



من الشعب الياباني
From the People of Japan



Construction of Main Electrical Power Supply line
For the
Construction of Khan Younis Waste Water Treatment Plant Project
(KY WWTP)

Tender Documents

Specification

Executing Entity: UNDP/PAPP

Employer: UNDP/PAPP

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Consultant



VOLUME 2 – SPECIFICATION

PART 1– General Requirements

PART 2 – Technical Specifications - Electrical Works

PART 3 – Technical Specifications - Civil Works

PALESTINE
CONSTRUCTION OF MAIN ELECTRICAL POWER SUPPLY LINE
FOR THE
CONSTRUCTION OF KHAN YOUNIS WASTE WATER TREATMENT PLANT PROJECT
(KY WWTP)

VOLUME 2 –SPECIFICATION
PART 1 – GENERAL REQUIREMENTS

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GENERAL REQUIREMENTS

1. GENERAL

1.1. REFERENCE TO OTHER CHAPTERS

Throughout the Specifications and Schedules of Prices, references are occasionally made to other Chapters. All such references are intended solely for the convenience of those using the documents, and the absence of a reference in no manner excludes the application of every other Chapter in the Specifications which may, in the opinion of the Engineer, have any bearing upon the point in question, the intention being that the Contract Documents shall be read and applied as a whole.

1.2. EXISTING FACILITIES WITHIN THE SITE OF WORKS

There are no facilities to be provided by the employer at the site.

The contractor shall be responsible of protecting, reallocating and reinstating all existing utilities with high quality and to their original functional status.

1.3. NON-DISCLOSURE OF INFORMATION

The Contractor shall not without the consent in writing of the Employer disclose particulars of the Contract to any person or furnish or publish or permit to be furnished or published any information with regard to the Employer's business to any person save in so far as may be necessary for the due performance of the Contract and shall preserve strict confidence with regard to any information of a confidential or secret nature received from the Employer or the Engineer.

1.4. ADJOINING CONTRACTS

This contract is one of four contracts to be implemented separately under the "Khan Younis Wastewater Treatment Plant, Phase I". These contracts are:

- 1- Construction of Khan Younis Waste Water Treatment Plant and Buildings (KY WWTP),
- 2- Construction of main pressure lines to the sea and to the infiltration basins,
- 3- Construction of the infiltration basins in Al Fukhari, and
- 4- Construction of the main electrical power supply line to the WWTP,

All interface issues, and related costs are deemed to be included in the unit prices.

2. SITE OF WORKS

2.1. THE SITE

The Site shall be deemed to include all areas on which temporary and permanent Works are to be constructed, all other areas made available to the Contractor for the execution of the Works and all roads, tracks and footpaths whether private or public between the various parts of the Works.

2.2. USE OF LAND AND RIGHT OF WAY

A. The Contractor will, during the execution of the Works, have free and temporary use of working areas and accesses thereto. The working areas will include space for the Contractor and the Engineer's offices, camps, stores, yards, constructional plant, temporary roads, parking areas and other temporary works. The Contractor's proposal for temporary works including overall layout plan in conformity with the Tender Documents shall be included in the Contractor proposal.

All use of land is subject to the Engineer's approval.

If the area of the sites is found to be inadequate, the Contractor shall make his own arrangements for all additional working areas in the vicinity of the Works or elsewhere for his site compound, offices, temporary accommodation and living facilities, for offices for the Engineer's Representative.

B. Apart from transport to and from these areas the Contractor shall confine his operations under the Contract to these areas. Before entering any working sites, the Contractor shall give 30 days' notice to the Engineer in writing. Such notices shall be given for each occupation of the working sites.

C. Before entering any additional working sites (if any) the Contractor shall obtain and forward to the Engineer a copy of the written consent of the owner or occupier or Authority having charge of the land stating the purposes for which such land is to be used by the Contractor, and defining the extent and periods of his occupation for which such consent is granted. Notwithstanding the requirements of such consent, additional working sites shall be protected by fences or barriers or other works as required by the Engineer. Wherever practicable a passage shall be maintained for vehicles and pedestrians along public roads and to all adjacent properties.

D. In the event of the Contractor making use of any special temporary way leave or additional accommodation acquired by him pursuant to the Conditions of Contract hereof or any trip for the disposal of surplus materials he shall obtain and forward to the Engineer a copy of the written consent of the owner and occupier or Authority having charge of the land in which such way leave, accommodation or tip is situated and shall make a record to be agreed by the Engineer of the condition of the surfaces of the land before entering thereon. The Contractor will not be permitted to occupy space in public roads or thoroughfares along the route of pipelines nor additional accommodation except with the written consent of the Engineer, whose consent will not be given unless the Contractor shall have first obtained the written consent of the Authority concerned and having charge of the road surface.

E. Temporary fences and barriers

Temporary fences and barriers shall be provided by the Contractor for the Working Sites.

Where there is no existing fencing or boundary walls the Contractor shall provide, erect before commencing the Works and maintain in good condition to the satisfaction of the Engineer temporary fencing in positions around the Contractor's areas shown on the Drawings or where directed by the Engineer. The Contractor shall remove all temporary fencing on completion of the Works, except for such fencing, or parts thereof as the Engineer may direct to be left in place in good condition for the Employer's use.

F. Temporary buildings etc, Classified as temporary works

Starting from the Commencement date, the Contractor shall have to bear the cost of management of all temporary buildings and/or works.

G. Notice boards

The Contractor shall manufacture 2 notice boards and erect these where directed by the Engineer. The notice boards shall be 2,00 x 3,00 m painted galvanized steel plates with support of steel pipes. The notice boards shall have the indication as instructed by the Engineer and be painted after fabrication on all surfaces.

The Contractor shall erect these boards on suitable supports in positions within the Site as directed by the Engineer.

The UNDP and funding agencies Visibility Guidelines as well shall be strictly applied.

H. Advertising and publicity

Advertising will not be allowed on any hoarding whether temporary or permanent, or on any other part of the Works, except such as the Employer may require for this own purposes.

The Contractor shall obtain the permission of the Employer before publishing any article describing the Works. The Engineer's permission shall be obtained before any member of the public is allowed to inspect the Works. All visitors will be required to sign a form of indemnity.

The UNDP and funding agencies Visibility Guidelines as well shall be strictly applied.

2.3. PROJECT LOCATION

The construction site for Khan Younis Waste Water Treatment Plant is located in the south-eastern part of Khan Younis Governorate close to the eastern borders of Gaza Strip near Sofa crossing.

The construction site for the main electrical power supply line are located from connection point at Salah Aldeen road to Khan Yonis Waste Water Treatment Plant.

2.4. SPECIAL CONDITIONS AND HAZARDS

The Contractor shall observe the local conditions and regulations and following conditions when drawing up his proposal for traffic access to the Sites and Working Sites and such proposals shall be submitted to the Engineer for his approval before implementation.

- a) Location of access routes to suit the agreed traffic plan;
- b) Restricted headroom due to flyovers and overhead cables;
- c) Restricted loading to existing services, manholes, etc;
- d) Restrictions on height of temporary structures and/or the location of temporary offices due to the proximity of commercial/residential property;

- e) Buildings in the locality particularly sensitive, due to their use or condition, to undue noise and vibration;
- f) Access to private and public properties and buildings;
- g) High voltage overhead cables;

2.5. TRAFFIC ARRANGEMENTS

The Contractor shall seek information on and comply with all requirements and recommendations of the police regarding traffic safety measures.

Plans for re-routing traffic along public streets during occupation of the Working Sites will be arranged by the contractor, and after the approval of the Engineer, with the appropriate Government Authorities which include the Traffic Police. Such arrangements include the acquisition of provisional Permits from the traffic authorities to occupy Working Sites. The Contractor shall not occupy any Working Sites without holding such Permits.

The Contractor shall provide, erect and maintain during his occupation all barriers and traffic signs as required by the Authorities or instructed by the Engineer. All signs must comply with standard international practice or as otherwise required by the traffic authorities. All written notices on signs shall be in both Arabic and English languages.

The Contractor shall arrange with the owners and occupiers of properties alternative temporary access and shall submit details of such agreed temporary access arrangements where necessary.

2.6. AMENITIES TO BE PRESERVED

The Contractor shall cause the least possible interference with existing amenities, whether natural or man-made. No trees shall be trimmed or felled except as authorised by the Engineer.

All lights provided by the Contractor shall be so placed or screened as not to interfere with the use of adjacent buildings, road users, traffic or signal lights or other equipment of the Employer or other authority.

The Contractor shall store and place all materials, plant and appliances in such a manner as to prevent them causing injury or damage to persons or property and at a safe distance from roads, tracks and footpaths.

3. SITE CONDITIONS

3.1. GENERAL

A site investigation has been carried out for the project, and the Contractor agreed that he was informed and he has analyzed (such investigation).

The Contractor shall draw his own conclusion from the Site Investigation Report and the Employer recognizes no responsibility of any conclusion the Contractor may draw thereof.

3.2. SEISMICITY

The evaluation of the ground acceleration to use for the structural calculations will be done in accordance with ACI 08 and UBC 97 codes.

3.3. CLIMATE

The climate is typically Mediterranean with hot dry summers and mild wet winters. The average daily temperature varies between 27°C to 13°C.

The average yearly rainfall is ranging between 400 mm in the northern part and 240 mm in the southern part of Gaza Strip which falls during the month of October to March. Rainfall can very occasionally exceed 35 mm per hour, and when this happen flooding occurs in low lying areas.

3.4. PROTECTION AND DIVERSION OF EXISTING SERVICES

A. The Contractor shall be responsible for notifying the service authorities and the Engineer of his intention to expose the services and where so required by the service authority shall not commence operations until the service authority is represented on Site.

B. The Contractor shall excavate, protect until backfill and backfill in a manner so as not to damage the services.

C. As soon as a service is encountered in the excavation whether previously located or discovered during the course of excavation for the Permanent Works the Contractor shall forthwith call the attention of the Engineer and the appropriate service authority thereto.

D. The Contractor shall be responsible for maintaining all such services including natural and artificial watercourses encountered by him in the construction of the Works and shall make good any damage caused directly or indirectly by his activities.

3.5. PROTECTION OF ANTIQUITIES AND FOSSILS

A. As soon as antiquities or fossils are encountered during the course of any excavation, the Contractor shall forthwith call the attention of the Engineer and the appropriate service authority thereto.

B. Vulnerable parts of the discovered antiquities of fossils shall be protected by the Contractor as may be reasonable required by the Engineer.

C. No requirement of the Specifications regarding the disposal of material arising from site clearance or excavation shall override any provision in the Conditions of Contract as to the discovery of ownership, of fossils, coins, articles of value or antiquity of anything of geological or archaeological interest found on the Site.

4. SCOPE OF WORKS

4.1. DESCRIPTION

The services to be provided by the Contractor include, but are not limited to the following:

- A. Any required design and additional studies
 - Additional soil investigations, as considered required by the Contractor
 - Shop drawings and working drawings
 - Detailed drawings of installation
- B. Implementation

Works to be carried out by the Contractor include but are not limited to the following:

- a) Installation of the site and preparatory works, connection to telecoms, water, electricity and other networks and services.
- b) Implementation of works in accordance with the "The Drawings and Specifications", as specified in the General Conditions of Contract, including:
 - preliminary drillings and investigations for the existing facilities and networks, if necessary,
 - earthworks and final backfilling, drainage (including removal and storage of materials and earth),
 - special foundations, if necessary
 - all construction (concrete, reinforced concrete, masonry, framework, roofing, sealing, cladding, etc.),
 - fences, roads and utilities networks,
 - demolition of existing structures to be removed, if any, including pipes and the reuse or removal and dumping of the corresponding materials in locations authorized by local legislation, and levelling of the land thus freed,
 - connection of the new installations with existing structures (pipes).
 - all pipes, whatever the position, as described on the drawings
- c) Implementation of the "electricity and electromechanical and hydromechanical equipment" works in conformity with the Drawings and the Specifications, including the supply, testing and transportation to site of all necessary materials and equipment and their implementation or erection and adjustment, namely:
 - hydraulic, mechanical and electrical equipment, including control, monitoring, measurement, protection and safety devices
 - miscellaneous equipment required for the proper operation and maintenance of the installations, (lighting, heating, telephone, etc.),
 - the remote surveillance system, if any
 - all small equipment, pipes, adjustment required for a proper operation
- d) The commissioning of the installation and performance of the tests.
- e) The provision of maintenance manuals, as-built drawings of the structures and networks.
- f) Supply of spare parts if any.
- g) Services for the Employer and the Engineer, as defined below and/or in this tender documents.
- h) All necessary works required to complete the construction of the project.

The Contractor shall be fully responsible for the review of the Engineering design and details of the Works and shall inform the Employer and the Engineer of any mistakes or incorrectness in such design and details which would affect the Works.

4.2. C. PARTICULAR PROVISIONS IN GAZA STRIP

4.2.1. SECURITY AND LOCAL CIRCUMSTANCES OF THE GAZA STRIP

While establishing their bids' prices, the bidder should be aware of and consider the security and local circumstances of the Gaza Strip including reiterated closure of boundary and crossings

between the Gaza Strip and Israel, delay of the custom procedures, delay of accessing people, supplies and construction materials and equipment to the Gaza Strip, etc.; which could affect the progress of works on the ground.

The Contractor has to familiarize himself with these circumstances through the construction and operation stages and shall take into account all the consequences that may arise due to these circumstances.

4.2.2. PRODUCTS AND COMPONENTS STORAGE

Considering the above mentioned security and local circumstances of the Gaza Strip, the Contactor shall organize the supply of the works and the construction materials and equipment in order to manage to have enough construction materials and equipment on site or inside the Gaza Strip in case of boundary and crossings' closure or delay of accessing the construction materials and equipment.

In particular, the minimum storage of the construction materials on site shall be as follows at any time:

- Galvanized steel poles, arms, wires, cables, fittings and accessories: 8 weeks
- Steel rebars: 8 weeks
- Cement: 8 weeks
- Form works: 8 weeks
- Aggregates: 8 weeks
- Any other products: 8 weeks

He shall also organize staff assignments on site in order to be sure to have the necessary staff management for the project. No claims shall be admitted by the Employer for such circumstances and access delay.

All amounts of related costs such as custom duties, additional costs for idle plant, or for extra storage inside Gaza or inside Israel, or for any forwarding agent, or for specific Israeli regulations in force at the date of the submission are deemed to have been included in the unit rates/prices of the Bill of Quantities.

4.3. HEALTH AND SAFETY

The Contractor shall submit a Health and Safety Plan and shall formulate and submit site safety regulations/guidelines.

The Contractor shall be responsible for the safety of all workmen and other persons entering the Works and shall, at his own expense (where not otherwise stated) and to the approval of the Engineer, take all measures necessary to ensure their safety. Reference in these respects is made to the Conditions of Contract, but in particular, such measures shall include, but are not limited to, the following:

- A. Provision of proper safety and emergency regulation; fire, gas (if any) and electric shock prevention, stretchers and first aid boxes, together with rescue facilities generally, for each place of working.
- B. Safe shoring of all excavations.
- C. Provision of efficient safety helmets for all personnel including the Employer and the Engineer and each of their staff and any authorized visitors to the Site.
- D. Safe control of water including provision of ample standby pumping plant.

E. Provision and maintenance of suitable lighting to provide adequate illumination of the Works with appropriate spares and standby equipment.

F. Provision of good and safe access to any part of the Works.

G. Provision of notices written in Arabic and English languages to be erected at points likely to be used by the public, which shall warn the public of the existence of the Works. These notices shall be in addition to any statutory requirements demanded of the Contractor.

The Contractor shall submit for the approval of the Engineer the detailed health and safety plan and the site safety regulations/guidelines. When the regulations/guidelines have been approved, and before the work is started, the Contractor shall distribute copies in English and Arabic languages to all his employees and to the Engineer.

The Contractor shall ensure that all his employees are fully conversant with the safety regulations/guidelines, emergency and rescue procedures, etc., and the Contractor shall enforce the rule that any employee committing a serious breach of such regulations shall be instantly dismissed and shall not be re-employed.

H. Personal protective equipment shall be available and used by operatives when appropriate, including: safety helmet, eye protection, ear protection, hand protection, foot protection.

4.4. TRANSPORTATION OF MATERIALS AND EQUIPMENT

A. The Contractor shall take all reasonable precautions to ensure that public streets and thoroughfares used by him either for the construction of the Works or for the transport of plant, labour and materials are not made dirty as a result of such construction or transport and in the event of their becoming thus dirtied in the opinion of the Engineer the Contractor shall take all necessary and immediate steps to clean them.

B. Vehicles shall be thoroughly cleaned down before leaving the Sites and shall be so loaded that spillage therefore is prevented. Particular care shall be observed when disposing of slurry type material in a highly fluid condition which may additionally be contaminated with bentonite.

C. Each individual site must be kept clean during the work and must be thoroughly cleaned upon completion.

4.5. SAFETY IN SEWERS AND AT SEWAGE WORKS

A. The recommendations contained in the booklet « Safety in Sewers and at Sewage Works » published by the Institution of Civil Engineers London shall be adhered to in respect of all work in operational sewers and waste water treatment plants.

B. The Contractor shall make all necessary arrangements with the appropriate authority before entering in or working on existing sewers and associated works.

C. The Contractor shall ensure that sufficient resources of supervisory staff are readily available to carry out such continuous working at established levels of safety.

4.6. SANITATION

A. The Contractor shall maintain the Site in a hygienic condition and shall comply with the requirements of the Engineer. At least all the wastewater produced on the Site, should be reasonably treated.

B. The Contractor shall comply with the requirements stipulated in British standards.

4.7. PREVENTION OF NOISE AND DISTURBANCE

- A. The Contractor shall in general comply with the recommendations of international standards.
- B. The Contractor shall justify the details and arrangements of all plant before installation to ensure that suitable provisions are provided to reduce noise emission in built-up areas.
- C. The Contractor shall take noise intensity readings as required by the Engineer and shall submit the results to the Engineer. The Contractor shall comply with measures required by the Engineer to keep noise and disturbance to the reasonable minimum.

4.8. FIRE PREVENTION

- A. The Contractor shall make arrangements to the satisfaction of the Engineer for the protection of the Works and any Temporary Works and any adjacent property from fire and shall give the Fire Authority all facilities periodically to inspect the fire prevention arrangements.
- B. Particular care must be exercised in connection with the operation of electric-arc welding equipment, oxy-acetylene cutting equipment and other processes involving the use of naked lights. Special arrangements will be necessary for the storage of highly flammable liquids on the Site.
- C. The Contractor shall remove all rubbish and surplus material of a flammable nature and take such other steps as the Engineer may require but this shall not relieve the Contractor of any of his obligations under the Contract.

4.9. WORK IN THE VICINITY OF OPERATIONAL MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Any permanent fencing or other safeguards required to be erected around electrical equipment shall be completed as far as practicable before connection is made to the electricity supply. In so far as this is not practicable the Engineer may permit the use of temporary fencing or other safeguards.
- B. Where work has to be carried out in proximity to operational mechanical and electrical equipment other than the Contractor's own plant, the Contractor shall put into operation a « Permit to Work » system to the approval of the Engineer.

5. GENERAL COORDINATION

The contractor shall co-ordinate his work with that of his sub-contractors and, if any of the other contractors at the site, and the other contractors implementing the other contracts of KY WWTP mentioned in above clause 1.4 to whatever extent may be necessary to complete the project in accordance with the program of works, the drawings and specifications and the requirements of the engineer.

5.1. EMPLOYER'S USE OF CONTRACTOR'S TEMPORARY WORKS

The Contractor shall during the progress of the Works allow the Employer, the Engineer and other contractors employed by the Employer in connection with the Works the use of his roads, scaffolding, constructional plant, other temporary works or services such as described in the present Section. The Contractor shall at every place of working provide proper drainage, lighting and ventilation for other contractors' erection work and for the Engineer's inspection of the Works. Except for those items entered in the Bill of Quantities, all costs of such assistance are deemed to have been included in the unit rates/prices of the Bill of Quantities.

5.2. ASSISTANCE TO THE ENGINEER'S STAFF AND TO OTHER CONTRACTORS

The Contractor shall provide labour for attendance on the Engineer for operations connected with supervision of the Works in particular for topographical survey. All costs of such attendance and assistance to the Engineer and his staff are deemed to have been included in the unit rates/prices of the Bill of Quantities.

5.3. DISPOSAL OF SURPLUS EXCAVATED MATERIALS

Surplus excavated material and debris arising from the Works shall be:

- dumped on agreed disposal sites at any distance far from the construction site within the Gaza Strip at the expenses of the Contractor. In order to avoid unauthorized disposal the Contractor shall arrange that each cartage contractor and lorry driver employed for the disposal of such materials is given written instructions as to the approved place where each load is to be tipped. The Contractor shall retain in his office copies of such instructions, together with a list of approved places to be used, for inspection at any time by the Engineer.

The Contractor shall indemnify the Employer against any claims arising from unauthorized disposal of such materials.

- re-used on the site for the landscaping development; in this case, the Contractor Proposal shall justify the characteristics and volume of materials; should the Contractor Proposal not include such arrangements, the re-use shall not be allowed.

6. TENDER DRAWINGS SUPPLIED TO THE CONTRACTOR

The only drawings provided by the Employer to the Contractor are the drawings included in the Tender Documents – Volume 3.

7. DOCUMENTS AND DRAWINGS TO BE CARRIED OUT BY THE CONTRACTOR

7.1. CONSTRUCTION DRAWINGS

A. General provisions for construction drawings

- a) Such drawings shall be deemed to be Construction Drawings, part of the Contractor's Documents pursuant to Clause 4.1 of the General Conditions of Contract.
- b) The drawings issued by the Contractor for construction will include:
 - The foundation drawings, including if any temporary works such as excavation drawings, etc.
 - Detailed drawings of installation of any steel works, wood works, including calculations notes if required.
 - The additional drawings as required by the Engineer to develop in greater detail the construction required.
 - Shop reinforcing steel drawings, formwork drawings.

All these drawings shall be referred to hereinafter as Construction Drawings.

These drawings will be submitted by the Contractor in accordance with the Documents' submittal program, to the approval of the Engineer.

c) Detail erection drawings, concrete placing (lift) drawings, shop drawings on mechanical and electrical drawings, wiring diagrams (electrical cabinet and structures) and cabling; other detail drawings shall be prepared by the Contractor on the basis of the Construction Drawings; they will be given for information to the Engineer before construction.

d) All drawings shall be in the English language, and all dimensions shall be in Metric system. Symbols shall be in accordance with approved Standards. All drawings submitted for approval shall conform to ISO paper sizes A1 to A3. Title block and numbering shall be approved by the Engineer.

e) The Permanent Works shall be executed in conformity with the Construction Drawings and other drawings approved by the Engineer.

B. Civil works

All particular arrangements on the civil structures (cranes, temporary loads, batching plant, additional or variant equipment, ...) shall comply with the following provisions.

a) Design calculations

The design calculations may be presented in a computer format and shall include in:

- A title page
- Design calculations conditions and criteria;
- The values of the maximum stresses under normal and exceptional operating conditions and during handling, transport and erection;
- The main dimensional characteristics;
- The properties of the materials used;
- Bibliographical references used for the calculations.
- The loads to which the supply is subjected and their origin;
- The forces transmitted to supplies and to the foundations;
- Stresses to which the equipment will be subjected under normal and exceptional operating conditions (including handling, transport and erection);
- The permitted safety factors;
- In general, any indications required for a proper understanding of the design of the supply;
- The output, power and characteristics of drive or control motors.
- All design calculations of the approved variant, if any.

b) Drawings

In addition to the drawings listed above, the Contractor shall prepare and deliver to the Engineer prior to construction for information the drawings for:

- the Temporary Works
- the performance of the Works as necessary for showing the construction methods
- the Drawings relevant to the Construction of
- Access roads;
- Contractor's camp and facilities,
- the detailed drawings of concrete reinforcement and calculation works, as well as bar bending and cutting list, as installed.
- All drawings of the approved variant, if any
- the as-built drawings of all Permanent Works constructed.

- the other drawings necessary for the performance of each part of the Works in accordance with the Contract.

The Contractor shall perform also the necessary calculations in connection with the required drawings.

- c) The drawings prepared by the Contractor will be established for cases of maximum load likely to occur during operation of the Permanent Works, and exceptional load situations which may occur during construction in compliance with the method of works.
- d) The Contractor shall be responsible for assuring the adequacy of all parts of the works with respect to loading which might occur during construction and shall supply calculation notes and drawings for any necessary falsework, supports, strengthening as may be required by the Engineer.
- e) The Contractor shall be responsible for the behaviour of the Permanent Works during the various phases of construction. He shall provide all equipment and accessories and all working arrangements necessary to limit stresses on the Works, so that stability of the structures is not threatened and so that stresses and deformation remain within acceptable limits.
- f) It is the responsibility of the Contractor to inform the Engineer in case of mistakes on the Tender Drawings.

C. Electrical and Mechanical equipment included in the present contract

a) General

The Contractor is responsible for the execution of documents (drawings, diagrams, design calculations, erection, etc.) for the different supplies.

A list of all drawings, diagrams and design calculations to be submitted to the Engineer shall be drawn up at the start of the Works in agreement with the Engineer. However, the Engineer reserves the right to request further details at a later stage in order to facilitate understanding of equipment functions.

b) Overall and detail drawings of the equipment

The Contractor shall supply drawings for information of assemblies, parts of assemblies and large parts of the equipment to the Engineer for information.

These drawings, or where applicable their technical associated documents, shall include, in addition to production dimensions, flatness, straightness, horizontal and vertical tolerances, the values of assembly and operating clearance with the minimum and maximum acceptable deviations, the type and the properties of the materials used in the different parts, The weld categories and the types of non-destructive testing to be carried out on welds, the surface condition valued to be achieved for parts machined in accordance with ISO/R 468 standard.

Drawings, or, where applicable, their technical associated documents shall also include the weights of assemblies, parts of assemblies and detailed parts as well as the surface areas to be painted for structures.

D. Submission and approval

- a) The Contractor shall submit in three (3) copies to the Engineer, for review, information or approval, all documents and drawings which he prepares under this Clause (except for "As-Built"). The Engineer will analyze all such designs and drawings, will appraise them as to

whether they are reasonable and consistent with the Construction Drawings, will approve if requested and will order changes when deemed necessary.

The Contractor's documents and drawings shall be submitted in a sequence to facilitate the Engineer's study and scrutiny of the same, shall be completed in regard to all computations and data, and shall be traced on size 840 mm x 594 mm (A1-size) or 297 mm x 420 mm (A3-size) paper. The title of the drawings, the signature of the Contractor's representative, the date of preparation and the reference to Construction Drawings, if any, shall appear in the bottom right hand corner of the drawing. Within twenty-one (21) days after submission of the drawings, the Engineer will advise the Contractor of his conclusions regarding the drawings.

b) When approval is requested, the Engineer's conclusions may be one of the following:

- "APPROVED"
- "DISAPPROVED" (with relevant reasons determining rejection duly indicated).

Within seven (7) days of the return of documents and drawings marked "APPROVED", the Contractor shall present to the Engineer one reproducible copy of the drawings traced in ink and two (2) prints of the same. These drawings will have an indices +1, noted "Approved for Execution by the Engineer on xxx"

No drawing shall be considered valid unless signed by the Engineer. The approval by the Engineer of such drawings shall not relieve the Contractor of his obligations and responsibilities under the Contract.

Those marked "DISAPPROVED" shall be redone and submitted a new to the Engineer.

The Contractor shall not be entitled to a time extension based upon the rejection of designs or detail drawings, because such designs or detail drawings fail to conform to sound engineering principles, or to the Specifications.

All Works should be executed with the relevant approved drawings. All materials ordered or Works performed prior to approval of the relevant designs, shall be at the Contractor's risk.

c) The Contractor shall bring to the attention of the Engineer any variation to the Contract in the document submitted for approval.

d) When no approval is requested within twenty-one (21) days after submission of the drawings, the Engineer will notify his comments or requests. All materials ordered, or work performed, prior this notification shall be at the Contractor's risk.

E. Ownership of drawings and data

All the drawings, details, bill of materials and any other information or documents furnished by the Contractor shall become the property of the Employer and shall be non-returnable. The Employer will have the right to use this property.

Such information shall be given in paper copy and in digital format.

7.2. AS BUILT DRAWINGS

1 (one) month before the date of the Taking Over Certificate, the Contractor should have submitted the full set of "As built" Drawings; 4 hard copies in A1 format and 4 copies in electronic form.

Drawings shall be filed and printed, within different books, each of them being organized as follows:

- Formworks,

- Reinforcements,
- Pipes,
- Electrical,
- Instrumentation,
- Mechanical,
- Roads and utilities.

The lack of submission of such drawings will automatically postpone the Taking Over Certificate, and such delay will be the responsibility of the Contractor.

8. LAYOUT OF WORKS AND SURVEYS

8.1. REFERENCE POINTS, LINES AND LEVELS

A. Level reference

The data for all levels shall be based on current national datum.

B. General setting out

At the beginning of the Works, the Contractor and the Engineer shall agree on the definition and general setting out of the structures to be built on the site, based on the general network established for the project.

Three points which shall be used as a reference basis in three dimensions (X, Y, Z) will be made available at site by the Engineer by the date of beginning of the work. These three points shall be handed over to the Contractor, which will accept them as references. The Contractor will provide a detailed table includes the coordinates of all the buildings corners.

Additional bench marks may be provided by the Contractor for triangulation reference.

The Contractor shall be responsible for the conservation of the related benchmarks during the entire duration of the construction and Defects Liability Period.

The Engineer shall draw up a report to confirm completion of these operations in the field.

C. Complementary setting out

During the execution of the Works, the Contractor shall complete the general setting out by as many stakes, seats and gauges as may be necessary.

D. Reference points

At the beginning of erection of equipment, complementary reference points shall be placed by the Contractor. Position of lines and levels shall be defined by mutual agreement of all parties. In case of disagreement the Engineer shall decide.

E. Approval

The Engineer will draw up a report to confirm completion of these operations in the field.

8.2. TOPOGRAPHICAL SURVEY

The initial topographical survey shall be provided by the Engineer as shown on the Volume 4 – Additional Information. The Contractor may either accept the results of this study or undertake a new topographical survey at his own expense.

In any case, the Contractor shall undertake all survey during the implementation of the works as required.

9. STANDARDS, CODES AND REGULATIONS

9.1. GENERAL

A. General Standard specifications and codes of the following listed authorities wherever cited herein are referred to by use of the abbreviations shown below. All materials and workmanship shall comply with requirements of applicable codes:

		Abbreviation
1	Gaza Electricity Distribution Corporation	GEDCO
2	British Standards Institution Linford Wood, Milton Keynes MK14 6LE - UK	BS
3	Commission Electrotechnique Internationale 1 rue de Varembe Case Postale 56	CEI
4	International Standard Organisation 1, rue de Varembe Case Postale 56 CH1211 GENEVE 20 - Suisse	ISO
5	European Committee for Standardization 36 rue de Strassart 1050 Brussels, Belgium	EN

B. Copies of Specifications, codes or standards of the above organizations may be obtained at the addresses shown.

9.2. STANDARDS TO BE ON SITE

If required, the Contractor shall obtain and keep on Site at least one copy of each standard which is referred to in the Specifications. One copy shall be at the disposal of the Engineer's Representative.

9.3. APPLICABLE STANDARDS

A. Unless otherwise specified, the Standard to apply will be as follows:

- Civil works and process: European Standards EN
- Electrical works: IEC (in addition to EAC requirements)
- Handling equipment: FEM

- B. Except if otherwise specified, where such standards are mentioned, the latest revision or edition on the Reference Date shall apply.
- C. When the Contract Documents contain particular specification or more restrictive specification than required in Standards and Codes listed above, the Contract Documents will always prevail.
- D. In case of lack of precise requirements in the Specifications and even if no reference to any standard listed in Sub-Clause hereof, these standards shall be used as a reference.

9.4. STANDARDS OTHER THAN THOSE SPECIFIED

- A. Where requirements are specified by reference to a standard which has its origin in one country, it is not the intention to restrict the requirements solely to that standard and that country. The Contractor may propose to the Engineer an equivalent standard other than that specified, in which case he shall submit the proposed standard and all other information required by Section 14 (Approval of Materials and Equipment), and shall submit written proof that his proposed standard is equivalent in all significant respects to the standard specified. All submissions shall be made in English language.
- B. If required, the Contractor shall supply a copy of these standards and regulations in English language.

10. WATER CONTROL

- A. Without prejudice to other stipulations in the Contract, all constraints related to the presence of or risks caused by water, all additional work which may prove necessary on this account, all damage caused by water, all pumping in all structures not mentioned in the Contract which the Contractor may find he has to build for water control purposes shall be at the expense of the Contractor.
- B. Without prejudice or other stipulations in the Contract, the Contractor shall be responsible for all damage caused to the foundations of the structure or any part of the Works and occasioned by floods, surface water or runoff, or by failure of any part of the diversion or protection works carried out by the Contractor. Any repairs that are necessary will be carried out at his own expense.
- C. Before any works are begun, the Contractor shall submit to the Engineer's approval the methods and arrangements he proposes to apply in order to protect the Works, unless these are imposed by the design incorporated in the Contract. Such Engineer's approval shall not relieve the Contractor of his obligations and responsibilities under this Section 11.

11. DEWATERING OF FOUNDATIONS

- A. The Contractor shall provide, install, maintain and operate all pumping and other equipment for dewatering for all parts of the Site where this is necessary, and for as long as required for implementation of the works.
- B. The dewatering facilities shall be such as to avoid any loss of fine materials, and shall ensure stability of the excavation works and adjacent buildings and facilities.
- C. Water removed from the excavations must not be allowed to cause nuisance or damage to traffic or any public or private property or service.

D. All costs relevant to the present section are deemed to have been included in the unit rates/prices of the Bill of Quantities.

12. TOPOGRAPHICAL EQUIPMENT

A. The Contractor shall provide for the use of the Employer and the Engineer on Site for every-day surveying the following normal accuracy instruments:

- 2 level with tripod,
- 1 theodolite (reading 1 sec.) with tripod,
- staff gauges,
- chains or steel tapes,
- and all other equipment necessary for the every-day surveying.
- 1 paint thickness controller
- Any other equipment and instruments necessary for testing and commission the installations.

B. All equipment supplied to the Engineer under this clause shall remain property of the Contractor on completion of the work.

C. All equipment for the use of the Employer and the Engineer on Site shall be maintained in good order by the Contractor.

D. All costs relevant to the present paragraph are deemed to have been included in the unit rates/prices of the Bill of Quantities.

13. QUALITY OF MATERIALS

13.1. MANUFACTURED MATERIALS

A. All materials, fixtures, fittings, and supplies furnished under the Contract shall be new and unused, of standard first-grade quality and of the best workmanship and design.

, and all work of assembly and construction shall be done in a first-class and workmanlike manner.

B. In asking for prices on materials intended for delivery to the site and incorporation in the Works under any portion of these Specifications, the Contractor shall provide the manufacturer or supplier with complete information as may, in any case, be necessary to secure compliance with this Clause and, in every case, he shall quote this Clause in full to each such manufacturer or supplier.

13.2. QUARRIED MATERIALS

The Contractor shall be responsible for investigating and obtaining riprap stones, rockfill, filters and transitions and aggregates for concrete and other purposes. The Contractor shall develop such investigations that he may require to meet the Contract requirements.

13.3. CEMENT

The Contractor shall, within 28 calendar days after the Commencement Date, submit i) all the chemical and physical characteristics of the cement in compliance with the specifications and ii) a forecast on a monthly basis detailing his local cement requirements for the duration of the Contract in a form approved by the Engineer. Throughout the Contract period, the Contractor shall review this forecast at quarterly or more frequent intervals as may seem to him necessary or as may be required by the Engineer. Prior to commencing the Works, the Contractor shall establish a stockpile of cement based on his forecast of cement requirements and sufficient for maintaining his operations.

14. APPROVAL OF MATERIALS AND EQUIPMENT

14.1. GENERAL

A. All materials and equipment intended to be incorporated in the Works shall be subject to information given by the Contractor to the Engineer. For the materials incorporated in the civil works (including architectural materials), the Engineer shall give approvals and the Contractor shall wait for this approval prior to order. For the mechanical and electrical equipment, the Engineer shall give only comments or refusals if necessary.

B. Unless otherwise authorized by the Engineer no material or equipment shall be shipped from its point of original manufacture or final shop assembly to the work site before it has been inspected in accordance with Clause 14.3.

14.2. SUBMISSION OF SAMPLES AND DATA

A. The Contractor shall submit for the approval of the Engineer samples, drawings, catalogues, cuts, diagrams and other descriptive data for all mechanical, electrical, architectural and such other materials and equipment as may be designated by the Engineer and which the Contractor proposed to incorporate in the Works. For certain materials and equipment data may be required to be submitted in accordance with a detail form furnished by the Engineer.

B. Items submitted shall be properly labeled to indicate the Project Contract number, Contractor, source of supply, manufacturer Contract Item number, and other data required by the Specifications.

C. All items shall be submitted in sufficient time, but not later than 90 calendar days prior to purchase, to permit proper consideration and action thereon without delaying the construction schedule.

D. Items sent for approval shall be shipped prepaid by the Contractor and the Contractor shall give the Engineer advance notice in writing of all items shipped.

E. The results of the tests shall generally indicate:

- Sample identification numbers.
- Sample origin.
- Part of the Works represented by the sample.
- Sampling date.
- Description of tests with reference to the relevant standards.
- Test results (with appropriate units when applicable).
- Date of tests.

- Reference of laboratory undertaking the tests.
- Conclusion (Satisfactory or Unsatisfactory).

14.3. INSPECTION AT THE PLACE OF MANUFACTURE

A. To allow possible inspection of materials, electrical materials and equipment in the course of or on completion of preparation or manufacture, the Contractor shall give the Engineer written notice of the workshops and places where the materials, electrical materials and equipment are manufactured or stored and advise him of the state of progress, so that the inspection may take place at appropriate times and without delaying the dispatch of materials and equipment to the Site. In particular, the Contractor will inform the Engineer of the date of final erection tests or inspection test prior shipping.

B. If the Employer and/or the Engineer decides to attend these tests (or any representatives duly nominated) abroad the State of Palestine, the cost of the transport, flights tickets and accommodation shall be paid by the Contractor (for 4 persons for both sides, for 2 times).

C. The Engineer could make tests on concrete, concrete aggregates, embankment materials, filter materials and other materials as he may from time to time elect, and the Contractor shall provide such samples or assistance in sampling materials at the Site as the Engineer may reasonably require. Testing by the Engineer shall in no way relieve the Contractor of his responsibility to test materials to ensure that they meet all the specified requirements and to control their quality.

14.4. MANUFACTURER'S CERTIFICATE OF COMPLIANCE

In the case of standard labelled stock products of standard manufacture which have a record of satisfactory performance in similar work over a period of not less than 2 years, the Engineer may accept a statement from the Manufacturer attested by a notary public certifying that the product conforms to the applicable Specifications.

14.5. MILL CERTIFICATES

In the case of materials for which such practice is usual, the Engineer may accept the manufacturer's certified mill and laboratory certificate.

14.6. SERVICE RECORD

If a demonstrable satisfactory service record is available for a material, certain specified tests may be waived by the Engineer.

14.7. TESTING LABORATORY CERTIFICATES

The Engineer may accept at is own decision a certificate from an independent commercial testing laboratory, satisfactory to him, certifying that the product has been tested within a period acceptable to the Engineer and that it conforms to the requirements of the Specifications.

14.8. ACCEPTANCE OF MATERIALS

The approval by the Engineer of any material or equipment shall in no way relieve the Contractor of any of his responsibilities for meeting all of the requirements of the Specifications and shall not

prevent subsequent rejection if such material or equipment is later found to be defective or not conforming to the Specifications.

15. ASSEMBLY MARKING

All parts, or units of shop assemblies, shall be marked, or tagged with piece marks. Marks shall be in accordance with approved erection drawings, shall be clearly legible and so placed as to be readily visible when the part is being erected in the field. Before dismantling for shipment, connecting parts assembled in the shop shall be matchmarked to facilitate erection in the field and marked so as to identify each part with the assembly to which it belongs. The location of the matchmarks shall be clearly indicated on erection drawings. All parts or assembly of parts shall also be so marked as to identify them with this Contract.

16. SHOP CLEANING AND PAINTING

After shop assembly and inspection all parts of the Plant and Erection Equipment shall be cleaned and painted in accordance with the Specifications.

17. NAMEPLATES

A. Each major and auxiliary items of equipment shall have a nameplate permanently affixed thereto, or as directed, showing in a legible and durable manner the serial number, name and address of the manufacturer, rating data, electrical and mechanical characteristics, and other significant information, as applicable. Nameplate of distributing agents only will not be acceptable.

B. Nameplates shall also be provided where required for panel-mounted devices. Dials, gauges, and nameplates shall be marked with the nomenclature and units of measure in the metric system, and a schedule of such makings shall be submitted for review and approval by the Engineer.

C. All nameplates shall be in the English language.

D. Nameplates for Plant Identification and record purposes shall be manufactured from stainless steel with satin finish and engraved with black lettering of a size which is legible from the working level.

E. Warning plate shall be manufactured from stainless steel with satin finish and engraved with red lettering and sited in a position affords maximum personnel safety.

18. TESTS CARRIED OUT BY THE CONTRACTOR

The costs of carrying out the specified and required tests by the contractor are deemed to have been included in the unit rates/prices of the Bill of Quantities.

18.1. CONTRACTOR'S TESTING LABORATORY

The Contractor shall nominate a laboratory equipped to perform the following main tests:

- A. Soils
 - Identification.
 - Compaction tests.
 - Relative density determination.
 - Permeability (laboratory).
 - Particle size determination.
- B. Concrete
 - Fresh concrete analysis.
 - Concrete workability.
 - Concrete strength (compression, tensile strength by Brazilian test).
 - Ultrasonic pulse velocity.
 - Permeability.
 - Concrete and grout modulus determination
 - Temperature
- C. Rock and aggregate
 - Dynamic crushing tests.
 - Particle size determination.
- D. Cement
 - Setting time.
 - Blaine fineness.
 - Heat of hydration.
 - Mechanical characteristics (Strength, Young Modulus, Poisson Ratio).
- E. Grout for injections
 - Design and control.
- F. Bituminous materials
 - Design and control.
- G. Laboratory computer equipment

The Laboratory shall be equipped with one PC Computer from a well-known manufacturer accompanied by printing facilities.

18.2. RECORD BOOKS OF TESTS RESULTS

- A. The sheets recording test results shall be of a type approved by the Engineer. The Records Book of tests and results shall be kept by the Contractor.
- B. A copy of the Records Book shall be supplied to the Engineer's Representative.

18.3. SPECIAL EQUIPMENT

In addition the Contractor shall provide other Laboratory equipment or/and field testing equipment as specified in the different Sections for the purpose of controlling particular works or/and determining in-site parameters. This equipment shall be available as necessary during the execution of such activities and could be removed from the Site as and when approved by the Engineer.

19. QUALITY ASSURANCE AND QUALITY CONTROL SYSTEM

Quality Assurance (QA) Quality Control (QC) System covering all aspects of the Contract and the Works must be implemented, documented and maintained by the Contractor during the period of the Contract. The system shall comply with a recognised international Quality Assurance Standard. The System shall as a minimum consist of the following items.

A. General

The Quality Assurance System for the Company shall show the overall QA Organisation and the lines of responsibility, monitoring and action. Furthermore, the overall principles and procedures for establishing Quality Assurance Plans, Control Plans, QA Organisation, etc. for specific projects and contracts, sub-contractors and suppliers shall be provided.

B. The Works included in this Contract

Quality Assurance Plan (QAP),

Control Plan (CP).

As a minimum the Contractor shall, submit the QA System for the Company, Quality Assurance Plan and initial Control Plans for the Works included in this Contract, providing all important and critical activities for controls, inspections and tests to fulfil the specifications.

It is a general requirement that works are only sub-contracted to companies with an effective QA System.

C. Quality Assurance Plan (QAP)

The QAP shall as a minimum cover the following issues:

- The Contractor's staff and management organization for the project, management plan, and the quality assurance organization.

The person responsible for the Contractor's QAS shall be authorized and qualified to take decisions on quality assurance issues, and his reference and communication lines to the Company's overall quality assurance organization and its responsible management shall be clearly shown. Persons performing quality control and testing shall be independent of those executing or supervising the Works.

- Management of documents.
- Management of procurement.
- Management of sub-contractors and suppliers, and requirements of their QAS's.
- Control of materials and workmanship, defects and material reconciliation, procedures for corrective actions, etc.
- Handling of deviations, additions or variations to the Contract Documents.

The Contractor's system of management of current documentation for the execution of the Works shall include his sub-contractors and suppliers. It shall show:

- how it is ensured that only valid and approved documents are used for the execution of the Works and
- the method of recording variations and amendments to the documentation.

The Contractor's initial proposed Control Plans describing important and critical verification activities based on the Tender Documents and the Contractor's own considerations in respect of execution of the Works.

D. Control Plans (CP)

The Contractor shall present for the Engineer's approval his detailed CP for all quality assurance efforts or measures for the Works or sections thereof. Such CP shall be presented to the Engineer not later than one week before the commencement of the Works or an approved section of the Works.

The CP shall include controls as specified in the Contract as well as any other normal and special controls that the Contractor finds necessary in order to ensure the quality of his work.

The CP shall for each control activity describe type, method, criteria for approval and documentation and who is responsible for performing the activity.

If the Engineer does not approve the CP as submitted, then the CP shall be amended for further approval. Subsequent changes in terms of the quality assurance work will not cause changes in agreed deadlines or contract sums.

E. The Contractor's control and documentation

1) General

During the Contract period, the Contractor shall, to the satisfaction of the Engineer and State Quality Control body, document that the Works comply with the quality assurance requirements stipulated in the Contract or approved during the Contract period.

Consequently, based on the approved QAP and the CP's, the Contractor shall during the execution of the Works carry out and document the quality control and its compliance with the stipulated requirements.

The Contractor's quality control does not limit his responsibility for the Works according to the Contract.

If the Engineer, during the period of the Contract, can substantiate that the Contractor's control and/or documentation shall be extended, the Contractor shall follow the Engineer's written instructions to this effect at his own cost and within the agreed time for completion.

2) Method of documentation and filing during execution of the Works

All control activities specified in the Control Plan shall be documented.

The CP's and all other issues related to the QA System shall be kept and maintained by the Contractor in the QA filing system, which shall be kept at the project site throughout the period of the Project.

On the basis of the QAP and CP's the Contractor shall produce the necessary forms for registration, log books, and check lists, etc. before work is commenced.

All documentation shall be provided with identification, the date and signature of the person responsible for the documentation. The identification shall as a minimum comprise:

- name of project,
- activity number as defined in the CP,
- time and place of the control activity.

The Engineer shall have full access to the filing system and he may without notice commission a quality audit.

The Contractor shall keep and maintain at his own costs the “Construction Book” (Log Book) according to Cypriot regulations and submit it regularly for the approval of the Engineer.

3) Documents at delivery

At the time of delivery of materials and goods, the Contractor shall submit the following documentation to the Engineer in one original and two certified copies, all certificates, documentation of tests etc. of materials and goods to be used in the Works.

All documents verifying that inspection, control and tests performed are in accordance with the Specifications.

Identification lists with cross-references between documents and materials and goods.

F. Quality control plan

a) Within 28 calendar days after the Commencement Date, the Contractor shall submit for the Engineer's approval a detailed description of his Quality Control Plan.

The plan shall include the quality control of all aspects of on-site construction, laboratory tests and on-site tests. It will include a quality inspection plan which will cover all items intended for inspection at the Contractor, Sub-contractors and Supplier's works and premises.

The plan shall contain but will not be limited to the following items:

- Organization chart for quality control.
- Curriculum vitae of his staff exclusively appointed for all aspects of quality control during the Contract period.
- List of the Contractor's staff engaged in quality control and material testing.
- Name and address of site materials testing laboratory.
- List of laboratory equipment and description of the laboratory testing capabilities.
- Arrangements for any tests to be performed beyond the capability of the Contractor's laboratory.
- Procedures for comprehensive records.

b) The Contractor shall be responsible for establishing and maintaining procedures for quality control which will ensure that all aspects of the Works comply with the requirements of the Contract.

c) The Contractor shall be responsible for routine inspection, sampling and testing of all materials, workmanship, plant and measuring devices.

d) The Contractor shall establish at Site an efficient, comprehensive records facility and library. Books, drawings, standards, publications and manuals shall be indexed and their distribution controlled.

20. SPECIFIED MATERIAL AND EQUIPMENT LIST

The Contractor shall submit to the Employer through the Engineer, a detailed item list, the Specified Material and Equipment List, of all construction materials, equipment and goods required by the Contractor to be imported for the execution and remedying defects of the Works.

The list, the Specified Material and Equipment List, is required for coordinating the access of the construction materials, equipment and goods into the Gaza Strip with the Israeli concerned authorities.

The Contractor shall be responsible for coordinating the access of the construction materials, equipment and goods to the Gaza Strip with the Israeli concerned authorities. The Contractor shall be responsible for obtaining the required permits from the competent authorities and for accessing the construction materials, equipment and goods into the Gaza Strip and no claim whatsoever will be accepted by the Employer for costs that may be incurred in obtaining the permits and in accessing the construction materials, equipment and goods into the Gaza Strip.

This list, the Specified Material and Equipment List, shall consist of three parts:

- a) Materials, Plant and Spares to be used and incorporated in the works, or delivered as stock to the Employer's (operator's) stores.
- b) Materials, Plant, Spares and Consumables, including office and engineering supplies, to be consumed during the construction of the works.
- c) Contractor's Equipment, Materials, Tools and Instruments, including office and engineering equipment, to be imported for the Works and re-exported after construction of the Works.

Supplier specifications must be attached to the Specified Material and Equipment List to demonstrate that all the items are in accordance with the Contract Specifications. After approval and certification by the Engineer and the Employer, this Specified Material and Equipment List will be used by the Contractor to obtain the necessary import permits and approvals from the relevant authorities and to accessing the Materials, Plant, Spares, Equipment, etc. to the Gaza Strip.

The Specified Material and Equipment List may be revised during the progress of the works to reflect changes or modifications resulting from the detailed field and final design of the project components or additional works ordered under the terms of the Contract, as long as such revisions of the Specified Material and Equipment List are approved by the Engineer as well as the Employer.

21. SITE FACILITIES TO BE PROVIDED BY THE CONTRACTOR

21.1. ACCESS TO WORKING AREAS

The Contractor shall construct, operate, maintain and remove, if required, access routes to construction site areas from existing permanent access and/or site roads, such alternative proposals and additional proposals by the Contractor as may be approved from time to time by the Engineer. Such proposals shall allow all phases of Construction.

Any of these accesses will not be removed except when formally agreed by the Engineer. Removal of these accesses shall be indicated with full details in the General Programme of Works.

21.2. HAUL AND ACCESS ROADS

- A. The Contractor shall maintain the existing roads to different site works, as are necessary for the conduct of the work under the contract.
- B. These roads will also be used as access roads by the Employer, the Engineer and other contractors engaged on the construction and completion of the Works.
- C. As indicated in paragraph 2.5 the Contractor shall establish reasonable traffic regulations governing traffic on the roads maintained by him, and shall provide signs, pavement markings, traffic signals or other control devices and flagmen as may be required to maintain a safe and unimpeded flow of traffic.
- D. Construction and maintenance of such haul and access roads not explicitly paid under separate bills will not be measured for payment as a separate Contract Item.

21.3. ELECTRICITY AND POWER SUPPLIES

- A. The Contractor shall make his own arrangements for the supply of electricity for his Temporary Works and other site usage, including tests.
- B. The Contractor shall install, operate, maintain and subsequently remove equipment to provide sufficient supplies of electricity for the heating lighting and air conditioning of all offices stores laboratories and other temporary buildings used by the Contractor and by the Engineer in addition to any supplies he may require in connection with the construction of the Works.
- C. In addition to his main source of power supply the Contractor shall where necessary provide and maintain standby power supplies adequate to ensure the safety of the Works in the event of failure of the main supply irrespective of the timing or duration of such failure.
- D. All site electrical installations shall be carried out in accordance with the current Regulations for the Electrical Equipment of Buildings.
- E. The Contractor shall also install on his own expenses all the equipment for the permanent power supply of the plant in accordance with the Drawings and Specifications.
- F. The Contractor shall provide at the date of the completion, all approval and clearance for connection of the Permanent Works, issued by GEDCO.

All costs of supplying the required electricity are deemed to have been included in the unit rates/prices of the Bill of Quantities

21.4. LIGHTING

- A. The Contractor shall provide sufficient lighting to ensure that, at all times:
- safe working conditions are provided for all personnel on the work sites;
 - the Works can be constructed in complete compliance with the Contract;
 - complete inspections of all work in progress can be made by the Engineer, and security of the Works area and public safety measures are adequate and effective.
- B. Unless otherwise directed the minimum intensity of illumination on ground or working surface to be provided for the various operators or work areas shall be as tabulated below:

Illuminance Operation or Area	Design Value (Lux)	Minimum Measured Value
-------------------------------	--------------------	------------------------

		(Lux)
Earthworks and excavation	50	20
Concrete placing	100	50
Maintenance shops and mechanical and electrical works	300	200

C. The Contractor shall supply a suitable instrument to the Engineer for measuring the intensity of illumination. The instrument shall comply with BS 667 or equivalent standard as approved by the Engineer.

D. All moving plant used during night operations shall be equipped with sufficient lights and reflectors and fluorescent markings to ensure safe working conditions.

E. The submission to or approval by the Engineer of the Contractor's proposals for lighting shall not relieve the Contractor of any of his liabilities or obligations under the Contract.

21.5. HOUSING FACILITIES FOR THE CONTRACTOR AND HIS SUB-CONTRACTORS

A. The Contractor shall supply:

- Sufficient and adequate Site offices for his staff.
- Site offices for each of his sub-contractors (one office of 20 m² for each sub-contractor).
- Stores, workshops, compounds.
- Temporary accommodations and living facilities.
- Parking areas.
- All necessary services in relation with these works including water supply, lighting, drainage, heating, air conditioning and refuse disposal.

B. The Contractor shall be responsible for the general cleaning and maintenance of the areas including sanitary installations.

C. Buildings shall be complete ready for use including furniture, household appliances (stove, fridge, fan, air-conditioner, heater, lighting tubes and bulbs). Buildings shall be of the same type as the ones provided for its own staff.

D. The Contractor shall provide medical facilities as required by the Medical Officer for Health.

E. Details and layout of site offices and appurtenant buildings and services shall be to the general approval of the Engineer. The Contractor shall obtain any necessary approval from any local authorities concerned.

21.6. WATER SUPPLY

A. The Contractor shall make all provisions for the supply of water required for the execution of the Works as well as adequate quantities of potable water for all personnel.

B. The Contractor shall supply water required for the execution and testing of the Works including any hydrostatic, flooding, water tightness and leakage tests for pipes, and any installation of the pressure line. All costs of supplying the required water are deemed to have been included in the unit rates/prices of the Bill of Quantities

C. The Contractor shall arrange for the water supply for his staff residences, labour camps, site offices, Works, workshops in addition to the supply of the Operator's Camp. Construction of tubewells, storage tanks, overhead tank, distribution system, and their proper running and maintenance shall be his responsibility. Potable water should be supplied 24 hours a day.

D. Water samples shall be tested every 3 months and certificates submitted to the Engineer indicating that the water is fit for human consumption from an agency approved by the Engineer.

E. The Contractor shall supply water to sub-contractors or other contractors for all their requirements.

F. The construction and maintenance of water supply facilities and the supply of water not explicitly paid under separate bills will not be measured for payment as a separate contract item, and all costs of those items are deemed to have been included in the unit rates/prices of the Bill of Quantities.

21.7. STORAGE AREAS

The Contractor shall make his own arrangements for the installation, operation and removal of this temporary storage and works and during the Contract period. Location and layout of these storage and workyard shall be subject to the prior Engineer's approval.

22. SEWERAGE

The Contractor shall make all provisions, subject to the Engineer's approval to construct, operate and maintain throughout the Construction Period a sewerage system comprising collection, treatment and disposal for all the camps.

23. SOLID WASTES

The Contractor shall make all provisions, subject to the Engineer's approval, for collection and disposal of solid wastes from all camps and work places. Wastes shall be collected at least twice a week and disposed in an approved location.

24. STORAGE AND USE OF EXPLOSIVES

Except as may be specifically approved by the Engineer in writing, the Contractor will not use explosives.

25. MEETINGS

A. The Contractor or his nominated Representative shall participate in weekly and monthly progress meetings convened by the Engineer and the Employer. Such meetings will generally be held at regular intervals through prior notice, but may also be convened without prior notice, in the event of any unusual occurrence, at the discretion of the Engineer and the Employer.

The Contractor shall immediately notify the Engineer of any unusual occurrence which he considers would justify an exceptional meeting.

B. The agenda shall include approval of the minutes of the previous meetings, progress of the works with respect to the schedule and analysis of the difficulties encountered in the work.

C. The minutes of the meeting shall be prepared by the Engineer and shall be deemed, after approval by the other participants, to be written confirmation of the declarations, instructions and decisions taken during the meeting.

D. The Contractor or his nominated representative shall be able to take decision during the meeting; otherwise he shall be considered that the Contractor didn't attend the meeting.

26. RECORDS

26.1. PROGRESS REPORTS

A. By the last working day of each calendar month, the Contractor shall submit two copies of a draft monthly progress report which shall contain at least the following information:

- Percentage progress of the Works compared with the approved programme, together with a description and percentage estimate of the work programmed for the following month.
- List of Contractor's Equipment on Site together with its deployment during the month.
- List of all personnel employed on Site.
- Accident record, if any.
- Summary of all work carried out during the month in question together with a description of any difficulties or problems occurring therein.
- Description of the daily climatic conditions during the month.
- Situation with respect to payments, together with the dates on which the Payment Certificates were submitted by the Contractor.
- Description of any claim made by the Contractor during the month.
- Progress photographs, when available.
- State of progress of customs clearance and local transport operations.
- Inventory of materials stored on Site.
- Tests in progress or already carried out during the month and those planned for the next month.

B. Within two working days of receipt of the draft monthly reports the Engineer will return to the Contractor one copy marked for amendment together with any separate comments for correction or addition to the draft report.

C. Within two working days of receipt of the Engineer's comments the Contractor shall submit ten copies of the final monthly progress report which will include all of the corrections, additions and amendments requested by the Engineer.

D. Each monthly report shall be in a format approved by the Engineer.

26.2. PHOTOGRAPHS

A. To record the general progress of the work as well as particular details and special phases of erection and commissioning the Contractor shall take photographs at regular intervals, not more than 2 months.

B. Photographs of a given part of the Works shall as far as possible be taken from the same location and at the same angle.

C. The negatives shall be colour negatives not less than 24 x 36 mm in size, alternatively, digital photographs will be provided on a CD.

- D. The Contractor shall take enough photographs of each stage of work or manufacture to enable the Engineer to make a representative selection of subsequent enlargement.
- E. The procedure shall be as follows:
- Ten days before the end of each reporting period the Contractor shall furnish two proofs (postcard size) of each view.
 - The Engineer will select the views to be enlarged.
 - Eight enlarged prints (18 x 24 cm) of each selected view shall be supplied with the corresponding Monthly Report.
- F. The number of views to be enlarged shall be 20 per each reported period.

27. OPERATION AND MAINTENANCE MANUAL

The Contractor has to submit an O&M Manual. This document will include the following items:

- Maintenance Plan: Maintenance procedures to ensure the continuous operation of the Works under normal operation conditions and in cases of outage.
- Comprehensive Safety Policy: Definition of the Contractor's responsibilities regarding safety and health of all authorised people being situated at the Site.
- Standard Procedures Document: Step-by-step implementation procedures for the effective management and operation of the works.
- Spare-Parts Books

The operation manual written for use by the plant or system operator shall contain in the specified order of priority but not be limited to the following:

- A brief description of the system, preferably illustrated with photos or drawings.
- General description and operation of each component of the system
- Drawings, diagrams, sketches or photographs shall be included whenever necessary for easier understanding or clarity.
- Precautions and warnings relating to the safety of persons and of the equipment shall be clearly stated.

The sections of the Manual shall be arranged in the following order for each component of the plant:

- Title page
- Table of Contents
- Section I - Operation
- Section II - Maintenance
- Section III - Dismantling
- Corresponding publications
- Perspective drawings, scale drawings, diagrams, etc.

28. PROTECTION OF FINISHES

The Contractor shall take every care to prevent damage to the works and shall ensure that adequate protection is given to all works from the activities of following trades and any third party. Vulnerable parts of the works particularly liable to damage shall be protected as may be reasonably required by the Engineer and shall be deemed to be insured against damage in accordance with the conditions of contract.

29. SPARE PARTS

A. Spare parts

1) Maintenance supplies:

They include small supplies, spare-parts (nuts, bolts, seals, filters, ...), lubricants which are needed to be used for the day to day operation, for the whole duration of the O & M period.

These supplies shall be approved by the Engineer.

The lack of any kind of above spare parts shall postpone the issuance of the Taking Over Certificate.

B. Spare part book

The Contractor shall give a spare part book. This spare parts book shall contain an assembly drawing of the plant which shall show all parts of the plant separately marked, designated and referenced.

The book shall also contain sketches of each part with the part number and the designation of the part. The material of the part shall also be indicated. These sketches and lists of parts shall be cross-indexed with the assembly drawings.

The spare parts book shall present information in a simple manner so that non-technical personnel may be able to indent these spare parts. The lists of spare parts required shall be made with reference to the spare parts book.

C. Duplicate

All spare parts shall be duplicates of the original parts furnished and interchangeable therewith.

D. Packing and packing list

The spare parts shall be suitably identified, treated and packed for a long storage in containers plainly marked "SPARE PARTS ONLY". A packing list, indicating the contents of each such container, shall be securely fastened in a moisture-proof envelope to the outside of the container. The packing list shall also provide the following information:

- Contractor and Contract number
- Identification, including Contractor's drawing number, reference of each spare part in the container.

E. Storage room

All spare parts shall be stored in a safe place under the responsibility of the Contractor up to the Taking Over Certificate; at this date, he will transfer the Spare Parts in a place indicated by the Engineer.

30. SERVICES TO BE PROVIDED TO THE ENGINEER AND THE EMPLOYER

30.1. VEHICLES

The Contractor shall make available at the Commencement Date of the Works, maintain, repair, and keep in sound, safe running condition two vehicles for the sole use of the Employer and the Engineer (engine capacities not less than 1600CC -model 2016 or higher).

The vehicles shall be complete with spare parts, tools and the like. The Contractor shall provide all necessary materials including fuel and lubrication.

The Contractor shall keep the vehicle insured during the Contract Period under a fully comprehensive motor insurance policy issued by a reputable insurance company. Both the policy and the insurer will be subject to the approval of the Engineer and Employer.

The vehicles shall be kept permanently at the disposal of the Engineer and the Employer. During periods of maintenance or repair the Contractor shall make an equivalent replacement vehicle available.

Upon completion or termination of the Contract the vehicle will remain the property of the Contractor.

30.2. SITE OFFICES FOR THE ENGINEER

A. The Contractor shall supply fully furnished and equipped site offices for the sole used of the Employer and Engineer as follows:

- 2 x 15 m² offices
- 1 x 20 m² offices
- 1 x meeting room for 20 persons (at least 30 m²)

B. The Contractor shall supply the offices for the Engineer's and Employer's use along with the required connections for electricity, phone, water and sanitation. He shall be responsible for adequate regular maintenance and repairs of structures, furniture, equipment and appliances therein.

C. Office shall be fitted with electric lighting and wall mounted socket outlets: water heater, hot plate, an air-conditioner, fan, one 0.8 m x 1.5 m table with drawers, one fixed 0.9 m x 1.8 m desk with shelves above to take fold drawings, one stool, four chairs, one cupboard fitted with shelves, hat and coat hooks.

D. The offices compound shall be provided with simple toilet facilities, chemical type or similar, located in a covered and enclosed privy separated from the field office, provided with lock and key. The type of toilet facilities, method of waste disposal, location and type of construction therefore shall be submitted to the Engineer for approval. The corridors between offices and relevant facilities shall be protected by suitable well mounted roof and drainage system against rain.

E. The complete offices shall have to be supplied with all utilities and facilities not more than 28 days after the Engineer's notice to commence the Works and be maintained until the Performance Certificate. The layout of the offices and its location on site shall be coordinated with the Engineer.

30.3. TELEPHONE AND COMMUNICATIONS

30.3.1. TELEPHONE FOR ENGINEER'S REPRESENTATIVE

A. The Contractor shall, subject to the Engineer's approval, design, supply, install, operate and maintain during the execution of the Works a telephone exchange which shall revert to the Employer at the completion of the Works. The minimum number of telephones and their locations shall be as follows:

Location	No. of lines (Telephones)
Employer's Site office	1 permanent lines
Engineer's site office	1 permanent line

B. These external telephone lines shall be suitable for making calls in National area with extensions connected to the public telephone system. The telephones shall be connected to central PABX switchboard which is capable of handling up to ten extensions. One line in each office shall be connected to the international network.

C. These telephone lines shall be for the sole and exclusive use of the Employer or the Engineer's Representative and his staff.

D. The Contractor shall pay for the installation and rental of such equipment and for local calls made by the Employer or the Engineer's Representative and his staff.

E. The Contractor shall supply Internet connection & ADSL system – min speed 8 MB including the wireless router type NEGSTAR or equivalent, the internet network to all the offices (wireless network).

30.3.2. SITE RADIO OR TELEPHONE SYSTEM

In the event of the Contractor being unable to provide a telephone system he shall arrange, install and maintain three private radio or telephone system for use by the Engineer's Representative and his staff and to his requirements.

Where the Contractor has installed a site radio or telephone system for communication he shall allow permanently the Engineer's Representative and his staff free use of such equipment for their own equipment.

30.4. OTHERS

The Contractor shall, subject to the Engineer's approval, design, supply, install, operate and maintain during the execution of the Works:

Item	Description	Number/QTY
Kitchenette	Min 8 m2 area with all necessary equipment including refrigerator	1
Laptops	P PROBOOK 4540s Laptop or equivalent Operating system: WINDOWS 7. Microprocessor: IVY BRIDGE 3rd GEN CORE I5-3210m-IB 2.5 GHZ/3MB. Memory: 6G DDR3. Hard disk: 500GB.	2

	Display: 15.6 inch. DVDRW. WIFI. WEBCAM. AMD RADEON HD 7560M WITH 2 GB DEDICATED. Minimum of 2 years warranty.	
Printer A4	Printer 3 in 1 :-HP LaserJet PRO M 1536 DNF or equivalent Print speed black (normal, A4):Up to 26 ppm SCAN SPEED 15 PPM RESOLUSTION UP TO 600*600*2 DPI	1
Printer A3	HP Office jet K8600 wide format (color)(Printer A3/A4 : or equivalent - At least 33 ppm. At least 32 RAM . High speed USB 2.0 includes USB cable. Minimum of 2 years warranty	1
Photo Copier machine	Photo Copier machine Photo Copier machine A3/A4 – Sharp – model AR-M420U- Include Feeder- Duplex, original table tray, LPT outlet, screen card,.etc.	1
Camera	Digital Camera - Canon or Kodak or sony 16 MP, memory card 8GB, Battery recharge (Lion), standby memory 12MB, Card Reader (Cable) & 2 years warranty.	2
Stand by Generator	Generator:- Supply, install stand by diesel generator set 10 KVA 50 Hz including generator mounted control panel, sound enclosure built in daily tank, lead acid starting batteries, automatic battery charger Robin type or equivalent. A fuel tank capacity of 250 liters. With covering the fuel, running and maintenance expenses during the construction & operation period.	1

31. COMMISSIONING

The Contractor shall develop and provide his strategy, scope, plan and schedule for the pre-commissioning and commissioning for the engineer's review and approval.

31.1. PRECOMMISSIONING

During the Precommissioning period, the Contractor will be able to perform and conduct any tests or adjustments he wishes, or as required by the Engineer.

The Contractor will take in charge the electricity, energy, chemical (if any) and staff costs during the Precommissioning period. All such costs are deemed to have been included in the unit rates/prices of the bill of quantities.

31.2. COMMISSIONING PERIOD

The duration of the Commissioning Period shall be 2 weeks.

The Contractor will take in charge the energy, electricity, chemical (if any) and staff costs during the commissioning period. All such costs are deemed to have been included in the unit rates/prices of the bill of quantities.

During the commissioning period, the Contractor is liable to successfully perform any additional adjustments to be made, if any, before the Commissioning tests.

In case of unavailability or deficiency of electricity from the public network, the contractor shall be responsible of providing the required energy and electricity during the commissioning period. The contractor can use the installed standby generators. The costs of providing the required energy, electricity, fuel, running and maintaining the generators during this period are deemed to have been included in the unit rates/prices of the Bill of Quantities.

At the end of the Commissioning period, the Engineer will issue, the Taking-Over Certificate, if agreeable.

31.3. TAKING-OVER CERTIFICATE

It will be issued by the Engineer as per the provisions of the Particular Conditions.

The lack of spare-parts (if any, stored as required, and the lack of as built drawings shall post-pone the issuance of the Taking Over Certificate.

31.4. PERFORMANCE CERTIFICATE

It will be issued by the Engineer as per the provisions of the Particular Conditions.

32. MAINTENANCE PERIOD

The Contractor shall be responsible for the maintenance of the project for a period of one and half year. During this period, the contractor shall closely cooperate with other contractors and with the international contractor who will perform the one-year operation after commissioning of Khan Younis Waste Water Treatment Plant. The contractor shall take prompt and immediate actions to remedy any defects in the power line to avoid any interruptions of running and operating Khan Younis waste water treatment plant and the related power line.

PALESTINE
CONSTRUCTION OF MAIN ELECTRICAL POWER SUPPLY LINE
FOR THE
CONSTRUCTION OF KHAN YOUNIS WASTE WATER TREATMENT PLANT
PROJECT
(KY WWTP)

VOLUME 2 – SPECIFICATIONS
PART 2 – TECHNICAL SPECIFICATIONS - ELECTRICAL WORKS

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Special Specification

SCOPE OF WORK

N.B: The priority is for GEDCos specifications and instructions.

The works will be implemented through the following main activities:

1. Installations and connection works of (MV- 22KV) Steel materials.
 2. Installations and connection works of (MV- 22KV) Electrical materials.
 3. Installation underground cables.
 4. Perform all required civil works.
- a) The contractor will supply all workmanship, materials, equipment's, machineries, and whatever needed to complete the tasks through the tender documents.
 - b) Works have to be executed within the official working hours. In case the contractor wishes to work beyond that, he has to obtain a written approval from the Engineer.
 - c) The contractor's project team: The contractor has to employ technical staff throughout the contract period of the project implementation and until preliminary handing over of the project. CV's and work experience in construction projects should be submitted in the process of approving the site staff. A certified agreement between the contractor and staff member should be submitted accordingly.

The technical staff during the implementation phase is as follows:

▪ **Required staff:**

- ✓ One Electrical Engineer 5 years experience
- ✓ One Civil Engineer 5 years experience
- ✓ Two Forman 5 years experience

The technical staff should be engaged on site on full time basis and have the sufficient experience and capabilities of carrying out their duties. Otherwise, the supervision will have the full right to replace any unsuitable staff with more competent one. However, any extra staff that will be needed due to the nature of work remains the contractor's responsibility.

- d) Time Schedule: The contractor has to submit a time schedule enclosed within his offer showing different activities of the project and the sequence of work activities using MS-Project. This time schedule will be revised and approved by the engineer before the initiation of work activities. The contractor has to update it and do all modifications deemed necessary to work activities as per the instructions of the supervision such that the contract duration is maintained. The contractor shall carry out quantity verification to be executed before the start up of work activities. Accordingly, the written approval on the scope of works shall be obtained prior to execution process.

- e) Schedule of material supply The contractor is required to submit a schedule of materials supply and assure continuous operations on work activities as per the approved time schedule. All raw materials relevant to the civil works are to be supplied and stored on site. The schedule of works should include the dates and quantities of material supply as well as the equipment supply to assure proper planning of work activities.
 - f) Work plan The contractor has to submit a written work plan that illustrates the methodology to be followed in implementation of each work activity.
 - g) Samples and catalogues: The contractor has to submit all samples and /or catalogues for all materials to be used on the project to verify their compliance with the technical specifications as follows:
 - *The samples and catalogues will be handed along with the request of material approval as per the schedule of material supply such that two weeks is allowed to obtain approval before order of material supply is placed.
 - *The samples and catalogues should show the data of technical specification and other data necessary for erecting, commissioning and maintenance.
 - h) Cash – Flow The contractor has to submit a cumulative cash flow chart (S-curve) expected during implementation. Updates should be carried out on regular basis to adapt the actual expenditure on the project.
 - i) Monthly reports and photographs. The contractor has to submit monthly reports in three copies reflecting the actual progress of works, executed work activities, difficulties faced and photos showing such progress.
 - j) Closures of borders. The closure of borders is expected risk and the contractor has to assure proper storage of materials such that to keep work activities going on smoothly. No financial claims will be accounted in case of any closure is taking place.
 - k) Contract documents: All tender documents stipulated in the ITB should be submitted, signed and stamped. All requirements set in the technical specification (General and Specific), drawings, bill of quantity, pre-bid meeting notes and/or any addendum thereof are deemed to be included in the unit prices of the items and no extra charges will be paid in that respect.
- 2) WORKMANSHIP:** The contractor has to engage competent workers to achieve the workmanship stated in the tender documents. It is expected that best local practices be utilized in case no specific workmanship is identified.
- 3) DRAWINGS:**
- a) The contractor has to abide to any additional detail or general drawings issued by the engineer and will be considered as part of the contract.
 - b) The contractor will develop shop drawings for all work activities and submit for approval. No activity can be started unless engineer approves relevant shop drawing.

- c) The contractor should submit three copies of the shop drawings according to the approved time schedule and obtain the approval of supervisor before commencing relevant work activities. In case of changes required, the contractor will resubmit the drawings with changes and obtain approval before execution of works.
- d) As Built Drawings: The contractor is responsible to submit as built drawings before the preliminary handing over in four hard copies A3 size and two CD's. They should show all details (architectural, structural, mechanical, and electrical along with services routes, trenches, manholes, and levels ...etc) for the review and approval of the engineer.

4) DISCREPANCY AND MISTAKES IN TENDER DOCUMENTS:

- a) The contractor is deemed to thoroughly study the tender documents and highlight any discrepancy or mistake in the tender documents during the tendering stage for the engineer to verify it and give the corrected information to base upon his price in the tendering phase.
 - b) In case there is missing information in the contract documents or discrepancy or improper description of details of the items, it doesn't relieve the contractor from carrying out the item in the most correct manner as if identified and properly described in the original documents.
 - c) The contractor has to acknowledge the engineer in case of omission, discrepancy or mistakes in the tender documents in the tendering stage and price according to the engineer's answer.
- 5) INSPECTION OF SITE:** The contractor is deemed to have visited and investigated the site and identified all site conditions in terms of ground nature, accessibility to site, availability of services like water & electricity and all factors affecting execution of work activities before submitting his offer. All such factors are deemed to be taken into consideration while pricing.
- 6) SUB-CONTRACTORS:** Sub- contractors are dealt with according to General Conditions of Contract. The main contractor should submit to the Engineer; the certified agreement between him and the subcontractor prior to commencement of the work.
- 7) EQUIVALENCE AND ENGINEER'S INSTRUCTION:** Wherever equivalence and Engineers' instruction are mentioned within the contract documents, they are interpreted to be dealt with and /or executed according to the consent of the engineer.
- 8) SITE MEETINGS:** Periodical site meetings will be carried out and the contractor or duly authorized delegate should attend the meetings.
- 9) TESTING:** The contractor at his own expenses shall provide any test as requested by the Engineer's Representative for any materials supplied, installed, or stored in the site according to the stipulated tests in the general specifications. The contractor has to secure devices and equipments that are necessary to test sanitary and electrical works as requested by the Engineer.
- 10) SPECIFICATIONS:** Specifications that will be adopted within this contract are to meet the international standards.

In case there is no clear or missing specification of items, it is deemed that the contractor has based his prices on high quality materials and best practice in implementation.

11) TAKE OFF QUANTITIES AND PRICING:

- a) Description of items The tender documents are complementary and self explanatory and what is deemed necessary in one is deemed necessary in all. Accordingly, the item specification is not limited to item description in the bill of quantity but rather to the tender documents as a whole.
- b) Quantities:
 - i) Net measurements of quantities as executed or erected in place will be used in the project ignoring losses and overlapping parts.
 - ii) Quantities are based on actual measurements on site.
 - iii) The contractor shall attach all supporting documents for all finished quantities with each payment to the Engineer for review.
 - iv) The contractor should inform the owner or his representative about any increase in quantities prior to execution in a written form. In case of extra quantities are executed without informing the owner or the Engineer and obtaining approval on the implementation will not be accounted in the quantities.
- c) Pricing:
 - i) Description of items: The contractor is deemed that he understood all items within the bill of quantities and that he included all required expenses for permanent or temporary activities and components inclusive but not limited to overhead, profit, fees for services, materials, samples, losses in materials, equipments,...etc, to achieve and maintain the works in first grade quality and in the correct form. No claims will be accepted for comprehensiveness in pricing.
 - ii) The contract individual price of items shall not include frontloading or backloading. All prices of items should be adequate to execute the relevant task individually.
 - iii) The cost of any item in the B.O.Q. shall include all prices of raw material, workmanship cost, profits, and all direct and indirect relevant costs.
 - iv) Any un-priced item in the B.O.Q. will be executed at zero cost.
 - v) The contractor is deemed to base his price according to proper breakdown of cost. Hence, he is expected to submit such price analysis within his offer.
 - vi) The unit rates shouldn't include VAT. All payments will be processed according to Zero VAT invoices all according to PA rules and regulations in that respect. The contractor has to include all expenses that might occur in his overhead expenses and no claims will be accepted regarding this issue.
 - vii) Price shall include fees of testing according to specification and engineer's instruction. UNDP has the right to change the testing laboratory from time to time.
 - viii) The contractor has to submit valid income and VAT tax clearance issued by the Ministry of finance along with the tender.

13) TEMPORARY INSTALLATIONS DURING IMPLEMENTATION :

all temporary facilities implemented before the start of project works and be at the expenses of the contractor and by the fall of the construction cost and the total after the expiration of the term of the project. In case of any delaying by the contractor in establishing of such buildings or any part thereof and removal of thereof, the Engineer's Representative and Employer have a right to establish the remainder and removal thereof at the end of the project and reduce the amounts disbursed from the account of the contractor without any objection to the action or cost.

14)

1- ELECTRICAL WORKS

1. GENERAL SPECIFICATIONS

1.1 Completeness of Contract

- ❖ All apparatus, accessories or fittings which may not have been specifically mentioned, but which are usual or necessary in the respective equipment for the completeness of the finished work in an operable status, shall be deemed to be included in the Contract and shall be provided by the Contractor without any extra charge. All equipment shall be complete in all details, whether or not such details are mentioned in the Specifications. This includes fixation details and connection clamps and/or terminals.
- ❖ Any reference in the quantity and price schedules, the delivery period schedule or in the various clauses and schedules of the text of either the Specification or the Bid, to any equipment shall imply that the equipment is complete with all accessories, apparatus and fittings as outlined in sub clause above.
- ❖ The Bidder shall be responsible for ensuring that the equipment supplied is fit for the purpose intended. Available information on the characteristics of the system to which the works will be connected and associated will be supplied on request to the Bidder who shall be responsible for obtaining and determining all applicable knowledge relevant to the works.

1.2 Drawings and Documentation

The Contractor shall prepare and submit to the Engineer/GEDCo/UNDP for approval dimensioned general and detailed design drawings and other pertinent information of all the Equipment specified in the Specifications.

The Contractor shall supply detailed instructions for erection, operation and maintenance of all equipment and components in English and preferably Arabic language.

In the event of any difference between the drawings and the Specifications, the latter shall prevail.

Approval of drawings shall not relieve the Contractor of his obligations to supply the Plant in accordance with the Specifications. In the event of any difference between scaled dimensions and figures on the drawings, the figures shall prevail. All text on drawings provided by the Contractor shall be in the English language in addition, if necessary, to that of the country of origin. All drawings shall be dimensioned in millimeters.

1.3 Time of Delivery and Completion

The guaranteed delivery times shall be stated in the appropriate schedule in this document.

1.4 Quality of Materials

All materials supplied under this Contract shall be new and of the best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of temperature and atmospheric conditions arising under working conditions without distortion or deterioration in the setting up of undue stresses in any parts and also without affecting the suitability of the various parts of the Works for which they were designed. No toxic material (such as Halon, PCB, and Asbestos) shall be utilized.

1.5 Contractor's Quality Assurance Procedures

The Bidder shall have established a quality assurance system based on ISO 9001 or 9002. The Contractor shall include a documentation of the system with a list of current procedures, an organigram of the quality organisation and the name of the quality manager. He shall also submit a list of quality revisions performed the last twelve months with a list of closed and unclosed findings as well planned revisions the coming twelve months.

The Contractor shall submit for approval a program of quality control and inspection procedures to assure that the product during manufacture and on completion complies with the specified requirements. The program shall relate the quality control and inspection activities to the production cycle. In support of the quality control and inspection program the Contractor shall provide details of quality control and inspection procedures available for use in the execution of the Contract. The Contractor shall retain responsibility for quality control and inspection activities made by his subcontractors and shall indicate on the program, which items are to be subcontracted.

1.6 Guarantees and Particulars

The Works shall comply with the technical guarantee data stated in the Bid. The Contractor shall be responsible for any discrepancies, errors and omissions in the particulars and guarantees, whether the Engineer/GEDCO/UNDP has approved such particulars and guarantees or not.

1.7 Places of Manufacture and Sub Contractors

The manufacturer's identity and places of manufacture, testing and inspection before shipment for the various portions of the Contract Works shall be specified in the Technical Schedules and shall not be departed from without the agreement of the Engineer/GEDCo/UNDP.

All Subcontractors and Sub suppliers of components and materials shall be subject to the approval of the Engineer/GEDCo/UNDP. Information shall be given on each Suborder sufficient to identify the material or equipment, to which the suborder relates, stating that the material is subject to inspection by the Engineer/GEDCo/UNDP before dispatch.

All equipment offered shall be the product of recognized and experienced manufacturers and shall be proven equipment of the same basic design and size similar to that which has been in successful continuous operation for at least three years preferably under similar climatic conditions. Proven plant reliability and high availability are of prime importance and the attention of the Bidder is drawn to these particular requirements.

1.8 Inspection and Testing

All materials used in the Contract Works may be to inspection by the Engineer/GEDCo/UNDP and it is the Contractor's responsibility to advise the Engineer/GEDCo/UNDP when equipment and materials are available for inspection, at least 1 month in advance.

Factory tests on equipment shall be made according to the applicable IEC Standards, or as specifically specified or according to standards approved by the Engineer/GEDCo/UNDP.

Routine tests shall be made on each unit of all equipment.

Type tests shall be made on one unit of each type of different equipment. Instead of carrying out the type tests the Contractor may submit suitable certificates of tests made on equipment of the same type; however, the Employer reserves the right of accepting these certificates or to reject them partially or totally.

The Engineer/GEDCo/UNDP shall be at liberty to demand any additional testing at the manufacturer's works, at site or elsewhere in order to verify that the equipment complies with the conditions of the Specifications.

A test program shall be submitted to the Engineer/GEDCo/UNDP for approval at least 1 month ahead of the commencement of testing.

Measuring apparatus shall be approved by the Engineer/GEDCo/UNDP and if required shall be calibrated at the expense of the Contractor at an approved laboratory.

1.9 Packing, Transportation and Storage

Packing shall give adequate protection to the enclosed materials against mechanical damage during transport to its final destination, including rough handling during sea, rail and road transport and transition from one mode of transport to another.

Packing should be stout close boarded wooden cases of adequate thickness, suitably braced and banded and lined internally with water-resistant material or equally solid enclosures.

Steelworks sections and similar items may be bundled provided that the ends are adequately protected and the enclosing bands or wires are robust.

Indoor electrical equipment must be enclosed in welded polythene envelopes inside packing cases and the envelopes shall be evacuated or have a desiccant inside.

All items in cases or crates shall be secured so that they are not free to move and cannot work loose in transport. If rotating parts are shipped within their bearings or mountings, they must be adequately braced and restrained to prevent relative movement. Loose items shall be placed in bags in a case, each bag having stitched onto it a label indicating the number and nature of its contents. Where a filler material is used in a case to restrict movement or provide additional protection, it must be inorganic and nonhygroscopic.

All surfaces liable to corrosion shall be thoroughly cleaned and special steps adapted to the nature of the materials and the time interval between packing and unpacking shall be taken to prevent corrosion. These steps may constitute the greasing on surfaces, the application of a protective coat, enclosure of the items in a hermetically sealed container, the addition of vapour phase inhibitor paper to the package or other approved means.

Steps shall be taken to ensure that moisture, moulds, insects or rodents cannot damage insulated materials. Items that include materials liable to be damaged by moisture shall be packed in hermetically sealed containers in which silica gel, or some other approved desiccant has been inserted.

Cases shall be marked with large lettering to show which side of the case is to be up, and if the contents are fragile, marked "FRAGILE" in large letters with the international

wineglass symbol. Packages shall be marked with their place of destination in such a way that rough handling or the effect of weather cannot remove or obliterate the marking. Each item shall be marked with its gross weight and, for all lifts over two tonnes, marks on the cases shall show the correct positions for the slings.

Special steps shall be taken to guard against theft during transport. No small items such as padlocks nameplates and so forth that could be torn off or unscrewed shall be accessible.

Cases, crates, barrels and drums shall be banded in such a manner as to obstruct the theft of any of the timber used for packaging and the bands shall be so secured that they are not rendered ineffective by shrinkage of the wood.

A descriptive and fully itemized list shall be prepared of the contents of each packing case. A copy of this list shall be placed in a waterproof envelope under a metal or other suitable plate securely fastened to the outside of one end of the case, and its position indicated by stenciling on the case. Where appropriate, drawings showing the erection markings of the items concerned shall be placed inside the case.

All stenciled markings on cases and crates, or other markings on descriptive metal tabs fixed to cable drums, bundles of structural steel works and so forth, shall be applied in two places with a material which cannot wash off and shall be additional to any erection or other marks or impressions which may be specified elsewhere.

Shipping marks are to be stenciled in oil based paint in block letters and symbols. When unobstructed flat smooth surfaces of sufficient size are not available on the case for the shipping marks they are to be stenciled on marineply notice boards of adequate size and of at least 6 mm thickness securely fastened to the packing case.

All packing cases, though not steel containers, shall remain the property of the Employer.

1.10 Tools

The Supplier shall supply in lockable boxes, for the Employer's use, any special tools that may be required for assembly, dismantling and adjustments to the equipment. The tools shall be unused and in new condition at the time of hand over. Suitable special spanners shall be provided for bolts and nuts which are not properly accessible by means of an ordinary spanner.

2. GENERAL TECHNICAL SPECIFICATION

2.1 General

This Chapter contains a general technical specification of electrical distribution equipment and may cover equipment not to be procured under this contract. For details about each type of equipment to be procured reference is made to Section 3 Particular Technical Specifications.

The design shall incorporate every reasonable precaution and provision for the safety of the general public as well as for all those engaged in the operation and maintenance of the Contract Equipment and of associated works supplied under other Contracts.

2.2 Drawings

The Bidder shall in his Bid enclose overall drawings showing dimensions, main working principles, internal components and fixing methods to a detail level allowing the Employer to evaluate the functionality and completeness of the equipment.

2.3 Standards

Ratings, characteristics, tests and test procedures, etc. for the electrical equipment encompassed by this specification shall comply with the relevant provisions and requirements of the Recommendations of the International Electro technical Commission (IEC), unless otherwise expressly stated in Particular Technical Specifications. This applies even where the specific standards are not referred to in the Particular Specifications. Where the IEC Recommendations do not fully cover all provisions and requirements for the design, construction, testing, etc. and for equipment and components that are not covered by IEC Recommendations, recognized national standards shall be applied. The rules of CEE (International Commission for the approval of electrical equipment) and the standards of CENELEC (Comite Europeen de Normalisation Electrotechnique) may also be applied.

The latest revision or edition in effect at the time of Bid Invitation shall apply. Where references are given to numbers in the old numbering system from IEC it shall be taken as to be the equivalent number in the new five digit number series.

The Precise Standard, complete with identification number, to which the various equipment and materials are manufactured shall be specifically stated by the Bidder.

In case of conflict or disagreement between the particulars of the Standard adopted by the Bidder and the particulars of this Specification, this Specification shall prevail over the

Standard. All conflicts or disagreements, mentioned above, must be clearly stated, failing which the materials and equipment offered shall be deemed to comply in every respect with this Specification both in manufacture and in performance, and compliance thereof be insisted upon without additional cost to the Employer.

2.4 Units

The SI system (meter, Newton, second) shall be used throughout the works covered by this Specification.

2.5 Definitions

Whenever the following terms or words are found in the specifications and/or other documents, they shall have the following meaning:

"High Voltage Equipment" (HV):

Mostly used for equipment provided for a maximum operating voltage higher than 36 kV (generically also used for voltages down to 1000 V).

"Medium Voltage Equipment" (MV):

Equipment provided for a maximum operating voltage higher than 1000 V and up to 36 kV.

"Low Voltage Equipment" (LV): Equipment provided for operation at 1000 V or below. (For transformers the term Low Voltage Winding is used for the side with lowest rated voltage regardless of value, . IEC 60076)

Reference to degree of protection (IP) is according to the classification in IEC 60529

2.6 System Characteristics

The basic characteristics of the electrical systems and equipment shall be as follows (not all voltages are applicable to this contract):

MV Equipment 33 kV Maximum operating voltage 36 kV, 3phase, 50 Hz, delta connected system with neutral solidly earthed via zigzagstar connected earthing transformer.

MV Equipment 22 kV (Used by "GEDCO")

Maximum operating voltage 24 kV, 3phase, 50 Hz, delta connected system with neutral solidly earthed via zigzagstar connected earthing transformer.

MV Equipment 11 kV (also to be used for 6.6 kV net)

Maximum operating voltage 12 kV, 3phase, 50 Hz, neutral solidly earthed.

MV Equipment 6.6 kV Maximum operating voltage 7.2 kV, 3 phase 50 Hz, neutral solidly earthed.

LV Equipment, 0.4 kV Maximum operating voltage 420 V, 3phase, 50 Hz, loaded and effectively earthed neutral TNS system.

2.7 Phase Relationship

The standard phase colors are Red (L1), Yellow (L2), Blue (L3) (RYB).

2.8 Design Criteria

The equipment shall be designed to withstand the design stresses given below without damage and disruption of service. All tests shall as a minimum is based on these design parameters.

Item	Description	Unit	Nominal voltage level				
			33	22	11	6.6	0.4
1	Nominal system voltage phase to phase	kV	33	22	11	6.6	0.4
2	Highest system voltage phase - phase	kV	36	24	12	7.2	0.42
3	System Frequency	Hz	50	50	50	50	50
4	System earth(see above)	---	Solid	Solid	Solid	Solid	Solid
5	Minimum Design Short circuit Current	kA	25	25	25	25	25

2.9 Ambient Temperatures, Relative Humidity, Wind Pressure

Unless otherwise specifically stated in Particular Technical Specification, any equipment, component and assembly shall be designed for the following service conditions: Wherever any of these maximum or 24 hour average temperatures exceed the normal service condition temperatures of the IEC Recommendations for the relevant equipment, or of such other standard which is approved to be applied, the

permissible temperature rises of the recommendations or the standard shall be reduced by the same amount as the difference between the above figures and the normal service condition temperatures.

Description	Unit	Value
1- Altitude of site above sea level	m	400 to + 900
2- Ambient Temps: Maximum Minimum	°C °C	45 5
3- Wind Speed	m/s	15
4- Isokeraunic Level		15
5- Pollution Type		Dust
6- Relative Humidity Maximum Minimum	% %	100 <10
7- Rainfall Average annual	mm	600
8- Hail		Yes
9- Fog		Yes
10- Sand Storms		Occasional

The Contractor shall guarantee these reduced temperature rises.

2.10 Power Cables

The following assumed values of soil thermal resistivity, soil and air temperatures are for Tender evaluation purposes only. Maximum ground temperature °C 30 Soil thermal resistivity °C m/W 1.8 Max. ambient shade temperature °C 3040

The underground cables shall be designed to withstand a short circuit current of 30 kA for 1 sec.

PALESTINE
CONSTRUCTION OF MAIN ELECTRICAL POWER SUPPLY LINE
FOR THE
CONSTRUCTION OF KHAN YOUNIS WASTE WATER TREATMENT
PLANT PROJECT
(KY WWTP)

VOLUME 2 –SPECIFICATION
PART 3 – TECHNICAL SPECIFICATIONS-CIVIL WORKS

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1 EXCAVATION, DEMOLITION ETC.

1.1 GENERAL

Definition and Classification

The entire area within the limits of earthwork as indicated shall be constructed to the lines, grades, elevations, slopes and cross sections indicated on the drawings with added allowance for the thickness of any lining and rip rap if required.

Slopes shall present a neat uniform appearance upon completion of the work and shall be approved by the Engineer's Representative.

Excavated materials meeting the requirement of fill materials may be conserved for subsequent use or placed as fill immediately after excavation upon approval of the Engineer's Representative. If not immediately re-used, the storage in streets of excavated material to be subsequently used as fill will not be permitted unless specifically approved by the Engineer's Representative.

Large rocks unacceptable as earth fill material may be stockpiled for use as rip rap, if required in the works, subject to all requirements specified for rip rap in the specifications. The suitability of all excavation materials for specific purposes shall be determined by the Engineer's Representative.

The Contractor shall not waste or otherwise dispose of suitable excavated materials. All excavation shall be performed under the limitations and requirements set out in the sections of this specification pertaining to control of Palestinian Water Authority.

The following terms shall have the meaning hereby assigned to them:

"Topsoil or Sweet Sand" Means any surface materials suitable for use in areas to be grassed or cultivated.

"Bulk Excavation" (excluding Trench and Structure Excavation) Means excavation in open cut down to levels specified in the Drawings or otherwise as being the general levels after completion of excavation other than Incidental Excavation

"Trench Excavation" Means excavation of trenches into which pipes or cables are to be laid to levels and limits specified on Drawings or otherwise.

"Structure Excavation" Means excavation for the construction of pump stations, tanks, structure and building footings and other structures to levels and limits specified in the Drawings or otherwise.

"Incidental Excavation" means excavation (generally in small quantities) below or outside the limits of Bulk Excavation Trench and Structure Excavation, but excluding Excess Excavation.

"Excess Excavation" means excavation outside the limits specified for Bulk, Trench, Structure, or Incidental Excavation.

Earthwork

Shall include all site preparation, excavation of all materials of whatever nature encountered, handling, hauling and compaction of required fill materials, disposal of all excess excavated material, shoring and protection work, preparation of subgrade, dewatering as necessary, protection of adjacent property, backfill, surface reinstatement, and embankment to the lines and grades indicated in the drawings.

Plant for Earthworks

The Contractor shall employ only such plant as is suited to the soils to be handled. He shall not at any time use any plant, which damages or reduces the natural strength of the soil either in situ or during handling and placing or in its final compacted state.

Clearing

All areas to be cleared will be as designated on the Drawings and/or directed by the Engineer's Representative. This work shall basically consist of clearing all trees, vegetation, stumps, roots, brush, rubbish and other objectionable matter from the specified area to the satisfaction of the Engineer's Representative.

The materials obtained from the clearing operations shall be burned, or otherwise disposed of as approved by the Engineer's Representative. Not trees shall be cut outside of the areas mentioned above without special approval. All merchantable timber cleared in the area shall remain the property of the Employer.

Levels to be Recorded.

Before the surface of any part of the Site is disturbed or the works thereon are begun, the Contractor shall take record levels of such part, in the manner specified or as agreed with the Engineer's Representative. Two working days notice is to be given the Engineer's Representative so that the recording of levels can be performed in the presence of the Engineer's Representative if he so wishes to participate.

Methods of Excavation and Supporting

Wherever practical, mechanical excavation methods shall be used, except where such methods may cause damage to existing structures, services, ruins or relics. In such locations, the contractor shall use hand methods only.

Blasting is not generally permitted.

Where the depth of excavation exceeds two meters, or any other depth as may be agreed with the Engineer's Representative, the Contractor shall either:-

- batter back the sides of the excavation to a gradient compatible with angle
- of repose of the soil,
- support the sides of the excavation with a system of sheeting and shoring, or
- adopt a combination of these.

Bracing and Shoring.

Excavated surfaces shall be supported as necessary to safeguard the work and workmen, to prevent sliding or settling of the adjacent ground, and to avoid damaging existing improvements. The width of the excavation shall be increased if necessary to provide space for sheeting, bracing, shoring, and other supporting installations.

The Contractor shall also obtain the permission of the relevant authorities for the surface width of the excavation required. The Contractor shall furnish, place and subsequently remove such supporting installations unless ordered otherwise by the Engineer's Representative.

At least 7 days prior to commencing any excavation work, the contractor shall design and submit to the Engineer's Representative for review, detailed shop drawings of the structure excavation support systems and methods he proposes to use, showing support member materials, sizes, spacing and engineering calculations to validate the design of the above, including the maximum theoretical deflections of the support members.

The support system shall be designed in such a manner that no rankers, struts or any other support members extend through surfaces exposed in the finish construction, and no shoring or bracing is placed under permanent structures.

The engineering calculations shall be in English and shall show lateral earth pressures for the full excavation depths, forces at various stages of support during installation and removal and concrete placement, the anticipated equipment loads, surcharge loads of any description, the maximum design loads to be carried by various members of the support system and strut prelude forces.

No excavation work shall commence until the Engineer's Representative's consent has been obtained. Provided, however, that such consent shall in no way relieve the Contractor from any of his contractual obligations and responsibilities.

Borrow Excavation.

If the quantities of suitable materials obtained from specified excavations are insufficient to construct the specified fills, additional materials shall be obtained from approved borrow areas.

Borrow pits shall be excavated and finally dressed in a manner to eliminate steep or unstable side slopes or other hazardous or unsightly conditions.

The extent and depth of borrow pits within the limits of the designated borrow areas shall be approved by the Engineer's Representative. The Contractor shall be responsible for the arrangement and payment for all borrow material and the material selected shall meet the approval of the Engineer's Representative.

Disposal of Materials from Excavations.

All requirements herein relating to the disposal by the Contractor of materials arising from Site clearance or from excavations are subject to contract. The contractor is to provide dumping site for all excavated material (surplus or unsuitable) not to be used under the works and that the cost thereof shall be born by him.

Regardless of dumping site used by the Contractor, the material, surplus or unsuitable, shall be considered as the property of the Employer and will not be allowed to be removed from the dumping site without the approval of the Engineer's Representative.

Subject to any specific requirements of the Contract, the Contractor shall make his own arrangements for the temporary storage of any excavated material, which is required for use in refilling trench or structure excavations, including any necessary double handling.

The storage in streets of excavated material not to be immediately reused in the backfill of trenches will not be permitted.

In this connection the Contractor shall have regard to the working areas available to him for the construction of the works particularly where this is located in roads or in other places to which the public has free access. Any temporary tips alongside the trench excavation shall be to stable slopes and heights.

Where the nature of the excavated material is suitable, the Contractor's temporary storage as aforesaid shall include for separate storage as the Engineer's Representative may direct of any of the various grades of materials hereinafter specified for the refilling and surface reinstatement of trench or structure excavation, namely, soft material, coarse material, hard material and topsoil.

Any excavated material not required for or not suitable for use as refilling as aforesaid or use elsewhere in the works shall become the property of the Employer and the Contractor shall be entirely responsible for its removal from the Site to the dumping site.

Excess Excavation to be Made Good.

The Contractor at his own expense shall remove from the Site all material resulting from excess excavations below that required for the foundations, lining or bedding and shall make good the same with concrete or suitable fill material as may be required by the Engineer's Representative.

Where, due to site conditions, an alternative method for supporting the foundations, linings or bedding, may be possible the Contractor shall provide three copies of a design report by a competent engineer together with all calculations demonstrating the sufficiency of the proposals.

No alternative proposals shall be undertaken except with the Engineer's Representative's consent. Provided, however that such consent shall in no way relieve the Contractor from any of his contractual obligations and responsibilities.

Control of Water.

The Contractor shall furnish, install and operate all necessary machinery, appliances, and equipment to keep excavations free from water during construction and shall remove all water so as not to cause damage to private property, or to cause a nuisance or menace to the public all as specified herein. Berms shall be provided to prevent surface water from draining into structural excavations.

Earth banks shall be suitably protected from damage by erosion during construction.

The Contractor shall ensure that, at all times, during construction no ground water shall come into contact with any concrete surface or reinforcement and that any structure shall be capable of withstanding any hydrostatic pressure to which it may be subjected during construction and until completed.

The Contractor shall include in his rates for excavation the provision for removing all water from excavations.

Standard Earthwork Compaction Test Procedure.

1.1.1.1 Test Methods.

All compacted earth fill dry density shall equal or exceed the specified percentage as determined by of BS 1377:1990. This method will be used to determine the maximum dry density of each type of soil used in compacted fills, backfill, and embankments, and to measure the relative compaction at optimum moisture content of compacted fills, backfill, embankments, and subgrade.

1.1.1.2 Compaction Tests.

During the course of the work, the Contractor, under supervision of the Engineer's Representative, will perform such tests as are required by the Engineer's Representative, to identify materials, to determine compaction characteristics, to determine moisture content, and to determine density of fill in place. These tests performed by the Contractor will be used to verify that the fills conform to the requirements of the specifications.

1.1.1.3 Testing.

Testing will be performed by qualified staff of the Contractor or testing laboratory approved by the Engineer's Representative when, where, and as directed by the Engineer's Representative. The costs of all compaction testing and other tests as stated above will be borne by the Contractor. The Contractor shall adjust his operations so as to permit time to make tests, and shall excavate and fill such holes as may be required for sampling and testing. Compaction tests shall be made prior to removal of dewatering systems.

Inspection by Engineer's Representative.

When the specified levels of trench or structure excavation are reached the Engineer's Representative will inspect the ground exposed and if he considers that any part of the ground is by its nature unsuitable, he may direct the Contractor to excavate further and to refill the further excavation with such materials as he may direct and such further excavation will not be held to be excess excavation. Should the bottom of any trench or structure excavation, while acceptable to the Engineer's Representative at the time of his inspection, subsequently become unacceptable due to exposure to weather conditions or due to flooding or have become puddle, soft or loose during the progress of the works, the Contractor shall remove such damaged, softened or loosened material and excavate further by hand. In this case the cost of the extra excavation and of the additional foundation materials required will be the Contractor's responsibility.

1.2 TRENCH EXCAVATION

General

Trench excavation means excavation in all materials of whatever nature encountered for trenches into which pipes and ducts etc. are to be laid, or appurtenances constructed. The term pipe shall mean pipe of all kinds and for whatever purposes.

The line and level of trenches shall be as shown on the drawings or as may be directed by the Engineer's Representative. Before commencing trench excavations, the route of the trench shall be pegged out accurately, adjusted if found necessary before final route of trench is approved by the Engineer's Representative. The natural ground level along the route shall be checked by the Contractor against drawings and its levels shall be agreed with the Engineer's Representative.

Strong sight rails shall then be fixed and maintained at each change of gradient, and at as many intermediate points as may be necessary. On these rails shall be marked the Center line and the level to which the excavation is to be carried out, such rails being not more than 20m apart. Alternate methods to maintain line and level of pipelines shall be to the approval of the Engineer's Representative.

Trench excavation shall be carried out by such methods and to such lines dimension and depths as shall allow for the proper construction of the works, or as indicated on drawings or other parts of these documents.

Notwithstanding the foregoing, any rock in trench excavation shall be so excavated that the clearance between the pipe, when laid, and the rock sides and bottom of the trench is kept to the minimum limits necessary to provide for the specified thickness of bedding and eventual concrete protection of the pipe.

Bell holes and holes and depressions for couplings, valves and the like shall be excavated the same distance below these installations. The materials excavated shall be used in the backfill or removed and disposed of by the Contractor, as required by the Engineer's Representative. The trench shall be dug only so far in advance of pipe laying as the Engineer's Representative shall permit. Typical cross-sections of trenches shall be as indicated on drawings. No length of trench excavation shall be started until the pipes and fittings to be laid in that length are available on the Site.

Obstructions

Where the grade or alignment of the pipes is obstructed by existing utilities (either shown or not shown on the drawings) such as conduits, ducts, pipes, branch connections etc. the obstructions shall be supported, relocated, removed, or reconstructed by the Contractor at his own cost unless opposite item has been included in the Bill of Quantity.

Whenever it is necessary to determine the location of existing underground utilities, the Contractor, after an examination of available records, shall make all explorations, excavation and survey as may be directed by the Engineer's Representative to determine these locations. Only such tools and equipment as have been approved by the Engineer's Representative shall be used by the Contractor to execute the work in a safe and efficient manner.

If the obstructions encountered require alterations to the drawings, the Contractor shall, in accordance to the above investigations and in accordance with the indications received by the Engineer's Representative, change the plan and profiles as necessary and submit the drawings to the Engineer's Representative for approval.

The Contractor shall not make any deviation from the specified line and/or grade without approval by the Engineer's Representative. Should any deviations in line and/or grade be permitted by the Engineer's Representative for convenience to the Contractor, any additional costs for the thrust blocks, valves, air and vacuum assemblies, blow-off assemblies, extra pipe footage, manholes or other appurtenances shall be borne by the Contractor.

Trench Width.

Unless otherwise specified or instructed the minimum trench width shall be 500mm away from the pipe from each side at the specified level (depth).

Trench Excavation in Roads.

Wherever possible road or utility crossings shall be carried out using non-destructive construction techniques as directed by the Engineer's Representative. Where open excavation is allowed all trench excavation and other work carried out within the limits of any existing road or highway shall be completed as rapidly as possible and, in the case of roads capable of carrying two or more lanes of traffic, not more than half of the width of the carriage way shall be obstructed at any one time. In single-lane roads, the Contractor shall program his work in such a manner that the minimum inconvenience is caused to those persons who have reasonable grounds for using the road and, in the case of private or restricted roads, who have authority to use them.

Unless indicated otherwise on drawings, the maximum width of trenches in paved road shall be as follow:

Pipe Dia. mm	Maximum top width of trench				
	Depth of trench (m)				
	0 to 1.50	1.51 to 2.00	2.01 to 3.00	3.01 to 4.00	> 4.01
< 350	0.80	1.10	1.40	1.70	2.10
350	0.95	1.25	1.55	1.85	2.25
500-600	1.15	1.45	1.75	2.05	2.45
700-800			2.00	2.30	2.80
900-1000			2.2	2.5	3.2
1400			2.75	3.00	4.00

The contractor shall take all necessary measures, such as shoring, bracing,. etc., to keep the top width of the trenches within the limits given.

Before cutting any road (unless not needed in the opinion of the Engineer's Representative) the Contractor shall construct and maintain temporary ramps for the use of the traffic.

If, in the opinion of the Engineer's Representative, the amount of traffic using a road which is completely or partly obstructed by the works is sufficiently great to make it necessary, the Contractor shall operate a system of traffic control to the approval of the Engineer's Representative. Any such system of control shall erect appropriate warning signs at the approaches to sections of road in which or adjacent to which work is being executed. These signs shall be removed immediately the dangers of which they provide a warning have been removed.

If the Contractor wishes to obstruct completely any road for any significant period of time, he shall apply to the Engineer's Representative for permission to do so. Obstruction of the road shall not begin until the Contractor receives the Engineer's Representative's permission in writing. Such permission will not, in general, be granted for roads, which have more than one traffic lane, or for those sections of roads for which satisfactory alternative routes do not exist.

The costs incurred by the Contractor in respect of all aspects of work in roads including maintaining access past the works, the provision of a traffic control system and warning signs and the like shall be included in the rates for excavation and pipe laying. The Employer will not be liable to pay any compensation to the Contractor should permission to close any road to traffic not be granted for any reason.

Where trenches are open cut in asphalt or concrete roads the roads shall be saw cut along the edges of the trench, prior to excavation.

Road drains and channels shall be kept free from obstruction at all times.

Normally trench excavation along roads will be located in the service reserves or verges adjacent to the road rather than in the carriageway itself. Trench excavation shall wherever practicable be carried out in such a way that every part of the excavation is at least 1m clear of the existing edge of the carriageway. In such event the Contractor shall take special precautions, which shall include the continuous support of the sides of the excavation, from the time when excavation is begun until the refilling of the trench is placed, to ensure that there is no disturbance of the adjacent road or road foundation.

The Engineer's Representative may direct the trench excavation to be realigned from that shown on the drawings in order to avoid interference with existing utilities and structures or to facilitate smooth traffic flow.

Where trench excavation or any other part of the works obstructs any footpath or right-of-way, the Contractor shall provide, at his own cost, a temporary footpath around the obstruction to the satisfaction of the Engineer's Representative. Where applicable, this temporary footpath shall include stout bridges of wooden planks or other approved construction across any open trenches. Where excavated material has temporarily been deposited on a grass margin or verge, the margin shall on completion of refill be restored entirely to its original condition and left free from loose stones.

Trench Excavation in Surfaces Other than Roads.

Trench Excavations in surfaces other than roads shall include all surfaces except those asphalt surfaces, which require road reinstatement. These surfaces include but are not limited to cultivated areas, undeveloped areas, footpaths, verges, non-asphalt roads, lanes, alley, and all private lands.

Trench excavation shall if the Engineer's Representative so requires have temporary fencing erected around that length. Temporary fencing shall not be removed without the Engineer's

Representative's permission, which will not normally be given until the trench excavation has been refilled and reinstated.

The Contractor shall have particular regard to the safety of animals, which may be introduced to the areas, and shall ensure that all open excavation, access routes and steep or loose slopes arising from the Contractor's operations are adequately fenced and protected.

Supporting Trench Excavations.

An excavation must be properly supported or the sides adequately battered to a safe angle as soon as the excavation reaches 1.5 m.

The Contractor shall well and effectively support the sides of all trench excavation. This support shall include the use of steel sheet piles, where necessary, to prevent any fall or run from any portion of the ground outside the excavation into the trench and to prevent settlement of or damage to structures adjacent to the excavation.

The Contractor shall be deemed to have made his own allowance for shoring up the sides of trenches, any extra excavation necessary to provide space for such support and for any other working space. If for any reason any portion of trench excavation shall give way, the Contractor shall at his own expense take all necessary remedial measures including the excavation and removal of all the ground thereby disturbed.

The Contractor shall not remove temporary works supporting the excavations until in the opinion of the Engineer's Representative the permanent work is sufficiently advanced to permit such removal, which shall be executed under the personal supervision of a competent foreman.

Any advice, permission, approval or instruction given by the Engineer's Representative relative to such support or the removal thereof shall not relieve the Contractor from his responsibilities under the Contract.

All temporary works supporting the excavation shall be removed during backfilling unless previous approval has been obtained from the Engineer's Representative. Where temporary supports have been used in the excavation any such supports left in because it is impracticable to remove them shall be left in at the expense of the Contractor.

Undisturbed Ground.

When excavating to specified levels for trench excavation or to specified limits for the face of any structure therein required to abut undisturbed ground, the Contractor shall not excavate the last 150 mm until immediately before commencing construction work except where the Engineer's Representative permits otherwise.

Should the Contractor has excavated to within 150 mm above these specified levels or to within 150 mm of these specified limits before he is ready or able to commence the construction work he shall where required by the Engineer's Representative excavate further so as to remove not less

than 150 mm of material immediately before commencing the constructional work and any such further excavation and additional foundation material ordered by the Engineer's Representative shall be at the cost of the Contractor.

Trenches not to be Left Open.

Trench excavation shall be carried out expeditiously and, subject to any specific requirements of the Contract, the refilling and surface reinstatement of trench excavations shall be commenced and completed as soon as reasonably practicable after the pipes have been laid and jointed.

Pipe laying shall follow closely upon the progress of trench excavation, and the Contractor shall not be permitted to leave unreasonably excessive lengths of trench excavation to remain open while awaiting testing of the pipes but in any case not more than 200m ahead of the pipe laying operation or greater lengths if approved by the Engineer's Representative.

The Contractor shall take precautions to prevent flotation of pipes in locations where open trench excavations may become flooded, and these precautions may include the partial refilling of the trench leaving pipe joints exposed for tests of the joints.

If the Engineer's Representative considers that the Contractor is not complying with any of the foregoing requirements he may prohibit further trench excavation until he is satisfied with the progress of laying and testing of pipes and refilling of trench excavation.

The Contractor will not be permitted to excavate trenches in more than one location in any one road at a given time without the Engineer's Representative's permission.

Trench Foundation. (Bedding)

Bedding material shall be clean natural sand unless not specified otherwise on drawings. All shattered and loose material shall be removed from the bottom of the trench excavations so that the bedding material rests on a solid and clean foundation.

Before bedding material is placed, any unsound material or soft spots naturally occurring in the bottom of any excavation shall be filled with selected material as directed by the Engineer's Representative.

Where the Contractor is laying a pipe into a port in an existing structure, manhole chamber or thrust block, and where the backfill material to previous excavation beneath the pipe formation, is not concrete, the backfill material shall be removed over its full depth and for the full width of the pipe trench shown on the Drawings. The resulting void shall be filled solid with selected material.

If in the opinion of the Engineer's Representative a formation is unsound as a result of the Contractor failing to keep the excavation free from water or other materials the Engineer's Representative will order the removal and disposal of the unsound material and the filling of the resulting void. The Contractor shall execute the work as directed and bear the costs of the same.

Backfilling Trench

1.2.1.1 General

The refilling of excavation shall be commenced as soon as practicable after the permanent works have been inspected and approved by the Engineer's Representative.

On completion of all bedding, backfilling to pipelines in trenches to the levels specified and with the granular bedding and surround material indicated according to the pipe type as detailed later, the remaining excavation shall be backfilled as detailed below.

1.2.1.2 Backfilling Open Cut - Non Paved Area

The materials for backfilling trench shall be obtained from required excavations or other approved borrow areas. Material from borrow areas is considered as not being required as backfill for trenches, but may be used by the Contractor at his own choice. Any additional cost associated with import of borrow material, shall in such case be borne by the Contractor.

No brush, roots, topsoil or other unsuitable materials shall be used or mixed with the specified materials. All materials shall be subject to the approval of the Engineer's Representative.

Selected fill material for pipe surround to the height shown on the drawings above the top of the pipe shall be clean natural sand, unless not indicated otherwise.

The remainder of the trench fill material shall be as specified for selected fill material, except that stones or clods of earth up to 50 mm in size may be allowed, provided in the opinion of the Engineer's Representative, the required densities can be achieved. The quantity of stones, over 100 mm in size shall not exceed 25% by volume.

This material shall be spread in layers of not greater depth than 200 mm and be thoroughly rammed by an approved mechanical rammer. Depths greater than 200 mm shall be allowed, provided it is demonstrated that the compaction equipment can achieve the required density through the depth of the backfill layer.

The coarse filling is to be carried up to such level as with the surface reinstatement of the whole of the topsoil will leave the finished work sufficiently "proud" to allow for future settlement to the original ground level.

Where necessary, the Contractor shall adjust the moisture content of the refill material either drying out or by adding water to assist the compaction of the material. During compaction, the backfill shall have a uniform moisture content equal to or a little above the optimum moisture content recorded in the Compaction Test. Backfill shall be compacted to a dry density of not less than 90 percent of the maximum dry density (unless otherwise shown on the Drawings) when tested in accordance with BS 1377:1999.

Should the material being placed as refilling, while acceptable at the time when approved, become unacceptable to the Engineer's Representative due to exposure to weather condition or due to flooding or have become puddle, soft or segregated during the progress of works, the Contractor

shall at his own expense remove such damaged, softened or segregated material and replace it with fresh approved material.

To permit the proper consolidation of backfill into the voids behind the trench sheeting and supports, trench sheeting shall be withdrawn gradually as backfill progresses in depth and along the trench. On no account shall any excavated material be dozed back when refilling trenches in roads and no backfilling shall be carried out unless, in the opinion of the Engineer's Representative, sufficient mechanical rammed are in operation on that portion of the work.

All filling materials which are, in the opinion of the Engineer's Representative, of a non-cohesive nature shall be well watered to the approval of the Engineer's Representative in the layers specified to obtain the specified compaction.

Any excavated material unsuitable for backfill shall be removed from the site by the Contractor.

1.2.1.3 Backfilling Open Cuts - Paved Areas

Trenches and excavations in roads and paved/tiled areas shall be backfilled in layers not exceeding 200 mm (compacted thickness) with suitable material. The soil used for backfilling shall have a minimum soaked CBR of 10% and shall be compacted to not less than 95% of the maximum dry density determined by BS 1377:1999.

Suitable material for backfill under roads and paved/tiles area shall be approved non-plastic material free from organic matter deriving from the excavation or from a source approved by the Engineer's Representative, which shall have the following properties:

- Soaked CBR at least 10% at 95% of MDD
- Liquid limit less than 35 and Plasticity Index less than 6.
- Maximum Particle Size not more than 100 mm
- MDD is Maximum Dry Density according to BS 1377:1999.

Surface Reinstatement in Paved Roads.

1.2.1.4 Temporary Reinstatement.

After refilling the trench and compacting it as specified in the foregoing paragraphs, the Contractor shall immediately provide a temporary reinstatement to enable the road to be used for vehicular traffic.:

1.2.1.5 Permanent Reinstatement.

Permanent reinstatement of all asphalt or block paved roads together with other paved areas and flagged areas shall be carried out by the Contractor in accordance with the requirements of the

appropriate Authority and shall comprise the provision of surfacing at least equal to that obtaining immediately before the Contractor first entered thereon.

The Contractor shall carry out the permanent reinstatement in accordance with a program agreed with the Engineer's Representative. Permanent reinstatement of private lands will comprise the provision of a surface at least equal to that obtaining immediately before the Contractor first entered thereon.

All permanent reinstatement shall include the Contractor's return to Site at regular intervals during the Defect Liability Period to carry out works necessary to ensure that surfaces are finally left in a condition at least equal to that existing before the Contractor first entered thereon.

The cost of permanent reinstatement including such visits and any remedial work shall be deemed to have been included in the Tender Price.

Reinstatement of Unpaved Roads.

All non-asphalt road shall be restored to their original condition by the Contractor. This reinstatement is deemed to be entirely covered by the Contractor's rates for pipe installation.

Appurtenant structure in the Pipeline

The contractor shall carry out further excavation as may be necessary to accommodate structures such as manholes and chambers. Such excavation shall include for disposal of surplus material and, where appropriate, for backfilling round the structures and reinstatement.

Excavation, backfilling, reinstatement etc. shall follow the requirements for work with trenches as described above.

Fill Adjacent to Structures.

Fill materials adjacent to structures shall be placed in such a manner as will ensure that they can be satisfactorily compacted without damage to the structures. Compaction adjacent to all structures shall be carried out by hand or by suitable hand operated plant. No fill material shall be placed and no compaction shall be permitted adjacent to concrete for fourteen days following placing the concrete.

Existing Services.

Where trench excavation is carried out close to or across the line of sewers, pipes, cables and other services the Contractor shall where necessary provide temporary supports or slings and where such sewer, pipe, cable or other service is temporarily disturbed it shall be replaced.

Where, in the opinion of the Engineer's Representative, construction of the pipeline cannot reasonably be carried out unless the sewer, pipe or other service is permanently severed or

permanently diverted or permanently supported by concrete he shall order the Contractor to undertake such work.

Notwithstanding any relevant information furnished by the Employer or Engineer's Representative, the Contractor shall be responsible for ascertaining from his own inspection of the Site and the respective utility authorities and other public bodies the position of all mains, pipes and cables whether underground or overhead, within or near the Site.

Fences and Walls.

Where the trench excavation crosses barriers such fences and walls the Contractor, as a temporary measure during construction of the pipeline, shall provide temporary fencing for any parts of such barriers as have had to be removed. After trench excavation has been reinstated, the Contractor shall carry out such work as the Engineer's Representative may order for permanent restoration of such barriers to its original condition.

Restoring Existing Improvements.

All road or street improvements excavated or damaged and any damage to adjoining property caused by construction operations, shall be restored or repaired by the Contractor to a condition equal to that which existed prior to commencement, shall be of the same kind and work, shall conform to the same dimensions and be of quality equal to the original construction and shall conform to the requirements of the agency having jurisdiction.

Cleanup.

Upon completion of work of this section, all rubbish, debris, and excess or waste material shall be removed from the Site. All construction equipment and implements of service shall be removed and the entire area involved shall be left in a neat, clean and acceptable condition.

1.3 REMOVAL, REINSTATEMENT AND/OR RELOCATION OF OBSTRUCTIONS, PIPELINES, PAVEMENT AND UTILITIES

Description

This Work shall consist of the removal, reinstatement and/or relocation wholly or in part, temporarily or permanently, and satisfactorily disposal of all existing utilities, fences, structures, abandoned pipelines, and any other obstruction which are encountered during construction and are not designated or permitted to remain, except for the obstructions to be demolished or removed

and disposed of under other items in the Contract. It shall also include the salvaging of designated materials and backfilling the resulting trenches, holes and pits.

When structures like pipes, tiles, trees etc. are to be removed only temporarily to excavate trenches or for similar works the Contractor shall take any possible measure to remove them without causing any damage and will provide for the reinstatement of the previous conditions to the satisfaction of the Engineer's Representative.

Removal and Relocation of Pipes, Conduits etc.

1.3.1.1 General

Pipes, conduits, utilities, etc., which necessarily cut shall be either permanently capped or re-routed as indicated on the Drawings or as directed by the Engineer's Representative. Utility lines not specifically noted for disposition, but which are encountered in the Work shall be capped, extended, protected, or reworked and relocated as necessary for completion of the work as directed by the Engineer's Representative.

1.3.1.2 Relocation

The relocation of the encountered utilities either shown on the Drawings or not shall be done by the Contractor at full satisfaction of the Engineer's Representative and in accordance with the recommendations of the relevant responsible Authority and the Contractor shall be held responsible for the satisfactory relocation and reinstatement of the working conditions of the encountered utilities.

The costs of this relocation shall not be paid directly but it shall be considered as subsidiary to the several paying items in the Bill of Quantities.

1.3.1.3 Removal

Unless otherwise provided, all pipes which are not used any more, shall be carefully removed and every precaution taken to avoid braking or damaging the pipe. The Contractor shall be held responsible in taking all the possible measures for the satisfactory removal of such structures in a usable condition. The removed utilities shall become property of the Employer.

Abandonment of Existing Pipelines

The Engineer's Representative shall direct where existing pipe house connections and pumping mains are to be abandoned. Prior to proceeding the Contractor shall inform the Engineer's Representative in writing of his intention to commence abandonment and shall obtain his written approval.

Unless otherwise shown on the drawings or instructed by the Engineer's Representative all existing pipes and house connections to be abandoned shall be completely filled with a cement

slurry or similar material using a grout pan or an alternative method approved by the Engineer's Representative by which the discharge slurry can be forced into the entire length of the abandoned pipeline under pressure.

The Contractor shall be responsible for ensuring that all existing connections into the pipe to be abandoned have been either plugged or disconnected before filling proceeds.

Where a pipe or house connection to be abandoned connects into a manhole or chamber to be retained, the connection shall be plugged at the chamber wall and the associated channel in the benching of the manhole or chambers shall be thoroughly cleaned and filled with cement mortar.

Unless otherwise shown on the Drawings or instructed by the Engineer's Representative existing pumping mains to be abandoned shall be flushed out and sealed at each end of the pipeline with a removable expanding stopper to the approval of the Engineer's Representative. Where chambers occur on the pipeline to be abandoned these shall be demolished and the pipeline ends sealed as detailed above.

Reinstatement of Surfaces

When to execute the Works an existing paved surface (concrete or asphalt) has to be excavated, the Contractor shall provide for the cutting of the same without causing any damage to the portion of surface not necessary to be cut.

When the excavation of the trench and the laying of new pipes have been completed and all tests have been successfully carried out, the Contractor shall provide for the reinstatement of the existing surface as the following, unless otherwise indicated on Drawings;

- The concrete surfaces shall be reinstated with a layer of 200 mm crushed stone base coarse and 100 mm of plain concrete class B200 to satisfaction of the Engineer's Representative.
- The tile (inter lock) roads shall reinstated with a layer of 200 mm crushed stone base coarse, 50 mm fine sand and inter lock tiles of the same type.
- The asphalt road shall be reinstated with a layer of 250 mm compacted crushed stone base coarse spread by bitumen MC 70 (1.0 kg/m²) ,two asphalt layers, the first layer 40 mm thick, 3/4" aggregate size and spread by RC2 at a rate of 1.0 kg /m² and a second layer is 30 mm thick and 1/2" aggregate size according B.S standards.

Removal of Road Furniture

All existing road furniture (guard rails, guard post, road signs, advertisement signs, cat's eyes etc.) which removal is not paid under pay item present in the Bill of Quantities and which is ordered by the Engineer's Representative to be removed, shall be removed and disposed off by the Contractor as per Engineer's Representative's instruction.

Where so instructed by the Engineer's Representative these road furniture will be relocated within the limits of the Contract at the same conditions of the one removed.

The above removals and reinstatement shall not be paid directly but it shall be considered as subsidiary to the several paying items in the Bill of Quantities.

Removal of Existing Trees and Plantation

Removal of trees and plantation shall be done as required and subject to the prior approval of the Engineer's Representative

The above removals shall not be paid directly but it shall be considered as subsidiary to the several paying items in the Bill of Quantities.

2 CONCRETE

2.1 GENERAL

This Section covers the provision of concrete work formwork and reinforcing work complete as indicate, specified and required.

Definition

Water bearing structure shall mean any structure, any part of which contains water or process liquids, or which protects spaces from groundwater.

Concrete shall consist of a mixture of Portland cement, water, and aggregates with or without air-entraining or water-reducing admixture.

Applicable Tests and Codes

All concrete, aggregate, cement and water shall be sampled and tested during construction as frequently as deemed necessary by the Engineer's Representative. All test samples shall be supplied by the Contractor at his expense. Samples shall be obtained in accordance with BS specified in section 4.2 and they shall be submitted also to Petrography examination before delivering material on Site. All costs connected with manufacturer's Certificates of Guarantee, laboratory analysis, and all subsequent testing for material acceptances shall be borne by the Contractor.

2.2 MATERIAL

Cement

2.2.1.1 Quality of Cement

Cement used shall be standard Portland Cement conforming with the requirements of ASTM, as required. The use of rapid hardening cement will not normally be permitted.

2.2.1.2 Sampling, Inspection and Test

Sampling, inspection and testing of all cement will be performed by the Contractor in presence of the Engineer's Representative's representative and such sampling, inspection and testing will be in accordance with ASTM as designed by the Engineer's Representative. Each separate consignment of cement shall be tested by the manufacturer before delivery and certified copies of such tests

shall be supplied to the Engineer's Representative's Representative before any part of the consignment is used in the Works. The Engineer's Representative shall have the right at all times to inspect the materials, the laboratory records of analysis and tests made at the cement plant and to take samples of the cement for testing. The Contractor shall provide all necessary assistance to the Engineer's Representative for taking samples.

The Engineer's Representative may require tests of the cement in storage at any time before use. Cement failing pass such tests shall be rejected. If any proves unsatisfactory and portions of it have been used in concrete, mortar or grout, then such concrete mortar or grout will be ordered to be removed and replaced using acceptable cement, at the Contractor's expense. Test cylinders, from concrete or mortar being used in the work may be made by the Engineer's Representative at any time for purposes of testing. The Contractor shall furnish all cement and concrete required for testing without any charge to the Employer.

Cement may be rejected, at the discretion of the Engineer's Representative, if it fails to meet any of the requirements of these Specifications. Cement may be accepted on the basis of the seven-days test results provided the quality history of the cement manufacturer has been established within the past 12 months, otherwise, the results of the 28 days tests at the normal testing rate must be approved prior to shipment of the cement from the plant. Immediately upon arrival to the site of work, the cement shall be stored.

Cement shall be delivered to site in sealed bags in quantities sufficient to ensure that there is no suspension of, or interruption to the work of concreting at any time.

Neither stale nor caked cement shall be used. Cement remaining in bulk storage at the mill, prior to shipment, for more than three (3) months or cement stored in bags in local storage by the Contractor or a vendor for more than one (1) month after shipment from the mill, may be retested before use and will be rejected if it fails to meet any of the requirements of these Specifications.

2.2.1.3 Storage

The Contractor shall provide suitable storage for cement at approved places convenient to the work, and the cement shall at all times be carefully protected against moisture and exposure to air. Cement storehouses shall be weather tight, shall have tight floors set at a proper minimum distance of 300 mm above the ground, shall be large enough to maintain a sufficient supply of cement on hand to prevent delays or interruptions to the work and shall have sufficient access thereto for sampling, counting of sack and removal. Cement in sack shall not be piled to a height exceeding 2 meters. When necessary cement shall be properly covered with tarpaulin, or other effective waterproof of covering.

To prevent undue aging of sacked cement after delivery, the Contractor shall used sacked cement in the chronological order in which it was delivered in the job. Each shipment of sacked cement shall be stored so that it may readily be distinguished from other shipment. All empty sacks shall be promptly disposed or marked by means approved by the Engineer's Representative.

Suitable, accurate scales shall be provided by the Contractor for weighing the cement in each storehouse and elsewhere on the work, and he shall also furnish all necessary weights.

The Contractor shall employ competent storekeepers who shall have charge of the cement storehouses and keep suitable records of the delivery and use of all cement. Copies of these records shall be furnished to the Engineer's Representative as requested, showing in such detail as he may require, the quantity of cement used during the day in each part of the work.

Bulk cement will be kept in airtight silos which will be emptied for cleaning at regular intervals not exceeding four months, or as otherwise directed by the Engineer's Representative.

Cement of different quality shall be stored in separate sections of the store, or in separate silos.

Aggregates

2.2.1.4 General

Except as may be modified thereunder the aggregate (fine and coarse) for all types of concrete shall comply in all aspects with BS 882 "Concrete aggregates from natural sources for concrete" where applicable. The use of aggregates containing limestone shall not be permitted. Contractor shall obtain representative samples of each grade he proposed to use and carry out the necessary tests and analysis to show that the samples comply with the Specification. The results of these tests, etc. shall be submitted to the Engineer's Representative and his approval shall be obtained before any of the material is used in the works. Part of each sample will be required for concrete trial mixes and part (minimum 50 kg for each sample) shall be retained for comparison with subsequent deliveries. Sampling, testing and analysis shall be carried out, where applicable, in accordance with BS 812.

The maximum size of aggregate shall not be larger than 1/5 of the narrowest dimension between sides of the member for which the concrete is to be used and not larger than 3/4 of the maximum clear distance between reinforcing bars. -Prior to acceptance of material, representative samples of the fine aggregate, coarse aggregate and stone will be obtained and their physical, mineral and chemical characteristics will be determined. During the progress of the work, the grading may be checked at frequent intervals.

The Contractor shall sample and carry out a mechanical analysis of the fine aggregate and each nominal size of coarse aggregate in use employing the methods described in ASTM for "Methods of Testing Concrete" at least one in each week when concreting is in progress and at such more frequent intervals as the Engineer's Representative may require. The grading of all aggregates shall be within the respective limits specified herein and should the fraction of aggregate retained on any sieve differ from the corresponding fraction of aggregate in the approved mix by more than two percent of the total quantity of fine and coarse aggregate the Engineer's Representative may instruct the Contractor to alter the relative proportions of the aggregates in the mix to allow for such difference.

2.2.1.5 Quarries

The Contractor may choose any quarry or alluvium source (hereinafter referred to as quarry) on the condition that the aggregates are uniform in shape and comply with the specified quality and grading.

The quarry shall be investigated by the Contractor by means of exploratory holes, pits, trenches, etc. in sufficient quantity to ascertain the possible exploitable volume and to draw the samples necessary to carry out a complete range of laboratory tests.

All quarries shall be approved by the Engineer's Representative before the Contractor commences its exploitation.

Approval of a source of aggregate shall not be construed as constituting approval of all materials taken from the source and the Engineer's Representative can at any time suspend the previous approval if the laboratory tests establish that the material is not longer suitable.

The Contractor shall clear and strip, at his expense, the areas of the quarry and deposits from which aggregates are to be produced.

The Contractor is responsible for providing all aggregates necessary to complete the works. Any change in source required to furnish sufficient quantities of acceptable materials for the work occasioned by lack of suitable material in any source shall be at the Contractor's cost and shall not be grounds for claiming additional payment.

2.2.1.6 Sand (Fine Aggregate) Definition

The term sand is used to indicate the part of the aggregate having the maximum dimension of 4.8 mm

2.2.1.6.1 Quality

The sand shall be clean, strong, hard, compact, unalterable and without flaky fragments of rock, and shall be free from adherent coating, clay, loam, alkali, organic material of other deleterious substances:

Either natural or manufactured sand shall be prepared for use by screening or washing, or both, as necessary to remove all deleterious substances, and objectionable amount of other foreign matters, while separating the sand grains into the required size fractions.

The sand must reach the mixing plant with uniform and constant moisture, which must not exceed 6% of its dry weight. Variations in moisture shall not exceed 0.5% from hour to hour or 2% over a 10-hour concreting shift.

2.2.1.6.2 Physical Properties

Amount of material finer than No.200 BS Sieve when tested in accordance with BS 812 (Decantation Method) shall not exceed:

- Natural Sand 3.0% by weight
- Crushed Stone Sands 5.0% by weight
- Portions of void forming hollow shells present in natural sand shall not exceed 5% by weight, when determined by direct visual separation.
- Water absorption shall not exceed 2% by weight for both natural and crushed sands
- Chemical Properties

Natural sand and crushed stone sand shall not contain more than 0.10% by weight of chlorides soluble in dilute nitric acid, when expressed as sodium chloride (NaCl).

Natural sand and crushed stone sand shall not contain more than 0.5% by weight of total acid soluble sulphates, when expressed as sulphur trioxide (SO₃).

Natural sand and crushed stone sand shall not contain any materials that are deleteriously reactive with alkalis in the cement and concrete in an amount sufficient to cause excessive expansion of concrete or mortar.

The Contractor shall mechanically wash aggregate to remove salts and other impurities in order to meet the requirement specified.

2.2.1.6.3 Grading

The grading of the sand used for concrete mixtures carried out according to BS 410 sieves and BS 812 procedure shall be within zone 2 and 3 of the following table as delivered to the mixers:

BS 410 test sieve		Percentage by weight passing BS sieve	
mm.	in.	Grading Zone 2	Grading Zone 3
3/8	9.52	100	100
3/16	4.76	90 - 100	90 - 100
No.	mm.		
7	2.40	75 - 100	85 - 100
14	1.20	55 - 90	75 - 100

	microns		
25	600	35 - 59	60 - 79
52	300	8 - 30	12 - 40
100	150	0 - 10	0 - 10

The grading of the sand shall also be controlled so that the fineness modules, in at least nine out of ten test samples of the fine aggregate, as delivered to the mixer shall not vary more than 0.20 from the average fineness modules of all samples previously taken.

Sand may be separated into two or more sizes or classifications, but the resulting combined sand shall be of uniform grading, within the limits specified above.

2.2.1.7 Coarse Aggregate

2.2.1.7.1 Definition

The term "coarse aggregate" is referred to the part of the aggregates with a minimum dimension of 3.16" (4.8 mm) and with the maximum dimension up to 3" (75 mm).

2.2.1.7.2 Quality

Coarse aggregate shall consist of hard, strong, clean, compact, unalterable, not flaky rock, with no particles of foreign matters.

It shall have not adherent coating, and shall be free of lumps of clay, loam, roots, sticks and other organic matter, alkali of other deleterious substances, and shall comply with requirements specified herein.

2.2.1.7.3 Physical Properties

Amount of material finer than a No.200 B.S. Sieve not more than 1.0% by weight when tested in accordance to B.S 812 (Decantation Method).

Water Absorption shall not exceed 2% by weight when tested in accordance to B.S. 812.

Flakiness Index and elongation index shall not exceed 20% and 35% respectively when determined in accordance with B.S 812.

The Aggregate Impact Value for coarse aggregate shall not exceed 30% when determined in accordance with B.S 812.

Coarse Aggregate shall be single sized aggregate obtained by mechanical crushing and screening and shall comply with the appropriate grading limits given in B.S. 882

2.2.1.7.4 Chemical Properties

Coarse aggregate shall not contain more than 0.05% by weight of chlorides soluble in dilute nitric acid, when expressed as sodium chloride (NaCl).

Coarse aggregate shall not contain more than 0.5% by weight total acid soluble sulphates, when expressed as sulphur trioxide (SO₃).

The Contractor shall mechanically wash aggregates to remove salts and other impurities in order to meet the requirements specified.

2.2.1.7.5 Total Salt Content Limit

The above chloride and sulphates limits may be modified providing that the total chloride and sulphates contents in a given concrete, including those in other materials, do not exceed 0.35% and 5.0% respectively by weight of the cement in the mix.

2.2.1.7.6 Particle Shape

The shape of the particles in the fine and coarse aggregate shall be generally spherical or cubical.

Manufactured coarse aggregates, containing more than 15 percent elongated or flat particles, shall not be used. An elongated particle is defined as a particle having a maximum length of more than 5 times its maximum width. A flat particle is defined as a particle in which its maximum diameter or length is more than 5 times its maximum thickness.

2.2.1.8 Storage of Aggregates

The Contractor shall provide means or storing the aggregates at each point where concrete is made such that (a) each nominal size of coarse aggregate and the fine aggregate shall be kept separated at all times; (b) contamination of the aggregates by the ground or other foreign matter shall be effectively prevented at all time; (c) each heap of aggregate shall be capable of draining freely; and (d) storage shall be such to prevent segregation. Stockpiles shall be on hard and clean surfaces with not more than 5 percent slope.

The Contractor shall ensure that graded coarse aggregates are tipped, stored and removed from store in a manner that does not cause segregation.

Methods of stockpiling, which permit the aggregate of roll down the slope as it is added to the pile, or which permit hauling equipment to operate over one area at the same level repeatedly, or which permit the free fall of material from a stacked, allowing fine material to be separated from coarse material by wind, will not be allowed. Stackers, if used, shall have an adjustable discharge height so that high falls can be prevented.

Sufficient aggregate shall be maintained at the site at all times, to permit continuous placement and completion of any lift of concrete started.

Wet fine aggregate shall not be used until it has a constant and uniform moisture content. If necessary to meet the requirements of these Clause. The Contractor shall protect the heaps of fine aggregate against inclement weather.

The Contractor shall make available to the Engineer's Representative such samples of the aggregate as he may require. Such samples shall be collected at the point of discharge of aggregate to the batching plant. If any such sample does not conform with the Specification the aggregate it represents shall be promptly removed from the Site and the Contractor shall carry out such modifications to the storage arrangements as may be necessary to secure compliance with the Specification.

Where site laminations preclude the storage of aggregates on site, aggregates shall be stored at a central location and shall be delivered daily as required to specific job sites in such a manner as to avoid contamination and segregation of the aggregates.

2.2.1.9 Aggregate Processing Plant

A modern and dependable aggregate plant, capable of producing satisfactory concrete aggregates in sufficient quantity, and at the rate necessary to meet the requirements of the construction schedule, shall be furnished, installed, operated and maintained at a location approved by the Engineer's Representative. Complete facilities shall be provided for proper crushing, scrubbing, screening, washing, classifying, storing, reclaiming and delivering the aggregate to the batching and mixing plant.

The plant shall include facilities for washing the aggregates after separation into the various size groups, to remove any fine material and organic matter before delivery to the concrete batching and mixing plant.

Plans and specifications in writing for the proposed aggregate processing plant, including description and capacity data on the processing equipment storage and flow charts of the whole processing operations shall be submitted to the Engineer's Representative for approval.

The flow charts shall show rates of flow of material at the various crushing and separation points, as well as the volumes of stockpiles and number and kind of equipment to be used in transporting the aggregate from the aggregate plant to the batching and mixing plant.

The aggregate plant shall be operative sufficiently in advance of the dates set for first placement of concrete, to permit the taking of samples and the making of necessary tests.

Mixing Water

Water shall not contain salt, oil, alkali, organic matter or any other deleterious substance, which would impair the quality of the concrete.

Water shall be tested in conformance with B.S. 3148.

The water shall neither contain an amount of impurities that will cause a change in setting time of Portland Cement of more than twenty five percent (25%) nor reduction in the compression strength of mortar at 14 days of more than 5 percent when compared to the results obtained with distilled water.

If potable water is not available the Contractor may use water from natural sources provide written approval is given by the Engineer's Representative.

However, if the water from local natural sources contains, at certain times, quantities of impurities in excess of the above limits, the Contractor will be required to make arrangements for ensuring its purity before used.

Admixture

The Contractor shall provide sufficiently large capacity in his concrete producing plant and concrete transporting arrangements and use an appropriate admixture to avoid cold joints.

The Contractor will submit to the Engineer's Representative the catalogues and samples of at least three manufacturers with recognised world-wide reputation in concrete admixtures, at least 90 days prior to its use in the works.

The Engineer's Representative will execute tests on the samples of admixture, after delivery to the site laboratory in order to verify the quality and fulfilment with the minimum specified requirements. The products, which have given the best technical results, will then be chosen. The admixtures, which have to be mixed in the same class of concrete, must be supplied by the same manufacturer.

The admixtures shall have a uniform quality in the different stocks, and will be supplied along with manufacturer's test certificate.

Liquid or powdered admixtures for concrete shall be stored in such a way that the materials are used in the same chronological order as their delivery to the site.

Admixtures, which have been in storage at the site for longer than six months, shall not be used until retest proves to be satisfactory.

No admixture containing calcium chloride shall be permitted.

Water reducing or water reducing retarding admixture shall be used in all concrete in quantity not less than four per thousand (4 _/00) of the weight of cement. Retarders shall not be used together with other admixtures in the same mix unless approved by the Engineer's Representative. The fluid content of admixtures shall be considered in the determination of water/cement ratios.

2.3 CLASSIFICATION, PROPORTIONING AND TESTS

Classification

The concrete is classified on the basis of its compressive strength at 28 days as well as on the maximum size of the aggregate, as shown in the following Table:

CLASS	STRENGTH AT 28 DAYS (Cube Kg/cm ²)	MAXIMUM AGGREGATE SIZE (mm)
B200	250 Kg/cm ²	25
B300	300 Kg/cm ²	25

The deviation from the specified strength shall be in accordance with the Code for structures designed in accordance with the working stress method i.e. the average of any five consecutive strength tests of the laboratory cured specimens representing each class of concrete shall be equal to or greater than the specified strength and not more than 20% of the strength tests shall have values less than the specified strength, but no value shall be less than 75% of the specific value.

Concrete Mix Design

2.3.1.1 General

Concrete Mix Design, shall mean the process of determining the proportions of the various ingredients, to be used to produce concrete of the required strength, and with the best workability and durability.

With a view to obtaining the best results, the type of the structure concerned and the pouring procedure involved shall be taken into consideration during proportioning.

Prior to beginning concreting operations, the Contractor shall design the concrete mix for each class of concrete and shall carry out technical checks on the components of the mixture, undertake the preparation of sample mixes and carry out compressive strength tests for every class of concrete and every slump required.

The concrete tests shall be made from materials to be used in the works and the Contractor, before starting concreting operations, shall furnish to the field laboratory the following materials:

- Rock for aggregate or natural aggregates
- Required admixtures

- Processed fine and coarse aggregates
- Water to be used in the mixes
- Batches of each class of concrete produced in the job site mixing plant(s)

The quantity of the materials will be established by the Contractor and approved by the Engineer's Representative.

No concreting will be permitted until the results of these tests are available.

After completing the tests, the Contractor shall submit to the Engineer's Representative for approval the proportioning of mixtures to be adopted for the various structures. The Contractor shall be completely responsible for producing and maintaining a quality of concrete with compressive strength not inferior to the specified one, except different approval or instruction given by the Engineer's Representative.

2.3.1.2 Water/Cement Ratio

Mixing water shall include all water present, that is, the surface moisture in the aggregate, and the water added in the mix (including the fluid content of admixtures); it shall not include the moisture absorbed within the surface of the aggregate, which is in a saturated surface dry state.

If not specified otherwise in this specification or on drawings, concrete B400 shall have a maximum water/cement ratio of 0,45 and 0,60 for concrete B250.

Once the proportion of a mix including its W/C ratio, has been determined and specified for use in a structure, it shall be maintained constant during the pouring.

Frequent tests including the slump and compaction factor tests shall be carried out to ensure that a consistent water/cement ratio is maintained.

The quantity of water used in mixing shall be the least amount that will produce a workable homogeneous plastic mixture, which can be worked into the forms and around the reinforcement. In no circumstances shall the consistency of the concrete be such as to permit a separation of the aggregate from the mortar during handling. Excess water shall not be permitted and any batch containing such excess will be rejected.

2.3.1.3 Cement Content

The minimum cement content shall be as follows:

Class of Concrete	Minimum Cement Content (kg/m ³)

B200	250
B300	350

When, in the opinion of the Engineer's Representative, an adjustment for protection against concrete deterioration due to salty environment is necessary, he may require the cement content be increased ten (10) percent over and above that cement content used in the approved trial-mix design for non-salty environment. Water content shall be adjusted accordingly to obtain a dense workable mix. No additional payment shall be made for the added cement.

When, in the opinion of the Engineer's Representative, cement is being lost due to windy conditions, the Contractor shall add additional amounts of cement as directed by the Engineer's Representative. No additional payment shall be made for the added cement.

Failure of the mixed concrete to meet specifications determined by the Engineer's Representative will be grounds for the Engineer's Representative to reject the concrete.

2.3.1.4 Consistency and Slump

Concrete shall be of a consistency and workability suitable for the conditions on the job. For most concrete a "plastic" mix is required, vibrated, without segregation.

Slump tests shall be performed to determine the consistency of concrete, and it shall be used and made in accordance with BS of "Methods of Testing Concrete" specified in section 4.2.

The Contractor shall provide the equipment necessary to determine the slump of freshly-mixed concrete at each place where concrete is being placed and shall determine the slump of the concrete on each occasion that a set of test cubes is made and not less than once a day or as the Engineer's Representative may direct.

Concrete delivered for placing, except as otherwise instructed by the Engineer's Representative, shall have a working slump limit as follows:

Type of Structure	Maximum Slump (mm)	
	Unreinforced Concrete	Reinforced Concrete
Sub footings	75	-
Massive structures	63	30
Inverts, foundations and footings	75	40
Linings, pre-linings and walls more than 600 mm in	100	50

thickness		
Structures such as slabs, columns, beams and walls to 600 mm in thickness	-	50

The Engineer's Representative may choose to adopt lesser slumps whenever concrete of such lesser slump can be poured and consolidated readily in place by means of vibrators.

Whenever these tolerance for working slump limits are exceeded, the concrete shall be rejected and disposed of at the Contractor's expense.

Concrete Tests

2.3.1.5 General

The methods used in sampling, making, curing and testing the concrete samples, either in the field or in the laboratory.

Adequate facilities shall be provided for the Engineer's Representative to inspect ingredients and processes used in the manufacture and delivery of the concrete. The manufacturer and/or Contractor shall afford the Engineer's Representative, without charge, all facilities necessary to secure samples and conduct tests to determine whether the concrete is being furnished in accordance with the Specifications.

A part the samples taken from the batching plant, to check the uniformity of production of the same, all samples taken in the field will be made from concrete in the form. The quantity of samples and tests will be established by the Engineer's Representative, but each class of concrete shall be represented by at least one test (9 specimens) for each 75 cubic meter of concrete poured, but there shall be at least one test for each day's concreting.

The cubes shall be numbered consecutively and marked with the date, section of work form, which they are taken, and any other relevant information and tested at an approved laboratory. The first set of three cubes shall be tested after seven days.

2.3.1.6 Use of 7-day Tests and Acceptance of the Concrete Works:

For any mix a correlation between 7-day, and 28-day strength may be made in laboratory. After that correlation has been established, the results of 7-day tests may be used as an index of the compressive strengths, which should be expected at 28 days.

If the average strength of the three, seven day cube tests is below that required to produce the required 28 days strength, the Contractor must immediately stop all concreting until checks are made on the material and equipment and immediately rectify any defect which has become

apparent as the result of such checking. If the Contractor elects to remove and replace the defective concrete without waiting for the results of the 28-day test, concreting can then continue entirely at the responsibility of the Contractor. The second set of three cubes, after 28 days of curing shall be tested as specified above.

If any of the cubes in any set shows definite evidence, other than low strength, of improper sampling, moulding, handling, curing or testing. It shall be discarded and the strength of the remaining cube shall then be considered the test result for that set.

Final acceptance of the concrete works is based on 28 days testing on the three cubes. The work is considered in compliance if the average of the three cubes equals or exceeds the minimum specified for the class of concrete being placed, and if no cubes strength fall below 85 percent of the specified works test strength.

2.3.1.7 Preparation followed in case Strength is not Attained

When the results of the twenty-eight day testing do not comply with the Specifications, the Engineer's Representative shall have the right to require that one or more of the following measured are taken:

Test the third set of three cubes at 56 days in order to verify if the strength can be attained

Extraction of a sufficient number of concrete samples (core taken with the rotary drilling method in accordance with BS "Methods of Testing Concrete" specified in section 4.2) from the structure for which a compressive test, or group of compressive tests, have given unsatisfactory results. These samples shall be tested according to BS "Methods of Testing Concrete" specified in section 4.2.

Performance of load tests, where possible, on the structure whose compressive tests were found unsatisfactory.

Other tests ordered case by case.

If, after carrying out such investigations, the Engineer's Representative, establishes that the concrete in the structure is not of the specified quality, he may order the strengthening or replacement of all or part of the entire volume of hardened concrete represented by the test failure, or any other part of the Work, whose safety, in the opinion of the Engineer's Representative is prejudiced or whose strength is impaired, either by virtue of the faulty concrete or the remedial measures ordered.

The expense for the above mentioned investigations and tests as well as for demolition and reconstruction of defective works shall be at Contractor's charge.

2.4 BATCHING AND MIXING

General

The Contractor shall provide automatic or semi-automatic batch-type mixing plants, with a minimum rated capacity stated by the manufacturer as required to meet the construction schedule of concrete works. The equipment shall be capable of combining the specified proportions of coarse and fine aggregates, cement, admixtures and water into a uniform mixture, without segregation. Plants shall be designed to batch several classes of concrete at the same time, without undue delay.

Batches

2.4.1.1 General

Individual weight batches shall be provided for each material except the liquid materials, which may be batched by volume, in all work requiring the use of more than two separate size groups of coarse aggregates. Cumulative weight batchers for aggregates may be provided for work requiring the use of not more than two separate size groups of coarse aggregates. Cement shall always be weighed and batched separately from the aggregates.

The batching plant shall have an automatic control capable of easy adjustment, to compensate for the varying moisture content of the aggregate, and to change the weights of the materials being batched.

2.4.1.2 Mixers

2.4.1.2.1 General

The components of concrete shall be mixed in proven-type mixers.

Mixers shall be mechanically operated stationary mixers, of either the tilting or non-tilting type, of a design approved by the Engineer's Representative.

Mixers shall not be charged in excess of the capacity recommended by the manufacturer: the Engineer's Representative may direct a reduction in the batch size when mixer performance tests indicate that it is necessary. Mixers shall be capable of combining the materials into a uniform mixture, without segregation.

If turbine-type mixers are used, they shall provide a scraping and folding action.

2.4.1.2.2 Maintenance

The mixers shall be maintained in satisfactory operating condition, and mixer drums shall be kept free of hardened mortar. Should any mixer, at any time produce unsatisfactory results, leak mortar, or cause waste of materials, its use shall be promptly stopped until completely repaired.

2.4.1.2.3 Concrete Not Accepted

The Engineer's Representative shall have the right to reject the concrete in any of the following events:

- when mixing operations have not been started within 30 minutes after the cement is added to the aggregates;
- when more than 30 minutes have elapsed between the discharging of the mixer and the actual placing of the concrete, without stirring;
- when more than one hour has elapsed between the addition of the cement to the aggregates, and the actual placing of the concrete;
- when the mixture does not comply with the Specifications.

The Engineer's Representative reserves the right to specify a lesser time, if hot weather or other conditions cause quick stiffening of the concrete.

None of the concrete rejected by the Engineer's Representative shall be utilised in any of the Permanent Works.

The tempering of concrete, which has partially hardened, that is, remixing with or without additional cement, aggregate or water, will not be permitted.

2.4.1.2.4 Ready Mixed Concrete

The use of ready-mixed concrete in any part of the Work shall require the Engineer's Representative's written approval.

The Contractor shall satisfy the Engineer's Representative that the materials used in ready-mixed concrete comply with the Specification in all respects and that the manufacturing and delivery resources of the proposed supplier are adequate to ensure proper and timely completion.

The specified requirements as to the sampling, trial mixing testing and quality of concrete of various grades shall apply equally to ready-mixed concrete, which shall furthermore be made and delivered in accordance with BS 8500.

Every additional facility, including transport, which the Engineer's Representative or persons authorised by him may require for the supervision and inspection of the batching mixing and transporting to Site of ready-mixed concrete shall be provided by the Contractor at no extra cost to the Department.

Ready-mixed concrete shall be supplied from an off-site commercial ready-mix plant approved by Engineer's Representative, each load shall be accompanied by a bonded weighmaster's certificate listing the quantity of each concrete ingredient, admixture quantity, water content and slump and time of loading and departure from ready-mix plant. Notations to indicate that the equipment was checked and found to be free of contaminants prior to batching shall also be included. A copy of the certificate shall be given to the Engineer's Representative's site representative for each load.

Unless approved otherwise in advance of batching all concrete of single design mix for any one day's pour shall be from a single batch plant of a single supplier.

Approval of any ready-mixed concrete plant will be granted only when an inspection of the plant indicates that the equipment, the method of storing and handling the materials, the production procedures, the transportation and rate of delivery of concrete from the plant to the point of use, all meet the requirements set forth herein.

Permission to use ready-mixed concrete from any previously approved plant may be rescinded at any time, upon failure to comply with the requirements of the Specifications.

Ready-mixed concrete shall be mixed and delivered to the point of use by means of one of the following combinations of operations:

- Mixed completely in a stationary central-mixing plant and the mixed concrete transported to the point of use in a truck or tank agitator operating at agitator speed, or when approved by the Engineer's Representative, in non-agitating equipment (known as "Central-mixed Concrete").
- Mixed completely in a truck mixer at the batching plant or while in transit (known as transit-mixed concrete).
- Mixed completely in a truck mixer at the point of use following the addition of mixing water (known as truck-mixed concrete).

2.5 TRANSPORTATION

General

Concrete shall be conveyed from the mixer to the place of final deposit, and finally poured as rapidly as practicable, by approved methods which will prevent segregation, loss of ingredients or damage by exposure to atmospheric agents, and shall be deposited as nearly as practicable in its final position. Concrete can be conveyed by truck mixers and agitators, buckets, truck or rail cars chutes and pipes, belt conveyors, concrete pumps and other equipment approved by the Engineer's Representative. Conveying equipment shall be of such size, design and condition to ensure a practically continuous supply of concrete at the point of placement, and of placing in approximately horizontal layers while the previous layer is still soft. The maximum height from which the concrete shall be dropped shall not exceed one and a half meters, except where the use

of suitable equipment to confine and control the falling concrete is specifically authorised and approved by the Engineer's Representative.

All conveying equipment shall be supported independently of the forms. The conveying equipment shall be kept free from hardened concrete and foreign materials, and shall be cleaned at frequent intervals.

Should the concrete show sign of segregation when it reaches the placing point, and provided the maximum permissible time has not elapsed, it shall be remixed by mechanical means in the vicinity of the placing, otherwise it shall be rejected at Contractor's charge.

In particular, the Contractor shall take appropriate measures to avoid excessive loss of moisture by evaporation, during the transportation and lacing of the concrete. Addition of water to the mixture to make up for the evaporation losses shall not be permitted.

2.6 FORMS

General

Forms shall be used whenever necessary to confine the concrete, and shape it to the required lines, grades and dimension shown on the Drawings. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete, and shall provide concrete surfaces conforming to the requirements of the finishes specified in paragraph 3.11. Forms shall be sufficiently tight to prevent the loss of mortar from the concrete. Where re-usable forms are used, the original strength, rigidity, tightness and surface smoothness of the forms shall be maintained throughout their usage.

The Contractor shall submit to the Engineer's Representative, for approval prior to the start of any concrete construction, the detailed design he proposes to adopt for formwork, but approval of the Drawings shall not relieve the Contractor of his responsibility for their adequacy. The Contractor is advised that it is recommended that formwork be fabricated by a specialist supplier but in any case formwork, wherever manufactured must be fabricated in a controlled environment facility.

The form surfaces in contact with the concrete shall be treated or protected to avoid chemical reactions in or discolouring of the concrete surface.

The use of forms with bruises, irregularities and encrustations shall not be permitted.

Should any of the elements show signs of deformation during the pouring, they shall immediately be replaced, in order to guarantee the perfect outcome of the work.

The Contractor shall be responsible for the calculations and designs for the formwork and if required, shall submit them to the Engineer's Representative before construction. On form work to external faces which will be permanently exposed, all horizontal and vertical form work joints shall be so arranged that joint lines will form a uniform pattern on the face of the concrete. Where

the Contractor proposes to make up the formwork from standard sized manufactured formwork panels, the size of such panels shall be approved by the Engineer's Representative before they are used in the construction of the Works. The finished appearance of the entire elevation of the structure and adjoining structures shall be considered when planning the pattern of joint lines caused by formwork and by construction joints to ensure continuity of horizontal and vertical lines. Adjacent panels of form lining shall be so placed that the grain of the wood will be in the same general direction (all horizontal or all vertical).

Formwork shall be provided for the top surfaces of sloping work where the slop exceeds fifteen degrees from the horizontal (except where such top surface is specified as spaded finish) and shall be anchored to enable the concrete to be properly compacted and to prevent flotation care being taken to prevent air being trapped.

Opening for inspection of the inside of the form work and for the removal of water used for washing down shall be provide and so formed as to be easily closed before placing concrete.

Before placing concrete, all bolts, pipes or conduits or any other fixtures which are to be built in shall be fixed in their correct positions, and cores and other devices for forming holes shall be held fast by fixing to the form work or otherwise. holes shall not be cut in any concrete without the approval of the Engineer's Representative. The support forms shall be such that no deflection occurs under the weight of wet concrete or other loads.

Cleaning and Lubricating

At the time of concrete placing, the inner surface of the forms, the contacts and connections shall be free from any encrustations, mortar, grout or other foreign matter that may contaminate the concrete. Prior to pouring, the surface of the forms, with the sole exception of those made of rough wood, shall be smeared with a bond-breaking compound such as emulsified oil, or with refined mineral paraffin oil, designed to prevent sticking of concrete on the form. The treatment of the forms shall not cause harmful effects or stains on the concrete surface, or on the reinforcement system. Bond-breaking compounds shall be applied before reinforcement is placed if this procedure is feasible.

Chamfering Strips:

Chamfering strips shall be placed in the forms; to produce bevelled edges on permanently exposed exterior corners in concrete surface and exposed joints except where specifically not required by the Engineer's Representative. Re-entrant corners on such surfaces will not require bevelling, unless requirement for bevelling is indicated on the Drawings. Unless otherwise specified, chamfering strips for exterior bevelled corners shall be 20 mm x 20 mm.

Removal of Forms

The removal of the forms shall be carried out when the concrete has reached a sufficient strength, except where shorter time is approved by the Engineer's Representative.

The minimum time, which shall elapse between the completion of concreting and removal of the forms, shall be established by the Engineer's Representative for any particular structure, according to the design calculations. After authorisation for removal, the forms shall be removed as soon as practicable, to avoid delay in specified curing of concrete, and also to enable the earliest practicable repair of surface imperfections. Methods of forms removal likely to cause over stressing of the concrete, or injury to the concrete surface, shall not be used. Forms and their supports shall be removed in such a manner as to allow the concrete to take the stresses due to its own weight uniformly and gradually. Provisions shall be made by means of suitable wedges, sand boxes or other devices, for the gradual relaxation of the support given by false work and centring.

Unless otherwise directed by the Engineer's Representative, forms shall remain in place for the following specified periods of time:

1. Arch Centres, Fourteen (14) days
2. Centring under beams, Ten (10) days
3. Floor slabs:
 - Less than three (3) meter span, Four (4) days
 - More than three (3) meter and less than six (6) meter span, Seven (7) days
 - More than six (6) meter and less than fourteen (14) meter span, Ten (10) days
4. Columns, walls, sides of beams, and other vertically formed surfaces shall be removed at an early date, as directed by the Engineer's Representative to facilitate finish and proper curing.

In any case removal of form works shall have to be carried out only after the concrete has reached a strength of 75% of the one required in the Specifications.

If high strength cement is used, the time limits may be decreased as determined by the Engineer's Representative. Special notes on the plans relative to the removal of forms and false worked under arches, continuous spans and other special structures shall have precedence over the above time limits for removal of forms and false work.

Defects in Formed Surfaces:

Workmanship in formwork and concreting shall be such that concrete shall normally require no making good the surface being perfectly compacted and smooth.

If any blemishes are revealed after removal of form work, the Contractor shall propose remedial measures which shall be subjected to the Engineer's Representative's approval. these measures may include, but shall not be limited to, the following:

- Fins, pinhole bubbles, surface discoloration and minor defects may be rubbed down with sacking immediately the form work is removed;
- Abrupt and gradual irregularities may be rubbed down with carborundum and water after the concrete has been fully cured.

These and any other defects shall be remedied by methods approved by the Engineer's Representative which may include using a suitable epoxy resin or, where necessary, cutting out to a regular dovetailed shaped at least 75 mm deep and refilling with concrete over steel mesh reinforcement sprung into the dovetail.

2.7 PLACING OF CONCRETE

General

All concrete placing equipment and methods shall be subjected to the approval of the Engineer's Representative. Concrete placing shall not be started until all form work, reinforcement, installation of embedded parts, and preparation of the surfaces of rock, and hardened concrete involved in the placement have been inspected and approved by the Engineer's Representative. The Contractor shall given sufficient notice as required by the Engineer's Representative, and allow a reasonable time for inspection before placing begins.

Methods of Placing

2.7.1.1 General

The concrete shall be deposited generally in horizontal layers in such a manner as to maintain, until completion of the pour, a plastic surface approximately horizontal. The thickness of each layer shall range from 300 to 600 mm as approved, and the placement shall be carried out at such a rate that no concrete surface can reach an initial set, before additional concrete is placed thereon and in any case not after 30 minutes (in the case that no retarding admixtures are used) or 2 hours (in the case that retarding admixtures are used).

The Engineer's Representative may authorise higher lifts or layers where concrete can be placed or consolidated in thick layers. Concrete shall be deposited, as nearly as practicable, directly in its final position; flowing of concrete with vibrators, or by other means will not be permitted. For locations where direct placement is not possible and in narrow forms, hoppers and trunks must be provided, of a size to allow proper placing.

Where steep slopes are required for placing concrete with chutes, the chutes shall be equipped with baffle boards or be in short lengths that reverse the direction of movement. Chutes and use of chutes must be approved by the Engineer's Representative.

All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. The water used for flushing shall be discharged clear of the concrete already in place.

Concrete shall not be dropped in the forms a distance of more than one and one-half (1/2) meters, unless confined by approved closed chutes or pipes, and care shall be taken to fill each part of the form by depositing the concrete as near to the final position as possible. The coarse aggregate shall be worked back from the forms and worked around the reinforcement without displacing the bars. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of projecting reinforcement.

Any tendency to segregation shall be corrected by shovelling stones into mortar, rather than mortar into stones.

Concrete that is of excessive slump, segregated, partially hardened, or unworkable, shall not be placed in forms or if placed, shall be removed and wasted as directed by the Engineer's Representative, at the Contractor's expense.

Each layer of the concrete shall be worked with suitable types of equipment, until the concrete is consolidated to the maximum practicable density, is free of pockets of coarse aggregate, and fits tightly against all form surfaces and embedded materials.

Construction equipment used for spreading, vibrating or other operations must absolutely not spatter loose oil, fuel and grease on the concrete.

No concrete work shall be stopped or temporarily discontinued within forty-five (45) centimetres of the top of any finished surface, unless such work is finished with a coping having a thickness less than forty-five (45) centimetres, in which case the joint shall be made at the under edge of the coping.

Concrete During Rain:

Outdoor concreting shall not be started during rain unless the Contractor has taken all protective measures including proper shelters so that the concrete maintains the slump tested at the mixing plant during transport and placing. If concreting is already in process, it shall be suspended if the rain affects the quality of concrete i.e. when the slump of vibrated concrete is 25 mm or more than the slump tested at the mixing plant for the same class of concrete.

Concrete at Night

No concrete shall be mixed, placed, or finished when the light is insufficient, unless an adequate and approved artificial lighting system is operated, and such night work is approved by the Employer.

Concreting in Hot Weather:

Unless otherwise directed, when concrete is placed in hot weather and the temperature is expected to reach thirty-three (33) degrees C, (ninety (90) degrees F) or higher, the Contractor shall schedule his operations to place and finish the concrete during the hours that the air temperature in the shade will be below thirty three (33) degrees C, ninety (90) degrees F); or as approved by the Engineer's Representative.

The setting time of concrete can be with hot weather very short and "cold joints" are often hard to avoid when large concreting works have to be carried out in continuous operation. To avoid cold joints, therefore, the Contractor shall provide sufficiently large capacity in his concrete producing plant and concrete transporting arrangements and use an appropriate retarder when deemed necessary by the Engineer's Representative to facilitate placing and finishing of concrete and additives to delay water evaporation. The Contractor shall use pumps for pouring concrete.

When the rate of evaporation of surface moisture from concrete is expected to approach 1 kg/m² per hour or when the shade air temperature is expected to reach 33 degrees C and above, precautions shall be taken, including the following:-

- dampening the forms which shall be painted white
- reducing the concrete temperature to the lowest practical level by procedures such as:
- shading the aggregate and cooling them by pre-wetting;
- cooling the water before mixing in concrete, by using appropriate and approved chilling equipment;
- screening the mixing plant and transporting vehicles from wind, rain and sun;
- shielding from the direct rays of the sun all the surfaces, including reinforcement, against which concrete is to be placed.
- erecting wind breaks and sunshades at the concrete placing location
- placing concrete at night
- reducing the time between the placing of the concrete and the start of curing to the minimum possible
- minimising evaporation particularly during the first few hours subsequent to placing the concrete) by suitable means such as applying moisture by fog spraying.

All precautions to be taken shall be subject to the Engineer's Representative's approval and the Contractor shall demonstrate that all approved precautions are available for use prior to the Engineer's Representative granting approval to any concreting operation.

The temperature of the concrete when placed shall not exceed 32 degrees C nor shall concrete be mixed or placed when the shade air temperature is 33 degrees C or above, or is expected to reach such a level during concreting, without special permission from the Engineer's Representative.

The Contractor shall provide a sufficient number of concrete thermometer for use both by his own and the Engineer's Representative's staff.

No additional compensation will be recognised or paid to the Contractor if he has to resort to special measures, such as are described above, to control the concrete temperature.

Vibration

Concrete shall be compacted with mechanical vibration equipment, supplemented by hand spading and tamping, to the maximum practicable density so that it is in complete contact with the forms, reinforcement and other embedded parts.

The vibration shall be carried out by means of immersion type high-frequency vibrators, of the electrically driven or compressed air types, or by means of engine driven vibrators. For the consolidation of concrete where immersion vibration shall prove impracticable, vibrators rigidly attached to the forms shall be adopted, subject to the approval of the Engineer's Representative.

The size and number of vibrators, at each pour, shall be sufficient to thoroughly compact concrete at the rate and conditions of placement.

When vibrating a layer of fresh concrete, the vibrators shall be held in a near-vertical position. The immersion of the vibrator shall be sufficiently deep to vibrate the entire depth of a new layer: the vibration should penetrate several centimetres into the layers below, to ensure the thorough union of the layers.

No new layer of concrete shall be placed, before the underlying one has been thoroughly vibrated. Immersion points for the vibrators shall be adequately spaced, so as to make sure that every part of the concrete has been properly vibrated. Care shall be taken to prevent contact of vibrators against reinforcement steel, especially that in concrete starting initial set. Vibrators shall not be allowed to come in contact with forms or finished surfaces.

Provisions shall be made ensure that any entrapped air, formed during the placing of concrete, be allowed to escape, by leaving effective air vents in the framework. Care shall be taken to provide a dense envelope of concrete surrounding the water stops with no voids or honeycombing.

Excessive vibration, causing segregation and laitance, and tending to bring water to the surface, shall be avoided.

Vibration or disturbance of concrete, which is partially hardened, will not be allowed. Necessary traffic over new concrete shall be on independently supported timber walkways, so constructed that the fresh concrete is not disturbed.

The evaluation of the satisfactory degree of vibration of the concrete shall be based on the criteria outlined in section 112 of the Concrete Manual USBR 7th Edition.

2.8 CURING CONCRETE

General

All concrete shall be cured for a period of time required to obtain the full specified strength but in any case not less than fourteen (14) consecutive days even if the specified strength is achieved before the fourteen (14) days period.

Curing provisions shall be made so that:

- hydration of cement is developed gradually and completely;
- concrete does not quickly pass from plastic state to elastic state;
- concrete is not cracked or damaged by high differential temperatures, or rapid changes in temperature; and surfaces of concrete are not damaged by traffic, nor discoloured by chemical agents.

The materials used in the curing process shall be, at all times, subject to the approval of the Engineer's Representative. All equipment needed for adequate curing and protection of any concrete shall be ready to be installed before actual concrete placement begins. Curing with membrane methods shall not be accepted in any case. Concrete shall be cured by water method only.

Water Curing

Water curing shall start as soon as concrete has hardened sufficiently, to prevent damage, and continue during the period when concrete is protected by forms.

Unformed surfaces shall be fully covered with hessian kept in close contact with the concrete surface, they shall be kept continuously (not periodically) wet and they shall be covered by a plastic sheet to reduce evaporation loss; the plastic sheet shall be firmly in contact with the wet hessian to avoid wind tunnel which could cause the hessian to dry rapidly. On formed surfaces, if the forms are removed before the end of the curing period, curing shall be continued as on the unformed surfaces. When burlap, sand, or other approved fabric materials are used, they shall not cause any undesirable finish such as rough surface or discolouring where exposed to sight. Formed structure members, prior to removal of forms, shall be kept continuously wet.

Water for curing shall meet the requirements of water for concrete mixing.

Protection

No traffic of any kind shall be permitted on the concrete during the curing period.

Unhardened concrete shall be protected from heavy rain, flowing water, direct rays of the sun, and wind.

2.9 GROUTING

General

Expanding grout concrete shall be used for:

- packing under horizontal surfaces such as stanchions and machine base plates;
- filling of pockets containing holding-down bolt anchorages or rag bolts;
- grouting of bolt tubes;
- packing cavities between pipework or embedded plant and the surface of structural concrete.

The grout shall be non-metallic, chloride free cementitious product supplied as a ready to use dry powder, requiring only addition of water to produce a free flowing non-shrink grout. The compressive strength of the grout shall be 350 Kg/cm² at 7 days and 600 Kg/cm² at 28 days.

The grout must be stored, handled and placed strictly in accordance with the manufacturer's instructions.

Class of Grout

Grout shall be classified as follows:

Class A grout, used for packing cavities or gaps exceeding 25 mm thickness and the filling of holding-down bolt pockets exceeding 150 mm x 150 mm in section;

Class B grout, used for packing under horizontal surfaces not exceeding 25 mm thickness and the filling of holding down bolt pockets not exceeding 150 mm x 150 mm in section.

The proportions of grout admixture, cement, fine aggregate and coarse aggregate for each class of grout shall be in accordance with the admixture manufacturer's recommendations.

Workability of Grout

The workability of Class A grout, shall be determined by the Slump Test described in BS “Methods of Testing Concrete” specified in section 4.2, and the slump shall be at least 125 mm but not greater than 225 mm.

The workability of Class B grout shall be such as to produce a grout capable of being worked into the place to be filled. The water/cement ratio shall be kept to the minimum necessary to achieve this.

Mixing of Grout

Grout shall normally be mixed in a batcher mixer of a type approved by the Engineer’s Representative. Grout shall not be mixed by hand unless specifically approved by the Engineer’s Representative.

Preparation of Foundation Surfaces

The surface of the structural concrete foundation shall be thoroughly scabbled to remove all laitance to provide a clean rough surface. The bolt packets and surface of the concrete foundation shall be cleaned immediately before the base plate is placed in position. Immediately before grouting, the space between the concrete and base plate shall be cleaned and thoroughly wetted. All excess water shall then be blown away by means of compressed air jet.

Transporting and Placing of Grout

The grout shall be transported from the mixer to the placing point quickly and in such a way that the materials do not segregate. Grout shall be placed within 45 minutes of being mixed.

Grout shall be worked into position with chains, bolts, rods or other suitable instruments until the whole of the space is completely filled with the grout. Mechanical vibrators shall not be used.

Cement Mortar

Cement mortar shall consist of cement and sand gauged by volume in wrought wooden boxes in the following proportions:

Proportion by Volume					
Mortar No.	Ordinary	Portland	Ce-	Sand	Line

	ment		
1	1	2	-
2	1	3	-
3	1	5	1

Unless otherwise specified cement mortar shall be No.2.

The ingredients shall be mixed in an approved mechanical mixer or shall be mixed together dry on a clean wooden stage until the mix is homogeneous in colour. Water shall then be added through a rose in sufficient quantity to give no more than stiff workability. The whole shall then be turned until perfectly mixed.

Mortar shall be used within 30 minutes and shall not be remixed or worked up again after it has stiffened. Any mortar that has commenced to set shall be removed from the Site.

2.10 LOADING OF STRUCTURES

No load of any kind shall be applied to any part of concrete structure until the concrete has matured for at least 7 days and then only with the approval of the Engineer's Representative and after confirmation that the specified 7 days cube strengths have been met.

The full design load shall not be applied until a period of 28 days has elapsed after casting.

The Contractor shall not permit backfilling around any structure incorporating a ground or floor slab before that slab has been cast and properly cured for a period of 28 days.

2.11 BACKFILLING OF STRUCTURES

No concrete shall be covered with filling until the concrete has attained sufficient strength to bear the loads. And in any case backfilling shall not be allowed before 7 days from the placing of the last of the concrete. No backfill shall take place before the Engineer's Representative's final inspection and approval.

2.12 REINFORCING STEEL

General

All the reinforcing steel shall be comply with the requirements of ASTM specification.

Materials

Reinforcing steel shall be High Bond, High Tension, Deformed bars having the following characteristics.

Minimum yield point	4,200kg/cm ²
Minimum ultimate tensile strength	6,300kg/cm ²

Submittals

The Contractor shall submit the following at least two weeks in advance of fabrication:

2.12.1.1 Shop Drawings

Before ordering reinforcing steel the Contractor shall submit bar bending schedules for reinforcing steel prepared showing layouts, bending diagrams, assembly diagrams, dimensioned types and locations of all bars laps and splices, and shapes, dimensions, and details of bar reinforcing and accessories. Layout plans for bar supports and chairs, with typical details shall be included. Engineer's Representative's review and approval of shop drawings will apply to the size, locations, and types of bars, and dimensions of bar lap splices only. Dimensions shown on the shop drawings are the responsibility of the Contractor and Engineer's Representative's approval of shop drawings shall not constitute approval of dimensions thereon.

2.12.1.2 Samples

Representative samples of all reinforcing steel that the Contractor proposes to use in the Works must be submitted, before work is commenced, to the Engineer's Representative for his written approval, together with manufacturer's certificates stating clearly for each sample the place of relevant details of composition, manufacture, strengths and other qualities of the steel. In the event a reinforcing steel sample under test fails to meet the specification requirements at any time, or the Engineer's Representative considers that samples which were presented to him for test were not truly representative, or if it becomes apparent that reinforcing steel which has not been approved has been used on the Works, then the Engineer's Representative may instruct the Contractor to break out and remove completely all such sections of the work already constructed using such suspect reinforcing steel.

All testing of reinforcing steel bars shall be carried out in accordance with BS 4449 and BS 4482.

Construction Requirements

2.12.1.3 Protection and Storage

Reinforcing steel shall be protected at all times from damage. Reinforcing steel shall be stored above the ground on platforms skids, or other supports. It shall be stored in such a manner and adequately marked to facilitate inspection and checking. When placed in the work, the reinforcing steel shall be free from dirt, detrimental scale, paint, oil or other foreign substance.

2.12.1.4 Cutting and Bending

All cutting and bending of reinforcement bars shall be done by competent workmen and with equipment approved by the Engineer's Representative. Unless shown otherwise on the plans or unless written approval is obtained from the Engineer's Representative, all reinforcement bars shall be cut and bent in an on-site fabrication shop.

Bent bar reinforcement shall be cold bent to the shapes shown on the plans, and unless otherwise provided on the plans or by written authorisation of the Engineer's Representative, bends shall conform to the following requirements:

$D = 6d$ for five (5) millimetre through twenty-two (22) millimetre bar sizes

$D = 8d$ for twenty-four (24) millimetre through twenty-eight (28) millimetre bar sizes, where D = Minimum pin diameter around which a bar may be bent.

d = Bar diameter

2.12.1.5 Placing, Supporting and Fastening

The reinforcement steel bars shall be placed in accordance with approved shop drawings, as specified herein and as directed by the Engineer's Representative.

Reinforcement steel bars shall be handled and stored in a manner to prevent damage to bars or to the epoxy coating. Bars or epoxy coating damaged in handling or other operations shall be satisfactorily repaired at no additional cost to the Department. Extra care in handling of these bars shall be beneficial to the Contractor in reducing or eliminating in-place coating repairs.

Before the reinforcement steel bars are lowered into place and prior to placement of the concrete, the coated bars will be inspected by the Engineer's Representative for damage to the epoxy coating. Sheared ends of bars and other areas requiring limited repair due to scars and minor defects shall be repaired, using the specified patching or repair material.

All reinforcement shall be securely and accurately fixed in positions shown in the Drawings to ensure that the reinforcement steel framework as a whole shall retain its shape, and framework shall be so temporarily supported as to retain its correct position in the forms during the process of depositing and consolidating the concrete. The ends of all tying wires shall be turned into the main body of the concrete and not allowed to project towards the surface.

Correct concrete cover to reinforcement shall be maintained with the aid of approved spacer pieces. Concrete cover to reinforcement shall be as detailed on the drawings.

No part of the reinforcement shall be used to support access ways, working platform or the placing of equipment or for the conducting of an electric current.

At the time of concreting, all reinforcement steel shall have been thoroughly cleaned and freed from all mud, oil or any other coatings that might destroy or reduce the bond and it shall also have been cleaned of all set or partially set concrete which may have been deposited thereon during the placing of a previous lift of concrete.

Immediately prior to concrete placing the reinforcing steel shall be washed thoroughly with potable water to remove any deposited salts.

The placing of all reinforcement steel bars will be checked by the Engineer's Representative and in no case is concrete to be placed around any reinforcement steel that has not been approved by the Engineer's Representative. The insertion of bars into or the removal of bars from concrete already placed will not be permitted by the Engineer's Representative. Reinforcing steel temporarily left projecting from the concrete at the joints shall not be bent without the prior approval of the Engineer's Representative.

2.12.1.6 Splicing - General

Splicing except where indicated on the Drawings or approved shop drawings, will not be permitted without the approval of the Engineer's Representative. Lap length shall be as indicated on the Drawings.

Whenever it is necessary for the Contractor to splice reinforcement at points other than those shown on the plans, because of the lengths of steel he has delivered to the site, drawings showing the location of each splice shall be submitted by the Contractor to the Engineer's Representative for approval before the reinforcing steel is placed. No measurement or payment shall be made for additional reinforcement steel used for splices not shown on the plans. Splices shall be avoided at points of maximum stress. They shall, where possible, be staggered, and shall be designed to develop the strength of the bar without exceeding the allowable unit bond stress. Unless otherwise shown on the plans, all epoxy coated bars shall have a minimum lapping of 55 times the diameter of the smaller bar to be lapped. In no case shall bars be lapped less than fifty-five (55) centimetres.

2.12.1.7 Method of Measurement

Measurement of "Reinforcing Steel" will be based on the theoretical number of metric tons complete in place as shown on the plans or placed as ordered in writing by the Engineer's Representative. No allowance will be made for the clips, wire or other fastening devices for holding the steel in place, and no measurement of splices not shown on the plans will be made.

2.12.1.8 Cover to Reinforcement

Except where otherwise specified or otherwise shown on the Drawings the concrete cover to the nearest reinforcement exclusive of plaster or other decorative finish and concrete blinding shall be as follows, unless indicated otherwise on drawings;

For external work and in liquid retaining structures - 50 mm.

For external work in a tidal environment and for concrete placed in or under water and for concrete underground 70 mm.

The distance between any two parallel bars shall not be less than 25 mm or the diameter of the larger bar whichever is the greater.

No concreting shall be commenced until the Engineer's Representative has inspected and approved the placed reinforcement.

2.12.1.9 Reinforcing Bar Trusses

Bar trusses shall be placed, supported and secured in proper position before beginning the placement of the concrete. Unless the bar trusses are so designed and fabricated with outstanding legs to be in contact with the forms they shall be supported on metal supports and spacers. If the weight of the trusses causes the supporting legs of trusses to indent into the forms, bar supports shall be used as auxiliary support for the truss legs.

2.12.1.10 Mesh Reinforcement for Structures

Mesh reinforcement shall be of the sizes and spacing of bars and sheets as shown on the plans. The sheets of mesh shall be lapped as indicated on the plans. The method of placing the mesh and securing it in proper position shall be approved by the Engineer's Representative.

2.12.1.11 Drilled Shaft Reinforcing

The Reinforcing steel unit for the shaft consisting of longitudinal bars and spiral hooping or lateral ties shall be completely assembled and placed into position as a unit for shaft of seventy-five (75) centimetres in diameter and less. The longitudinal bars shall be tied to the spiral reinforcement at intervals, not to exceed forty-five (45) centimetres on centres, and such tying shall be staggered on the various bars in order to provide a rigid unit. Bars shall be tied to lateral tie bars at all intersections. The lower end of each vertical bar shall be supported upon a suitable precast concrete spacer block. Side spacer blocks of concrete shall be used at suitable intervals along the unit to insure accurate spacing for the entire length of the shaft.

2.13 PRECAST CONCRETE

General

The Contractor is required to submit the methods of construction, erection and assembly of any precast concrete unit, to the Engineer's Representative for approval, prior to commencing any such work.

Should these units be delivered to the Construction site by a manufacturer, the Contractor shall submit complete documentation showing that they are in accordance with the required specifications. The Engineer's Representative may request some additional field testing of the precast concrete units at no cost to the Contract.

Concrete

Precast concrete units shall where appropriate be constructed in accordance with ASTM Standards.

Other precast concrete units shall be manufactured in the Class of concrete (B300 if not shown on the Drawings) and to the sizes and details shown on the Drawings. The concrete shall comply in every respect with the provisions set forth for cast-in-place concrete whether such units are manufactured on Site or obtained from approved manufacturers.

Mortar for bedding and jointing precast units shall be type 2 mortar.

All precast concrete members shall be clearly and neatly engraved with the word "TOP" on the appropriate face and shall be provided with galvanised mild steel lifting eyes.

The surface finish shall be in accordance with F3 degree. Each unit is to be cast in one continuous operation and no construction joints will be permitted unless expressly approved. The reinforcement of the precast concrete units shall be in accordance with the provision set forth in this Section of the Specifications.

Storage and Handling

The method used for storage and handling of the precast concrete shall be such that the units will not be subjected to overstress, spalling or other injury.

Precast units shall remain undisturbed until concrete has developed at least a compressive strength of 80 kg/cm² and shall not be installed until the unit has developed the required strength at 28 days.

Precast Concrete Members

The contractor shall cast and install precast concrete beams and slabs according to details shown on the drawings. The contractor shall complete casting of the precast elements in due time, so as to avoid delays to the execution of other works. The contractor may either bring to the site ready-made precast concrete members cast elsewhere or cast them on the site of works. In any case casting shall be carried out under the Engineer's Representative's supervision and the contractor shall be obliged to obtain the Engineer's Representative's approval to the casting methods prior to commencement of work. precast members shall be of concrete class B-400, in accordance with subsection above.

During casting, concrete shall be well consolidated and vibrated by mechanical vibrators, so as to produce members free of void or stone pockets.

All precast concrete elements shall agree with the drawing as to shape and dimensions, all concrete faces shall be straight and bevelled, unless otherwise shown on the Drawings. Installation of precast elements on the site shall be carried out by placing the position according to details shown on the Drawings. Surfaces resulting from installation of precast elements shall be straight and accurately levelled unless otherwise directed.

Any precast concrete elements damaged during casting or fixing or from any other cause will be rejected by the Engineer's Representative, and the contractor shall forthwith remove such rejected elements from the site of works, and shall provide new elements to replace those rejected, all at the contractor's expense.

2.14 MANHOLES

Standard and special sewer manholes and chambers shall be constructed in accordance with this specification and drawings.

Standard manholes shall be constructed of precast type, while the special manholes and chambers shall be cast-in-situ. All manholes and chambers shall be complete with cast-in-situ bases, covers, fittings and other appurtenances in accordance with the details on the standard drawings.

Special coupling joints shall be built- in into the walls of the manholes for the connection of the pipes.

Drawings And Data

Shop drawings and data covering the precast concrete sections, including cones, manhole frames and covers, and manhole steps shall be submitted for the Engineer's Representative approval before starting the work.

Product Delivery and Inspection

Precast concrete sections shall not be delivered to the site until representative concrete control cubes/cylinders have attained strength of least 80% of the specific minimum.

Precast concrete sections shall be inspected when delivered to the site and all cracked or otherwise visibly defective units shall be rejected.

Products

2.14.1.1 Materials

Concrete and blinding materials, handling, forms, finishing, curing and other work as specified in Concrete Section.

2.14.1.2 Manhole Rings and Covers

All rings and covers surfaces that connected to the soil shall be coated with asphalt, while the surfaces connected to the sewer must be coated with epoxy paint after pointing between rings and testing the manhole.

The covers shall be Heavy-duty grade (minimum load capacity 40 tons) to be provided. Covers shall be Non-ventilated type and shall have the word “SEWAGE” cast thereon in English and Arabic.

2.14.1.3 Manhole Rungs

Rungs shall be fabricated from A36 steel bar to dimensions shown on drawings. Rungs shall be hot-dip galvanized after fabrication.

Execution

Excavation at manhole shall be sufficiently large to permit proper construction and to allow adequate inspection, and all costs therefore shall be included in the Contractor’s rates of related items in the Bills of quantities.

If water is present then it must be removed or dewatered by a well point pumps if needed, and this has to be considered in the Contractor’s unit rates.

Placing of 100 mm of plain concrete below the base, and thoroughly compacted and levelled.

Construct the concrete base according to the dimensions and details shown in the drawings. Flow channels shall be formed afterwards using plain concrete. All surfaces shall be steel trowelling finished to produce smooth, even flow channels without projections, sharp corners or abrupt direction changes.

Deposit sufficient mortar on base to assure watertight seal between base and manhole wall. First precast section shall be properly centred over the manhole base and plumb.

The precast sections shall have clean ends of foreign materials, thoroughly wet joints with clean water prior placing mortar on the groove of the lower section. Joints shall be filled completely with mortar and troweled from interior and exterior sides to provide a smooth surfaces on standard tongue-and-groove joints.

Grade rings shall be laid in mortar with sides plumb and tops level. Joints shall be sealed as described above. Grade rings shall be watertight.

Field install rungs in all manholes and chambers as shown in drawings, shall be carried out after placing the manholes sections or cast-in-situ, by drilling or making holes into the wall of the manhole or chamber at the spacing shown in the drawings. Rungs shall be installed truly horizontal.

Caulk the space around the imbedded portion of the rung with dry pack mortar, and finish the surface of caulked area smooth with face of walls.

The black bitumen paint shall be applied, minimum two coats, and to be applied with a coverage rate of 8m²/litre for concrete surfaces.

All surfaces must be sound and free from dust, dirt, all loose material, grease and oil etc., and dry before applying the black bitumen paint.

The black bitumen paint shall comply to BS 3416 Type I and II, as well as BS 476: Part 7 class 1 for fire resistance.

Thixotropic pitch extended epoxy resin for all concrete surfaces contacted with sewer. The resin shall comply with BS 5493.

Two coats minimum shall be applied according to the Engineer's instructions. All surfaces must be sound and free from dust, dirt, all loose material, grease and oil etc., and dry.

Hydrophilic solid rubber strip that swells (approximately 300% expansion ratio) when exposed to water to prevent leakage paths in concrete shall be used in the construction joints as shown in the drawings. The strip cross section shall be 10 x 25 mm, and 100mm overlaps shall be secured at the ends. The strip must have a hydrostatic pressure resistance up to 50 m.

Concrete surface must be clean, free from loose materials and debris, and dry before fixing the strip. Strip can be fixed either by nails every 30-40 cm at the concrete surface or by an approved bonding adhesive.

2.15 MANHOLE COVERS, GRID INLETS, ETC.

Manhole covers and frames, grid inlets and other metal accessories shall be supplied and/or manufactured in accordance with the details shown on the Drawings and in accordance to the instructions of the Engineer's Representative.

Before fixing, manhole covers and frames shall be dipped in an approved preservative and gratings and frames shall be painted with two coats of bituminous paint. Manhole frames shall be set firmly in cement mortar so that the covers are flush with the final surface.

2.16 INTERLOCK TILING

General specifications of inter lock tiling works it includes the components dimensions colours, maintenance and construction of inter lock tiles according to the technical specifications and to the approval of the project engineer.

1. Components for the m3 unit.

- Cement 400 Kg.
- Sand 600 Kg.
- Well-graded coarse aggregate. 1200 Kg.
- In condition that the mix will give result of 300 Kg/cm² after 28 day under the compression test.

2. Dimensions: As illustrated with a depth of 8 cm.

3. Colour as described by the project Engineer's Representative.

4. Construction.

Excavation and adjustment the level are required for the site to maximum depth of 30 with the reasonable slops.

Then it's damped to the required standard of specification 95% with the complete rising of excess material away. And if there is a need for excavation it should be calculated according to the other articles according to a budget approved by the engineer.

A layer of base course 20 cm thick is spread, compacted according to specifications, then a fine sand layer of 5cm thick is spread over the base course to receive the inter lock tiling between two reinforced concrete edge beam as shown in the drawings.

The tiles are fixed tightly a concrete mix is use to fill the spaces for maximum distance of 5 cm near the edge beams, with the same depth of tiles.

Expansion joints every 20 m. are applied of 2 cm width which will be in between two half pieces of tiles filled with a sand bituminous mix up to 2 cm from the upper level of tiles then the rest 2 cm are filled with sand.

General Points:

- No dirt of concrete or any other material is allowed to be on the tiles.
- The tiles angles should be straight, equal, and smooth.
- No cracks are allowed in tiles.
- The tiles must be transported & stored or kept in a good way.
- Electrical cutting tools must be used to cut the tiles.

3 CONCRETE BLOCK PAVING

3.1 FORM OF CONSTRUCTION

Concrete block surfacing shall consist of precast concrete blocks on a laying course 50mm thick sand on sub-base on subgrade.

3.2 TEST STANDARDS

Unless stated otherwise, testing of subgrade, sub-base materials and workmanship shall be carried out in accordance with BS 812 and BS 1377, Laboratory Maximum Dry Density tests shall be in accordance with Test 13 of BS 1377 and liquid limit shall be determined in accordance with test 2A or 2B of BS 1377, In-situ C.B.R testing shall be in accordance with Test 15 BS 1377.

3.3 SUBGRADE

Subgrade shall consist of approved granular material compacted to 95% of the laboratory maximum dry density , The C.B.R value shall not be less than 95% (in case of supplying imported fill material)

3.4 SUB-BASE MATERIAL

Sub-base material shall be crushed rock or similar hard material or naturally occurring gravel which is clean and free from organic matter, clay balls and other deleterious materials, The materials shall comply with the following grading :-

sieve size (mm)	Percentage by weight Passing
75	100
37.5	85-100
10	40-70
5	25-45
0.600	8-22
0.075	0-10

The total acid-soluble sulphate content (as S03) (BS 812 Test 118) shall not exceed 2% by weight, The total acid-soluble chloride content (as NaCl) (BS 812: Test 117) shall not exceed 3.3% by weight.

The laboratory C.B.R value shall be a minimum of 60% at 95% of the laboratory maximum dry density after soaking for 96 hours.

Material for Sub-base shall have physical Properties which do not exceed the following test value:

Liquid limit	25%
Linear shrinkage	3%
Plasticity index	6%
Stone size	50mm
Aggregate crushing value	25%
Water absorption	2%
Flakiness index	35%
Elongation index	35%
Soundness	
(5 cycles) (ASTM C 88)	15%

The sand equivalent shall not be less than 45 when tested in accordance with ASTM D24419.

3.5 LAYING COMPACTION OF AND TESTING SUB-BASE

Sub-base material shall be spread evenly and compacted in layer not exceeding 200mm compacted thickness to obtain a well-bound surface finish, loose or segregated areas shall be made good by addition of lines or by removal and replacement of the material as directed.

Compaction shall be carried out by approved plant operating on the material at an approved moisture content until a dry density of not less than 100% of the laboratory maximum dry density is achieved. One density test shall be carried per 250m².

The sub-base shall be laid to the level shown on the Drawings the rate of one set of tests for each 500m². The set contains of 3 sand cones tests.

The edge restraints to the paved area shall be installed before the laying course.

The sand shall be laid at a uniform moisture content and carefully screened to form a smooth compacted surface.

The profile of the laying course before compaction shall be similar to that of the finished surface, The maximum deviation from the design levels shall be + 5mm. The laying course shall be placed to a level which takes into account the compaction which occurs during vibration of the blocks ; the amount of this compaction shall be determined by trials prior to commencement of surfacing.

3.6 SURFACE COURSE

The surface course shall consist of approved precast concrete blocks complying with BS6717: part 1. The concrete constituent shall comply with the requirement of the concrete specification given elsewhere.

Additional requirements are contained in the following Clauses of this specification.

3.7 FINE AGGREGATE

Fine aggregate shall not contain more than 25% by weight of soluble calcium carbonate in either the fraction retained on or the fraction passing a 600 micron BS sieve.

3.8 COARSE AGGREGATE

Coarse aggregate shall be material retained on a 4.75mm BS sieve, the nominal maximum size shall be 10mm, The grading shall comply with BS 882, Table 4 so that when mixed with sand and cement a high density concrete is produced.

3.9 SAMPLING AND TESTING

Sampling and testing of blocks shall be carried out in accordance with BS 6717. Sampled blocks shall be subjected to all the tests covered by appendices A and B of BS 6717.

If any of the 20 test blocks do not comply with the requirements for dimensional accuracy the whole consignment may be rejected.

3.10 TEST FOR COMPRESSIVE STRENGTH

Testing of blocks for compressive strength shall be carried out in accordance with appendix B of BS 6717 except that blocks shall be soaked for 24 hours in fresh water at 20 degrees centigrade immediately prior to testing Fresh plywood packing shall be used for each specimen tested.

3.11 WATER ABSORPTION

Blocks shall be tested for water absorption , The test shall be based on that specified in BS 1881 : Part 122 and the maximum acceptable limits for water absorption.

2.5% absorbed after 10 minutes.

5.0% absorbed after 24 hours.

The acceptable limits for water absorption may be required to be varied to achieve the minimum absorption compatible with the aggregate approved for use in the paving blocks.

3.12 COLOR

The color of blocks shall be uniform and as detailed on the drawings or as directed, Samples of each different color shall be submitted for approval.

3.13 BLOCK LAYING

Block laying shall commence at angles to the main pavement axis starting at one end of the area.

Interlocking blocks shall be laid in a herringbone pattern at 45 degree to the main pavement axis or other pattern as approved or directed, Rectangular blocks shall be laid in patterns as directed using different colors if directed.

Blocks shall be laid on the sand laying course so that blocks already laid are not distributed, Blocks shall be placed to fit closely together, the width of joints shall not exceed 3mm.

Dimensional accuracy, uniformity of joint gaps, alignment and squares shall be checked after laying the first three rows of blocks and thereafter at regular intervals.

If joints begin to open, the blocks shall be knocked together using a hide mallet.

3.14 EDGE DETAILS

Special edge blocks shall be used on all edges of interlocking block paving which are parallel to or perpendicular to the main pavement axis,

Where the shape or dimensions of paved areas preclude the use of special or standard blocks on all edges, cut blocks shall be used , Blocks shall be cut to suit, using a mechanical block splatter, In-situ concrete shall not be used to make up to edge restraints.

3.15 COMPACTION BY VIBRATION

Blocks shall be compacted to the required levels using a plate vibrator as each area of 20 m² is laid.

The plate vibrator shall have a plate area of 0.2 to 0.3m² and compaction force of 9 to 16KN. Two passes of the plate vibrator shall be made in two directions at 90 degrees to each other.

3.16 FILLING JOINTS

Joints shall be filled by brushing in line dry sand with a particle size up to 2mm and maximum sulphate content (as S03) of 0.4% by weight a further pass of the plate vibrator shall be made in each direction.

Weed killer have to be mixed with residual qualities with the sand used for sealing the joints.

The vibrator shall not be used within 1m of an unrestrained edge. Paving shall not otherwise be left uncompleted overnight.

3.17 LAYING TOLERANCE

The finished surface level shall be within 5mm of the design level and the maximum deviation within the compacted surface, measured by a 3m straight edge shall not exceed 5mm. The level of any two adjacent blocks shall not differ by more than 2mm.

3.18 LAYING COURSE

This is a 50mm thick layer of clean sharp sand containing not more than 3% silt and clay. and with not more than 10% by weight retained on a 5mm sieve. For best results, the moisture content of the laying course sand should be within 1% of the optimum, as determined by Test 12 of BS 1377.

The sand should be spread over the area to be paved. The actual thickness will vary according to the tolerance of the Sub-base layer. Sub-bases Specification are allowed a tolerance of 25mm.

3.19 COMPRESSIVE STRENGTH

The average compressive strength of the Block on delivery when sampled and tested in the manner described in BOQ shall not be less than 40N/mm² in wet condition.

4 BITUMINOUS CONSTRUCTION

4.1 MATERIAL:

SCOPE:

All material sources and the quality of materials proposed for use in the works shall be approved prior to procurement or processing material from such sources. Inspection, sampling, testing and re-testing as necessary, shall be at the contractors expenses.

SAMPLING AND TESTING OF AGGREGATE:

- In order to ascertain the properties of aggregate materials, the contractor shall submit for testing and approval, representative samples of all materials intended for corporation in the works, prior to starting quarry operations, the samples shall be taken by contractor in the presence of the Director of works or his representative.
- Tests performed by the contractor shall utilized in assessing the locations, extent of deposits and quantities of materials which will conform to the specifications when properly processed. All testing as carried out by the contractor shall in no way obviate the need for further testing by Director of works or his representative.

Approval of specific sources of materials shall not be construed as final approval and acceptance of materials from such sources.

- Unsatisfactory materials whether in place or not, shall be removed promptly from the site. The contractor shall furnish all necessary material, labor, tools, and equipment and transport required by the Director of works or his representative for such inspections.

AGGREGATES FOR BITUMINOUS PAVING MIXES

1. Aggregate for use in bituminous, binder and wearing courses, shall consist of crushed stone.
2. course aggregate shall be the fraction of crushed aggregate material retained on 4.75 mm (No. 4) sieve. Fine aggregate shall be the fraction of crushed aggregate material passing 4.75 mm (No. 4) sieve. Mineral filler shall be added when the combined grading of course and fine aggregates is deficient in material passing 0.075 mm (No. 200) sieve.
3. The material from hot bins passing the number 40 sieve (0.425 mm) when tested in accordance with AASHTO T90 shall be non plastic.

4. Aggregate shall not contain gypsum more than 1% and the coarse fraction of the aggregate shall not contain more than:
5% chert and flint for aggregate to be used in the Wearing course.
5% chert and flint for aggregate to be used in the Binder course.
5. Aggregates shall be of uniform quality, free from decomposed stone, organic matter, shale.
6. The percentage by weight of friable particles, clay lumps, and other deleterious matter shall not exceed 1% as determined by AASHTO T112.
7. Aggregate particles shall be clean, hard, durable and sound. Crushing shall result in a product such that, for particles retained on 4.75 mm (No. 4) sieve, at least 90% by weight shall have 2 or more fractured faces.
8. The flakiness index and the elongation index test should be conducted in accordance with BS 812, the following are the maximum limits:

Wearing Course & Binder Course:

Flakiness Index F.I = 2530

Elongation Index E.I. = 2530

9. Aggregates shall be washed if directed, to remove any clay lumps, organic matter, adherent dust or clay films or other extraneous or deleterious matter that may prevent or detract from proper adhesion of bitumen to the aggregate particles.
10. Material filler shall consist of fine divided mineral matter such as limestone dust if added separately; hydrated lime; other non-plastic mineral filler, free from clay and organic impurities; or Portland cement, conforming to AASHTO M17.
11. The mineral aggregate for the base course shall be of such size that the percentage composition by weight as determined by laboratory screens, will conform to the grading specified in the following tables. Grading of the aggregate shall be determined by ASTM C 117 and C 136.

Aggregate Grading (asphalt base layer of ¾" aggregate size)

Pavement	Sieve Size (square opening)	Percentage by Weight Passing Square Mesh Sieve
Base	1½"	-
	1" (25.4 mm)	100
	¾" (19.0 mm)	70 - 100
	½" (12.5 mm)	53 - 90
	3/8" (9.5 mm)	40 - 80
	No. 4 (4.85 mm)	30 - 56
	No. 8 (2.36 mm)	23 - 38
	No. 20 (1.18 mm)	13 - 27
	No. 50 (0,300 mm)	5 - 17
	No. 80 (0,150 mm)	4 - 14
	No. 200 (0,075 mm)	2 - 8
	Bitumen content by weight of total mix (%)	4-6

Aggregate Grading (asphalt wearing layer of ½" aggregate size)

Sieve	Percentage by Weight Passing Sieves
1½"	-
1" (25.4 mm)	100
¾" (19.0 mm)	90 - 100
½" (12.5 mm)	71 - 90
3/8" (9.5 mm)	56 - 80
No. 4 (4.25 mm)	35 - 65
No. 8 (2.36 mm)	23 - 49

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No. 20 (1.18 mm)	14 - 43
No. 50 (0,300 mm)	5 - 19
No. 80 (0,150 mm)	4 - 15
No. 200 (0,075 mm)	2 - 8
Bitumen content by weight of total mix (%)	4 - 6

Aggregate Grading (asphalt wearing layer of 3/8" aggregate size)

Sieve	Percentage by Weight Passing Sieves
1/2" (12.52 mm)	100
3/8" (9.53 mm)	90-100
No. 4 (4.75 mm)	60-80
No. 8 (2.36 mm)	35-65
No. 50 (0.300 mm)	6-25
No. 200 (0.075 mm)	2-10
Bitumen content by weight of total mix (%)	4-6

12. The loss in weight of aggregate after 500 revolutions, when tested in accordance with AASHTO T96, shall not exceed 35%.

$$\text{Ratio of wear loss} = \frac{\text{Abrasion after 100 Rev.}}{\text{Abrasion after 500 Rev.}} \quad \text{is less than or equal 25.}$$

13. When tested for soundness in accordance with AASHTO T104 the course aggregate (retained on No. 4 sieve) shall not shown sings of disintegration and the loss by weight after 5 cycles shall not exceed 9% in the case of the sodium sulphate test and 12% in the case of the magnesium sulphate test.

14. When tested for resistance to stripping in accordance with the AASHTO T-182 at least 95% coated particles should be achieved. Scandinavian test shall be carried out and at least 60% of the coarse aggregate surfaces area shall remain coated with a bitumen film especially for exposed surfaces otherwise anti stripping agent must be added to achieve the required coating.
15. The material shall contain minimum 50% sand equivalent. Test sample shall be taken from hot bins.

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HEATING OF BITUMEN

- 1- Heating equipment shall be of an approved type. Any method of heating that introduces free steam or moisture into the bitumen will not be approved.
2. Bitumen shall not be heated more than 170°C. materials heated in excess of this temperature will be rejected and shall not be used in the works.
3. Heating of bitumen shall be uniform and under control at all times, to the specified temperature. The circulation system shall be of adequate size to insure proper and continuous circulation of bitumen during the entire operating period.
4. Thermometers of adequate range (calibrated in 2 degrees C increments) for accurately measuring the temperature of the bitumen, shall be located so as to be readily visible and shall be kept clean and working order at all times.

4.2 BITUMINOUS PRIME AND TACK COATS

SCOPE

This work shall consist of furnishing and applying and MC cutback bitumen prime coat to a previously constructed aggregate base course and applying tack coat on Asphalt or concrete surfaces all as and where shown on the Drawings.

MEDIUM CURING CUTBACK BITUMEN

1. MC-70 cutback bitumen for prime coat shall be used as recommended by ASTM D2399-83 for open and tight surface, and RC-70 should be used as tack coat.
2. All surfaces to receive either prime or tack coats shall conform with the specified tolerances and compaction requirements and shall be properly cleaned and finally approved before applying any bitumen material.

3. Application of prime and tack coats shall be performed only when the surface to be treated is sufficiently moist and atmospheric temperature is above 15 c. There should be no fog, rain , strong winds, dusty conditions, or dust storms.
4. The surface of all structures shall be protected in an approved manner during the equipment operation. The contractor shall be responsible for making good any staining or damage of the structures to the satisfaction of the Director of works or his representative
5. Traffic shall not be permitted to surfaces after they have been cleaned and prepared for prime coat application.
6. The contractor shall maintain prime or tack coats until it is covered by the subsequent pavement course. Any area where the coats have been damaged shall be cleaned of all loose material and re-applied at the contractor's expense.
7. Applying temperature of MC- 70 shall be 45-80c.
8. Areas to be primed shall be including 200 mm widths outside the edge of the permanent line.
9. Application rate for prime coat shall be 1 lit/sq.m and tack coat application shall be 0.5 lit/sq.m.
10. Asphalt pavement shall not be placed on prime coat before 24 hours, and no traffic is allowed to pass on prime coat.

4.3 BITUMINOUS COURSES

SCOPE:

This work shall consist of the general requirements of furnishing materials, mixing at a central mixing plant, spreading and compacting bituminous courses.

JOB MIX AND PROJECT MIXES:

1. The contractor shall submit his proposed Job Mix Formula for approval , at least 30 days prior to beginning production. Therefore , samples from materials use in the preparing mix design (aggregates and bitumen) shall be sent to specialized laboratories to be tested for final approval of mix design.
2. The Job Mix Formula be established by the contractor, under the supervision of the Director of works or his representative, in the field laboratory Mix design procedures shall conform with the Marshall method of mix design. All trial mixes shall be prepared and tested by the contractor in the presence of the Director of works or his representative .
3. The Job Mix Formula shall specify a combination of mineral aggregates including filler and bitumen in such proportions as to produce a Job Mix which is within the limits of the specified gradation and bitumen content ranges and which meets the Marshall test

- requirements. It shall also stipulate the mixing temperature at discharge from the mixer which, unless otherwise directed, shall be 170 C°.
4. The Marshall test procedure shall be used to determine the percentage of bitumen to be incorporated in the mix. The Job Mix Formula shall take into consideration the absorption of bitumen into the aggregates. Air voids shall be calculated in accordance with the procedure given in the Asphalt Institute Manual, MS-2.
 5. When compacting specimens on accordance with the Marshall test procedure, the number of blows applied with the compaction hammer shall be 75 on each test.
 6. In order to meet the requirements, an approved additive such as Portland cement, hydrated lime or liquid antistrip agent, may be required in the Job Mix. Portland cement shall meet the requirements of ASTM M 85. Hydrated lime shall meet the requirements of ASTM C207, Type N. Cement or hydrated lime will normally be required in the approximate range of 2-3% by weight of the aggregates and shall be added at the cold feed in dry or slurry form as directed. Liquid antistripping agent, if needed will normally be required in the approximate range of 0.6-1.0% by weight of the bitumen, or according to the manufacturers specifications.
 7. Upon receipt of approval of the Job Mix Formula, the Contractor shall adjust his mixing plant to proportion the individual aggregates, mineral filler and bitumen to produce a final project mix within the limits given in Table shown with respect to the Job Mix gradation:-

Maximum Variations of Project Mix from Approved Job Mix

Sieve Designation (square openings)	Specified Tolerances
9.5 mm (3/8 in.) and above	± 5.0%
4.75 mm (No. 4)	± 4.0%
2.36 mm (No. 8)	± 4.0%
1.18 mm (No. 16)	± 4.0%
0.600 mm (No. 30)	± 4.0%
0.300 mm (No. 50)	± 4.0%
0.150 mm (No. 100)	± 4.0%
0.75 mm (No. 200)	± 1.5%
Bitumen Content	± 0.3%
Temperature of Mix on	± 5 C° of the specified

discharge temperature	mixing
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- 8 Conformance to gradation requirements will be determined on the extracted aggregate in accordance with AASHTO T 30. The bitumen content shall be determined in accordance with AASHTO T 164.
- 9 The participation of the Director of works or his representative in the preparation of the Job Mix Formula shall in no way relieve the Contractor of responsibility for producing project mixes meeting the specified requirements.
- 10 At the commencement of the contract one copy of the ASTM, AASHTO and Manuals MS-2 MS3, MS and MS22 shall be furnished by the contractor for use by Director of works or his representative.

SPREADING AND FINISHING EQUIPMENT

1. Bituminous course shall be spread and finished using approved type, self contained, power-propelled pavers of sufficient capacity. Pavers shall be provided with electronically controlled vibratory screed or strike-off assembly and shall be capable of spreading and finishing the course of bituminous mix to the proper thickness and in lane widths applicable to the typical cross sections shown on the Drawings.
2. The pavers shall employ mechanical devices such as equalizing runners, straightedge runners, evener arms or other compensating devices, to maintain trueness of grade and confine the edges of the mix to true lines without the use of stationary side forms. Joint levelling devices shall be provided for smoothing adjusting longitudinal joints between lanes.
3. The paver shall be equipped with receiving hopper having sufficient capacity for a uniform spreading operation. The hopper be equipped with a distribution system to place the mix uniformly in front of the full length of the screed.
4. The screed or strike-off assembly and extensions shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or grouting the mix.
5. The paver shall be capable of being operated at forward speeds consistent with satisfactory laying of the mix. Speed shall be fully adjustable
6. The Contractor shall make available, for reference by the Director of works or his representative, the manufacturer's instruction and operating manuals for each paver intended for use

SURFACE PREPARATION.

1. When the bituminous mix is to be placed on a base, course the surface shall be prepared to meet the appropriate specified compaction and surface tolerance requirements. The surface shall then be primed as specified “Bituminous Prime Coat”. No bituminous mix shall be laid on a prime coat until it has been inspected and approved.
2. Broken, soft, or unstable areas of aggregate base course shall be removed and replaced. The areas shall be excavated to a depth as directed and refilled with the specified bituminous mix.

DELIVERY, SPREADING AND FINISHING

a) Delivery of Mix to Site

1. A sufficient number of haul vehicles shall be provided so that adequate supplies of mix are delivered to ensure that continuous paving will be achieved.
2. Hauling equipment for aggregates and bituminous mixes shall consist of vehicles having dump bodies suitable for dumping materials in a windrow or in spreader boxes. The bodies shall be so constructed that their volume measurement can be accurately determined. They shall be constructed and maintained such that loss of materials during hauling operations will not occur.

Dump controls shall be capable of operation from the driver's seat.

3. Hauling equipment for hot bituminous mixes shall have tight, clean, smooth metal beds which are periodically thinly coated with a lime solution or other approved material to prevent adherence of the mix. All hauling units shall be equipped with a canvas or other approved type cover which shall be used to cover the hot material upon loading at the mixing plant and shall not be removed until the mix is discharged into the paver.
4. The dispatching of the hauling vehicles to the site shall be so scheduled that all material delivered is placed at least 90 minutes before sunset to allow sufficient time for compaction. Delivery of material shall be at a uniform rate and in an amount well within the capacity of the paving and compacting equipment.
5. The mix at delivery to the paver shall be not more than 10C below discharge temperature at the mixing plant. The minimum temperature for the commencement of breakdown rolling is 120 C. Mix loads of temperature less than 120C shall not be accepted, and the load shall be disposed of and another load used. If there is consistent failure to meet the temperature requirement the Director of works or his representative shall order paving operations to stop until suitable measures are taken by the Contractor to ensure that temperature requirements are met.

6. Each haul vehicle shall be weight after each loading at the mixing plant and accurate records shall be kept of the gross weight and net weight of each load, for each vehicle dates and time of loading.

b) Setting Out Reference Line

1. The Contractor shall survey the centerline profile and crown of the existing surface or base and determine a reference grade line which will be submitted for approval. A reference line of wire or suitable cord shall be installed at a uniform grade parallel to the approved reference grade line such that conformance with the required geometric, surface tolerance and minimum thickness requirements shall be ensured.
2. The reference line shall be maintained taut and free from sags at all times during spreading and initial compacting operations.
3. A wire or cord reference line shall be installed on both sides of the paver for the initial bituminous course being laid. Thereafter only one reference line will normally be required, if the paver is equipped with adequate automatic superelevation control.

c) Spreading and Finishing

1. Bituminous mixes shall be laid only when the air temperature is at least 5 degrees C or above when the existing surface is free from moisture, and when the weather is not foggy, rainy, dusty or excessively windy (particularly at low temperatures).
2. After completion of surface preparation, the bituminous mix shall be spread and finished true to crown and grade by approved automatically controlled bituminous pavers. The mix may be spread and finished by approved hand methods only where the Director of works or his representative determines that machine methods are impracticable. Hand methods include heated hand tampers of at least 10 kg weight and approved type mechanical (vibratory) tampers.
3. The paver shall spread the bituminous mix without tearing the surface and shall strike a finish that is smooth, true to cross section, uniform in density and texture and free from hollows, transverse corrugations and other irregularities.
4. The paver shall be operated at a speed which gives the best results for the type of paver being used and which coordinates satisfactorily with the rate of delivery of the mix to the paver. A uniform rate of placement shall be achieved without repeated intermittent operation of the paver.
5. The mix shall be delivered to the paver in time to permit completion of spreading, finishing and compaction of the mix during daylight hours.
6. If during laying, the paver is repeatedly delayed because of lack of mix or if the paver stands at one location for an extended period, resulting in the (unrolled) mat under and adjacent to

- the rear of the spreader falling below the minimum temperature for breakdown rolling, the affected portion of mat shall be cut out and discarded and a transverse joint shall be constructed. Paving shall not recommence until the Director of works or his representative is satisfied that paving will proceed without interruptions.
7. Contact surfaces of curbing, gutters, manholes, and similar structures shall be painted with a thin, uniform coating of tack coat material. The bituminous mixture shall be placed uniformly high near the contact surfaces so that after compaction it will be 10 mm above the edge of such structure.
 8. If during the paving operations, it is found that the spreading and finishing equipment in operation leaves in the pavement surface tracks or indented areas or other objectionable irregularities that are not satisfactorily corrected by the scheduled operations, the use of the equipment shall be discontinued, until faults are corrected to the approval of the Director of works or his representative. If this is not possible, other satisfactory spreading and finishing equipment shall be provided by the Contractor.
 9. Transverse joints in succeeding layers shall be offset by at least 2 m. Longitudinal joints shall be offset at least 150 mm.
 10. Bituminous mix shall be spread in one or more layers so that, after rolling, the nominal thickness of each layer of the compacted bituminous material does not exceed 2 to 3 times maximum size of aggregate. This maximum thickness may be increased slightly when such increase is more appropriate to total pavement thickness and provided the Director of works or his representative determines that such increased thickness will not be detrimental to the quality of the finished bituminous course, and the Contractor can show that the required density is attained throughout the layer thickness.
 11. Transitions and structure approaches shall meet the design criteria for geometric, the surface tolerance specifications, and shall not be visually discontinuous or abrupt in appearance.

d) Joints and Edges

1. All joints between old and new pavements or between successive days' work shall be as to ensure thorough and continuous bond between the old and new material.
2. Before placing fresh mix against previously laid, the contact surface shall be cut back to a near vertical face, and shall be sprayed or painted with a thin uniform coat of tack coat material. Longitudinal joints shall be made by overlapping the paver screed on the previously laid material (cut back as necessary) and depositing a sufficient amount of fresh mix so that the joint formed will be smooth and tight.
3. Unsupported edges of bituminous layers shall be rolled immediately following the rolling of the longitudinal joint. The material along the unsupported edge may, if approved, be raised

- slightly by hand methods, to ensure that the full weight of the roller will bear fully on the edge material
4. On completion, the longitudinal edges of bituminous pavement shall be true to the width and alignment as shown on the Drawings. The edges shall be cut back if necessary prior to rolling, additional mix placed manually in a longitudinal strip adjoining each pavement edge, and the edge rolled down to a neat 3:1 (H:V) slope.
 5. Transverse joints shall be carefully constructed and thoroughly compacted to provide a smooth riding surface. Joints shall be straight-edged and string-lined to assure smoothness and true alignment

e) Compaction

1. After spreading and strike-off, and as soon as the mix conditions permit the rolling to be performed without excessive shoving or tearing, the mixture shall be thoroughly and uniformly compacted, using approved types, sizes and number of rollers. rolling shall not be prolonged to the point where cracks appear or shoving or displacement occur.
2. All rollers shall be self-propelled vibratory steel wheel, 2-axle tandem steel-tired and pneumatic-tired types, in proper operating condition, capable of reversing without backlash or tearing of the surface, and shall be operated at numbers of rollers required is 3, of which one must be pneumatic type. The Contractor shall select a suitable method and pattern of rolling that will achieve the required compaction, to Director of works or his representative approval.
3. Prior to use on Site of pneumatic-tired rollers, the Contractor shall furnish, for reference and retention by the Director of works or his representative, manufacturers' charts or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of tire loading for each type and size of compactor tire to be used. The Contractor shall ensure that tire pressures are maintained at all times in conformity with such charts or tabulations. The maximum allowable tolerances shall be plus or minus 35 KN/sq.m (5 psi).
4. Rollers should move at a slow but uniform speed, generally with the drive roll or wheels nearest the paver.
5. Minimum temperature of the mat at which rolling shall be allowed to start is 120c.
6. Breakdown rolling shall be consist of 3 complete coverage unless otherwise directed Rolling shall be longitudinal, and over lapping on successive trips by at least one half the width of the rear wheels.
7. To prevent adhesion of the mix to the rollers, the wheels shall be kept lightly moistened with water. Excessive use of water will not be permitted.
8. The initial or breakdown rolling shall be followed by intermediate rolling involving 3 coverages with pneumatic-tired rollers unless otherwise specified.

9. Finishing rolling shall then be carried out by means of tandem power steel rollers unless otherwise designated. If specified density is not achieved, changes shall be made in size and number of rollers being used to ensure the compaction requirements are met.
10. The compacted density shall be equal to or more than 97% and 98% for binder course and wearing course, respectively, of average Marshall bulk specific gravity for each days production unless otherwise directed by the Director of works or his representative.
11. Any mix that becomes loose, broken, mixed with foreign material, or which does not conform in all other respects with the specified requirements, shall be removed, replaced with suitable materials and properly finished.

e) Test For Bituminous Pavements

1. Minimum Tests Required

Work item	Tests at Source of material	Frequency of tests	Tests at road site	Frequency of tests
1- Materials used in Asphalt mix (at Batching plant)	1- Specific gravity and water absorption 2- Abrasion test 3- Chert content 4- Clay lumps and friable materials 5- Flaky and elongayed particles 6- Soundness	- Test for each source - When materials quality changes - As requested		
2- Materials used in Asphalt mix (from hot bins)	1- Gradation 2- Specific gravity and water absorption 3- Plasticity index 4-Sand equivalent 5- Stripping with	- Test for each source - when materials quality changes - As requested		

	asphalt			
3- Asphalt mix design (At batching plant)	1. Complete mix design in accordance with American Asphalt Institute (MS2) 2. Loss of stability	-For each project -When materials quality changes -When results are not consistent with the mix design results - As requested		
4- Asphalt	At Batching plant 1- Stability 2- Flow 3- Extraction (binder content and gradation) 4- Air voids 5- Voids in mineral aggregates 6- Daily Marshall density	- Test each 3 working days - Test for each batching plant - As requested	Behind spreader 1- Stability 2- Flow 3-Extraction (binder content and gradation 4-Air voids 5- Voids in mineral aggregates 6-Marshall density	-Test each working day - Test for each batch - As requested
	7-Loss of Stability	- Once a week - As requested	7- Road density and thickness (after final compaction	- Test each 200 lin.m. per lane - As requested
			8-Loss off stability	- Once a week - As requested

2. The Marshall bulk specific gravity shall be determined in accordance with AASHTO T 166 or AASHTO T 275. The Marshall specimens shall be prepared from the same material used in construction, taken from samples of fresh bituminous mix at the mixing plant or from trucks delivering mix to the site. Oven heating for up to 30 minutes to maintain the heat of the sample is permissible.

3. The bulk specific gravity of the mix as placed and compacted in situ shall be determined from 100 mm nominal diameter core samples, or slab samples cut from compacted layer on the road at locations designated by the Director of works or his representative who may require additional tests to determine limits of areas deficient in density, or for recheck.
4. Samples for in situ bulk specific gravity determinations shall be taken in sets of 2 from each pavement location. Minimum frequency of sampling for each bituminous layer shall be one set/lane/500 m, with a minimum of one set per day of placing bituminous layers.
5. The Contractor shall, cut the samples with an approved core drill in the presence of the Director of works or his representative. the equipment shall be capable of cutting the mixture without shattering the edges or otherwise disturbing the density of the specimen. The contractor shall fill and compact all test holes at his own expense.

f) Surface Tolerances

1. The fully compacted and completed bituminous course shall conform to the lines, grades and cross sections as shown on the Drawings.
2. The elevations of the finished course shall be checked by the Contractor in the presence of the Director of works or his representative at maximum intervals of 25 and at intermediate points as directed.
3. When the finished surface is tested with a 3 m long straightedge, placed parallel to, or at right angles to the centerline, the maximum deviation of the surface from the test edge between any 2 contact points shall not exceed the tolerances specified for each type of bituminous course laid.
4. All areas which exceed the specified tolerances shall be corrected by removing the defective sections of bituminous course and reconstructing them or, if approved, by adding new material and recompacting and finishing to the specified standard or increasing the thickness of the succeeding course.
5. The tolerances specified for evenness of finished surfaces for all types of bituminous course, shall not invalidate the tolerances specified for construction thickness and elevations of such courses.

g) Determination of Thickness of Course

1. Cylinder core samples shall be taken as specified for in situ bulk specified gravity core samples.
2. Thickness of bituminous course shall be determined by average caliper measurement of cores, rounded upwards to the nearest mm.
3. Paved sections to be measured separately shall consist of each 300 lin. m section in each traffic lane. The last section in each traffic lane shall be 300 m plus the fractional part of 300 m remaining. Other areas such as intersections, entrances, etc. Shall be measured as one

- section and the thickness of each shall be determined separately. Small irregular unit areas may be included as part of another section.
4. One core shall be taken from each section by the Contractor at approved locations and in the presence of the Director of works or his representative. When the measurement of the core from any paved section is not deficient by more than 5 mm from the specified thickness, the core will be deemed to be of the specified thickness as shown on the Drawings.
 5. When the measurement of the core from any paved section is deficient by more than 5 mm but not more than 20 mm, 2 additional cores spaced at not less than 100 m shall be taken and used together with the first core to determine the average thickness of such section.
 6. When the measurement of the core from any paved section is less than the specified thickness by more than 20 mm, the average thickness of such section shall be determined by taking additional cores at not less than 5 m intervals parallel to the centerline in each direction from the affected location until, in each direction, a core is taken which is not deficient by more than 20 mm. Exploratory cores for deficient thickness will not be used in average thickness determinations.
 7. Any deficiencies in the total thickness of bituminous courses shall be subject to a proportional reduction in the area of (wearing) course measured for payment. Alternatively, the Contractor shall construct all at his own expense, a wearing course overlay, if practicable in the judgement of the Director of works or his representative. Any such overlay shall be a minimum of 40 mm compacted thickness and to the specified standard of the course it is overlaying.
 8. If the deficiency in total asphalt layers thickness is from 0 -3 mm, full payment will be made, on condition that deficiencies are not found in more than 10% of the total project. Deficiencies exceeding 3 mm shall be left to the substantial handing -over procedure.

h) Measurement

- ☐ Bituminous course shall be measured by sq.m for furnished, paved compacted, tested and approved areas placed according to drawing.
- ☐ Any correction, tests, samples, etc. shall not be measured for direct payment.

4.4 BITUMINOUS BINDER AND WEARING COURSES

SCOPE

These works shall consist of furnishing materials, mixing at mixing plant, spreading and compacting bituminous binder and wearing course on an approved aggregate base course as and where shown in the Drawings.

MATERIALS:

1. Materials shall conform with relevant requirements of section “Materials” mentioned before.
2. Unless otherwise shown on Drawings, bitumen for binder and wearing course construction shall be 60/70 penetration graded bitumen.

JOB MIX AND PROJECT MIX:

1. The Job Mix formula shall be established by the contractor in accordance with the procedure and requirements of section “Bituminous Course” mentioned before.
2. The Job Mix for bituminous binder and wearing courses shall conform to the following composition limits, as shown in Table:

a) Job Mix Requirements To Bituminous Courses

Property Medium-Light		
	<i>Binder</i>	<i>Wearing</i>
Marshall Stability at 60c (kg)	800	900
Flow (mms)	2-4	2-4
Voids in Mineral aggregate (WA)	13(-1)	14(-1)
Air Voids (%)	4-5	3-5
Stiffness (kg/mm)		400 (Min)
* Loss of stability (%)		25 (Max)
Asphalt Content (% in weight)	4.5-6	5-7

- ☐ This test to be carried out in accordance with AASHTO T 165-82.
- ☐ After the Job Mix Formula has been established and approved, all subsequent mixes shall conform to it within the allowable tolerances.

b) Equipment:

Plant and equipment for mixing, hauling, placing and compacting bituminous binder courses and wearing course materials, shall conform with the relevant requirements of section “Bituminous Course”.

c) Surface Preparation:

Preparation of surface upon which bituminous binder course and the bituminous wearing course mixes are to be laid, and the use of prime coat, shall be appropriate to type and condition of such surface and shall conform with the relevant requirements of section "Bituminous Courses".

d) Delivery, Spreading And Finishing

General :

The delivery, spreading and finishing of bituminous mixes for binder and wearing courses shall conform with the relevant requirements of Section "Bituminous Course" and with the following particular requirements.

Rollers:

1. Initial breakdown rolling shall be carried out by use of 2 dual-drum steel-wheeled rollers each of minimum weight 7,000 kg. These rollers shall be purpose made for compaction of hot bituminous courses.
2. Intermediate rolling shall be carried out by of at least 2 self-propelled, tandem pneumatic smooth-tired rollers each capable of exerting contact pressures of up to 690 kN/sq.m (100 psi) and ballast- adjustable to ensure uniform wheel loading.
3. Final rolling shall be carried out by use 2, 2-axle tandem, steel-tired rollers each of minimum weight 10.000 kg, capable of exerting contract pressures of up to 65 kg/cm (350 lb/in.)

Standard of Compaction:

The compacted density of the bituminous wearing course shall be not less than 98% of the average Marshall bulk density for each day's production.

e) Sampling And Testing

Sampling and testing shall conform with the relevant requirements of Section "Bituminous Course".

h) Surface Tolerances

1. Surface tolerances shall conform with the relevant requirements of Section "Bituminous Course", and with the following particular requirements.
2. The tolerances on elevations of the final bituminous wearing course surface shall not be greater than 10 mm.
3. When the finished wearing course surface is tested with a 3 m long straightedge, placed parallel to, or at right angles to the centerline, the maximum deviation of the surface from the testing edge between any 2 contact points shall not exceed 5.0 mm.

i) Determination of Thickness

1. Procedures for determining the average compacted thickness of bituminous binder and wearing course shall conform with the relevant requirements of Section " Bituminous Courses" and the following particular requirements.
2. Cores for thickness measurements of binder course shall be used to determine if changes are necessary in the constructed thickness of the wearing course and thickness deficiencies in the binder course.

j) Measurement

1. Bituminous binder course and bituminous wearing course shall be measured by sq.m. of mix finished, spread, compacted, completed and accepted. Measurements shall be of the areas and thickness as shown on the drawings.
2. Deficiencies in thickness of wearing course shall, unless an overlay is constructed at contractor's expense, result in proportion only of the wearing course area being measured for payment. Proportions shall be determined in accordance with the thickness deficiencies and area proportions mentioned in section " Bituminous Course".
3. Bituminous Prime coat and Tack coat shall be measured as prescribed in "Bituminous Prime and Tack Coats".
4. All other items shall not be measured for direct payment as prescribed in section " Bituminous Course".