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# **TECHNICAL SPECIFICATIONS**

TECHNICAL SPECIFICATIONS ARE IN TWO (2) PARTS;

PART 1: TECHNICAL SPECIFICATIONS FOR ENVIRONMENTAL, SOCIAL, HEALTH, AND SAFETY (ESHS)

PART 2: TECHNICAL SPECIFICATIONS FOR ROADS, MARKETS & TERMINALS

**PART 1:**

**TECHNICAL SPECIFICATIONS FOR ENVIRONMENTAL, SOCIAL, HEALTH, AND SAFETY (ESHS)**

**1.0 HEALTH AND SAFETY**

The Contractor shall take due precautions to ensure the health and safety of his employees and shall comply with statutory and local health and safety and labour regulations. He shall ensure that medical first aid, trained personnel and emergency transportation for sick and injured workers are available on the Site at all times. The Contractor shall notify the Project Manager immediately any accident occurs that results in injury to any person, whether concerned with the Site or a third party.

The Contractor shall include in his work plan details of the measures he proposes to adopt to combat the spread of HIV/AIDS and STI’s (sexually transmitted infections) amongst his workforce and the local community. Such measures shall include education and awareness promotion campaigns conducted in conjunction with local health authorities and access to condom supplies.

The specific provisions for health and safety, labour and HIV/AIDS prevention measures are provided below.

**1.1 LABOUR**

Labour Standards included in this Contract should not be regarded merely as protection for employees but as a way of improving the worker’s welfare and hence their productivity.

The Contractor shall fully comply with the following requirements in respect of Labour Standards the majority of which are already in force and embodied in the labour laws of Ghana. References to various laws, statutes, decrees legal instruments and other ordinances are given for information purposes and the Contractor shall ascertain for himself his obligations in respect thereof including those arising from any subsequent legislation. Compliance with this list of Labour Standards shall in no way absolve the Contractor of any of his obligations in respect of any of the labour laws in force in Ghana.

Freedom of Association and Collective Bargaining: The Contractor shall adopt a co-operative attitude towards officers and members of registered trades unions in accordance with the provisions of the Industrial Relations Act, 1965. Section 7 of this Act lends legal force to process of collective bargaining and any collective agreement concluded through that process. The current collective agreement between the Association of Building and Civil Contractors of Ghana (ABCCG) and the Construction and Building Materials Workers Union of TUC (CBMWU) for the period from 1st January 2000 to 31st December 2001 provides for many of the following Labour Standards.

Equality of Treatment: The Contractor shall comply fully with Legal Instrument 632, Labour Relations, 1969. Part VIII provides that males and females shall receive equal pay for equal work. As a requirement of this Contract the Contractor shall afford equal opportunity for women to perform any site task including those of a supervisory nature.

Payment of Remuneration: N.L.C.D. 157, Labour Decree, 1967, Part VII requires that the whole of worker’s remuneration shall be in legal tender. The minimum rates of remuneration for the various groups recognised by the industry are set out in Section 9.8 of the current collective agreement between ABCCG and CBMWU for the period from 1st January 2000 to 31st December 2001. However, the rates contained therein were only applicable for the year 2000 and the Contractor shall pay any increases to those minimum rates that may have subsequently been agreed. The Contractor shall ensure that prompt and full payment of remuneration shall be made directly to individual workers.

Hours of Work: Normal working hours as set out in Section 3.3 of the current collective agreement between ABCCG and CBMWU shall not exceed 40 in any week worked from Monday to Friday. Time worked in excess of the normal working hours shall be paid as overtime in accordance with Section 3.5 of that collective agreement which provides that overtime will be paid at the following rates:

Monday – Friday Normal hourly rate x 1.25

Saturday Normal hourly rate x 1.50

Sunday Normal hourly rate x 2.00

The Labour Regulations, 1969 provide that workers shall be given a rest period of 36 consecutive hours in every 7 days of normal working hours.

Where work is allocated on a task basis, a task should be capable of being completed by an average worker within an 8-hour working day.

It is important that a task work rate over a 6-hour in a day for public works is fixed at a level not higher than the prevailing market wage for unskilled labor in the country. Adopting this principle, task work rate will be developed for each activity.

Employment of Children: N.I.C.D. 157, Labour Decree, 1967, Section 44 proscribes child employment. Section 45 defines a child as a person under the apparent age of 15. Section 46 requires the Contractor to keep a register of young persons employed including their dates of birth or, if unknown, their apparent age. Section 45 provides that young persons under the age of 18 should not work at night.

**Forced Labour:** In accordance with the provisions of N.I.C.D. 157, Labour Decree, 1967, Part IX the use of forced labour by the Contractor is prohibited.

**Weight Convention**: No worker should be required or permitted to engage in the manual transport of a load which by reason of its weight is likely to jeopardize his/her health or safety (adult male = 55kg max; adult female <=35kg). Pregnant women including ten (10) weeks after delivery should be assigned suitable task.

**Record Keeping:** The Contractor shall maintain contemporaneous records of all employees engaged under the Contract. Records shall be kept at the site and shall be made available for inspection by the Project Manager or any Labour Officer pursuant to L.I. 632, Labour Relations, 1969, Section 19 at any reasonable time. Records are to be maintained from the date of the Project Manager’s instruction to commence the Works pursuant to the Clause in the General Conditions of Contract.

Contractors shall use the standard forms to keep Employment Records, Daily Records of Hours Worked, Monthly Pay Records and Accident Records.

Contractors shall not engage workers through repeated temporary contracts or apprenticeship schemes to avoid meeting the wages and other benefits given to permanent workers.

The tendered rate shall include for the full costs associated with complying with the requirements of this specification including the provision of stationery, clerical staff and associated office facilities.

**1.2 SAFETY**

Protective Clothing: The provisions of Act 328, the Factories, Offices and Shops Act, 1970, Section 25 require the Contractor to provide each worker with adequate, free protective clothing and appliances appropriate to their tasks. Minimum requirements for protective clothing particular to the industry are set out in Section 5.3 of the current collective agreement. The Contractor shall provide protective clothing to all site employees as follows:

Basic protective clothing for all employees (including supervisors)

Wellington boots

Overalls

Gloves

Raincoats for any works in rainy seasons

**Additional protective clothing and equipment for specific tasks**

Safety helmets for workers engaged in the construction of bridges or box culverts of height 2m and above.

Wellington boots, dust masks and safety goggles for concreting works.

Dust masks for work in dusty conditions.

Wellington boots for work in wet conditions.

Ear defenders/plugs for work in noisy conditions.

The Contractor shall provide the protective clothing and equipment to his employees as soon as practicable during the mobilisation period and in any case no later than 42 days from the Project Manager’s instruction to commence the Works.

Section 5.3 of the collective agreement states that, it is an infringement of the spirit and letter of that agreement for an employer to fail to provide the necessary protective clothing and equipment. Notwithstanding that similarly it is an infringement of the spirit and letter of that Agreement for an employee having been provided with protective clothing and equipment to fail to use them, the Contractor shall stringently endeavour to ensure that any safety equipment provided for his workforce is effectively utilised.

The Contractor’s attention is drawn to the fact that different sizes of clothing will be required to meet individual needs and that non-standard sizes e.g. safety boots for women may need advance ordering from suppliers.

Separate payment shall be made under the Provisional Sum Items in the Bills of Quantities.

A percentage adjustment on those Provisional Sum Items is included as Items in the Bills of Quantities.

**Safety Officer:** The Contractor shall nominate and train one employee per lot as safety officer. The Contractor shall establish a safety committee during the mobilisation period comprising the Contractor’s Safety Officer, the Project Manager’s Representative and one worker’s representative from each site. The committee shall meet monthly to discuss the promotion of safe working practices, the prevention of accidents and other safety issues and shall report to the monthly progress meetings.

The Contractor shall nominate and train one employee per site to be responsible for first aid. The Contractor shall organise and pay for the first aid training of his nominated employee with the Ghana Red Cross Society.

Pursuant to the Factories, Offices and Shops Act 1970, Section 28, the Contractor shall provide and place under the charge of the person responsible for first aid a first aid kit at each site. That person shall be responsible for managing the first aid kit and informing the Contractor from time to time of any first aid items that have expired or been consumed. The Contractor shall immediately arrange for the replacement of such items.

The first aid kit shall include: Bandages, Gentian Violet, Scissors, Surgical Gloves, Cotton, Wool, Iodine, Plasters, Eye Wash, Gauze, Safety Pins, Hydrogen Peroxide, Antiseptic Cream

The Contractor shall establish emergency evacuation procedures to enable rapid response to accidents viz establish prior contact with local clinics, health centers and district hospitals, make prior arrangements for transport, etc.

Separate payment will be made for the provision of a first aid kit and training of a first aider under the Provisional Sum Item in the Bills of Quantities.

**1.3 HIV/AIDS AND MALARIA AWARENESS**

The Contractor shall display appropriate health education materials at the Site concerning the dangers and impact of Sexually Transmitted Diseases (STDs) in general and HIV/AIDS in particular. Suitable materials are available from the Ministry of Health and the Ghana AIDS Commission. The Contractor shall also facilitate local Ministry of Health staff to conduct awareness and consultation visits to each site at least every four months for the benefit of site staff and labour.

The Contractor shall throughout the Contract (including the Defects Liability Period if workers are on site) also facilitate local Ministry of Health staff to operate an STD clinic on site periodically or make arrangements for workers to visit suitable local clinics.

All the above provisions shall be provided free of charge to staff and labour.

The Contractor shall make condoms freely available to the entire workforce free of charge. No separate measurement and payment shall be made for the provision of condoms the costs of which shall be deemed to have been covered elsewhere in the Contractors rates and prices.

Separate payment for the education of workers and local communities in STDs and HIV/AIDS awareness shall be made under the Provisional Sum of the Bills of Quantities “Provide assistance to and facilitate site visits by MOH personnel to educate workers and local communities in STDs HIV/AIDS awareness and consultation meetings”.

**1.4 SANITATION**

Latrines: Pursuant to the Factories, Offices and Shops Act, 1970, Section 19, the Contractor shall construct temporary latrines at each culvert location unless otherwise directed by the Project Manager. Separate facilities shall be provided for male and female workers.

The Contractor shall locate sanitary facilities so that the disposal of waste does not pollute any groundwater or surface watercourses. Pit latrines shall be kept clean and odour free. The Contractor shall not use disinfectants or detergents to clean such latrines, only water. Pit latrines shall be filled in and the superstructure completely removed when the pit is no longer required, or when the pit is full to within 700 mm of ground level, all to the approval of the Project Manager.

Where instructed, the Contractor shall construct permanent pit latrines in accordance with the Drawings and to the Project Manager’s satisfaction. Where the use of pit latrines is not appropriate, the Contractor shall ensure that his workforce dig holes and cover their excrement on an individual basis. More detailed requirements for sanitation are given in the Special Specifications.

Latrines shall be provided with privacy screens, screened ventilation pipes, covers and airtight slabs or squatting plates that may be readily cleaned so as to reduce any fly-borne nuisance. In formulating their design for temporary latrines Contractors shall take into consideration the economic need to maximise the re-use of materials and the frequency that such facilities will need to be relocated. Contractors shall submit their proposed designs for approval in respect of temporary latrines within 14 days from the date of the Project Manager’s instruction to commence the Works pursuant to the Clause of the General Conditions of Contract. The location of individual latrine sites shall be as directed by the Project Manager.

Latrines construction shall commence as soon as practicable during the mobilisation period and continue from time to time on an “as needs” basis such that adequate facilities are available to the whole workforce.

The Contractor shall ensure that latrines are continuously maintained in a clean and sanitary condition. The Contractor shall provide and maintain hand- washing facilities including adequate supplies of soap and water for hand washing at all latrine sites.

**Water**

The Contractor shall provide an adequate supply of drinking and other water for the use of his employees in accordance with the provisions provided below.

Drinking Water: The Contractor shall provide, pursuant to the Factories, Offices and Shops Act, 1970, Section 20 an adequate supply of potable water for all employees at each site. Potable water shall comply with WHO standards. A minimum of 10 litres per employee per day is to be provided and a minimum buffer supply of 250 litres is to be maintained at each site irrespective of the number of employees at the site.

**Water for Other Purposes:** Pursuant to the Factories, Offices and Shops Act, 1970, Section 16, the Contractor shall provide adequate and suitable washing facilities at each site. The design, construction and location of washing facilities shall be subject to the approval of the Project Manager. The Contractor shall provide hand-washing facilities (washing bowl, stand and soap) at each latrine location. The Contractor shall maintain a continual supply of clean water at each washing and hand-washing facility.

**Water for Construction:** The Contractor shall arrange clean water for construction that is free of concentrations of deleterious salts and other materials. He shall arrange water sources so as to not adversely affect the quality or availability of ground water or surface water resources to indigenous users.

The vessels used to transport and store drinking water shall be manufactured from polythene or similar approved material and shall only be used for those purposes. Such vessels shall be clearly and legibly marked “Drinking Water Only”. The Contractor shall take all necessary steps to preserve the water and vessels from contamination and they shall be emptied, cleaned and sterilised with a solution of chlorine powder on a regular basis at intervals not exceeding twice per week.

The cost of providing water for construction shall be included in the prices tendered for the various items of work for which water is needed.

**1.5 ACCOMMODATION OF TRAFFIC**

The Contractor shall be responsible for the safe and easy passage of public transport over sections of the road that have been handed over to him. If at any time it becomes necessary to close a section of the existing road to traffic the Contractor shall construct deviations.

The Contractor shall erect and maintain barricades, traffic signs and warning boards and provide flagmen as necessary for the protection of the Works and for the safety of the travelling public.

If the Contractor should fail to adequately accomplish this, the Project Manager shall have the right to suspend the progress of the Works until the situation has been rectified.

Roads signs shall comply with the Ghanaian Road Traffic Regulations.

Details of the accommodation of traffic to be provided by the Contractor for various work situations are given below. The minimum layout of road signs is shown diagrammatically in Appendix A. The Contractor shall ensure that the signage at each location is appropriate to the particular site conditions.

The Project Manager may instruct the Contractor to alter or increase the road signing if he considers this necessary for public safety.

**Road Constructed in Half-Widths**

Wherever possible the Contractor shall construct the road in half widths allowing traffic to use the half of the road not under construction. Where this necessitates only allowing one-way traffic, the Contractor shall provide flagmen and sufficient signs to ensure a reasonable flow of traffic and provision for traffic travelling in opposite directions to pass at frequent intervals. The Contractor shall program his work, particularly with regard to the spreading and compaction of wearing course, to avoid excessively long continuous lengths of this type of deviation.

The minimum road signing shall be:

“Men Working Ahead” signs placed 200m before the road works at each end;

flagmen at each end of the work area with red and green signal flags or Stop/Go signs;

lane closure barriers or painted drums at each end of the work area.

**Complete Closure of the Road**

Where it is necessary to close the road the Contractor shall construct deviations using acceptable material which shall be shaped, watered and compacted to give adequate density for traffic and shall also construct any temporary drainage works required. The width of the deviation shall be 6m for two-way traffic and 4m for each lane where two separate lanes are used. The deviations shall be maintained in a safe trafficable condition including grading and watering when necessary.

The minimum road signing shall be:

“Men Working Ahead” signs placed 200mm before the road works at each end;

“Turn Left/Right Ahead” signs placed 100m before the deviation;

cones or barriers placed diagonally across the road to lead into the deviation;

flagmen at each end of the work area as necessary.

**Work on the Roadside**

Where activities such as grass cutting or ditch excavation are taking place the minimum road signing shall be:

two red flags on short poles placed on each side of the road 100m from the work site and at each end of the work area.

**1.6 CONTRACTOR’S ESTABLISHMENT ON SITE**

It is the Contractor’s responsibility to obtain suitable land for his working areas and campsites. Such sites shall be located so as to minimise the adverse effects on crops, trees and natural habitats and shall be subject to the approval of the Project Manager. At the end of the Contract the Contractor shall reinstate these areas and leave them in a clean and tidy condition free of all debris. The Contractor shall undertake a public consultation exercise with all affected persons in full accordance with the provisions of this Specification.

The Contractor shall take all reasonable precautions to prevent any spillage of fuels, hydraulic oils, lubricants, materials, etc. that have the potential to pollute land or water resources or create fire hazard conditions. Any such spillage which may occur shall be removed and any damage repaired to the satisfaction of the Project Manager at the Contractor’s own expense.

Equipment that present leakages of fuels, hydraulic oils or other deleterious liquids shall not be allowed on the site and, if any such item of equipment is found on the Works, it shall be instantly immobilised and taken by means of other transport to the workshops for repairs.

Any pollution caused by the Contractor’s activities shall be cleared and the land returned, as a minimum, to its former condition, all at the Contractor’s own cost. The Contractor shall put in adequate measures to prevent and control risks related to fire on site.

The Contractor shall arrange for, construct, maintain and afterwards remove all temporary site roads and reinstate all accesses required by him for the execution of the Works. Reinstatement shall include restoring such roads and affected watercourses to at least the same condition that existed before the Contractor entered the Site and the deep scarification of soil that has been compacted on agricultural land.

All costs incurred by the Contractor in establishing, maintaining and removing on completion of the Contractor’s facilities including accesses, camps, offices, stores, workshops, compounds and the like will be deemed to be covered by the rates tendered against Items in Bill No.1 of the Bills of Quantities for the Setting-up, Maintaining and Removing of the Contractor’s Office and Compound respectively.

**1.7 PUBLIC CONSULTATION AND PAYMENT TO PROPERTY OWNERS AND USERS**

**Land required for the Permanent Works**

The District Assembly shall be responsible for the assessment of compensation to property owners for all land to be permanently acquired and incorporated in the works within the site boundary (defined as 1m outside the outer limits of the slopes of cuttings, fills, side fills and side drains) together with all buildings, crops, trees and any other properties so defined from that land.

The District Assembly shall be responsible for organising such land acquisition and the payment of compensation to the property owners.

Payment of compensation to the property owners for land to be permanently acquired shall be included as a Provisional Sum under of the Bills of Quantities.

The Contractor shall pay the compensation amounts as authorised by the Project Manager and shall be reimbursed those cost in the interim payment certificates together with a percentage addition under an Item in Bill No.1 of the Bills of Quantities for his costs in facilitating this process.

Land required for the Contractor’s Temporary Works

The Contractor shall be responsible for the payment of compensation to property owners for land acquired by him outside the site boundary for temporary works, borrow, stockpile and spoil areas, detours, the Contractor’s facilities and the like, together with all buildings, crops, trees and any other properties so defined from that land. All payments for land used for the Contractor’s temporary works shall be made to the same level as those payments for the Permanent Works. A schedule of payments is included in the Special Specification covering the following crops, and structures:

Maize, yams, cassava, sorghum, millet, peppers, plantain, bananas, dawadawa tree, shea nut tree, mango tree, houses, stores, etc.

**1.8 BORROW AREAS**

This section covers the work involved in obtaining borrow materials including negotiations with the owners of land on which borrow areas are situated, clearing the site, stripping and disposing of excess overburden, excavating selected material for use on the Works and reinstatement of borrow areas when they are no longer required. The Contractor shall not commence any work on a borrow area until the area has been set out, inspected by the Project Manager and written approval has been given for works to commence. The Project Manager shall withhold his approval until such time as the Contractor provides proof that the public consultations have been successfully completed.

Negotiations with Property Owners

The Contractor shall be responsible for conducting public consultations for all land on which he requires to open borrow pits and related access roads and of settling all claims in respect of royalties, duties, taxes, and levies for the extraction of material, compensation for crops, trees and buildings, temporary occupation of private land, use of haul roads, or any other related matters in accordance with the Contract and this Specification.

For each borrow area the Contractor shall, upon the request of the Project Manager, provide proof that he has conducted public consultations, and shall provide a copy of all agreements reached to use land. Trees shall not be felled in borrow areas but shall be left standing on “islands” as indicated on the Drawings.

Borrow Pit Locations

The Contractor is responsible for the location of all borrow areas and access thereto for the construction of the Works. The locations of borrow areas shall be subject to the approval of the Project Manager which may be withheld for any of the following reasons:

the detrimental effect on the environment;

difficulty in acquiring the land;

necessity to build an excessively long access road;

excessive haul distance involved;

location of a closer suitable source;

excessively thick layers of overburden.

The Contractor shall carry out investigations on all possible sources of borrow material so that the best available material may be used and the haul distance kept to a minimum. At each location the Contractor shall excavate trial holes, take samples and perform such tests as are necessary to confirm the suitability of the material for its intended use in the Works. Details of testing to be carried out are given in Appendix B. The Contractor shall submit the test results to the Project Manager for his approval of the material although this shall not relieve the Contractor of ensuring that all material from the borrow area used in the Works complies with the Specification.

Clearing and Removal of Overburden

The rate for excavation and haul of borrowed material in the various items in the Bill of Quantities shall include for clearing and grubbing and removal of topsoil and any overburden to a depth of 300mm.

**Excavation of Borrow Material**

The Contractor shall plan his work in the borrow area so that the material can be selected and either loaded directly or temporarily stockpiled for later use including at locations outside the borrow area if necessary. He shall ensure that borrow material is neither wasted nor contaminated through mixture with topsoil or overburden.

The Contractor shall take all reasonable care to avoid contamination of borrow material with unsuitable material in the borrow pit. Borrow pits shall also be protected against the ingress of surface water and the Contractor shall construct such temporary banks as required to divert such water.

The Contractor shall cut berms into any vertical cut faces in the borrow pit that exceed 2m in height so as to reduce the risk of serious accidents to persons or animals.

The Contractor shall carry out sufficient tests on the material being excavated to ensure that the material always complies with the Specification.

During the construction the Project Manager may at any time direct the Contractor to operate in specific approved borrow areas which in his opinion are the most suitable having regard to quality and quantities of the material available and the cost to the Employer and the Contractor shall not receive any extra payment for the transfer of his operations from one borrow area to another in complying with this instruction.

**Reinstatement of Borrow Areas**

The Contractor shall reinstate borrow pits, including the haul roads, as the works proceed. Borrow pits shall be reinstated with even contours so as to blend with the surrounding area and to permit the re-establishment of vegetation. Hard areas, whether as a result of trafficking by construction plant or the nature of the ground, shall be ripped and broken down to provide a suitable seed bed for grasses and other indigenous vegetation.

Spoil material from the roadworks shall be deposited, spread and shaped in the borrow pit to natural contours. Material not capable of supporting vegetation shall be placed first and covered with successive layers of stockpiled overburden and topsoil. All material placed in the borrow pit shall be spread in thin layers to follow natural contour lines. On completion of the spreading, the contractor shall collect seeds from indigenous grasses and vegetation in the area and spread and lightly rake these into the finished surface.

Measurement and Payment

The excavation, loading and haulage of borrow material from the borrow area to the location in the Works where it is required shall be paid for under the applicable Items in the Bills of Quantities:

No separate payment shall be made for any other work carried out in the borrow areas or constructing and removing access roads and the Contractor shall be deemed to have allowed for negotiation with the property owners, the payment of royalties, duties, taxes, and levies for the extraction of material, exploration, testing of materials, clearing and grubbing, removal and stockpiling of topsoil and overburden to a depth of 300mm and the cutting of berms where necessary in his billed rates for the related items of work.

Haulage of borrow materials in excess of 1km shall be paid separately under the applicable Items in the Bills of Quantities for excess haulage distances of 1-5km, 50-20km and 20-100km respectively. The unit of measurement is the average overhaul in cubic metre kilometres.

Payment for the finishing-off of borrow areas after use to the requirements of section e) above shall be made under an Item in the Bills of Quantities.

The unit for the reinstatement of borrow pits shall be the square metre calculated in accordance with the area initially set out by the Contractor and inspected and approved in writing by the Project Manager. Any reinstatement required outside those authorised boundaries shall be entirely at the expense of the Contractor unless prior agreement to extend those boundaries had been sought, with the necessary public consultation processes, and approved by the Project Manager in writing.

The rate for the reinstatement of borrow pits shall include for full compliance with the requirements of this specification.

**PART 2: TECHNICAL SPECIFICATIONS FOR WORKS**

**2.1 GENERAL SPECIFICATIONS**

**General**

The specifications of this section cover conditions and materials of general nature and which are not covered under any specific topic in the Technical Specifications. The Contractor is referred to appropriate topics for much more detailed specifications of materials under the appropriate section.

**Description of the Works**

Where the Engineer has carried out a site investigation, the results are given on the drawings

**Site Investigations**

The Contractor shall draw his own conclusions from such results, particularly in regard to the level of rock etc. and may if he wishes, subject to the approval of the Engineer, make further explorations at his own expense.

**Contract Drawings**

**General**

A list of Contract Drawings is included under Section (J).

Further drawings may be issued to the Contractor by the Engineer from time to time in accordance with the Conditions of Contract.

Any drawings which are submitted by the Contractor to further describe the permanent works and which are approved by the Engineer shall become Contract drawings upon the issue of approval but the accuracy of such drawings shall be the responsibility of the Contractor.

**Level Datum**

All levels are referred to mean sea or to an established bench and the Contractor shall obtain in writing from the Engineer’s Representative the location and value of the permanent benchmarks to be used.

Before the commencement of constructional work the Contractor shall establish at each site in a position to the approval of the Engineer’s Representative, a steel datum peg which shall be securely concreted in. The level of this peg shall be established and agreed with the Engineer’s Representative and all levels used in the construction of the works shall be referred to this established datum. The correctness of this established datum shall be checked at regular intervals during the construction period as agreed with the Engineer’s Representatives.

**Levels, Dimensions and Setting Out**

The levels of the ground and the levels and dimensions of existing features shown on the drawings are believed but are not guaranteed to be correct. In the event of any discrepancies the Contractor shall notify the Engineer in writing immediately, who will issue such corrected dimensions levels or positions within two days.

Wherever dimensions or levels are marked on the drawings such dimensions or levels shall take precedence over dimensions scaled from the drawings. When no dimensions or levels are shown on the drawings, instructions shall be obtained from the Engineer’s Representative. Large scale drawings shall be taken in preference to smaller scale.

**Boundaries of Works**

The Employer will provide land on which the Permanent Works included in the Contract are to be constructed. The boundaries of the Works are shown on the contract drawings. The Contractor shall be given possession of such parts of the Site he requires; provided his operations do not interfere with other Contractors, he shall be given the whole of the Site.

The Contractor shall not enter upon or occupy with men, tools, equipment and materials any land other than land or rights of way provided by the Employer without the written consent of the owner of such land.

The Contractor shall provide temporary fencing, or immediately install permanent fencing where such is required. Where the Permanent Works do not include fencing (drains and pipelines etc). Contractor shall submit his proposals to the Engineer as to how he intends to fulfil his obligations under the Contract which shall be to the approval of the Engineer.

**Contractor to Work from Points as Directed**

The Contractor shall start the work at such points as the Engineer’s Representative may from time to time direct.

Restrictions on Use of Roads

**Traffic Restrictions**

The Contractor shall not run tracked vehicles or tracked plant on any public or private road without the written approval of the Engineer and the responsible authority or owner and subject to such conditions as each may reasonably require.

The Contractor shall observe weight and dimensions restrictions which apply to roads and tracks in Ghana, and he shall comply with all reasonable restrictions which may from time to time be imposed by the Engineer, Employer, Police, responsible Authority or Owner.

The Engineer shall have the power to restrict the Contractor’s use of any roads, either in direction of traffic, speed or traffic or numbers of vehicles in order to preserve such roads to make such roads safe for use by the general public.

Where other Contractors require the use of these roads or tracks, the Engineer may prescribe time of usage, or any other form of control, which shall be executed by the Contractor, including the supply of traffic lights, flagmen, or any other thing.

**Site Office and Facilities for Engineer’s Representative**

The Contractor shall provide and erect, equip, maintain, keep clean and remove on completion of the Works a site office to be used by the Engineer’s Representative and other employees of the Engineer. The office is to be erected on site and in such position as the Engineer may direct. The cost thereof shall be charged under the appropriate Provisional Sum in the Bills of Quantities.

**Transport For Workmen**

The Contractor shall provide adequate transport for the conveyance of his workmen to and from site at all times. Such transport shall be kept in good condition and comply with required roads and traffic regulation in force.

**Demolition of Contractor’s Temporary Buildings**

The Engineer may at any time before the end of the period of maintenance give the Contractor notice in writing to demolish and remove those buildings and works which are no longer required, whereupon the title to such buildings and works and all materials connected therewith shall revert to the Contractor. After the demolition and removal of buildings and works as required by the Engineer, the Contractor shall level, clear, restore and make good the site and surrounding ground and fill in and compact all latrines, drains, pits and similar works leaving the whole area in a neat and tidy condition to the satisfaction of the Engineer’s Representative acting in conjunction with the Medical Officer of Health.

**Sanitary Convenience and First Aid**

The Contractor shall make his own arrangement for the provision of sanitary conveniences with all necessary drainage on the Site for the use of his staff and workmen and shall make all necessary arrangements thereof with the competent authority to the approval of the Engineer.

The Contractor shall make his own arrangement for the treatment of casualties on site and provide and maintain sufficient first aid appliance which shall at all times be available for use. In addition at least one person permanently on the Site shall be instructed in its use and the person so designed shall be made known to all employed by the posting of his position at the Site.

Protective Clothing

The Contractor shall provide all protective or any other special clothing or equipment for his employees that may be necessary.

Temporary Water and Electricity Supplies

**Water**

The Contractor shall make all arrangements for an adequate supply of water to each construction site both for carrying out the Contract and as potable water for his workmen. The water shall be of a chemical and purity standard such that it will not pollute, injure or cause any deterioration of the Works, and it shall generally comply with the requirements specified in that section of the Specification dealing with concrete.

Electricity

The Contractor shall make arrangements for and provide any electricity supply for the execution of the Works. The electricity supply shall meet the safety standards for temporary installations.

**Inspections By Engineer During Period of Maintenance**

The Engineer will give the Contractor due notice of his intention to carry out any inspections during the Period of Maintenance and the Contractor shall thereupon arrange for a responsible representative to be present at the times and dates named by the Engineer. This representative shall render all necessary assistance and take note of all matters and things to which his attention is directed by the Engineer.

**Advertisements**

No advertisements shall be placed on any boarding, fencing or scaffolding erected for any purpose connected with the Contract without the written permission of the Engineer.

Sample

General

Before incorporating in the finished work any material or articles to be supplied by the Contractor under the terms of the Contract the Contractor shall submit to the Engineer’s Representative for approval a sample of each respective material or article and such samples shall be delivered to any kept at the latter’s office for reference. All the respective kinds of materials and articles used in and upon the Works shall be at least equal in quality to the approved samples. Each and every sample shall be a fair average of the bulk material or of the article, which it represents. The Engineer’s Representative shall decide on the method of sampling.

The responsibility for ordering and delivering materials and manufactured articles and ensuring that samples are tested sufficiently far in advance of the work as not to delay it shall rest upon the Contractor and he shall not be entitled to anytime credit for delays occasioned by his neglect to order sufficiently well in advance or to payment of any costs he may incur as a result thereof.

With regard to any item in the Bills of Quantities which is the subject of a Provisional Sum the Contractor shall notify the Engineer of his work schedule requirements in ample time for the Engineer to make all necessary arrangements so that no delays occur in the progress of the work.

Testing of Materials and Manufactured Articles Before Use

Any or all of the material and manufactured articles supplied by the Contractor for use in any of the Works shall be subject in advance to such tests as may be specified in the relevant British Standard or as may from time to time be deemed necessary by the Engineer.

Facilities for Engineer’s Representative to Take Sample

The Contractor shall provide facilities for the Engineer’s Representative to take samples for testing of any of the concrete or other materials to be incorporated in the Works. Such samples may be taken before or after incorporation into the Works or at any state during construction at the discretion of the Engineer’s Representative.

**2.2 QUALITY OF MATERIALS AND WORKMANSHIP**

**General**

The materials and workmanship shall be the best of their respective kinds and to the approval of the Engineer. In the reading of the Specification the words “to the approval of the Engineer” shall be deemed to be included in the description of all operations for the due execution of the Works.

Rejected Materials

Should any materials or manufactured articles be brought on to the Site which, in the judgement of the Engineer, are unsound or inferior quality or in any way are unsuited for the work in which it is proposed to employ them, then each materials or manufactured articles shall not be used upon the Works but shall be branded, if in the opinion of the Engineer this is necessary, and shall forthwith be removed from the Site.

**Quality Control**

The Contractor shall be responsible for his own quality control and shall provide sufficient competent personnel on the Site for taking and preparing samples and for carrying out necessary tests.

**2.3 EXISTING SERVICES AND INSTALLATIONS**

**General**

The Contractor shall take every precaution to ensure that all existing services, pipes, culverts, cables, boundary walls and fences, retaining walls, drainage and irrigation ditches etc. within and near the line of excavation are located, supported and safeguarded from damage. Any damage caused to such services, pipes, culverts, cables, boundary walls and fences, retaining walls, drainage and irrigation ditches etc. attributable to the Contractor’s operations, his constructional traffic or his negligence shall be made good by the Contractor at his own expense to the satisfaction of the Engineer, Owner or responsible Authority.

In the event of the Owner or responsible Authority electing to repair such damage the Contractor shall pay the cost of his or their so doing the work. Should the Contractor fail to pay the cost of the said work within a reasonable period of the account being presented, the Employer reserves the right to settle the account and deduct the sum paid by him from moneys due or which may become due to the Contractor.

**Temporary Removal of Existing Services**

If it should become necessary for the proper execution of the work temporarily to remove or divert any existing pipe, sewer, field drain, cable, drainage or irrigation ditch or other service, the Contractor shall obtain permission from the competent Authority or Owner and shall carry out the work at his own expense in a manner and at times to be approved by such Authority or Owner.

In the event of the Owner or responsible Authority electing to arrange for the temporary removal of an existing service, the Contractor shall pay the cost of his or their doing the work. Should the Contractor fail to pay the cost of the said work within a reasonable period of the account being presented, the Employer reserves the right to settle the account and deduct the sum paid by him from moneys due or which may become due to the Contractor.

The Contractor’s attention is particularly drawn to the requirement to maintain drainage and irrigation ditches in order to avoid any interruption of low water therein to the satisfaction of the Engineer, Owner or responsible Authority and the Contractor shall be deemed to have included in his rates and prices for all temporary works so required.

Permanent Diversion of Existing Services

If in the opinion of the Engineer and/or of the Competent Authority or Owner it should become necessary permanently to remove or realign any existing pipe, sewer, field drain, cable, ditch or other services, other than allowed for in the Bills of Quantities, the Contractor shall obtain permission, where necessary, from the competent Authority or Owner and shall carry out and complete the work to the satisfaction of the Engineer and such Authority or Owner. Payment for such additional work will be made in accordance with the Conditions of Contract, provided always that the necessity for such permanent diversion has not arisen due to the fault of the Contractor.

In the event of the Owner or responsible Authority electing to arrange for the permanent diversion of an existing service, the permanent diversion of which has become necessary due to the fault of the Contractor, the Contractor shall pay the cost of this or their doing the work. Should the Contractor fail to pay the cost of the said work within a reasonable period of the account being presented, the Employer reserves the right to settle the account and deduct the sum paid by him from the moneys due or which may become due to the Contractor.

Setting Out

Before the Works or any part thereof are begun, the Contractor and the Engineer or the Supervising Officer shall together survey and establish the levels of the whole site of the Works and agree on the levels so taken. These levels shall be recorded in a site plan and shall form the basis of measurement for excavation and all other works where the site levels have bearing. The Contractor shall give 24 hours’ notice to the Engineer of his request for the setting out to be checked and shall provide all instruments, tapes, etc. ad assistance in the checking thereof. The Engineer will give the Contractor the height of and indicate to him the position on Site of all full responsibility thereafter for maintaining them intact and accurate. The Contractor must ensure that all plant operators, and key men working on the Site are made aware of both of the positions of all important line and levels marks in order not to cause any disturbance of same.

**Progress Report**

The Contractor shall submit to the Engineer on the first day of each week or such longer period as the Engineer may direct, his progress report for the preceding period showing up to date progress on all important items of such section or portion of the Works, number and classes of labour and supervisory staff employed and constructional plant. Notwithstanding the submission of this Progress Report the Contractor shall report to the Engineer promptly in writing the particulars of any accident or unusual or unforeseen occurrence on the Site, whether likely to affect the progress of the work or not, stating also the steps he has taken or its arranging to take in the matter.

**Photographs**

Before commencing and during the progress of the Works, photographs shall be taken by an approved photographer of the site, building, erection works, machinery, plant etc, as may be directed by the Engineer. The photographs shall be of such size and supplied in numbers as may be directed by the Engineer.

**Clearing of Site**

Before final acceptance and upon the completion of the work the Contractor shall at his own expense, remove and dispose of all rubbish and remove all equipment, surplus materials, camps and construction buildings which the Contractor has provided and such temporary works as ordered by the Engineer and shall leave the Site absolutely clean thereof and in good order and condition to the entire satisfaction of the Engineer.

**2.4 EARTHWORKS**

**Description and Scope**

Earthworks shall consist of performing all operations necessary to excavate earth and rock, regardless of character and sub-surface conditions; to excavate all materials of whatever nature, necessary for the construction of foundations for structures and other aspects of the Works; to excavate drainage channels; to excavate selected materials from the roadway and borrow material for use as specified to construct embankments including the placing of selected material in connection therewith as specified, to backfill for structures, culverts and other aspects of the Works; to backfill trenches and depressions resulting from the removal of obstructions to backfill holes, pits and other depressions (within the area of the Works); to remove, dispose and replace unsuitable material; to excavate and grade road approaches to construct protection cofferdams where necessary; to remove slide material which has slipped from embankments; to prepare basement material for the placing of other material thereon; all labour, materials, tools equipment, including timbering, pumps, removal of water, fencing, lighting, watching, reinstatement and maintenance of surfaces and every other expense entailed in complying with the Specifications.

**Removal of The Topsoil**

Before commencing any excavation or other work in any area of the work, including rights of way for pipelines, the topsoil shall be removed in accordance with the areas indicated on the plans, pulling up all trees, shrubs and other vegetation which shall be disposed off to the satisfaction of the Engineer.

All grass, topsoil and other surface materials shall carefully be separated, should they be required to be re-used on the Contract.

Should it be necessary to remove the topsoil in other areas outside the area indicated on the plans for the construction of roads, storage areas and the like or for borrow areas, quarries, the waste shall be disposed off in accordance with the requirement of the Engineer.

The Contractor shall take all necessary precautions for the protection of those trees that the Engineer wishes to maintain in those areas where the topsoil is to be removed. This requirement shall apply to the areas of the permanent works as well as temporary ones.

**Ground Levels and Measurement of Excavation**

After having completed the removal of the topsoil and before commencing any other excavation or filling, the Contractor shall take levels at frequent intervals and agree upon them with the Engineer’s Representative. The depth of excavations shall be taken as the depth from the ground surface after removal of the topsoil to the levels designated on the drawings, except that if the Engineer orders additional excavation below the required formation level the extra depth shall be added to the direct measurement.

Where it is necessary to form, extend or deepen the foundation under or around any part of the new or existing works, the additional excavation so ordered by the Engineer will be paid for as extra work, unless in the Engineer’s opinion the extra work is due to the Contractor’s method of working.

Where measurements are based on volumes, where for excavation in open trench, backfilling excavations with concrete or other approved material, or for any other purpose, the dimensions of excavation shall, for the purpose of measurement and payment, be taken as the plan dimensions except otherwise specified. The Contractor should in his rate make due allowance for working space.

Nature of Ground

The Contractor shall satisfy himself of the nature of the ground to be excavated and his prices are to include for excavating in whatever soil that may be met with exception of concrete, blockwork, masonry and rock, which shall be measured and paid for separately.

Turf, topsoil to a depth not exceeding 300mm and any artificial paving or surfaces of any kind shall be excavated separately from the sub-soil and kept separately for re-use in reinstatement or to cover excavations, embankments or tips as directed by the Engineer.

**Existing Services**

The Employer accepts no responsibility for the correct representation on the Drawings of existing services nor for any omission, and before commencing excavation the Contractor shall satisfy himself as to the correct nature and location of services which may be affected.

The Contractor will excavate, refill and reinstate in advance of commencing the works all trial pits that are necessary to locate pipelines, cables, rock etc. The cost of these holes shall be measured and paid for separately.

The diversion of an existing service will be ordered by the Engineer if it would obstruct the permanent works. The Engineer will also order the permanent or temporary diversion of services when in his opinion it is reasonable that this should be done before carrying out the work. The diversions referred to above shall be paid for under the Contract, but any other diversion requested by the Contractor shall be at his own expense.

No service diversion shall be made without the approval of the Engineer and the responsibility Authority.

**Excavation**

The Excavation shall proceed with such portions at one time as the Engineer may direct. No concrete shall be placed, no pipes laid and no permanent works of any kind begun upon the surface prepared by excavation without the permission of the Engineer.

Any excavation made by the Contractor below the depths shown on the Drawings in order to remove unsuitable base material or ordered by the Engineer is to the filled with Concrete Grade 15. The volume of such concrete is to be measured separately and paid at the appropriate rate.

Where excavation has been carried out to a depth greater than that specified by the Engineer, the Contractor shall at his own expense fill the void with Concrete Grade 15 or as the Engineer may direct.

Excavation shall not be carried down in the first instance to a depth nearer than 150mm to formation level; the bottom-up to formation shall be done by hand immediately in advance of placing concrete or pipe laying.

If indicated by the Engineer the trench for the pipe work will be excavated 10cm. Below the bottom of the trench and it will be refilled with material free of stones and well compacted in order to provide a suitable foundation for the pipework.

The Contractor shall also take such steps as are necessary to prevent damage to the formation due to exposure to the atmosphere. Should any part of the formation be damaged by the Contractor’s negligence or method of working such portion shall be further excavated to such depths as the Engineer directs and refilled to original formation level with Concrete Grade E or selected material, all at the expense of the Contractor.

**Mechanical Excavation**

Mechanical Excavators will only be used where the soil conditions so permit or it is possible to install temporary supports so that the trenches or other excavations are sufficiently stable. When mechanical excavators are used a layer of material of sufficient thickness shall be left at the bottom of the excavations in order to be sure that the soil at foundation level is not damaged or disturbed. The excavations shall be completed to the final levels by hand.

**Extent of Excavation**

All excavation shall be carried out to the required lengths, depths, inclinations and curvatures as shown in the Drawings or as may be necessary for the construction of the works in whatever material that may be found and the surplus soil shall be disposed of as specified.

**Excavated Materials**

All excavated material shall be deposited so that it will cause as little damage and inconvenience as possible.

If required by the Engineer, different classes of material shall be deposited and kept separately. The Contractor shall arrange for handling different classes of material and for re-handling all excavated materials as often as may be necessary.

Excavation for Foundation: Structure Excavation

Structure Excavation shall consist of the removal of material for the construction of foundations for retaining walls, headwalls and handwalls for culverts and other structures, the excavation of trenches for culverts and pipes, rods, cut-off walls for slope paving and concrete aprons, footings and end return and cut-off stubs for slope protection and other excavation designed on the plans or in these specifications or in the special provision as structure excavations.

Foundations will be excavated to the depths indicated by the Engineer and concrete and other material shall not be placed until the excavations have been examined and approved by the Engineer.

The Engineer will be advised in advance in order to permit the examination of the foundations before the placement of concrete etc.

If in the opinion of the Engineer the excavation has deteriorated before the placing of concrete or other materials by the fault of the Contractor the unsatisfactory soil shall be removed and replaced by selected granular fill approved and compacted to the level of the original formation.

**Excavation for the Installation of Pipeline**

The width of any trench for pipework of whatever diameter will be the minimum required for the installation of the pipe and for the installation of temporary supports, should they be necessary. The width of the trench shall be approved by the Engineer. All pipework shall have minimum 150mm sand bedding below and above crown level and around it.

Materials taken from the trenches will be placed at the side of the trench except when in the opinion of the Engineer the materials will obstruct the passing of traffic or pedestrians. In such a case, the Contractor will excavate the trench to short lengths approved by the Engineer and will keep the excavated material at a convenient distance.

The bottoms of the trenches will be maintained level and uniform and free of stones and other obstructions, where pipes are to be installed without a granular or concrete bed. Holes made for the joints will be of a minimum size and the pipework will be supported uniformly over the full length.

The length of trench to be excavated in advance of pipelaying shall not exceed 150 metres. If in the opinion of the Engineer and by fault of the Contractor the excavation has deteriorated before the installation of pipework the unsatisfactory material shall be removed and replaced by selected compacted fill to the level of the original formation.

**Excavation in Excess**

If any trench or foundation is excavated by mistake, deeper or wider than necessary the excess excavation shall be filled with concrete or selected granular fill approved and compacted to the original formation level, all at the expense of the Contractor.

**Inspection of Foundation and Blinding Concrete**

Whenever any structure excavation is completed, the Contractor shall notify the Engineer who will make an inspection of the foundation. No blinding concrete or masonry shall be placed until the foundation has been approved by the Engineer.

All foundations for walls, columns, floors, manholes or similar structures of reinforced concrete will be covered with a layer of blinding concrete Grade 10, 50mm thick to form the base for the structural concrete. Blinding concrete shall be placed immediately after having completed the excavation.

**Surplus Excavated Materials**

If the excavated materials are appropriate and comply with the technical specifications, they may be used in the construction of the Works. All excess excavated material will be disposed of to a site approved by the Engineer, the Contractor paying all charges in connections therewith.

The Contractor will be allowed to dispose of those excess excavated materials within the areas indicated (should there be any) on the plans.

The materials disposed of in these areas will be placed in layers and consolidated all in accordance with Clause on embankments and shall be of such shape, slope dimension and levels as directed by the Engineer. These embankments will be grassed all as specified in Clause 2.41 and 2.42.

The cost of placing the excess materials including any grassing will be included in the prices quoted for excavation.

**Disposal**

The prices for the disposal of excavated material are to include for the selection of spoil as it arises and for all re-handling or re-excavation from spoil heaps as may be required.

**Hardcore and Ballast**

Hardcore is to be composed of hard, clean, dry broken stone, concrete, rock laterite or other suitable material approved by the Engineer, free from dust or other foreign matter and broken to pass a 76mm ring and to be retained on a 50mm ring.

The hardcore to be used in the foundations for pavements and similar paved areas will consist of hard solid stone or broken rock or concrete derived from excavations or the demolition of structures and will be of 80mm nominal size.

A small quantity of ballast may be used to level the surface of the hardcore at the discretion of the Engineer’s Representative.

The ballast which is to be used in the foundations for roads, temporary restoration etc. will be of good qualify and approved by the Engineer’s Representative.

**Laterite**

Laterite is to be hard, clean, dry selected, roughly graded rock laterite free from dust or other foreign matter and broken to pass a 100mm ring.

The hardcore and laterite beds are to be deposited and consolidated in layers not exceeding 150mm thick and are to contain sufficient fine material to form a solid and homogenous mass and are to be thoroughly consolidated by tamping and rolling with heavy roller and the top surface blinded with approved fine material and finished to exact levels to form a clean and solid foundation.

**Embankments, Tops and Fills**

Only suitable portions of the excavated material shall be used in refilling, where ordered by the Engineer, selected material from an approved source shall be imported for refilling, for which extra payment will be allowed.

The Engineer may direct the Contractor to place selected excavated material anywhere. Such material will not become the property of the Contractor and nothing in this Specification shall be construed to give the Contractor the right of ownership.

The Contractor will not be permitted to incorporate in the Works any sand, gravel, puddle clay, or other material arising out of the excavations except with the permission in writing of the Engineer.

Except where otherwise specified or ordered the refilling of pipe trenches, around the pipes and to a consolidated depth of 300mm (minimum) above the crown of the pipe or the toe of the surround shall be done with selected material free from the large stones or rock. The fill shall be deposited by hand in layers of not more than 225mm thick, watered, if the Engineer considers this necessary, and consolidated by hand rammers in separated layers.

All other fill in trenches or other excavations shall be consolidated in an approved manner. If hand rammers are used, the depth of each layer shall not exceed 225mm before consolidation. If mechanically operated rammers are used, the depth of each layer shall be determined by the Engineer but shall not exceed 600mm.

The water content of the filling materials shall when placed be as near to its optimum as practicable. If in the Engineer’s opinion it is too wet, it shall not be used, if too dry, it shall be watered at the expense of the Contractor in an approved manner during refilling.

Before placing material of any description on natural ground surfaces the topsoil of such surfaces shall be excavated and removed as directed by the Engineer.

Embankments and tips shall be raised by approved methods with selected materials, and after thorough consolidation, shall be carefully trimmed to the forms, dimensions and inclinations specified or ordered by the Engineer.

The Contractor shall make due allowance for consolidation and settlement of embankments and tips both in width and height and shall make good at his own expense any subsidence that may occur.

**Slides And Slipout**

The Contractor shall excavate and remove material outside the planned area of the Works, which in the opinion of the Engineer is unstable and constitutes potential slides. The material shall be excavated to designated lines or slopes either by benching or in such manner as directed by the Engineer. Such material shall be used in the construction of embankments or disposed of as directed by the Engineer.

Where slopes have been previously completed by the Contractor and resloping is required in areas where unstable or stable material is removed at the direction of the Engineer the cost of resloping shall be paid for at the appropriate rate.

The above provisions shall not be so construed as to relieve the Contractor from the duty of maintaining all slopes true and smooth. Erosion, regardless of amount or extent caused by the action of the elements which results in damage to work or materials, shall in no way be considered a slide or slipout.

**Timbering**

The term timbering shall cover all normal methods of temporary support including the use of timber, concrete, steel sheet piling or such other materials as may be approved by the Engineer.

Where necessary in the opinion of the Contractor or of the Engineer, the Contractor shall supply and fix without extra cost to the Employer strong and sufficient timbering to support the sides and/or bottom of the excavations to the satisfaction of the Engineer.

Where any excavation is carried out near or under any existing structure or work liable to be affected by subsidence, the Contractor shall at his own expense prevent damage by subsidence due to his temporary works, in a manner approved by the Engineer.

All timbering shall be properly maintained until the permanent work is sufficiently advanced to permit the timbering to be removed. The removal of timbering shall be carried out only under the supervision of a competent foreman.

The Contractor shall be responsible for any injury to the Works and for any consequential damage caused by or arising out of the removal of timbering and the Engineer’s permission or approval to the removal of timbering shall not relieve the Contractor from this responsibility.

If, when the excavations are being filled in, it is necessary in the opinion of the Engineer, to leave in position any timbering, the Contractor will be paid for such timbering at the appropriate rate provided that in the opinion of the Engineer the necessity has not arisen from carelessness or neglect by the Contractor.

When a concrete bed, granular or selected fill is required in the trenches the timbering shall be designed to permit the gradual withdrawal during the placing of the bed or fill and this shall be effected in such a manner that no gaps or voids are left between the bed or fill and the sides of the trenches.

**Excavation of Rock or Hard Material**

For the purpose of payment under this Contract, rock is defined as natural material which is so hard that, in the opinion of the Engineer, it cannot be removed by the ordinary methods of hand or machine excavation without undue difficulty or the solid surface or layer of material that cannot be removed without the systematic use of the explosives or barring and wedging, boulders and pieces of rock of more than 0.5 cubic metres in volume.

No excavation of material that can be made with pick and shovel will be considered as rock for the purposes of payment.

If any dispute should arise as to whether or not the material or any excavation is to be classified rock the dispute shall be referred to an independent Consulting Engineer to be agreed upon between the Parties, the decision of such Engineer to be the final and binding upon the Parties.

**Foundation Treatment**

When footing concrete or masonry is to rest upon rock, the rock will be fully uncovered and the surface thereof shall be removed to a depth sufficient to expose sound rock. The rock shall be roughly levelled off or cut to approximate horizontal and vertical steps and shall be roughened. Scams in the rock shall be grouted under pressure or treated as the Engineer may direct and the cost thereof shall be paid as extra work at the appropriate rate.

**Drainage of Trenches in Rock**

The Contractor will keep the surfaces of the rock on which concrete is to be placed, free of running water and concrete will not be placed until the surfaces of the rock have been drained.

Special precautions will be taken in order to avoid running water washing the cement or the concrete during setting or in any other way damaging the works.

Drains and pipes will be provided within or behind the concrete works should it be necessary temporarily to remove water. The pipes will be refilled with cement mortar and the installation and the refilling will be paid for by the Contractor.

**Cleaning of the Rock Surface**

The surface of all rock on which concrete is to be placed will be adequately cleaned after having been excavated to the required limits and will be kept free of all dust, stones, loose rock, dirt and other soft materials and will be kept perfectly clean when concrete is being placed.

**Explosives**

The Contractor must comply with all the laws, regulations and appropriate requirements of the code of security and the relative regulations handling, storage and use of explosives, protection of life and property.

The Contractor shall not use any explosives without the permission in writing of the Engineer who shall require evidence from the Contractor that all relevant legislation of the Government of Ghana has been complied with. When such permission is given excessive blasting shall not be permitted. Any material outside the authorised cross-section which may be shattered or loosened because of blasting shall be removed by the Contractor at his own expense. The Contractor shall discontinue any method of blasting which leads to overshooting or is dangerous to the public or destructive to property or to natural features.

Every precaution will be taken for the use of explosives, placing of the changes and the quantity so as not to damage any existing structure foundation or adjacent soils of the proposed or existing works.

Heavy covers of other acceptable protection will be provided or the excavations will be refilled with sand or any approved material before detonation of the explosive in order to confine all the materials that are to be removed.

The Contractor will supply a special store suitable for explosives and will provide men experienced in the handling of explosives all to the satisfaction of the Engineer or interested Authorities. The Contractor will take every precaution in order to avoid loss or damage that result from the use of explosives.

**Control of Water**

The Contractor shall keep all excavations clear of water. The Contractor shall provide, operate and maintain a system satisfactory to the Engineer of temporary drains, intercepting ditches, cut-off drains, sub-drains, sumps, well points, dewatering equipment and all other things necessary to keep surface water out of the excavations, sub-soil water or water from any other source to maintain the water table below the formation level.

The Contractor shall convey the water from the Works in such a manner as not to cause any nuisance or injury. Particular care shall be taken to avoid undermining any part of the new or existing works due to the method adopted for the removal and disposal of water. No pipes or culverts in the new or existing works shall be used for this purpose without permission in writing from the Engineer. Should such permission be given, the Contractor shall be responsible for cleaning out and removing all silt, etc. and for making good any damage whatsoever resulting from such use.

The Contractor shall obtain the written permission of the statutory Authorities and Owner’s before connecting temporary drainage to existing drains, sewers and watercourses.

All temporary works for the control of water shall be sited clear of the Works, the pipes shall be laid with a 76mm surround of gravel, and the top surface of the surround shall be covered with tarred felt cloth or other approved material.

Unless otherwise directed by the Engineer all temporary drains and sub-drains shall be finally sealed with concrete at intervals to the Engineer’s satisfaction, and all temporary ditches, sumps, wells, etc. shall be refilled and reinstated as specified elsewhere.

Springs in Excavation for Foundations

Any spring discovered in the foundations for structures will be dealt with in accordance with the instructions of the Engineer, before placing any fill.

**Porous Fill for Drainage**

The porous fill for drainage, which is used as filling behind walls, will consist of solid hard stones or rock or concrete obtained from the demolition of structures. The particles will be approximately cubic form and the size of 8m³ to 3m³. Small particles, dust, rubbish and organic matter will not be included.

**Selected Gravel for Drains**

The gravel around drainage pipes will be clean washed stones of hard broken rock and will have a size ranging from 20mm to 5mm.

**Structure Backfill**

Structure backfill shall consist of furnishing, placing and compacting backfill material around structures to the lines designated on the plans or specified or directed by the Engineer.

**Structure Excavation and Structure Backfill**

Structure excavation and structure backfill shall include the furnishing of all materials and equipment and the construction or installation of all cofferdams and other aspects of the Works which may be necessary to perform the excavations and place and compact the backfill and the subsequent removal of such aspect of the Works, except where they are required or permitted by the plans or Specifications to remain in place.

When shown on the drawings or directed by the Engineer, recesses at culverts inlets shall be excavated in excavation slopes to the dimensions designated and the resulting material disposed of in roadway embankments as directed by the Engineer and such work will be paid for as structure excavation for the quantities involved.

Materials from structure excavation not used as structure backfill shall be deposited in roadway embankments or disposed of as surplus material, all as directed by the Engineer, and no additional compensation shall be allowed for such work.

**Structure Backfill Operations**

Structure backfill operations shall conform to the following requirements:

Material for use as structure backfill shall have sand equivalent (percentage of sand) value nor less than 30. The percentage composition by weight as determined by laboratory sieves shall conform to the following grade:

Sieve Size Percentage Passing

75mm 100

No. 4 35 - 100

Structure backfill shall not be placed until the structure footings or other portions of the structure or facility have been inspected by the Engineer, and approved for backfill. No backfilling material shall be deposited against the back of the concrete retaining walls or the outside walls of cast-in-place concrete structures until concrete has developed a strength of not less than 20N/mm² as determined by the standard 150mm cube tests.

Approval of the Engineer shall not relieve the Contractor of his liability to make good any concrete, which may be damage by premature backfilling of walls.

Swell or Subsidence

When swell or subsidence results from driving piles, the Contractor shall at his own expense, excavate or backfill with structure backfill material, the footing area to the grade of the bottom of the footing as shown on the drawings.

**Refilling of Trenches for Pipework**

Material to be used for the permanent refilling of trenches as specified in article 96 will be selected material obtained from the trench excavation which will form a solid homogeneous fill after compaction. All materials of high organic content material containing rubbish, organic fill or similar waste will be rejected and disposed of to an approved site selected by the Contractor.

Refilling around the pipe and for 15cm above the pipe will be with material free of stones all to the satisfaction of the Engineer, if necessary, the material will be sieved in order to remove materials that should damage the pipe and it will be only lightly compacted with hand tampers in uniform layers not exceeding 10cm of compacted thickness.

Particular attention will be paid to the refilling of the holes excavated for the joints at the sides of the pipes in order to obtain a firm and solid fill.

Before commencing the refilling and compaction of the rest of the trench the Contractor will obtain the agreement of the Engineer to the methods and equipment he proposes to use for the refilling and the compaction and it would have been shown by tests that a degree of compaction not less than 95% could be achieved. At all times the methods of compaction shall be to the satisfaction of the Engineer and once agreed it will not be changed without the approval of the Engineer.

During the excavation of trenches the Contractor shall make sure that the material which is appropriate for the filling around the pipe is separated for further use.

The Contractor will supply an additional material required for filling around and on top of the pipe.

Laying and Compaction of Material

Backfill material, both structure and previous, shall be placed in horizontal uniform layers not exceeding 225mm in thickness before compaction and shall be brought up uniformly on all sides of the structure or facility. Each layer of backfill shall be compacted to a relative compaction of not less than 25%. Compaction equipment or methods that produce horizontal or vertical earth pressures, which may cause excessive displacement or may damage structures, shall not be used. The walls shall be well propped to the Engineer’s satisfaction before compaction commences.

At locations where material would be exposed to erosion, graded rubble shall be covered with at least one foot layer of earth material approved by the Engineer.

**Rock fill**

Rock fill will consist of a mixture of hard and solid broken rock obtained from a quarry approved by the Engineer. The broken rock will have a grading between size 30mm and 10mm and will not contain more than 5% dry weight of material that will pass a 10mm sieve.

**Repair of Settlement of the Refilling**

Whatever settlement that occurs in the refilling caused by inadequate compaction will be repaired by the Contractor with additional compacted material as ordered by the Engineer.

**Reinstatement**

Unless otherwise specified the permanent reinstatement of trenches or any other excavated areas, shall restore the surface to its original condition so far as practicable.

Permanent reinstatement shall not be carried out until the fill is fully consolidated and not normally within six months of completing the filling. During the intervening period the surface shall be temporarily reinstated and maintained to the satisfaction of the Engineer and in a manner adequate for its function.

After refilling and surface reinstatement has been completed, the site shall be cleared, without delay, of surplus materials, spoil, rubbish and other waste matter.

**Formation of Embankments and Areas of Fill**

Embankments and fill areas will be made to the levels and dimensions and shape that are indicated in the plans or as directed by the Engineer.

Before commencing any refilling, the ground on which the embankments are to be constructed shall be cleared of all grass, turf, topsoil and any unsuitable materials.

**Topsoil and Grassing**

Cultivated areas will be of selected fertile sieve black soil placed in a uniform layer of the thickness not less than 100mm and will be raked in order to provide a suitable finish.

The areas to be grassed will be grassed with an improved local turf. Should the turfing not give satisfactory results or for whatever reason the turf is destroyed, the areas will be once again turfed. The turf will be looked after until the grass is fully established.

Grassing on embankment slopes will be carried out immediately after the construction of the embankment.

Before turfing, all levelling and finishing of the areas must be done to the satisfaction of the Engineer. Once approved, an appropriate fertilizer will be applied uniformly to the area to be turfed all in accordance with the recommendations of the manufacturer. The turf will be cut and weeded until the work has been approved and accepted by the Engineer.

Restoration of Borrow Areas, Tips and Quarries

Any quarry or borrow area used by the Contractor for the construction of the Works will be restored to a safe condition and the slopes will be adequate and to the satisfaction of the Engineer. The areas will be turfed when so required by the Engineer. The cost of these works will be included in the Contractor’s prices.

**Ensuring Public Safety**

The Contractor shall so conduct his operations as to offer the least possible construction and inconvenience to the public. In this connection the Contractor shall conduct his haulage operations in such a way that no spillage shall result along or across any public place or travel way. Any spillage resulting from haulage operations along or across any public place or travel way shall be removed immediately by the Contractor at his own expense.

Whenever the Contractor’s operations create a condition hazardous to traffic or to the public, he shall furnish, erect, and maintain at his own expense such fences, barricades, signs, lights and other devices as are necessary to prevent accidents or damage or injury to the public. The Contractor shall also furnish such flagmen and guards as are necessary to give adequate warning to traffic or to the public of any dangerous conditions to be encountered and payment, therefore, should be made according to the appropriate rate. Flagmen and guards, while on duty and assigned to give warning to the public that the highway is under construction of any dangerous condition to be encountered as a result thereof, shall perform their duties and shall be provided with the necessary equipment in accordance with the current “instructions to Flagmen” of the Ghana Highway Authority.

**Anti-Termite Treatment**

All termite nests on the Site shall be opened up, the Queen extracted and destroyed. The nest shall be broken open at the top and treated with chemical approved by the Engineer.

The nests and surrounds, 3 days after treatment with approved chemical, shall be totally excavated 300mm in each direction clear the fungus gardens and filled with approved material.

During building operations on the Site the Contractor is to make careful inspection daily and runways traced and treated as described above until termite life is exterminated.

**2.5 EMBANKMENTS**

**Tests for Quality of Materials and Control of Construction**

Before any section of the embankment is commenced and during its construction, tests as required by the Engineer shall be carried out in order to determine the quality of materials and the required degree of compaction in the fills. The Engineer may make use of the following tests:

Plasticity Index Tests

Grading Tests

Moisture Content Tests

In-situ dry density measurements

Compaction Tests

In-situ and Laboratory CBR Tests

Tests 1, 2, 3 and 4 shall be carried out in accordance with B.S. 1377, 1961, the sand replacement method being used for the measurement of dry density in-situ.

The compaction tests shall be carried out in a mould 150mm internal diameter and 125mm internal height. The mould shall be filled in 5 equal layers, each layer given 25 blows of a 4.5kg hammer falling freely 450mm (Ghana Compaction Standard Modified A.A.S.H.O. compaction rammer).

The condition of tests for laboratory C.B.R. tests shall be agreed upon by the Engineer before commencement of the Works. Failing this, laboratory C.B.R. tests shall be carried out on materials at the optimum moisture content given by compaction tests.

Preparation of Ground Before Placing Embankment

Before replacing embankments and where required by the Engineer, the topsoil shall be stripped to a depth of 150mm or as directed.

If after the soil has been stripped and the ground in any area is not suitable, in the opinion of the Engineer, for placing the fill, the Contractor shall excavate this area to such additional depth as directed by the Engineer and shall dispose of the excavated materials as directed by the Engineer.

Compaction

The imported material shall be dug, spread and compacted with a minimum of delay so that the material is compacted at its natural moisture content without being allowed to dry or wet up. Compaction shall be carried out by means approved by the Engineer. Irrespective of compaction carried out by the special equipment, maximum use shall be made of all construction traffic to assist in the compaction of all earthworks. All construction equipment must operate over the whole area to ensure uniform compaction. All filling shall be deposited in layers of not greater than 225mm loose depth. Longitudinal and transverse joints in any two successive layers shall be staggered by a minimum of 3 metres.

Compaction of Rock fill Embankment

The rock shall be placed in level layers approximately 600mm in thickness. The materials shall be reasonably graded to prevent the occurrence of large air voids in the finished work. Each layer shall be thoroughly rolled and sluiced with water. The quantity of sluicing water shall be not less than twice the volume of rock in the layer and under sufficient pressure to ensure that all fines will be washed down to fill interstices amongst the large stones.

**Fill on Steep Slopes**

Where embankments are to be placed on side slopes steeper than 1 in 5, provision shall be made to ensure a bond between them and the old ground by ploughing furrows at least 225mm deep and 600mm apart, parallel to the centre-line of the road or as directed by the Engineer.

**Fill Adjacent to Culverts**

Special attention shall be paid to the compaction of filling material placed over a distance of 7.5 metres or 3 times the depth of fill whichever is greater, measured from culverts. Compaction shall be carried out if necessary by suitable punners or other approved means so that a wedge of material tapering to zero depth or such other depths as may be directed by the Engineer at the above distance from the culvert shall have a compaction of 100% of the maximum dry density. The Engineer may direct that the filling of this wedge shall be carried out with laterite gravel or other specially selected materials.

**Fill Material for Top 600mm Earth Embankments**

Material for the top 600mm of each fill embankments shall be free from clay lumps and reasonably free from vegetable matter and perishable material. Lumps of rocks or earthly material shall be broken down to such a size that they will not interfere with the compaction of the material. The material shall be approved by the Engineer and when compacted in the laboratory at the maximum dry density and optimum moisture content shall have C.B.R. of not less than 10% (determined after 48 hours of soaking). The fill material shall be compacted in layers not exceeding 225mm loose depth or 150mm compacted, and 98% of maximum dry density obtained from laboratory compaction minimum.

**2.6 ROADS, PAVINGS AND WORKSHOP YARD SURFACING**

**Scope**

“PAVING” shall include for supply of all materials, labour, machinery and any other incidentals and shall include for carrying out the Works in accordance with the Specifications and to the complete satisfaction of the Engineer.

Preparation of Formation (Road And Yard)

Excavation or filling for road works shall in the first instance be carried out to a level 300mm below the base of the road or to any such depth as directed by the Engineer.

The 300mm below the base shall be filled as follows:

150mm consolidated sub-base material as specified below, on prepared formation.

150mm consolidated base material as specified below.

A 10 – 20 tonne roller shall be used for compaction.

Sub-Base and Base

The sub-base shall be gravel or other approved material. Material for the base shall be naturally occurring gravels or crushed rock and its quality and grading shall be approved by the Engineer. Where the base material is gravel, it shall normally comply with the condition of grading and plasticity given below.

|  |  |  |  |
| --- | --- | --- | --- |
| B.S. Sieve Size | Percentage Passing | | |
| Nominal Maximum Size | 76mm | 38mm | 19mm |
| 76mm  38mm  19mm  10mm  5mm  No. 7  No. 14  No. 25  No. 52  No. 200 | 100  80 – 100  60 – 80  45 – 65  30 – 50  -  -  10-30  -  0 - 10 | 100  80 – 100  55 – 80  40 – 60  30 – 50  -  15 – 30  -  0 - 10 | 100  80 – 100  59 – 75  35 – 60  -  15 – 33  -  0 - 10 |

**Asphaltic Concrete**

After a period of not less than 4 weeks or so long as required by the Engineer to allow for consolidation, sufficient material shall be removed to allow placing of 50mm asphaltic concrete.

**Tack Coat**

The surface shall be cleaned of all loose material immediately before the application of a tack coat.

The tack coat shall be applied at a rate of 6 litres bitumen per 16 square metres at a temperature of 130oC or higher. In special cases the Engineer may instruct that an emulsion shall be applied at the rate of 5 litres per 10 square metres. Any collection of the bitumen or emulsion in depressions shall be brushed out.

The application of the tack coat shall be followed immediately by the laying of the asphaltic concrete wearing course. The following temperatures shall be observed:

Mixing aggregate 135oC - 177oC

Binder 135oC - 163oC

Laying 105oC - 132oC

Rolling 93oC - 120oC

The transportation, delivery and rolling of the Asphaltic concrete shall be completed to British Standard 594, Clauses 14, 15 and 16.

**Aggregate for Asphaltic Concrete**

For Asphaltic concrete the coarse aggregate shall be hard, durable, clean crushed igneous rock approved by the Engineer. The stone particles shall be angular but not flaky. Fine aggregate shall be approved clean natural bank, river, dune or pit sand, or quarry sand produced by a secondary plant, free from organic impurities or other deleterious matter. It shall be hard and non-absorbent but necessarily sharp grained.

Not less than 100% should be retained on each successive pair of sieves specified for use, except the largest pair.

The materials passing a No. 36 Sieve shall have the following characteristics (B.S. 1377).

Liquid limit not exceeding 25%

Plasticity Index not exceeding 6%.

Crushed Rock as Base Material

The grading of the crushed rock is not critical but when laid it shall be such that there is a minimum of voids present in the compacted layer. The maximum size of stone used shall be 65mm.

Crushed rock material will normally be found to be different in fine material when laid and during compaction, stone fines (5mm to dust) shall be fed into the surface until the whole layer is chocked and a close well knit surface obtained.

The base and sub-base material shall be spread longitudinally in uniform layers not exceeding 200mm. loose or 150mm compacted and be compacted to 100mm maximum density.

In no circumstance shall sub-base or base material be laid if the previous surface has been affected by rain until it has been made good to the satisfaction of the Engineer.

The C.B.R. value of the sub-base measured in-situ under saturated conditions shall not be less than 35% and the C.B.R. value of the base measure in-situ shall not be less than 80%. When the materials are tested in the laboratory at the maximum dry density these values shall be normally obtained after 24 hours soaking.

**Prime Coat**

The laying of the prime coat shall follow immediately after the base course has been compacted and its C.B.R. and density measured and approved by the Engineer.

If dry, the base course shall be slightly dampened (not wetted) as directed by the Engineer. The prime coat shall be MC/2 bitumen and spread at the rate of 2 litres bitumen per 1 square metre at a temperature of 126oC or higher.

After not less than 3 hours it shall be blinded with 6mm chippings or quarry dust or sand to a rate of 1 cubic metre per 100 square metres or such other rate as may be found necessary to secure adequate coverage. The chippings or quarry dust or sand shall be brushed if necessary to secure even coverage.

**Wearing Coat**

The Wearing Coat shall be a double layer S/125 bituminous treatment at the rate of 1.25 litres/sq.m. including surface preparations and cover with 19mm chippings applied at the rate of 1 cu.m/75 sq.m. at a temperature of between 132 and 160 degrees Celsius and shall be laid as stated below.

**First Coat:** After a period of not less than 14 days or as long as required by the Engineer to allow for consolidation the surface shall be swept clean of all loose material. Shelmac S/125 or similar approved cutback bitumen or other similar approved bituminous compound shall be applied at the rate of 2 litres per 1 square metre of road surface at a temperature of 132oC to 160oC and blinded immediately with 19mm machine crushed chippings applied t the rate of 1 cubic metre per 75 square metres or at such other rate as may be found necessary to ensure adequate coverage.

**Second Coat:** After a period of not less than 14 days or as long as required by the Engineer, the surface shall be swept clean of loose chippings and other materials. Shelmac S/125 of similar viscosity as he first coat shall be applied at the same rate of temperature and blinded immediately with 12mm machine crushed chippings applied at the rate of 1 cubic metre per 75 square metres or at such other rate as may be found necessary to ensure adequate coverage. The chippings shall be brushed to ensure even coverage and then thoroughly rolled in with a light roller (4-6 tonne) allowed to stand overnight. Further rolling shall be carried out before the surface is opened to traffic.

**Filler Material**

At least 60% of the material passing a No. 200 B.S. sieve in the table below. The filler is to be Portland cement to B.S. 12 or crushed rock.

The grading of the filler shall be 100% passing a No. 52 B.S. Sieve; 85 – 100 passing a No. 200 B.S. Sieve.

The Bitumen for the prime coat shall be M.C. 2 or similar approved cutback bitumen.

Binder to asphaltic concrete shall be 80 - 100 straight run bitumen.

Asphaltic Concrete Mix

The Asphaltic concrete mix shall have the following constitution:

Aggregate

|  |  |
| --- | --- |
| B.S. Sieve | % Passing Wearing Course |
| 25mm  19mm  12mm  10mm  5mm  No. 7  No. 14  No. 25  No. 72  No. 200 | 100  100  85 – 100  75 – 90  60 – 76  49 – 64  35 – 50  26 – 40  15 – 26  7 – 14 |

Binder

(Expressed as parts by weight per 100 parts of dry aggregate)

|  |  |
| --- | --- |
| Wearing Course | |
| % Binder Content of Total Mix | 5.5 – 6.2 |

**2.7 CONCRETE**

**General**

This section includes the supply by the Contractor of all the materials, labour and equipment necessary for the construction of all works in concrete: un-reinforced, reinforced, precast. The reinforced concrete is to comply with the requirement of the British Standard Specifications BS 8110 or equivalent standard.

**Cement**

The cement used shall be Portland cement or Portland Blast-Furnace Cement of approved manufactured Portland Cement shall comply with the requirement of B.S. 12 or equivalent standard for “Ordinary Portland and Rapid-Hardening Portland Cement. Portland Blast-Furnace Cement shall comply with the requirements of B.S. 145 for Portland Blast-Furnace Cement not exceeding 65 percent blast furnace slag. Manufacturer’s general certificates of test will in general be accepted as proof of soundness, but the Engineer may require additional test to be carried out on any cement which appears to him to have deteriorated through age, damage to containers, improper storage or for any other reason. The Engineer may, without tests being made, order that any bag of cement, a portion of the contents of which has hardened, or which appears to be defective in any other way, be removed from the site forthwith. The Contractor may elect to use either ordinary Portland, Blast-Furnace or Rapid-Hardening cement but no extra amount will be paid on account of using a cement priced higher than the price entered for normal Portland Cement in the Schedule of Rates under the Contract, unless work using such cement is ordered in writing by the Engineer.

The cement shall be transported to the Site in covered vehicles adequately protected against water. It shall be stored in a weatherproof cement store to the approval of the Engineer and shall be taken for use in the Works in the order of its delivery in the store. Cement required for use within 24 hours may be stored in the open on a floor raised 300mm high above ground if covered by tarpaulins.

**Aggregates General**

The fine and coarse aggregates shall be naturally occurring sand, gravel or stone, crushed or uncrushed, and shall comply with the requirements of B.S. 882 “Concrete Aggregate From Natural Source”. They shall be obtained from a source approved by Engineer and shall be hard, strong, durable, clean and free from adherent coatings or harmful organic impurities and shall not contain any harmful material in such a form or sufficient quantity as to affect adversely the strength, durability or permeability of the concrete or to attack the steel reinforcement. They shall not contain water-soluble sulphur trioxide (SO3) in excess of 0.1 percent.

**Fine Aggregate**

The fine aggregate shall not contain silt or other fine material exceeding 6 percent by volume when tested according to the Standard method given in B.S. 812 Clause 15, neither shall it contain organic material in sufficient quantity to show a darker colour than the standard depth of colour No. 3 when tested according to the method in B.S. 812 Clause 28 “organic impurities”.

**Coarse Aggregate**

The coarse aggregate shall be granite or other hard stone from a source approved by the Engineer. The aggregate shall not contain clay lumps exceeding 1% by weight. A representative dry sample shall not show an increase in weight exceeding 8% Clauses 19 – 21, it shall be well shaped and not flaky. The nominal size of coarse aggregate shall be as stipulated below.

Grading Aggregates

**Coarse Aggregate**

The grading of coarse aggregate shall be within the limits given in the following table:

|  |  |  |
| --- | --- | --- |
| B.S. Sieve | Percentage by Weight Passing  B.S. Sieve | |
| Nominal Size of Graded Aggregate | |
| 75mm  38mm  19mm  10mm  5mm | 38mm to 5 mm | 9mm to 5mm |
| 100  95 - 100  30 - 70  10 - 35  0 - 5 | -  -  95 - 100  25 - 35  0 – 10 |

**Fine Aggregate**

The grading of fine aggregate shall be within the limits given in the following table:

|  |  |  |
| --- | --- | --- |
| B.S. Sieve | Percentage by Weight Passing  B.S. Sieve | |
| 5mm  No. 7  No. 14  No. 25  No. 52  No. 100 | Natural Sand or Crushed Gravel  Sand | Crushed Stone Sand |
| 95 - 100  70 - 95  45 - 85  25 - 60  5 – 30  0 - 10 | 90 – 100  60 – 90  40 – 80  20 – 50  5 – 30  0 - 15 |

Notwithstanding that the coarse and fine aggregates may each separately comply with the requirements stated above, they will not be accepted unless when mixed together in suitable proportions the combined aggregates produce uniformly graded and compacted dense concrete of the strength required with adequate workability for the position in the work.

**Samples of Aggregates**

Samples of both fine and coarse aggregates are to be submitted to the Engineer for testing at least two weeks before commencing deliveries. No deliveries in bulk are to be commenced until samples have been approved by the Engineer as complying with the Specifications.

Samples of the fine and coarse aggregate approved by the Engineer shall be kept on site, and shall give a fair indication of the general quality of the aggregates for comparison with the aggregates delivered during the course of work. Tests shall be carried out on samples of the latter taken at intervals as required by the Engineer. The method of sampling and the amount of aggregate to be provided for the tests shall be in accordance with B.S. 812 Section 1 “Sampling and Aggregate”. These tests shall be those laid down in B.S. 812 Section 2 – 6 inclusive. The tests will be carried out by the Engineer or his Representative. Should a sample fail to comply with any of the tests the Engineer may, at this discretion, either reject the batch from which the sample was taken, order it to be washed and/or screened or permit it to be used with variations in proportions of the concrete mixes specified.

Any batch of aggregate rejected by the Engineer shall be removed from the works site forthwith.

Water

The water shall be clean and free from harmful matter and shall be from a source approved by the Engineer. The Contractor shall make adequate arrangements to deliver and store sufficient water at the works site for use in mixing and curing the concrete. Water shall comply with the requirements of the latest edition of B.S. 3148 or equivalent standard.

**2.8 REINFORCEMENT**

**Quality**

The reinforcement shall be either rolled mild steel or high tensile steel bent by an approved bar-bending machine. The bending dimensions and tolerances and dimension of all anchorages, hooks, binders, stirrups, links and the like shall be in accordance with B.S. 1478 “Bending Dimensions of Bars for Concrete Reinforcement” or equivalent. The internal radius at the corner of the stirrups and binders shall be not less than the radius of the longitudinal bars embraced by the stirrups or binders. The steel fabric reinforcement is to be hard drawn steel wire fabric and is to comply with B.S. 1221 or equivalent and of the weight and reference specified. Manufacturer’s test certificate shall be supplied as required by the Engineer. Every consignment of steel shall be accompanied by the Manufacturer’s certificate stipulating compliance with above specifications. Steel reinforcement shall be obtained from a source approved by the Engineer.

**Testing Reinforcement**

Test Specimens from the steel reinforcement delivered to the Site are to be taken by the Contractor from any consignment as required by the Engineer notwithstanding the existence of a Manufacturer’s test certificate in accordance with the requirements of B.S. 785 or equivalent and sent, carriage paid, to the Nominated Testing Authority for testing. No steel is to be used before such testing and until steel has been approved in writing by the Engineer.

Any consignment not meeting the specification shall be removed from the Site at the Contractor’s expense within 24 hours upon notification to do so by the Engineer. Not less than one such test specimen shall be taken from every diameter of each cast. Where one cast exceeds 25 tonnes, a second specimen shall be taken from each diameter from that cast. The Contractor is to make arrangements with the steel suppliers so that the cast number shall be clearly given on a label attached to each consignment and if one consignment shall include steel from more than one cast, the steel from each cast shall be bundled separately from any other cast.

**Placing of Reinforcement**

The reinforcement shall be placed in the forms and held firm against displacement, by approved types of small precast concrete fixing blocks and wire ties, in the exact position shown in the drawing. Fixing blocks may be left embedded in the concrete in cases where the Engineer approves. Bars intended to be in contact when passing each other shall be securely held together at intersection points with tying wire binders and stirrups shall tightly embrace the longitudinal reinforcement to which they shall be securely wired or spot welded.

The wire ties shall be No. 16 SWG soft annealed steel wire; the ends shall be turned in from the face of the formwork and shall not be left projecting beyond the reinforcing bars. The reinforcement shall be inspected and passed by the Engineer or his representative before concrete is placed in the forms. The exact amount of cover over the reinforcement shall be obtained when the reinforcement is placed and shall be held during concreting.

**Welding**

Welding of reinforcement by electric arc may be permitted by the Engineer under suitable conditions and with suitable safeguards. Welding shall be carried out in accordance with B.S. 1856 “General Requirements for the Metal Arc Welding of Mild Steel”. But welds shall be of the double V type and two butt weld bend tests shall be carried out on a specimen prepared to represent each form of butt welded joint used in welding the reinforcement and for each position of welding. The method of making butt-weld tests shall be that laid down in B.S. 709. The specimen shall pass the tests to the satisfaction of the Engineer before the approval is accorded to use the joint, which the specimen represents. Tack welds between reinforcing bars, used merely to fix them in position shall not be subjected to tests.

**Storage of Aggregates and Reinforcement**

The fine and coarse aggregates shall be stored in properly constructed open bins with hard, clean drained floors. Each size of aggregate shall be stored in a separate bin. The reinforcement shall be stacked tidily in a manner that permits its inspection.

**Concrete Mixes**

The concrete for structural works shall be designated mixes which will comply with the minimum requirements specified. The batches are to be gauged appropriately to obtain the strength specified in the table below.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Concrete  Grade | Characteristic Strength  N/mm2 | Cubic Strength at an age of: | | | | |
| 7 days | 2 months | 3 mths | 6 mths | 1 year |
| N/mm2 | N/mm2 | N/mm2 | N/mm2 | N/mm2 |
| 20  25  30  40  50 | 20.0  25.0  30.0  40.0  50.0 | 13.5  16.5  20.0  28.0  36.0 | 22.0  27.5  33.0  44.0  54.0 | 23.0  29.0  35.0  45.5  55.5 | 24.0  30.0  36.0  47.5  57.5 | 25.0  31.0  37.0  50.0  60.0 |

The Engineer may require allowance to be made in the gauging of fine aggregate to counteract the increase in volume (often termed “building”) due to moisture content.

**Workmanship General**

The aggregates are to be gauged by weight; the weights of aggregates per batch must be accurately determined and agreed with the Engineer.

The quantity of cement in a concrete mix is always to be measured by weight and the mixer is to be of sufficient size to ensure that a batch of the specified mix may be made using whole bags of cement to achieve this. The 50kg bag is to be considered to be of a volume of 0.355mm3 in calculating volumetric proportions. The amount of water used is to be the minimum consistent with practical workability and is to be varied as required to suit the moisture content of the aggregates.

When the amount of water per batch has been determined by trial, the water is to be measured at this fixed amount throughout the concreting by means of water gauge on the batch mixer or by a marked measuring can. In no circumstances is water to be added to the mix after it has left the batch mixer.

All concrete is to be mechanically mixed in batch mixer of approved type. The dry concrete materials are to be mixed for at least three turns in the mixer, after which the gauge amount of water is to be generally added while the mixer is turning. When the water has been added, the concrete is to achieve a uniform mix. On the cessation of work, the mixer and all handling plants are to be washed out clean.

**Testing Generally**

Prices for concrete and steel reinforcement are to include for supplying all test cubes, slump cones and rods and steel test specimens and for carrying out all tests specified as and when required to the satisfaction of the Engineer and for making curing and sending test cubes and steel specimens carriage paid to the Nominated Testing Authority and for the cost of the testing of unsatisfactory cubes and specimens, etc. The cost of Laboratory Testing of satisfactory cubes and specimens is allowed for elsewhere.

**Testing Concrete**

The consistency of the concrete shall be determined at all times by means of the standard slump test. For normal concrete, the slump shall not exceed 100mm: for mechanically vibrated concrete the slump shall not exceed 40mm.

The strength of the concrete shall be determined by the testing of 150mm specimen test cubes taken from the concrete at random during the progress of the work. Four such cubes shall be taken from each day‘s concreting or for each 15m3 of concrete placed, whichever is less. Two cubes are to be tested at 7 days’ age and two at 28 days’ age. The method of making, marking, recording, curing and testing the cubes is to be agreed with the Engineer before commencement of concreting work.

The test cubes referred to above, made, cured and tested in accordance with the foregoing provisions, shall show, to the satisfaction of the Engineer, that the concrete complies with the following minimum requirements.

|  |  |  |
| --- | --- | --- |
| Concrete Grade | 7 days after Mixing  N/mm2 | 28 Days after Mixing  N/mm2 |
| 10  20  25  30  40  50 | 8.0  13.5  16.5  20.0  28.0  36.0 | 12.5  20.0  25.0  30.0  40.0  50.0 |

Should cubes fail before the specified strength is obtained, the Contractor shall, if so ordered by the Engineer, cut out and replace at his own expense all the work represented by these cubes.

The Contractor shall keep on site sufficient 150mm cast iron cube moulds.

Whenever practicable, concrete for test cubes shall be taken immediately after it has been deposited in the Works. Where this is not practicable, samples shall be taken as the concrete is being delivered at the point of deposit.

**Placing of Concrete**

The concrete shall be placed in the Works as soon as possible after mixing and shall be thoroughly compacted by both hand tamping and mechanical vibration. It shall be thoroughly worked into the corners of formwork by hand tamping. After tamping into place the concrete shall not be subject to disturbance other than such as is incidental to compaction by vibration. The concrete shall be placed in the formwork in layers not exceeding 600mm deep. The vibrations shall be used solely for compacting the concrete and not for distributing it into place. Concreting shall be carried out continuously between and up to pre-determined construction joint specified below in the one sequence of operation. The surface of the concrete shall be maintained reasonably level during placing. In the event of unavoidable stoppage in positions not pre-determined, the concreting shall be terminated on horizontal planes and against vertical surfaces by the use of stopping-off boards. A record shall be kept on the Works site of the time and date of placing the concrete in each portion of the structure, and the reference numbers of the test cubes pertaining to batches of concrete in particular part of the structure.

**Compacting**

The concrete maintained between two walls of formwork shall be compacted by vibrators of the internal types and concrete in slab vibrators of the pan type or by a vibrating screen. The vibrators shall be of ample power and of a kind approved by the Engineer. They shall be operated by workmen skilled in their use who shall be additional to the labourers employed on placing and tamping the concrete. The internal vibrators shall be inserted and withdrawn slowly and at a uniform pace of approximately 100mm per second. Compacting shall be deemed to be complete when cement mortar appears in a circle around the vibrators; over-vibrating leading to segregation of the mix must be avoided. The internal vibrators shall be inserted at points judged by the area of mortar showing after compaction, with a certain allowance made for overlapping, and they shall not be allowed to come into contact with the formwork or the reinforcement and shall be inserted at a distance of 75mm from the former. The pan vibrators shall be placed on the surface of the concrete, which shall have previously been tamped and levelled leaving an allowance in height for compaction until the cement mortar appears under the pan. The vibrator shall then be lifted and placed on the adjoining surface and this operation shall be repeated until the whole surface has been compacted. Alternatively a vibrating screen spanning the full width of the surface may also be used.

**Construction Joints**

Construction joints shall be located in the position directed by the Engineer and as shown in the drawings. Such joints shall be in a plane at right angle to the axis of the member concerned or, when forming the upper surface of lifts in certain walls or beams shall e horizontal. At joints other than those occurring in a horizontal plane the concrete shall be prevented from flowing laterally by the use of rigid stopping-off forms. Wooden fillets 50mm, slightly chamfered, shall be fixed to stopping-off forms to produce rebates in the face of the joints; these rebates shall be formed centrally in the case of piers and slabs and shall run the full length of the joint.

Horizontal joints shall have all excess water and laitance removed from the surface after the concrete has been compacted and before it has set.

Construction joints in floors shall be located near the middle of spans of slabs, beams or girders, unless a beam intersects a girder at the middle location, in which case joints in girders shall be offset a distance equal to twice the width of the beam. Provision shall be made for transfer of shear and other force through construction joints.

Beams, girders, column capitals and haunches shall be considered as part of a slab system and shall be placed monolithically therewith.

Before concreting is resumed, the face of the joint already formed shall have all laitance removed, shall be well roughened, scrubbed clean and thoroughly saturated with water. The face shall then be rendered with a 12mm thick layer of mortar composed of equal parts of Portland cement and sand against which the freshly mixed concrete shall be immediately deposited and thoroughly tamped into the cement mortar.

**Expansion Joints**

Expansion joints shall be formed where indicated on the drawings. The Contractor shall ensure that any space designed to be filled with a compressible material, or which is shown on the drawings as a void, is kept clean of any rubbish or other material likely to impair the efficiency of the joint, and shall provide such means as is approved by the Engineer of sealing the joint until such time as a permanent seal can be made.

**Curing and Protection of Concrete**

Exposed surfaces, immediately after final set, shall be protected from the sun in a manner approved by the Engineer. All concrete shall be well watered after it has set and shall be kept continuously damp until thoroughly cured. Provision shall be made for adequate water distribution to all parts of the works, so that, if required this treatment can be continued efficiently throughout the whole period of construction. In order to keep the concrete continuously damp; all exposed surfaces shall be covered with damped gunny sacks or shall have water impounded on them, for the full period of curing, which shall not be less than 10 days.

All works shall be protected from damage by shock overloading, etc.

**Surface Treatment**

As soon as the formwork has been removed and after inspection by the Engineer, honey combing or small holes in surfaces shall be cut to a depth and shape required by the Engineer and made up with fine concrete of equal quality. No further treatment shall be given to concealed surfaces. Permanently visible surfaces shall be then treated as follows:

All projecting imperfections shall be rubbed down with carborundum stone or other means approved by the Engineer, the grit or dirt therefrom, thoroughly washed off with clean water.

As a separate operation, after completion as described above, surfaces shall be brushed over with coating of Portland cement wash, which shall be rubbed into the pores and smoothed off with carborundum blocks. The finished surfaces shall be protected against drying too rapidly by use of damp sacking or other approved means.

Top surfaces of slabs and other surfaces for which formwork is not provided shall be floated to a smooth finish with a wooden float after compaction of the concrete.

**Additives**

The use of additives in the concrete, for the purpose of promoting rapid hardening, for water-proofing, for increasing workability or for other reasons, may be permitted in special circumstances. Such additives shall be of a brand and type approved in writing by the Engineer and shall be used strictly in accordance with the maker’s instructions, and to be used only subject to such preliminary tests as the Engineer may require before permission is given to use the additives, in any part of the structure.

**2.9 FORMWORK**

**General**

Formwork section includes footings, walls, steps and slabs.

The formwork shall be constructed of sound, aluminium, steel or other suitable and approved material of such quality and strength as will ensure complete rigidity throughout the placing, ramming, vibration and setting of the concrete: it shall be sufficiently tight to prevent loss of liquid from the concrete. Where formwork is not provided with special lining as specified in Clause CS28, the faces in contact with concrete shall be planed smooth true to alignment and free from surface imperfections and the joints between boards shall be tongued and grooved or caulked with tight fitting fillets recessed into adjacent boards and covering the joint. Internals ties or struts shall be avoided as far as possible, and if used, they shall be of metal and capable of removal without injury to the concrete. No part of any metal tie or spacer remaining permanently embedded in the concrete shall be nearer than 50mm to the finished surface of the concrete. Construction details shall be arranged to permit easy removal, and wedges and bolts shall be employed whenever possible in preference to nails.

**Materials**

A. Minimum standard for design of formwork and supports: refer to structural engineer’s recommendation.

B. Form material to comply with aluminium or steel Form-work systems and/or British Standard Specifications.

Aluminium forms are not allowed to be in contact with concrete. Use concrete form materials in a manner to provide surface finish specified in architectural and structural drawings.

1. Rough form finish as defined by British Standard Specifications for concrete surfaces not exposed to view in finished Work. Set and maintain forms so finished concrete dimensions conform to tolerances of required sections.

2. Smooth form finish for concrete surfaces exposed to view in finish Work.

C. Form oil to be as manufactured for type of form material used to prevent adhesion of concrete to form material: Non-staining type, compatible with finish material to be applied.

D. Form ties and accessories to be of such design that upon removal of forms, no metal shall be less than ½-inchfrom the surfaces that are not visible and 1½ -inches from all visible surfaces in finished or unfinished spaces.

E. Vapor barrier: 6-mil thick fungi resistant polyethylene sheet conforming to Voluntary Products Standard PS 17-69.

F. Tape; Polyethylene adhesive backed tape.

**Execution**

A. Examine all areas and conditions under which work is to be performed and notify Architect in writing of conditions detrimental to proper and timely completion of Work.

B. NOT USED.

C. Construct required forms for concrete work to conform dimensions shown, plumb, straight, and sufficiently tight to prevent leakage. Secure brace and share forms to prevent displacement and to safely support construction loads.

D. Set and maintain forms so completed concrete will conform to dimensional tolerances given in dimensional tolerances given in B.S. 1478 “Bending Dimensions of Bars for Concrete Reinforcement” or equivalent.

E. Contactor is responsible for coordinating, accepting delivery, storage, and installation of structural steel plates, ledge angle inserts, and other embedded weld plates and angles.

F. Build in anchors, inserts, bolts, and other devices indicated or required for various portions of the Work. Accurately position and support all built-in items furnished by other trades.

G. Install a vapor barrier over compacted sand cushion under floor slabs on grade where specified. Lap joints six inches.

H. Do not remove forms until concrete has acquired sufficient strength to support its own weight and superimposed loads, and until concrete has hardened sufficiently to resist damage from removal operations

**Wrot Formwork**

**Not Used**

**Lining Formwork**

**Not Used**

**Cleaning and Treatment of Formwork**

Before concrete is deposited, the forms shall be thoroughly cleaned and freed from sawdust shavings, dust, mud or other debris by hosing them with clean water. Temporary openings shall be provided in the forms to drain away the water and rubbish. Unless otherwise directed by the Engineer, the inside surface forms shall, before placing of the reinforcement, be coasted with lime wash or an approved mould oil, care being taken at all times thereafter to keep the reinforcement free from any such material. There shall be not excess coating material in the form prior to concreting.

All formwork shall be inspected by the Engineer after preparation and immediately prior to depositing concrete and no concrete shall be deposited until approval of the formwork has been obtained from the Engineer.

**Removal of Formwork**

Formwork shall be removed without such shock or vibrations as would damage the concrete. Before general removal of the formwork the concrete shall be exposed over a small area in order to ascertain that the concrete has sufficiently hardened. The minimum periods for the removal of the formwork for various parts of the structure are given in the following table, but compliance with these requirements shall not relieve the Contractor of the obligation to delay the removal of formwork if the concrete has not sufficiently hardened.

|  |  |  |
| --- | --- | --- |
| Position of Formwork | Ordinary Portland Cement/Days | Rapid Hardening Portland Cement/Days |
| Beams’ sides, Walls and Columns (unloaded)  Slabs (prop left under)  Removal of props to Slabs  Beams’ soffits (prop left Under)  Removal of props to Beams | 3  4  10  8  21 | 2  3  5  5  8 |

The foregoing table is given as a guide for Normal and Rapid Hardening cement, and gives the minimum times which will normally be approved by the Engineer, who may at his discretion increase the above time if he considers such increase to be necessary. Any variations proposed by the Contractor by virtue of the use of other types of cement or formwork systems, or of additives, shall be subject to the approval of the Engineer.

**Steelwork Cast into Concrete**

The surface of all structural steel which is to be cast into the concrete of the structure shall be thoroughly cleaned of any protective paint or other adherent coatings and shall be wire brushed clean of surface rust. All oil and other deleterious matter shall be removed from the surface of the steelwork immediately before casting the concrete.

**Precast Concrete**

Precast concrete units, unless otherwise specified, shall be constructed in Grade B1 concrete. They shall be fair faced and true to line with a tolerance of plus zero or minus 3mm on length of units 600mm or less in length and plus zero and minus 12mm for units exceeding in length. The maximum deviation of any side measured from a straight edge shall not exceed the equivalent of plus zero and minus 1mm in 1500mm.

Precast concrete paving slabs shall be to B.S. 368 or equivalent.

Precast concrete kerbs and edgings shall be to B.S. 340 or equivalent.

No precast units shall be built into the Works until it has matured for 28 days unless otherwise agreed by the Engineer.

Units may be rejected if they have any of the following defects:

Broken edges

Repairs

Misplaced reinforcement

Honeycombing or air holes

Rejected units shall be replaced by the Contractor at his own expense.

Precast concrete units shall be cast in approved moulds on clean platforms. All exposed faces to be left fair and finished smooth as have been so described elsewhere.

**2.10 STRUCTURAL STEEL**

**Materials**

All steelwork shall be mild steel in accordance with B.S. 15. All workmanship and materials shall be in accordance with the British Standard 499 “The Use of Structural Steel in Building” and B.S. 1856 “General Requirements for the Metal-Arc Welding of Mild Steel.”

Drawings

The drawings prepared by the Engineer are layout drawings and typical details for the purposes of tendering and contracting. The Contractor shall prepare his own shop drawings showing all sizes, dimensions and details as are required for purposes of fabrication and erection.

Before fabrication is commenced, the Contractor shall submit two copies of his shop drawings to the Engineer for approval. When approved, one set will be returned to the Contractor signed as approved, upon receipt of which the Contractor will be free to commence fabrication.

It is to be expressly understood that such approval of shop drawings by the Engineer does not relieve the Contractor from responsibility for errors or omissions contained in the drawings.

Measuring to scale on any drawing is not permitted.

The Contractor must include in his price, the cost of preparing shop drawings and blue prints for approval and fabrication purposes.

**Bolted Connections**

Black bolts may be used throughout unless shown otherwise on the drawings.

All bolts shall be fitted with washers under the nut and all bolts shall extend through the nut by at least one thread after the nut has been tightened.

Where a nut or bold head is bearing against an inclined surface, a bevelled washer of the correct shape shall be interposed between the two surfaces. Bevelled washers shall not be allowed to get out of position during fabrication and erection and for this purpose they may be tack-welded onto the steel surface.

Where a bolt is designed for bearing, care shall be taken that no bearing is taken on the thread. The nuts of all bolts subject to vibration shall be locked in approved fashion.

**Bolts Holes**

All holes shall be truly cylindrical and perpendicular to the connecting surfaces and shall be free from burns. Finished sizes of bolt holes shall be not more than 2mm larger than the nominal diameter of block bolts nor more than the nominal diameter of the bolt for turned and fitted bolts.

Punching of holes will only be allowed for black bolts whose thicknesses are less than 12mm otherwise all holes shall be drilled.

Burning of holes shall not be permitted.

Holes for turned and fitted bolts shall be sub-drilled 2mm smaller than the finished size and reamed on assembly. Finished holes in connecting members shall match fit such that bolts may be placed without further remaining or drifting on the site.

Bolts, Nuts and Washers

Bolts and nuts shall be of the best quality with Whitworth threads. They shall have hexagonal heads and round shanks unless otherwise specified, and furnished with spring washers (except encased members) of an outside diameter equal to two and half times the diameter of the bolt. For flanges of joints and similar positions, tapered washers shall be supplied. Bolts shall be of such lengths as to project not less than 5mm or more than 10mm beyond the nut when tightened up.

All bolts are to be tightened dead tight. Bolts, nuts and washers shall be dipped in a protective fluid “Shell Ensis Fluid Ref. No. 260” or equivalent.

**Connections**

Shop connections may be riveted, welded or bolted. Site connection shall be bolted except where specified otherwise.

Site welding shall preferably not be carried out. When site welding is unavoidable, screens against wind and weather and suitable platform are to be provided. Suitable means of holding the members in their correct position shall be provided until the joints are welded.

**High Strength Friction Grip Bolts**

All bolts for steelwork are to be High Strength Friction Grip Bolts in accordance with B.S. 3294 Part 1 and B.S. 3139 or equivalent.

High Strength Friction Grip Bolts shall be used in conjunction with Load Indicating Washers of approved make in addition to the normal washers.

**Welding**

All surfaces to be welded shall be free of rust, dirt, grease, loose peels, paints slags and other foreign matter.

All welding shall be in accordance with B.S. 1856 “General Requirements for the Metal-Arc Welding of Mild Steel”. B.S. 449 and B.S. 2645 wherever applicable. Only skilled welders who have previously passed selected tests as described in B.S. 2645 Part I and II and who have good reference shall be employed for the work.

**Inspection of Steelwork**

The works must at all times be open to the Engineer and portions of the work not entirely to his satisfaction shall be open to rejection and shall be replaced at the Contractor’s own expense.

The Engineer shall be informed of the completion of the works in the shop so that an inspection may be carried out prior to undercoating and delivery.

**Transport**

All structural steelworks are to be handled and transported such that the members are not subjected to excessive stresses, deformed or otherwise damaged. Long members are to be bundled together for transport. No “Projecting” members are to be left on long members which can cause bending or damage of these during transit. Cleats and small parts are to be bagged and packed in kegs of cases. Bolts, rivets, washers, small and loose pieces shall be securely bagged and marked for easy identifications.

**Erection of All Steelwork**

When lifting and fitting steelwork into position, care shall be taken to ensure that the members are not strained, twisted, bent or damaged in any manner whatsoever. Should any part be strained, twisted, bent or damaged it shall be reinstated in such a manner as the Engineer may direct, by gently heating and bending and not by hammering. Any parts that, in the opinion of the Engineer, are badly damaged shall be replaced with new parts all at the cost of the Contractor.

Proper and suitable slings, lifting appliance, blocking and all other necessary plant and equipment shall be provided. The lifting of steelwork in bundles, which in the opinion of the Engineer is liable to cause damage or strain, will not be permitted. The stacking of materials prior to erection or during erection in a manner or in such a position as may, in the opinion of the Engineer, cause damage to the materials so stacked or to permanent works so loaded will not be permitted.

**Holding Down Bolts**

Generally holding down bolts shall be cast into the foundations for the building. They shall be placed as follows:

the holding down bolts shall consist of a bolt inside a length of pipe with a large washer at the base to provide anchorage. The pipe and bolt shall be welded to the washer to ensure that the bolt remains rigidly fixed in the centre of the pipe;

the holding down bolts shall be placed in sufficiently large and deep pockets made in concrete base.

The bolts shall be held firmly and rigidly in position during concreting and care taken to ensure that no concrete flows down between the pipe and the bolt.

The threads shall be protected at all times until the bolt is tightened with a nut and washer.

**Grouting Baseplates**

The mortar used for this purpose shall be in the proportion of 1 part cement to 2 parts sand by volume. As little water is practicable shall be used for the mortar, which shall be properly rammed in tight under the baseplates.

All steelwork shall be complete, all bolts, fully tightened and all stanchions fixed and grouted up before any cladding is fixed.

Grouting baseplates shall be done in two operations. First the baseplates and stanchions shall be firmly fixed and packed with steel places before grouting. The grout shall then be poured in up to the level of the underside of the baseplates.

After an interval of seven days, the nuts shall again be tightened down hard and thereafter the stanchions grouted up to floor level.

**Galvanised Work**

All materials to be galvanised shall be of the full dimensions shown or specified and all holes shall be drilled before galvanising. All galvanising shall be down by the hot process with the bost virgin spleiter, not less than 98% of which shall be pure zinc. It shall be uniform, clean, smooth and as free from spangle as possible throughout.

**Painting Steel and Ironwork**

All paint shall be of the best qualify of an approved made and obtained from an approved supplier.

**Surface Preparation**

All surfaces shall be wire brushed clean to removed rust, mill scale, welding deposits, etc. dine, washed with water and left to dry before the application of paint.

**Paint**

One priming coat of Grey Green Chromate Metal Primer No. F500-388 manufactured by ICI Limited or a similar approved primer shall be applied at the place of fabrication. This priming coat where damaged during transport and/or handling and erection, shall be made good with similar primer before the finishing coats are put on.

The finishing paint shall be first class fungus resistant gloss paint Micaceous Iron Oxide (F30A-line) of ICI manufacture or a similar approved paint of selected colours. Two finishing coats shall be applied and this shall be done after erection of the members.

**Application of Paint**

All external paint work shall be executed in dry weather and all surfaces are to be perfectly dry before any paint is applied. No successive coat of paint is to be put on until the Engineer has given his approval. The interval between the application of each coat of paint shall be 4 days or as recommended by the paint manufacturer.

The paint shall be thoroughly mixed to ensure that all pigment is in suspension and the paint is of proper consistence. No oil or thinner shall be used. Stiff brushes of an approved quality shall be used to give a smooth even surface. As far as practicable, the painted steelwork shall not be handled or stacked until the paint is thoroughly dry and sufficiently hard to avoid being damaged.

Contract surfaces to be bolted together shall be properly cleaned and painted immediately before joining.

**2.11 ELECTRICAL SERVICES**

**General**

**Extent of Work**

The Electrical Installation Works shall include delivery to site, installation, testing and setting to work of all the equipment, fittings, cabling and other materials to be supplied by the Contractor to complete the electrical installation for power, lighting, control, alarms, instrumentation and telephones in the relevant portions of the Works as specified.

The Works shall cover the provision of all plant, tackle, tools, skilled and unskilled labour required for the unloading of materials and the execution of the whole of the Works included in the specification.

Excavation, backfilling of trenches, the cutting of concrete or brickwork and the subsequent making good and provision of ducts under roads, buildings, etc., shall form part of the builder’s work which have been measured separately.

**Rules and Regulations**

The current regulations, rule and requirements of Electricity Corporation of Ghana and the Institution of Electrical Engineers and the relevant B.S. Codes of Practice shall be deemed to form part of this Specification.

**Electricity Supply**

The electricity supply shall be 11 KV, 3 Phase 50Hz, taken from Volta River Authority nearest 11KV line to feed the transformers through fuse switches, or source specified by the Engineer.

**Works Testing**

The contractor shall serve all notices on the Volta River Authority or any other approved organisation for testing and pay all fees in connection therewith. The cost of such tests is allowed for elsewhere. Any additional charges made for re-testing as a result of faulty installations or poor workmanship shall be at the expense of the Contractor.

**Identification of Circuits**

Circuit lists shall be provided inside all distribution boards, control boards and other such locations clearly marked in indelible ink.

**Earthing of Equipment**

The whole of the electrical installation and all other equipment connected thereto shall be earthed in conformity to the IEE Regulations and in addition to the requirement of ECG.

**Position of Points and Equipment**

The position of all points and equipment shown on the plans shall be assumed correct for the purposes of the tender, but it is the Contractor’s responsibility to check the positions with the drawings which will be available on site.

**Installation Drawings**

Installation drawings have been prepared by the Engineer showing the layout of the complete installation. The Contractor shall generally adhere to these drawings. In the event of any discrepancy between the specification and the drawings, the Engineer’s attention shall be drawn to such discrepancies for ratification.

It is important that the Contractor during the course of the works shall maintain a fully detailed record of all changes from the tender drawings to facilitate easy and accurate preparation of the “As Installed Drawings” to ensure that those drawings are in all respect a true record of the installation.

**Cabling**

**Armoured PVC Cables**

The installation shall require laying of armoured PVC insulated cables. PVC insulated cables shall be XLPE sheathed cover over the armouring wires. The cable shall be suitable for the use of voltages up to and including 600/1000 volts.

The minimum internal radius of any bend formed in these cables shall be eight times the cable overall diameter.

Termination shall be made with a clamping gland of approved pattern, the gland to be complete with a PVC sheath.

Joints in this type of cable should be made in a joint box of approved type complete with armour bonds and split ferrules.

All joints shall be made by a qualified jointer and the joints shall be filled with cold-filling compound as Henly List No. 57017 or similar approved.

Armoured cables installed in buildings shall be fastened by saddles to galvanised cable trays securely fixed to walls or ceiling or be supported by cable cleats of approved design held in position by bolts or studs securely fixed into the supporting steelwork or masonry.

PVC Cables in Conduit

PVC cables for drawing into conduits shall be 250 to 660 volts grade, single core with a minimum cross-sectional area of 1.5mm2 and complying with B.S. 6007; 1969 or B.S. 6004; 1969 whichever is applicable.

**Wiring**

All joints are to be made at main switches, distribution boards sealing boxes, socket outlet boxes and fuse-boards only. No joint shall be made in joint boxes. The wiring shall be run in the conduit so as not to exceed the capacities set out in Table BSM of the IEE Regulations 16th Edition.

**Conduits and Fittings**

All conduit fittings shall conform with B.S. 4568 Part 2: 1970 and subsequent amendments. No solid or inspection bend tees or elbows shall be used. All conduits shall be heavy gauged welded and screwed. It shall be protected by black enamel or galvanised where so specified.

**Cabling to Motors**

Cables to motors, whether PVC insulated cables in conduit or otherwise shall be terminated in cable changing boxes mounted adjacent to the motor. Final connections between the cable changing boxes and the motor terminal boxes shall be carried out using flexible armoured cables.

**Conduit Connections**

Conduit embedded in plaster and floor screed, etc. shall be painted with two coats of red lead paint after erection.

Screwed connections shall be metal to metal and shall be painted with two coats of red lead paint. Connections between conduit and sheet metal adaptable boxes or trunking etc. shall be made by means of brass hexagonal smooth bore bush fitted inside the box or trunk and connected through a coupler to the conduit. This method shall be also used with connecting conduit to a cast box not provided with a spout.

**Layout of Cable Boxes and Running Joints**

Boxes shall be so spaced that they are not more than two 90o solid sands or more than 9m of straight run between them. All free ends of conduits shall be fitted with female brass bushes.

**Flexible Metallic Conduit**

This shall conform to B.S. 731 Part 1: 1952 including latest amendments and shall be PVC covered. The conduit is to be terminated in two part brass adaptors. In all cases an earth wire of size not less than 2.5mm2 shall be drawn through this conduit and secured at either end. This earth wire shall be insulated and identified green.

Where it is required to connect PVC insulated cable to lighting fittings or to B.S. box to which a batten holder or lighting fitting may be directly attached, a heat-resisting grade of PVC shall be used unless the cable are to be terminated outside and well clear of the fittings or box and final connection made by means of tails insulated with silicon rubber to B.S. 600: 1969.

Vulcanised rubber insulated cable may not be used at all in these circumstances.

**Switch and Socket Outlets**

Switches and switch socket outlets shall be installed either of 13 or 15 Amp rating as called for in the

**Bills of Quantities.**

Normally all switches shall be mounted at a height of 1350mm above finished floor level and any variation of this height must be to the approval of the Engineer.

**Building Superstructure**

Switches shall be single-pole with a substantial actuating toggle of an insulating material, the whole being contained within a metal enclosure. Switches for concealment behind plaster shall have an enclosure of heavy gauge pressed steel covered with a switch-place fixed to the enclosure by separate screws and having a satin chrome finish.

Switch socket outlets for use under similar conditions shall be generally to B.S. 1363: 1947 or of similar construction to the switches where applicable and with matching cover plates. The socket outlets shall have three contact tubes and shall be interlocked with the switch such that the tubes are effectively shuttered to prevent accidental contact or mal-operation when the plug is withdrawn.

**Switchboards and Control Panel**

Switchboards and Control Panel shall generally be of the self-standing cubicle type. All switchboards and cubicles shall be bonded to the generally earthing system.

**Switch and Fuse Gear**

All units shall be provided with identification labels as specified elsewhere having the circuit designation clearly engraved. All units shall be capable of withstanding a symmetrical short circuit fault to 15MVA at 415 volts

**Distribution Boards**

Distribution boards shall be generally in accordance with B.S. 214 including amendments. All live parts shall be effectively screened to prevent inadvertent contact. Distribution Boards incorporating miniature circuit breakers (MCB) shall have a category of duty M3.

**Moulded Case Circuit Breakers (MCCB)**

Moulded case circuit breakers shall comply with B.S. 3871 Part 2. The breaking capacities shall be 10KA standard rated currents up to and including 100 amperes; 22KA for standard rated current above 100 amperes up to and including 1200 amperes.

**Consumer’s Electricity Supply Units**

Consumer’s electricity supply nits shall comply with B.S. 1454. The number of outgoing circuits and their respective current ratings together with the current rating of the main switch and form of protective device(s) required, i.e. miniature circuit breakers, and the form of the enclosure shall be as indicated or as directed by the Engineer. Where miniature circuit breakers are incorporated, units with a current rating of 4 Amps shall have a category of duty according to B.S. 3871 Part 1.

**Labels**

All insolating switches, switch fuses, fuse switches MCB’s distribution boards and other specified items shall be labelled as to their function, the letters to be engraved on the underside of a levelled colourless transparent plastic label not less than 3mm thick, and engraving being filled and the underside painted and sealed to form a complete label having while letters on a B.S. 2660 – 7086 background. All labels must be affixed to apparatus before final acceptance tests are carried out.

**Internal Lighting**

Internal lighting fittings shall be provided as set out in Bills of Quantities and shall be of first class workmanship throughout. All fittings shall be left in complete working order to the satisfaction of the Engineer. Any fitting which exceeds 1.5kg in weight shall be suspended by independent means so that no part of the weight of the fitting is borne by the flexible cable.

**Earthing**

All metalwork forming part of the electrical installation other than the current carrying part of the electrical circuits, including the casing of alternators, motors, transformers, switchgear, distribution boards, cable sheaths and armouring ducts, conduit boxes, metal lighting fittings etc. shall be efficiently connected to the station’s main earthing system.

**Site Tests**

Cables laid underground shall be tested for insulation resistance and continuity of earth circuit in the presence of the Engineer. All joints made during the installation of the cables which prove faulty when tested shall be made good and re-tested to the satisfaction of the Engineer at the Contractor’s expense.

The connection of all electrical circuits shall be proved to be correct and the whole installation shall be tested for insulation resistance and earth loop resistance in the presence of the Engineer with the instruments provided by the Contractor. Any faults or defects shall be remedied at the Contractor’s expense. All tests shall comply with Section E of the IEE Regulations.

On completion of erection each item of apparatus and plant shall be tested and proved under working conditions. The installation shall then be operated continuously for 24 hours or such less time as the Engineer may direct during which time the Engineer in the presence of the Contractor shall check that the installation is complete in safe working order and fulfils the function for which it is intended.

**General Earthing System**

The earthing system for the installation shall be as specified to provide an efficient grounding system to serve the following functions:

To provide adequate lightning protection to the equipment and building.

To provide a low impedance between the ground associated with each building to prevent excessive voltages appearing across signal lines due to ground currents.

To provide a safe power system so that in the event of a short-circuit to ground at any electrical power apparatus, no dangerous voltages should appear on equipment ground or other conducting surfaces with which personnel may come into contact.

To eliminate any radio frequency (RF) interference due to static electricity producing flashover between adjacent members of the metal structures.

The resistance to ground of the total grounding system shall be less than 10 ohms.

All connections to ground system shall be made with suitable clips approved by the Engineer.

**Lighting System**

The offices and rooms shall be lighted by a general lighting system using fluorescent fittings giving an average lighting level of 200 lux, unless otherwise specified.

The lamps shall be braced to the ceiling structures generally. In some cases and where specified fittings shall be suspended on chains.

Telephone System

Telephone system for the plant shall also be installed in conduit. The conduit for telephone wiring shall be separated from conduit for mains voltage wiring. Wiring shall conform to the requirements of the Ghana Telecommunications Company Limited.

**2.12 PLUMBING**

**Extent of Work**

The Contract for the plumbing and pipe installation works shall include delivery to site, installation, testing and setting to work of all pipes and fitting and other materials supplied by either the Client or the Contractor to complete the installations to the satisfaction of the Engineer.

The Contract shall also cover the provision of all plant, tackle, tools, skilled and unskilled labour required for the unloading of materials and the execution of the whole of the works included in this specification.

Excavation, backfilling of trenches, the cutting of concrete or brickwork and the subsequent making good and provision of ducts under roads, buildings, etc. shall form part of builders work which have been measured separately elsewhere.

**Rules and Regulations**

The Contractor shall comply with all Rules and Regulations as specified elsewhere in this specification. In addition, the installation shall be in accordance with the regulations of Ghana Water Company Limited. In cases where these are found to be at variance with any clause in this specification immediate notice shall be given to the Engineer.

**Drawings**

The Engineer has prepared schematic drawings of the layout of the complete installation. The drawings are schematic and do not indicate all offsets and fittings which may be required. The Contractor shall investigate the structural conditions and installation of other trades and arrange his work accordingly furnishing such offsets and equipment as may be necessary all to the Engineer’s approval.

**Water Supply**

The Contractor shall supply and lay pipe-work from water mains and underground water reservoir from water mains to drinking fountains and kitchens shall also be made.

Pipe work shall be fixed to the concrete walls, floor, ceiling slab as shown on the drawings.

**Testing Plumber’s Work**

The plumbing work and sanitary fittings shall be tested at such time as the Engineer may direct.

**Pipes and Fitting**

All pipes shall be neatly run in a proper workmanlike fashion and secured to walls with approved clips, brackets or holder bats. Where plugging is required Phil plug or similar approved plugs shall be used. All made bends shall be formed by approved mechanical means without diminishing the internal diameter of the pipe or causing fracture or weakness to the tube walls. All joints to sanitary fittings, cylinders, tanks machinery etc. shall have disconnecting unions to facilitate easy removal of fittings without undue disturbance.

**Pipe Laying**

The following shall be observed for pipe laying

All pipes shall be installed so as to preserve access to all valves and equipment.

The horizontal water mains shall pitch upwards in the direction of flow

Eccentric couplings and horizontal lines shall bring the pipe flush on the top for liquid lines.

All pipes, valves and fittings shall be installed at sufficient distance from other work to permit clearance not less than 13mm between the finished covering of such piping and all adjacent work whether under this or any other section of the specifications.

Dielectric insulators shall be installed between ferrous pipe and non-ferrous pipe and equipment.

All openings in pipes and fittings shall be capped or plugged until permanent connections are made. Care should be taken to keep foreign materials out of the system.

The Contractor shall be responsible for quick and free circulation of water, compressed air, oil, fuel or gas in all piping under actual working conditions. Systems shall be free from noise due to pipe expansion or contraction of water.

All pipes shall be run concealed wherever possible in masonry wall and floor slabs.

All pipes buried at least than 1.2m from the surface and or under a building or road shall be surrounded with 1:3:6 concrete Class “E” 150mm thick.

**Labels**

Labels are to be fitted to valves, stop cocks etc. except for local valves and stop cocks fixed adjacent to the fittings. All labels shall be coloured as given for pipe work identification and where not obvious from the value position, the room/equipment shall be noted on the label. So far as possible labels should consist of a die held under the hand-wheel unit.

**Pipe Hangers and Guides**

Pipe hangers and guides shall be of an approved type and arranged to maintain the required grading and pitching at all times to prevent vibration and to provide for expansion and contraction.

All hangers shall be secured to approved inserts, wherever possible and practicable. Expansion shield may be used in special cases. Spacing of the hangers shall not be greater than the following:

3m on centres for 32mm to 50mm

4m on centres for piping 62 diameter and larger.

Vertical lines in the building shall be supported at their bases using a suitable hanger placed in the horizontal line near the riser and with clamps at intermediate floors. Hanger shall be insulated from the pipe line to prevent seating of the hangers or support. Vertical risers are to be supported at base by structural members to be provided by the general contractor.

Hangers for piping 50mm and smaller shall be of the split ring type with fastening device. Hangers for piping 50mm to 100mm shall be adjustable clevis hangers.

**Expansion of Pipe**

All pipes shall be so installed and properly anchored so that it will be in no way strained or distorted by expansion and contraction.

**Floor, Wall and Ceiling Plates**

Pipes passing through the floors, walls or ceiling of finishing rooms shall be fitted with floor, wall or ceiling plates and securely fastened in place.

**Identification of Pipes**

All piping in all of the equipment rooms shall be identified at 5m intervals by standard colour markers with legend and flow arrow for easy identification “section” pipe markers or approved equal.

**Installation of the Works**

**Septic Tank and Soakaway**

All drains from, drainage points, water closets, sinks, shower and urinals in PVC pipes shall discharge into septic tanks, drains or soakaways as shown on the drawings.

All fixtures requiring venting shall be vented through the roof in a stack of proper size.

**Sewage Disposal**

Sewage from the building shall be connected to septic tanks, or as shown on drawings

Ventilation Pipes and Fittings

The sewer pipes above the highest branch are to be continued upwards of the full diameter above eaves and to such a height and in such a position as to afford a safe outlet for foul air.

**APPENDIX**

**3.1 GENERAL**

**Scope**

The specification covers the technical requirements for installations, materials and equipment associated with plumbing equipment installations for the building as set out hereinafter and in the applicable drawings. The specifications also cover associated requirements for erection, testing and setting to work of the installations.

**Equipment and Materials**

All materials and equipment installed shall be suitable in all respects for the site conditions, in terms of both climate and conditions in which the items are to be installed and also in terms of the specific locations on the site.

* 1. **GENERAL MECHANICAL INSTALLATION REQUIREMENTS**

The work throughout shall be executed in the best and most thorough manner, under the direction of and to the satisfaction of the Engineer, who will interpret the meaning of the drawings and specifications, and shall have the power to reject any work and materials which in his judgement are not in full accordance therewith.

The Contractor must guarantee that the materials and workmanship supplied will be of the best grade, that the equipment will be erected in a practical and first-class manner, that it will be complete in operation, nothing being omitted in the way of labour and materials required to make it so, although not specifically shown or mentioned herein and that it will be delivered in well-working order, complete and perfect in every respect.

The Contractor shall thoroughly acquaint himself with the work involved, and must verify at the building all measurements necessary for the proper installation of his work, obtaining the same when necessary from the Engineer or other Contractors. He shall be prepared to promptly furnish to the Engineer for other Contractors any information relating to his own work necessary for the proper installation of other contracts and shall co-operate with them to achieve a good working relationship. The Contractor shall confer with other Contractors on finishes adjacent to his own work and arrange to have visible portions of his work (such as access doors, grilles, etc.) fit harmoniously in a manner satisfactory to the Engineer.

* 1. **DRAWINGS AND SPECIFICATIONS**

**Engineering Drawings and Specifications**

The contract drawings are primarily intended to enable the Contractor prepare his estimate and submit a tender. Where runs of piping, ducts, cables, conduits, etc. are shown to small scale, they do not necessarily indicate exact positions. The contract drawings are based on agreements with the Architect taking into account other services and no alteration in principle will be allowed without approval.

During the tender period the Contractor has to convince himself how far the other services may influence the preparation of his estimate. The drawings concerning other services are available in the Engineer's office for inspection.

The Engineer will supply to the Contractor free of charge, on signing of this contract, three copies each of the contract drawings and two copies of the specifications.

**Contractor’s Drawings and Information**

The Contractor shall as soon as possible after signing of the contract and well before the relevant work proceeds prepare and submit for approval detailed builder's work and installation drawings, taking into account any modification either to the building or to the installation, which may have taken place and correctly related to the details of the actual items of plant and equipment to be installed. The Contractor shall similarly prepare all necessary schedules of equipment etc. and also all necessary wiring diagrams, both internal wiring diagrams for items of electrical equipment and diagrams showing the inter-connections between different items. All installation drawings are to be on a scale of 1 to 50 for all services in the building and of 1 to 20 for all plant rooms and similar spaces. All such drawings, schedules, diagrams, etc. are to be submitted to and approved by the Engineers in writing before any work is put in hand. After approval, up to six copies of all such approved drawings or schedules are to be supplied by the Contractor for distribution.

**Record of Site Drawings**

The Contractor is to arrange for a full set of white prints to be kept on the site showing the progress of all work in connection with this contract. Such prints must be kept up-to-date and all conduits, cable, pipe and duct runs, positions of equipment and machineries etc. are to be recorded on the drawings as they are installed.

Upon completion of the installation the Contractor shall at his own expense, furnish six complete sets of as-built shop drawings, one of which shall be furnished on printable transparencies and five of which shall be printed drawings. These drawings shall be submitted to the Engineer for approval. After approval they shall become the property of the Employer. Final payment will be withheld until receipt of the approved record drawings. The cost of furnishing above prints and preparing these record drawings shall be borne by the Contractor.

All record drawings shall bear the text as specified by the Engineer in a stage.

**PART 4**

1. **REGULATIONS AND GOVERNMENT LAWS**

The Contractor shall comply with all regulations and requirements, including those of the Government of Ghana, the Fire Services Department, Ghana Water and Sewerage Corporation and Electricity Corporation of Ghana and shall be responsible for giving notifications to the appropriate authorities and for paying all fees levied, such fees shall be included in the tender price. No `extra' will be entertained in complying with the requirements of any of the Government or Public Utility Regulations.

All electrical equipment and installations shall comply with local regulations and shall generally be in accordance with the IEC regulations, and IEE publication.

**CO-ORDINATIONS OF WORKS**

The civil Contractor shall make an overall planning and time schedule. The Contractor shall adapt his planning to the overall planning/time schedule of the civil Contractor.

Various items of apparatus and equipment will be furnished and set under other contracts. The Contractor shall familiarize himself with the requirements of the civil Contractor and the other Contractors and shall examine the plans and specifications covering each of these contracts.

The Contractor shall carefully check space requirements with other Contractors to ensure that his equipment, pipes, ducts, etc. can be installed in the spaces allotted for same.

The Contractor shall consult with the civil Contractor and with the Contractors for other trades so that wherever possible all motors and motor starters and all valves are of the same manufacture throughout the entire building.

Wherever the Contractor's work and the other Contractor's work inter connects, the Contractor shall co-ordinate his work with the other Contractors to ensure that the other Contractors give the information necessary for him to carry out his installation. The Contractor shall also co-ordinate with the other Contractors in order to ensure that the other Contractors have all the information necessary to properly complete the electrical and mechanical works associated with the work.

The Contractor shall identify all work items (valves, fittings, fixtures, etc.) in an approved manner in order that the civil Contractor may know where to install an access type panel in walls and ceilings.

The Contractor shall caution men both verbally and in writing as to the danger involved in doing work within or adjacent to the electrical equipment on the various floors, and in plant rooms, due to the dangers caused by the presence of high voltages and current present in these areas.