic colour control shall be used to ensure that allowable colour uniformity is achieved within the Manufacturer's specified parameters. Sheets of a colour outside of these limits shall be rejected.

The instrument used shall have a valid calibration record and shall be regularly checked against the Manufacturer's approved calibration standard.

Colour measurement frequency shall be every 15 minutes and every colour and sheet thickness change.

Glass Thickness Measurement

Finished sheets shall be inspected for coating thickness using an approved electronic instrument suitable for a measurement range of 0 0.50mm (0 20.0 mils).

The instrument shall have a valid calibration record and shall be regularly checked against the Manufacturer's approved calibration standard.

The thickness of the glass coating shall be maintained in the range specified in AWWA D103-97 section 10.4.2.2. Sheets that have a thickness outside of these limits shall be rejected at this point.

Coating Inspection – External Surface

The external/non-contact surfaces of all sheets shall be inspected visually under good daylight (or equivalent lighting) for defects in the glass coating.

Any sheet having visible defects larger than 1.0mm (0.04") shall be rejected. Any sheet having more than 3 visible lesser defects per square yard of external surface shall be rejected.

Any visible defects on the external surface of accepted sheets shall be repaired to the Manufacturer's approved procedure.

Coating Inspection – Internal Surface

Voltage testing shall be performed on the contact surfaces of the finished sheets in accordance with ASTM C 537 – 87 (Re-approved 2004) and BS EN 14430. The voltage test shall be used to identify any discontinuities in the glass contact surfaces.

Inspection shall be carried out using a sampling procedure complying with ISO 2859: Part 1.

The Tester shall have an accuracy of $\pm 1\%$ at the test probe and shall have a valid calibration record.

Only finished sheets with zero glass continuity defects on the contact surfaces shall be released for packing. Sheets containing any discontinuities on the contact surfaces shall be rejected.

Chemical Resistance Testing

Production specimen shall be tested in accordance to the following:

- PEI Test T-21.
- Clause 9 of BS EN 14483-1:2004[13] – Citric Acid at Room Temperature.
- Clause 10 of BS EN 14483-2:2004[14] – Boiling Citric Acid
- Clause 13 of BS EN 14483-2:2004 – Boiling Distilled or Demineralised Water.
- Clause 9 of BS EN 14483-4:2004[15] – Hot Sodium Hydroxide.

Chemical resistance tests shall be conducted on a monthly or annual basis in accordance to the Manufacturer's specifications.

Physical Property Tests

Adherence tests on production specimen shall be in accordance to BS EN 102.

Impact tests on production specimen shall be in accordance to ISO 4532.

Scratch hardness tests on production specimen shall be in accordance to EN 101.

Physical property tests shall be conducted on a monthly basis in accordance to the Manufacturer's specifications.

An owner's representative may be present during these inspection procedures at their own cost.

Packing

All finished sheets shall be handled within the manufacturing plant using magnetic or suction pads.

All approved sheets shall be protected from damage prior to packing for shipment. Heavy paper sheets shall be placed between each panel to eliminate sheet-to-sheet abrasion.

Individual stacks of panels shall be wrapped in a specified heavy duty plastic and steel banded to special pallets built to the roll radius of the tank panels where necessary. This procedure eliminates contact movement of finished panels during shipment.

Transportation of finished products shall be by dedicated haulier.

3202.7 Erection

General

Field erection of the Glass-Fused-to-Steel bolted water storage tank shall be in accordance with the procedures outlined in the Manufacturer's Construction Guide and performed by an Authorised Distributor of the Manufacturer, regularly engaged in erection of these tanks or a suitably qualified specialist sub-contract builder under the control and supervision of the Authorised Distributor.

Levelling of the starter ring (or first full ring) shall be required and the maximum differential elevation within the ring shall not exceed 2.8mm (0.11"), nor shall it exceed 1.0mm (0.04") within any 914mm length (3ft).

Specialised erection jacks or building equipment as specified by the Manufacturer shall be used to erect the tanks.

No backfill or mechanical loads shall be placed on the tank side wall without prior written approval of the Manufacturer. Any backfill shall be placed according to the instructions of the Manufacturer.

Particular care shall be taken in handling and bolting of the tank panels, structural items and ancillaries to avoid abrasion of the coating system.

Bolting and Sealants

All bolts are to be located and tightened in accordance with the procedures outlined in the Manufacturer's Construction Guide.

All sealants are to be applied in accordance with the procedures outlined in the Manufacturer's Construction Guide.

Coating Inspection and Repair

All surface areas may be visually inspected by the Supervisor's Representative during construction and prior to liquid tests.

An electrical Holiday test shall be performed on all contact surfaces of the shell plates during or following construction using a 9-volt leak detection device. Any electrical leak points found on the contact surface shall be repaired in accordance with the Manufacturer's Inspection and Maintenance Manual.

After completion of the tank build and liquid tests, the Supervisor's Representative shall sign the Manufacturer's standard Certificate of Satisfaction issued by the Authorised Distributor.

3202.8 Foundation Design

Foundation Design Requirements

The tank foundation is a core aspect of the tank design. The foundation design is not the sole responsibility of the Manufacturer; the Manufacturer is not responsible for the base design unless otherwise stated by the Purchaser. A suitably qualified geotechnical Supervisor's Representative shall establish the foundation design and the foundation specification.

The tank foundations shall be based on the soil bearing capacity as detailed in section 2.4.4 of this specification. All earthquake factors are to be considered. Should the foundation be part of this supply, the information required for the design is to be supplied free of charge by the Supervisor's Representative prior to the bid date. All information is to be certified by a licensed Supervisors Representative.

The Manufacturer will provide data on the live and dead loading of the bolted water tank.

Glass Coated Bolted Steel Floor (If Required)

The floor shall comprise sectional Glass-Fused-to-Steel plates utilising the same fixings and sealant as the tank shell.

The tank foundation is to be covered with a minimum 13mm (0.5") layer of bituminous sand for the floor to be installed upon.

3202.9 Roof

Small Diameter Roofs

Tanks with diameters of 4.269m (14ft) to 9.393m (31ft) shall include roofs with either radially sectioned Glass-Fused-to-Steel or Stainless Steel (grade 316) plates utilising the same fixings and sealant as the tank shell.

The roof shall be free span and self-supporting.

The roof shall be equipped with a 610mm (24") roof opening for inspection purposes.

The roof shall be air limiting and equipped with suitable venting for air displacement when the tank is filled and emptied so as not to allow an internal pressure or vacuum.

All venting shall be screened to prevent bird / animal entrance.

Large Diameter Roofs

Tanks with diameters greater than 9.393m (31ft) and up to 18.897m (62ft) shall include either a radially sectioned Glass-Fused-to-Steel roof utilising the same fixings and sealant as the tank shell or an aluminium dome structure of interlocking construction. Tanks with diameters greater than 18.897m (62ft) shall only include an aluminium dome structure of interlocking construction.

The roof shall be free span and self-supporting.

The live loads of the roofs shall be fully considered in the tank design.

The roof shall be fully vented and shall include a suitably sized vent in the centre so as not to allow an internal pressure or vacuum.

All venting shall be screened to prevent bird / animal entrance.

3202.10 Accessories

Inclusion and Location of Accessories

All accessories are to be included and located as detailed on the Supervisors Representatives drawings.

Pipe Connections

Pipe connections penetrating through the tank panels are to be pre-cut in the Manufacturer's facility.

Where the location of pipe connections is unconfirmed due to site restrictions or added after the opportunity to factory cut has passed, they shall be field located in accordance with the Manufacturer's Construction Guide.

All pipe connections through the tank shell shall utilise the same fixings and sealant as the tank shell.

Overflow piping shall be _____ mm (_____ inches) in diameter and shall include an external overflow down pipe of _____ m (_____ ft.) in length.

Outside Tank Ladder

An outside tank ladder shall be furnished and installed as detailed in the Supervisors Representative's drawings.

Ladders shall be manufactured in accordance to Occupational Health and Safety Administration (OSHA 29 CF3 Part 1910) [19] requirements.

Ladders shall have a hinged and lockable anti-climbing device if required to conform to local safety requirements.

Shell Manholes

One manhole shall be provided in the first ring of the tank shell as detailed in the Supervisors Representative's drawings.

The manhole shall be minimum 610mm (24") in diameter up to a maximum of 800mm (31.5") in diameter and shall be suitably reinforced.

The manhole shall be hinged or fitted with a davit so as to allow opening without the need for additional lifting equipment.

Identification Plat

The tank shall be furnished with an identification plate that is fixed to the tank shell during construction. The identification plate shall list all relevant information for the Manufacturer to trace the tank in the future (serial number, model reference, date of manufacture and project number).

Cathodic Protection

The tank may be supplied with a passive cathodic protection system at the request of the Purchaser.

3202.11 Fielding Testing

Hydrostatic Testing

On completion of erection, Holiday testing (as detailed in section 5.3.2) and curing of the tank sealant the tank shall be tested for liquid tightness by filling with water to the overflow elevation and being observed over a 24 hour period.

Any leaks identified during this test shall be corrected in accordance with the Manufacturer's recommended method.

Water for the hydrostatic test shall be provided by the owner at the scheduled time of sealant curing and shall be free of charge. Disposal of the water shall be the owner's responsibility.

3202.12 **Disinfection**

Disinfection Standard

At the time of testing the tank shall be disinfected for use by Chlorination in accordance with method 3 of ANSI/AWWA C-652-02, as amended by the Manufacturer.

3202.13 **Warranty**

Materials and Coating

The Manufacturer shall provide a warranty for the tank materials and coating. This warranty shall cover against defects in material or workmanship for a period of 1 year and against manufacturing defects in the coating for a period of 5 years.

3202.14 **Quality Assurance**

Quality System

The Contract (including any investigations, design, construction, and provision, erection, setting out work, testing and maintenance, whether carried out by the Contractor or a sub-contractor) shall be executed in accordance with a quality system, which satisfies the relevant requirements of BS5750 and the particular requirements of this Specification.

The Contractor shall prepare an overall Contractor's Quality Plan describing the quality system to be implemented for the Contract. The Contractor's Quality Plan shall describe in detail the quality management policies, organisation, responsibilities and procedures to be applied, identifying the applicable requirements of BS 5750.

The Contractor's Quality Plan shall be prepared and issued within 4 weeks of award of Contract.

The Contractor shall require and verify that sub-contractors comply with the Contractor's Quality Plan.

The Contractor shall prepare management and technical procedures supporting or implementing the Contractor's Quality Plan. The procedures shall cover such activities as required by BS 5750.

The Contractor shall control quality related activities for key processes to ensure that quality objectives are met. The submission of any item at any stage to the Supervisor's Representative shall not form part of the direct quality control process and shall not relieve the Contractor of his responsibility for meeting specified requirements. Such submissions shall be regarded as part of the commitment and responsibility of the Contractor to interface with the Supervisor's Representative to ensure confidence in the output and work

The Contractor shall, in writing:

- Within two weeks of award of Contract appoint a Quality Manager with the responsibility for and the authority to resolve quality matters;
- Appoint a Quality Representative at each location of work two weeks before work starts at that location;

- Inform the Supervisor's Representative of the initial appointees on appointment and any subsequent changes.

The Contractor shall make available to the Supervisor's Representative records of internal audits, external audits, management reviews and corrective actions.

Release Certificates

The Contractor and his sub-contractors shall only deliver to Site for incorporation in the Works, items, which comply with Contract requirements and have satisfactorily passed all inspections and tests required under the Contract or the Contractor's Quality Plan. Each item shall be accompanied by a Release Certificate in accordance with a set procedure

3300 HEALTH AND SAFETY

3301 Health and Safety Standards

The standards and guidelines regarding health and safety to be adopted by the Contractor shall be in accordance with the governing legislation in St. Lucia: The Labour Act 2006; PART IV- Occupational Safety and Health.

3302 Health and Safety Plan and Monthly Health and Safety Reports

The Contractor's Method Statements shall include a Health and Safety (H&S) Plan, which sets out, to the satisfaction of the Supervisor's Representative the general and specific measures and procedures which are to be adopted to ensure the health and safety of the workforce and of the general public in the vicinity of the site, during construction of temporary and permanent works. The Health and Safety Plan shall also set out the emergency procedures to be adopted in the event of unforeseen events occurring which present a hazard to the workforce or to the general public. All activities shall be undertaken in accordance with the approved Plan. The Contractor is required to submit a monthly Health and Safety Report to the Supervisor's Representative, which is to document all H&S provisions being implemented during the period, such that he can be fully satisfied that the provisions set out are being adhered to and justifies payment. The format of the Health and Safety Report shall be discussed with and approved by the Supervisor's Representative prior to the first submission.

3303 Appointment of Health and Safety Officer

The task of ensuring that all workforce health and safety matters are properly and fully addressed shall be the responsibility of a senior member of the Contractor's site staff, designated by the Contractor as the Health and Safety Officer. A deputy shall also be designated by the Contractor to act during temporary absences of the Health and Safety Officer from the site.

The Contractor shall notify the Supervisor's Representative of the names of the Health and Safety Officer and his deputy, together with the method whereby they can be contacted at any time during normal working hours. This information shall also be prominently displayed in the Contractor's site offices in a location where the workforce can see it easily. In the event that, in the opinion of the Supervisor's Representative, the Health and Safety Officer or his deputy is failing to address health and safety issues adequately, the Supervisor's Representative shall require his immediate replacement.

The assigned responsibilities of the Health and Safety Officer shall cover all aspects of workforce health and safety. They shall include, but not be limited to, instruction of the workforce in the measures and procedures which are to be adopted in relation to health and safety matters, safe working practices and site monitoring to ensure that such measures and procedures are being adopted and are effective, and the preparation of health and safety action plans to accompany the Contractor's method statements.

3304 Protective Clothing and Safety Equipment (PPE)

All members of the workforce and Contractor’s supervisory staff shall be issued with protective clothing and other safety equipment (PPE) appropriate to the tasks being undertaken or supervised, as set out in the Health and Safety Standards, at no cost to themselves. It shall be a condition of employment that the appropriate clothing and equipment be worn and/or used as indicated in relation to specific activities set out in the Standards, on pain of instant dismissal. All workers shall be provided with overalls, hard-toe cap safety boots and safety helmets of patterns approved by the Supervisor’s Representative, and the Contractor shall replace these when they become worn-out or damaged. All workers and supervisory staff deployed on or adjacent to public roads, and as may be decided by the Supervisor’s Representative at such other locations shall wear fluorescent jackets of a type approved by the Supervisor’s Representative.

3304.1 First Aid Kits to be Available

First aid kits, of a type equivalent to that specified in the Health and Safety Standards, or as approved by the Supervisor’s Representative, shall be provided by the Contractor at each worksite and in the Contractor’s offices. Any consumable items, which have been used, shall be replaced without undue delay. The Health and Safety Officer or his Deputy shall be responsible for making weekly checks to ensure that the kits are complete. The location of first aid kits at each workplace shall be made known to all members of the workforce. The kits shall be freely accessible, and shall not be kept locked or in locked storage during working hours.

Minimum requirements of the First Aid Kit should be as follows:

No.	Item
10	Antiseptic towelettes
50	Band-Aid strips
10	4x4" Sterile Gauze pads
3	4" Compress with ties
3	6" Compress with ties
1	ABD pad
2	3" Roller gauze bandage
4	Triangular bandages
8	Safety pins
1	First aid scissors
1	Splinter forceps (tweezers)
1	1" Hospital tape
2	3" Tensor bandage
1	CPR barrier device w/one way valve
6	pr. Disposable gloves
No.	Item
1	First aid pocket guide
1	Waterproof waste bag
5	Campus accident reports
1	Kit inventory list

3304.2 Staff to be trained as First-Aiders

One person who has been trained in basic first aid/CPR and holds a currently valid first aid certificate issued by an organisation approved by the Supervisor's Representative, shall be present at each work location and at the Contractor's site offices or, in cases where a number of separate work locations are close together, at each group of locations, during all construction operations. In the event that one first-aider is to be responsible for a group of locations, the Supervisor's Representative will determine the number of locations, which constitute a group for first aid purposes.

First aid certificates shall be those determined to be valid by the Engineer in accordance with the governing regulations. The Engineer shall be provided by the Contractor with a list of names of first-aiders and copies of their certificates. The Contractor's Health and Safety Officer shall ensure that the workforce at each worksite is made aware of the name of the person responsible for first aid at that worksite, and the means whereby they can be called in the event of an accident occurring.

3305 Reporting of Accidents

The Contractor shall provide, within 24 hours of the occurrence of any accident at or about the site or in connection with the execution of the accident, a report to the Engineer. The Contractor shall also report such accident to the competent authority whenever such report is required by law.

The Contractor's Health and Safety Officer shall institute procedures for the reporting of minor and major accidents, and shall keep a record of such events in an Accident Register of a form acceptable to the Supervisor's Representative. The Accident Register shall be available at all times during normal working hours for inspection by the Supervisor's Representative.

3306 Emergency Evacuation Plans

The Contractor's Health and Safety Officer shall draw up plans, to the satisfaction of the Supervisor's Representative, for the emergency evacuation to hospital of any seriously injured member of the workforce. The plan shall not rely on the provision of transport by the public ambulance service but shall make provision for transport using the Contractor's own resources. Each person responsible for first aid shall be advised in writing of the procedure to be adopted to call for emergency evacuation.

The Contractor shall provide such equipment and facilities as are necessary or required, in case of accidents, for first aid service to any, who may be injured in the progress of the Work; and he shall have standard arrangements with local hospitals for the removal and hospital treatment of any employee who may be injured or who may become ill. Details of the equipment, facilities and hospital arrangements shall be submitted to the Supervisor's Representative for approval.

3307 Contractor's Site Office

The Contractor shall provide appropriate sanitary/ablution facilities for the use of base-camp personnel, with separate facilities for males and females. The numbers of male and female toilets and male and female washbasins shall be appropriate to the peak numbers of staff of each sex working at the base camp. The toilet facilities shall be provided at all times with adequate supplies of toilet paper.

Washbasins shall be provided at all times with adequate supplies of water, soap and paper towels. The toilets/ablution facilities shall be maintained in a clean and hygienic condition at all times to the satisfaction of the Supervisor's Representative. The Supervisor's Representative, prior to commencement of base camp establishment, shall approve the arrangements for toilet/ablution facilities.

Toilets shall be of the flush WC type, and shall be located in a ventilated weatherproof enclosure. An adequate water supply for flushing shall be available at all times. In the event that connection to municipal sewer is not feasible and, in the opinion of the Supervisor's Representative, the soil conditions are suitable, all wastewater arising from toilets, ablution and other site office facilities shall be discharged to a septic tank connected to a soakaway. In the event that soil conditions are unsuitable for soakaways to be effective, wastewater discharges shall be to a cess pit, which shall be pumped out as and when necessary. Rainwater shall be prevented from entering septic tanks or cesspits.

The Contractor's Site office and compound for the project shall have proper fencing, lighting and adequate number of security guards to ensure the safety of all personnel and equipment on the project.

3308 Contractor's Site Sanitary Facilities

The use of pit latrines as site toilets is specifically prohibited. Site toilets shall be of the portable chemical type in a ventilated weatherproof housing, and shall be emptied at least once a week, well before they become full, by a contractor who is duly authorised and licensed to carry out this activity. Separate facilities shall be provided for male and female site workers.

The number of toilets at each worksite shall be in a ratio of not less than one toilet for every 12 workers, with the proviso that there shall be at least one toilet reserved for female use, if any female workers are present at the worksite.

The toilets shall have adequate supplies of toilet paper available at all times. Hand washing facilities including soap, and paper towels shall be provided adjacent to each toilet and an adequate supply of water shall be available at all times. Toilet and hand washing facilities shall be maintained in clean, tidy and hygienic condition at all times, to the satisfaction of the Supervisor's Representative.

3400 SUB-SURFACE DRAINAGE

3401 Materials

3401.1 Drainage aggregate

Aggregate shall be:

- Clean, rounded stone, 25 – 50 mm diameter, and
- Free from weeds, other building materials, foreign matter and contamination.
- Drainage aggregates, if so instructed by the Supervisor's Representative, shall be subjected to sieve analyses to BS EN 933-1.

3401.2 Lightweight aggregate

Lightweight aggregate shall be clean clinker, or equal and approved, 20-50 mm in diameter, weighing a maximum of 500 kg/m³ when compacted.

3401.3 Filter layer

Filter layer shall be a permeable non-woven, thermally bonded geotextile filter fabric, which is not affected by acids, alkalis, bacteria, humidity, or rotting, and shall meet performance requirements set out in Table 15 in sound performance for minimum 12 years:

Table 15: Types of Filter Layers

Type	Properties	Test Method	Acceptance Standards
A	Mechanical Properties		
	(1) Wide width strip tensile Mean peak strength Elongation at peak	BS EN ISO 10319	3.0 kN/m 35 %
	(2) Strength Strength at 5 % strain	BS EN ISO 12236	1.3 kN/m
	(3) CBR puncture resistance Mean peak strength		525 N
	Hydraulic Properties	BS EN ISO 12956	
	(1) Pore size Mean AOS O90		300 µm
	(2) Permeability 5cm head	BS EN ISO 11058	150 l/m ² /s

Type	Properties	Test Method	Acceptance Standards
B	Mechanical Properties (1) Wide width strip tensile Mean peak strength Elongation at peak (2) strength Strength at 5 % strain (3) CBR puncture resistance Mean peak strength	BS EN ISO 10319 BS EN ISO 12236	6.0 kN/m 25 % 2.6 kN/m 1050 N
	Hydraulic Properties (1) Pore size Mean AOS O90 (2) Permeability 5cm head	BS EN ISO 12956 BS EN ISO 11058	180 μm 130 l/m ² /s
C	Mechanical Properties (1) Wide width strip tensile Mean peak strength Elongation at peak strength Strength at 5 % strain (2) CBR puncture resistance Mean peak strength	BS EN ISO 10319 BS EN ISO 12236	8.0 kN/m 28 % 3.4 kN/m 1500 N
	Hydraulic Properties (1) Pore size Mean AOS O90 (2) Permeability 5cm head	BS EN ISO 12956 BS EN ISO 11058	150 μm 100 l/m ² /s

Pea gravel

Pea gravel shall be clean rounded river washed gravel 5 – 12 mm in size.

Gravel

Gravel shall be clean, broken granite stone, 10 – 30 mm in size.

3402 Workmanship

3402.1 Filter layer application

Cover all drainage aggregate with a sheet of filter layer having 200 mm minimum overlaps. Ensure entire filter layer as Clause 25.11(c) is smooth and free of tension stress, folds, wrinkles and creases. Overlap each successive strip of over previously laid strip by 200 mm minimum over previously laid strip and all in accordance with manufacturer's instructions and recommendations.

3402.2 Protection of filter layer

Protect installed filter layer from displacement, damage or deterioration before, during and after placement of drainage system. Do not permit passage of any vehicle or machinery directly on drainage system at any time. No storage or stockpiling of any kind shall be allowed on any part of filter layer. Replace damaged or deteriorated filter layer and/or any part of the subsoil drainage to the satisfaction of the Supervisor's Representative.