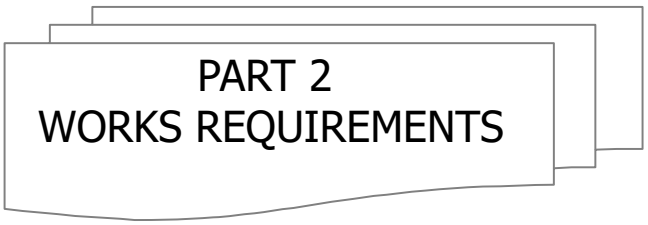
Table of contents


PART 2
WORKS REQUIREMENTS


Section VII
Vol. 3 - Specifications

Section VII – Vol 3 – Specifications

Contents

1 PREAMBLE TO THE TECHNICAL SPECIFICATIONS

1.1 GENERAL

1) The following Specifications are part of the requirements related to the Works which are to be provided according to the stipulations of the Contract. Hence, the instructions given herein form an integral part of, and are applicable to, all technical and Contract Documents issued for the Works.
2) These Specifications shall be read in conjunction with the Conditions of Contract, the Drawings and the Bill of Quantities, and the Contractor shall comply with all provisions contained within the Contract Documents and Engineer's instructions.
3) It is the intent of these Specifications, together with other relevant documents issued as part of the Bid (or Contract Documents to follow later on), to provide the Contractor with complete and detailed information and subsequent instructions necessary to enable him to submit a well-planned Bid, to carry out the design, where and when required, and to execute properly the work prescribed.
4) It is the intent of these Specifications to establish acceptable standards of quality. Minor deviations in details due to manufacturer's standard shop process will be considered for acceptance provided that, in the opinion of the Engineer, the proposed substitutions are equal in quality to those specified. All deviations shall be called out in writing in the Bid and shall be specifically indicated on the shop drawings.
5) All work shall be executed according to the Detailed Design and/or Construction Drawings as approved by the Engineer and requirements released for construction, in a professional and diligent manner, and all supplies and work shall comply with the quality requirements defined in the relevant sections of these Specifications and other Contract Documents. The Contractor shall make all necessary efforts to comply with the intent of these Specifications to the satisfaction of the Engineer.
6) Any approval given by the Engineer of the Contractor's methods and equipment shall not relieve the Contractor of his full responsibility for the proper and safe execution of any work covered by these Specifications, or his liability for injuries to or death of persons, or any other obligation under this contract.

1.2 SUBMITTAL

1) The Contractor shall provide the Engineer with all submittals required by these Specifications and other Contract Documents. Although their extent shall be at the Contractor’s discretion, such submittals shall adequately illustrate all the main aspects of the matter under consideration for an easy understanding by the Engineer.
2) At any time, the Engineer may call either for additional information, completion of the submittal or request the Contractor not to submit some of them.
3) The Contractor shall submit these documents to the Engineer so that, even if not specifically expressed, reasonable time will be given to the Engineer to comment on or approve the submittal.

1.3 STANDARDS AND CODES

1.3.1 GENERAL

1) Standards referred to in these Specifications are considered to form part of these Specifications.
2) All standards and codes employed or referred to shall be the latest current issue in effect at the date 28 days prior to the Bid submission date.
3) One complete set of standards and codes adopted for the Works shall be submitted free of

charge by the Contractor to the Engineer immediately after the Contract has come into force or upon the Engineer's request. Such copies shall also be available at the Contractor's business domicile(s) and at Site, for the use also of the Employer and of the Engineer.

4) In case of discrepancies between these Specifications and national or international standards and codes, these Specifications being part of Contract Documents shall govern, unless otherwise established by the Engineer in each particular case.

1.3.2 NATIONAL STANDARDS, CODES, LAWS AND REGULATIONS

1) Throughout the duration of the Contract, the materials, equipment, services, design and workmanship shall conform to applicable national codes, standards, laws and regulations in force in Republic of Uganda if not otherwise specified.
2) It is the Contractor's duty to acquaint himself with all available national codes, standards, laws and regulations related to the Works in any way and he shall procure and keep at the Site a copy of each of such applicable documents.

1.3.3 INTERNATIONAL STANDARDS AND CODES

1) International standards/codes series may be adopted provided:
   - The standards/codes proposed are at least as stringent as the equivalent national ones relevant to the Works, or if there is no applicable national standard/code for the specific item concerned.
   - The Contractor states, prior to starting the work, the international standard/code he proposes to apply, giving full identification of each of them. The Contractor's proposals are subject to the approval by the Engineer.
2) Where reference is made in the technical documents to standards/codes of the country of origin for a supply item, it shall be a recognized national standard/code of the country where the specific supply item is manufactured. To be acceptable under these Specifications, such standards/codes must comply in all respects with the quality requirements of above mentioned international standards/codes and must be approved by the Engineer.

1.3.4 SYSTEM OF UNITS

1) The SI system of units has been used throughout these Specifications and this system of units shall be used consequently throughout the duration of Contract for all technical or contractual purposes.
2) The following abbreviations are used in these Specifications and related other Contract Documents:

	Unit	Abbreviation
Length	millimeter centimeter meter kilometer	mm cm km
Area	square millimeter square centimeter square meter	mm^2 cm^2 m^2
Volume	cubic meter	m^3
Mass	kilogram ton	kg t
Density	kilogram per cubic meter	kg/m^3

Force	Newton kilo Newton mega Newton	N kN MN
Moment	kilo Newton-meter	kN m
Stress or Strength	Newton per square millimeter kilo Newton per square millimeter kilo Newton per square meter	N/mm^2 kN/mm^2 kN/m^2
Pressure	bar Pascal mega Pascal	bar Pa MPa
Time	millisecond second hour	ms s h
Rate of Flow	liters per second or minute cubic meters per second cubic meters per minute	l/s, l/min m/s m^3/min
Velocity	meter per second	m/s
Velocity of Rotation	revolutions per minute	rpm
Temperature	degree Celsius	°C
Concentration	parts per million	ppm
Illumination Intensity	lux	lx
Energy	kilowatt-hour	kWh
Power	Watt kilowatt Megawatt	W kW MW
Slope and Percentage	percent	%

3) The term "day" as used in these Specifications means the calendar day according to the Gregorian Calendar.
4) Any other system of units utilized shall have only a descriptive value and shall in no case replace the above-mentioned SI system.

1.4 DEFINITION OF TIME AND KEY DATES

The periods of time and key dates used throughout these Specifications have the meanings as assigned to them in the “CONDITIONS OF CONTRACT FOR CONSTRUCTION” by FIDIC, 2017, with amendments.

2 SAFETY PRECAUTIONS

2.1 SAFETY PROGRAM AND ITS IMPLEMENTATION

1) Within 14 days from the date of issue of the Notice to Commence, the Contractor shall submit, in writing, his proposal for a comprehensive safety program covering all aspects of the Works.
2) This safety program shall detail policies, procedures, and plans which the Contractor intends to implement to ensure the safety and health of his employees. It shall comply with the standards and regulations in force in the country of the Works applicable to construction safety.
3) The Contractor shall designate a competent employee specially trained and experienced to act as Safety Officer, who will administer and be responsible for the implementation of the safety program. He shall carry out frequent and regular safety inspections of the working areas, materials, and equipment. The name and qualifications of the Safety Officer shall be submitted for approval to the Engineer prior to his appointment.
4) The Contractor shall be responsible for the enforcement of the health and safety provisions that he himself and his subcontractors shall adopt on Site.
5) Prior to the start of any major construction activity or hazardous operation, the Contractor shall submit to the Engineer for approval, a specific plan for safety precautions covering such operation.
6) All accidental occurrences with serious accident potential such as major equipment failures, contact with high-voltage lines, exposure to hazardous materials, slides, cave-ins, etc., shall be reported to the Engineer as soon as practicable.
7) All serious and fatal injuries and diseases caused by the progress of work shall be immediately investigated by the Contractor and a comprehensive report shall be submitted to the Engineer.
8) In case of a fatal accident, only rescue and emergency teams and operations shall be permitted at the place of the occurrence until the Engineer gives permission to resume normal operations.

2.2 SAFETY STANDARDS

In addition to the requirements specified herein, the Contractor shall comply with applicable safety requirements of the following documents and/or organizations:

a) Safety regulations in force in the country of the Works
b) US Bureau of Mines or equivalent
c) USBR-Construction Safety Standards or equivalent

In addition to the requirements specified herein, the Contractor shall comply with applicable safety requirements in force in the United Republic of Uganda.

2.3 PERSONAL SAFETY EQUIPMENT

1) The Contractor shall provide his and his subcontractor's personnel as well as the Employer's and Engineer's representatives and visitors with appropriate personal safety equipment. The use of such equipment shall be compulsory.
2) All persons entering the working areas wear a protective helmet.
3) Safety footwear with steel toe caps shall be worn by all personnel engaged in work having an inherent danger to the feet.
4) During drilling works and in areas where workers are exposed to harmful noise and dust levels, ear protectors and dust masks shall be worn.
5) Workers engaged in work having an inherent danger of eye or face injury shall be furnished and required to wear protection glasses, goggles or face masks. Where irritants or toxic substances may come in contact with the skin or clothing, employees shall wear protective clothing or apply a protective ointment prescribed by a competent physician.
6) Employees working on steep slopes or otherwise subject to possible falls from levels not protected by fixed guardrail or safety nets, shall be secured by safety belts and lifelines.
7) A suitable protection shall be installed on the upstream face of the dam during construction of

the asphaltic concrete facing to limit fall hazard associated with this type of work.

2.4 RESCUE TEAM

1) Prior to the commencement of construction, the Contractor shall organize and train a Rescue Team composed of his employees. This Rescue Team shall be capable to render help after accidents caused by fire, gas, explosion, rockslides, etc.
2) The Rescue Team shall be organized in such a way that a sufficient number of its members will be ready for action at any time until the Completion of Works.
3) The Rescue Team members shall be instructed and trained for their task by a qualified and experienced person. If necessary, the Contractor shall hire an outside specialist to perform such training. A refresher training for all members of the Rescue Team shall be conducted at least every six months
4) Each Rescue Team member shall be skilled in giving the first aid, dealing with the appliances for artificial respiration, and firefighting equipment and shall possess a good local knowledge. Adequate equipment for reaching even the remotest working area shall be at their disposal.
5) The Contractor shall submit the details of the proposed Rescue Team organization to the Engineer for approval.

2.5 ILLUMINATION AND EARTHING

2.5.1 ILLUMINATION

All outdoor working sites, roads, storage and borrow areas, stationary plants, and all other site facilities, shall be adequately illuminated during night work by electrical lights.

2.5.2 EARTHING, WET WORK AREAS, CONTROL OF ELECTRIC DISCHARGES

1) Equipment and appliances which are exposed to lightning shall be electrically earthed and the effectiveness of such earthing shall be periodically checked by the Contractor's specialized personnel.
2) Where electrical blasting will be used, equipment shall be installed to control possible electric discharges in the ground due to storms, electrical motors, etc. As soon as such discharges are noted, electrical blasting operations shall be suspended, or the detonator type changed.
3) No equipment electrically powered by more than 24 Volts shall be operated by personnel standing in water.
4) Only suitable insulated equipment shall be allowed in the very wet areas.

2.5.3 MAINTENANCE OF TRAFFIC AND SAFETY ON PUBLIC ROADS

1) The Contractor shall be responsible for the safety along the roads related to the Site, and he shall take all necessary precautions for the protection of the work and the safety of the public on the roads affected by his activities. Where the work will be carried out at the site of, or close to an existing road, the Contractor shall maintain the vehicular and pedestrian traffic safe at all times. If his operations can cause traffic hazards, he shall repair or fence or take such other measures for ensuring safety which are satisfactory to the Engineer.
2) Public roads subject to interference by the works shall be kept open or suitable detours shall be provided and maintained by the Contractor, who shall provide, erect and maintain all necessary barricades, suitable and sufficient flagmen, danger signals, signs etc.
3) Roads which will be closed to traffic shall be protected by effective barricades on which acceptable warning and detour signs shall be placed. All barricades and all lights shall be kept burning from sunset to sunrise.
4) The Contractor shall submit his weekly activities schedule and the locations of his work along the existing public roads to the authorities concerned and obtain all necessary approvals prior to commencement of the respective work.
5) At the road crossings or in heavy traffic locations, the Contractor shall carry out the work within the working hours as directed by the Engineer, and after the completion of the work he shall immediately make the necessary backfill and pavement at the crossings.

6) The Contractor shall provide temporary passes and bridges to give an access to the existing villages, houses, etc., to the satisfaction of the Engineer and the authorities concerned whenever he disturbs such existing way during the execution of the Works.

2.6 STORAGE AND TRANSPORT OF EXPLOSIVES

1) The Contractor shall in due time apply for a permit which allows him to buy, store and use the explosives required for the Works. The local security forces or other competent authorities will issue the permit.
2) The Contractor shall strictly comply with the rules and regulations in force in the country of the Works regarding purchase, transport, storage, handling and use of explosives.
3) Explosive magazines shall be reinforced concrete buildings with walls and slabs of a minimum 25 cm thickness. Doors shall be made of double sheets having a minimum thickness of 5 mm each and shall be fitted with safety type locks.
4) Explosives magazines shall be kept at a safe distance from working areas and living quarters. They shall be surrounded with barbed wire, protected by safety locks, ventilated, and fitted with lightning arresters. An air space shall be provided between the ceiling and the roof to prevent temperatures from reaching dangerous levels.
5) Blasting caps and detonators shall not be stored in the same magazines as explosives but shall be located in separate magazines at least 15 m away if barricaded and 30 m if un- barricaded.
6) Explosives shall be stored only in their original containers and with the top side up as designated on the container.
7) Access to the magazines and permission to handle explosives shall be granted exclusively to trustworthy personnel, adequately instructed and experienced in the use and handling of explosives.
8) The Contractor shall provide all reasonable and adequate security measures necessary to prevent loss or theft of explosives. Storage of explosives and detonators outside of the magazines shall not be permitted.
9) The Contractor shall maintain a record of storage and withdrawal of all explosives. This record shall be made available to the Engineer on request. The Engineer shall be promptly notified of any loss or theft of explosives.
10) Between the magazines and the place of use, the explosives and detonators shall be transported separately in lockable metallic containers loaded on a special wagon destined for the purpose of explosives transport only. These wagons shall be painted with striking colours for easy recognition. The inside of the containers shall be lined with wood in order to prevent a direct contact of the explosive or detonators with the metal.

2.7 BLASTING

1) All blasting shall be carried out in a proper and safe manner by a competent and experienced blast-man and no blast shall be fired without his approval.
2) Blasting will be permitted only after adequate provisions have been made for the protection of persons, the Works, and public or private property. The Engineer's approval of any of the Contractor's blasting operations shall not relieve the Contractor of his sole responsibility for the safety of persons and property. Any damage done to the Works or property by blasting shall be repaired by the Contractor.
3) Blasting in the open air shall be carried out only at certain hours of the day agreed upon by the Contractor and the Engineer. Barriers shall be erected, and warning shall be given to the workers at the Site and to the public immediately before blasting, so that no person will enter the danger zone until blasting is finished.
4) Upon completion of blasting, an "all clear" signal shall be given by the responsible blasting engineer after he has satisfied himself that all charges loaded have detonated and that no delay-explosions or misfiring are to be expected.

5) Such methods of blasting shall be employed that shock and vibration are minimized.
6) No blasts involving charges larger than 200 kg shall be carried without the written approval by the Engineer, who shall be notified at least one hour prior to the blast.
7) No blasting shall be permitted within 30 m of any concrete placed within the previous 7 days. After 7 days, blasting may be performed only with the approval of the Engineer. Blasting will not be permitted within 10 m of structures or installations vulnerable to damage by blasting.
8) No charging and firing will be executed during thunderstorm (except in underground works) and other electrical disturbances which can cause uncontrolled blasting.
9) Mats or rubber tires tied together with rope shall be used as protection from flying debris to cover the charges where blasting may expose persons or property to injury or damage.

2.8 FIRE PRECAUTIONS

1) The Contractor shall organize a fire brigade equipped for the fighting of any fires which could break out on the construction sites, in temporary structures, stores, residential quarters, etc.
2) An adequate number of fire extinguisher shall always be available at each construction site and in each building in camps and in offices and they shall be kept in satisfactory working order.
3) Firefighting equipment shall be of the gas, dry powder or other suitable chemical or pumped water type. Their number, type and location will be subject to the approval of the Engineer.

2.9 DUST ABATEMENT

During the performance of the work and any operations appurtenant there to, the Contractor shall carry out proper and efficient measures, such as sprinkling with water or other means, whenever necessary to reduce the dust nuisance, and to prevent dust which has originated from his operations from damaging crops, cultivated fields, and dwellings, or causing a nuisance to persons. The Contractor will be held liable for any damage resulting from dust originating from his operations.

2.10 POLLUTION OF STREAMS AND RIVERS

1) The Contractor shall take all possible steps to prevent pollution of streams, rivers, and other water supplies, at or in the vicinity of the Site and shall comply with applicable laws, orders and regulations in force in the country of the Works concerning the control and abatement of water pollution.
2) Under no circumstances shall the sewage from the camps, or other contaminated water, be released directly into river or other natural streams or any open areas without prior treatment.

2.11 NOISE DUE TO CONSTRUCTION ACTIVITIES

1) The Contractor shall take adequate measures to keep as low as possible noise caused by construction activities and specially that due to construction equipment and stationary plant. In particular, the following shall be observed.
    a) All engine operated equipment shall be as a minimum provided with standard silencer; however, equipment operating near the Contractor's camps or existing villages and houses shall be provided with high performance silencers, keeping the noise level below 70 dB measured at a distance of 3 m from the equipment.
    b) Motor compressors, motor generators, ventilation fans and other similar equipment if located near camps or existing villages and houses shall also, if necessary, be housed in a building;
    c) Equipment and stationary plant shall be generally located at adequate distance from camps or existing villages and houses, in such a way to avoid disturbance to

personnel working on the project and local inhabitants.

2) The Engineer shall have the right to require additional measures such as sound-dampening screens or more efficient silencers in case the noise level results higher than 70 dB measured at camp or village or house close- to the source of noise.

2.12 LOCAL COMMUNITIES AND RELIGIOUS CUSTOMS

1) The Contractor shall pay care to avoid damage to properties, buildings, artifacts and objects of local communities or individuals during the execution of the Works; similarly, he shall avoid to make use or occupy areas without the prior consent of the owners.
2) The Contractor shall also have due regard to religious and other, customs of local communities, and shall never interfere in any religious or civil ceremony.

2.13 VEGETATION AND WILDLIFE

The Contractor shall care, in planning, constructing, maintaining and operating temporary works, such as camps, roads, spoil, stockpile and construction facilities areas, to avoid unnecessary damage to areas of particular environmental interest, such as patches of remaining forest, valuable trees and erosion sensitive areas.

2.14 FINDINGS OF ARCHEOLOGICAL, HISTORICAL OR CULTURAL INTEREST

1) In case fossils, articles of value or antiquity and/or structures and other remains of things of archaeological, historical or cultural interest are discovered during the activities related to the construction of permanents or temporary works, the Contractor shall notify the Engineer without removing any part of the article or thing found.
2) The Contractor shall take the necessary measures for preventing that any person or equipment may damage the article or thing, and shall provide barricades, fences, signals and, if necessary, protection against atmospheric agents.
3) The Engineer shall agree with the Contractor about the possible required modification of permanent and/or temporary works in connection with archeological or historical findings and deal with the additional costs to the Works, if any, as a Variation.

2.15 ESHS RISKS AND IMPLEMENTATION PLANS

The Contractor shall submit the Implementation Plans to manage the following key Environmental, Social, Health and Safety (ESHS) risks.

- Construction Environmental and Social management Plan, to ensure the compliance with the ESMP findings
- Labour Influx Plan, to avoid negative impacts on the host community,
- Traffic Management Plan, to ensure safety of local communities from construction traffic
- Water Resource Protection Plan, to prevent contamination of drinking water
- Boundary Marking and Protection Strategy, for mobilization and construction to prevent offsite adverse impacts
- Consents/Permits Strategy, to obtain Consents/Permits prior to the start of relevant earth works,
- Occupational Health and Safety Plan, to entails the inclusion of EHS considerations in the implementation processes
- Access Road Plan, to cover the road risks and to avoid erosion effects,
- Material Use, Handling and Storage Plan, for the management for use and disposal of hazardous substances
- Waste management Plan, for the management of waste and dump sites
- Wastewater Plan, to adhere to the national rules and regulations,
- Dust, Air Emission and Noise Pollution Plan, to avoid risks of related accidents and risks,
- Emergency Preparedness Plan, to ensure the efficiency of the safety procedures

The Contractor shall be required to submit for approval, and subsequently implement, the Contractor's Environment and Social Management Plan (C-ESMP), in accordance with the Particular Conditions of Contract Sub-Clause 4.1, that includes the agreed Management Strategies and Implementation Plans described here.

The CESMP will cover the remedial and/or mitigation measures identified and reported in the Environmental and Social Impact Assessment (ESIA), Environmental and Social Management Plan (ESMP), Resettlement Action Plan and the Consent Conditions issued by the regulatory authority and to be attached to any permits or approvals for the project.

Furthermore, it will indicate the strategies to be adopted during the construction and operation phases to be submitted in appropriate Method Statements namely: Work site boundaries and safety area, Access Roads, Site clearing, Materials Use, Handling and Storage, Quarries, Refueling and Workshop management, Waste Management, Wastewater, Fire Control, Dust control and Air Pollution Management, Water Pollution Management, Noise control, Cement and concrete batching, Emergency Procedures, Safety Plan, Traffic Management Plan, Biodiversity protection.

2.16 MEASUREMENT AND PAYMENT

1) No extra measurement for payment or payment will be made for the items listed in the chapter 2 and the entire cost thereof shall be included in the Unit Prices for other items of the Works.
2) Any repair work or any indemnities required due to Contractor's non-compliance with the safety requirements shall be to the Contractor's expense.

3 SURVEYING, SETTING-OUT WORK AND CONSTRUCTION DRAWINGS

3.1 SCOPE OF WORKS

The Contractor shall:

1) verify the accuracy of the existing topographic surveys, provided by the Employer;
2) set-up a network of permanent benchmarks to be used for laying out the project works;
3) perform some additional geological and geotechnical investigations (Drillings, Situ and Laboratory Tests);
4) Prepare Construction Drawings (and relative support calculations); These drawings must take into consideration:
   a. detailed geological conditions that could emerge during excavations;
   b. details (such as weights and dimensions, etc.) provided by the electromechanical and hydromechanical equipment contractors;

These drawings shall be sufficiently detailed to allow construction of each project component.

3.2 SUBMITTALS

The Contractor shall submit to the Employer within one month from the completion of specific survey for establishing the new main benchmarks the following:

1) the survey methods and the instrumentation used for establishing the benchmarks and base lines necessary for the construction of the permanent works;
2) the calculations performed for establishing such benchmarks and base lines.

The Contractor shall submit to the Engineer at least forty-five (45) days before the start of each activity the relative Construction Drawings. The Engineer shall issue his observations within twenty-one (21) days from receipt of such drawings after which time the Drawings will automatically be deemed to be approved.

3.3 GROUND CONTROL POINTS

1) Prior to commencing the work, the Contractor shall undertake the check survey of the reference data provided by the Employer and satisfy himself as to their accuracy. Should he have any objections to this data and the relevant drawings, he shall inform the Engineer in writing within 2 weeks of the hand-over.
2) The Contractor shall realize, in order to locate accurately the setting out points, a net of permanent benchmarks, according to the detailed instructions given by the Engineer.
   The following requirements shall apply:

3.3.1 GENERAL

1) The Contractor shall perform surveys and setting-out necessary to establish the accurate location of the structures as shown on the Tender Design or Construction Drawings and shall carry out all necessary surveys to verify the topographical data used by the Engineer for the tender design and measuring purposes.
2) Within 15 days after the day of receipt of the Notice to Commence, the Contractor shall submit his proposed survey plan to the Engineer. The proposed plan shall indicate the accuracy for all surveys.
3) In advance of any setting-out work associated with all principal project features, the Contractor shall submit to the Engineer for approval a description of the method and procedures he intends to use in establishing Bench Marks and base lines.
4) If the Contractor chooses to use triangulation points or Bench Marks other than those furnished by the Employer, he shall do so at his own expense and risk.
5) The Contractor shall carry out topographical surveys of the original ground surface in each sector of the Works where surface excavation will be necessary, and produce sufficient and adequate cross-sections which will permit later to evaluate the volume of excavation for the measurement purposes and payment of excavation.

6) The Contractor shall entrust the surveying works only to persons who, by their training and experience, have sufficient qualifications and knowledge to ensure proper fulfillment of the survey tasks assigned to them. For the performance of survey work, the Contractor shall provide a sufficient number of reliable and accurate survey instruments.

3.3.2 BENCH MARKS AND TRIANGULATION STATIONS

1) Permanent survey control points shall be established prior to starting the work and such permanent points shall be preserved and protected during construction operations.
2) A minimum of 2 permanent bench marks shall be established for each major structure, and referenced to data established by survey control points. The location of such points with horizontal and vertical data shall be recorded on the construction record drawings by the Contractor.
3) From the primary survey control points the construction surveys shall be performed as required to locate, set-out and construct each portion of the Works.
4) Complete and adequate logs of all control and survey work shall be maintained as it progresses. Such logs shall be available for the Engineer's inspection at all times.
5) The Contractor shall protect, preserve and keep accessible the bench marks and triangulation stations of the basic survey and those provided by himself. Any damage or removal of bench marks and stations, including such of other parties shall be prevented. Any accidental damage shall immediately be brought to the attention of the Engineer. It is expressly stated that the Contractor will be made responsible for the damage and its consequences.
6) Bench marks shall be of stainless steel or cast iron. In softer soil, the steel bolt shall be embedded in a block of concrete of suitable size, and absolutely stable. Inscriptions shall be durable and clearly legible.
7) Subordinate points may be marked by steel pipes or pegs, subject to the approval of the Engineer. Every newly fixed point shall be checked, as far as possible, through elements other than those used to establish the point.

3.3.3 ACCURACY OF SURVEYING

1) Horizontal distances shall normally be measured with optical or electronic distance measuring instruments. Chaining shall be restricted to measuring of short distances and will not be used in survey of traverse nets.
2) Elevations and angles shall be measured by using an appropriate electronic or optical instrument.
3) Traverse nets shall be executed with the precision as indicated in Table 3-1 at the end of this Section.
4) Levelling shall be checked by closing the loop to the initial bench mark. The elevation difference of the two legs of the loop shall not exceed 12mm √K
5) where K is the total levelling distance in kilometres.
6) The Contractor may adopt GPS differential methods for the measurement of coordinates and levels after prior approval by the Engineer of the proposed procedure and the relative accuracy of the measurements.

3.3.4 AUXILIARY WORKS

The Contractor shall perform auxiliary works with regard to surveying which shall include, but not be limited to, the following:

a) Perform all necessary calculations with clear presentation of calculations and results in order to facilitate verification
b) Expose covered bench marks
c) Provide bench marks in lieu of and/or in addition to the existing ones
d) Remove machinery and obstructions from the required sight-lines
e) If it is hindering the survey work, stop all machinery, drilling, blasting, driving and

other work causing ground vibration and stop all smoke, dust, gas, etc., obscuring clear view or causing refraction

f) Restrict or stop traffic of persons and vehicles near instruments or in sight-lines during instrument observations as required
g) Provide adequate lighting or shut off sources of interfering light to ensure the necessary clear view
h) Provide adequate labour, and materials as deemed necessary and suitable by the Engineer for the control and auxiliary surveys
i) Remove all obstructive accumulation of water
j) Carry out additional topographical surveys in cases where the existing topographical data is, in the opinion of the Engineer, insufficient for accurate measurement of the Works
k) Carry out all necessary topographical surveys for the incorporation of measuring equipment and instrumentation located in the Permanent Works
l) Carry out all necessary topographical surveys for the observation of the behavior of structures during construction

3.3.5 DAMAGE TO CROPS AND VEGETATION

1) No trees or crops of economic value existing at the Site shall be damaged or removed by the Contractor during survey and cross-sectioning works prior to their enumeration and evaluation.
2) Throughout the surveying and setting-out the Contractor shall work closely with the authorized local appraisers of crops and vegetation in question and shall provide them with facilities necessary for the expeditious performance of their duties.
3) As soon as a section of work has been defined and valued, the Contractor shall delineate the boundaries of the areas to be cleared by approved markings.

3.3.6 CHECKING OF CONTRACTOR'S WORK BY THE ENGINEER

1) All elements of the Contractor's survey work associated with the setting-out of principal project features will be regularly checked by the Engineer during the course of the work, and the Contractor shall provide assistance at any time as required in the performance of such control work.
2) The Contractor may be required to provide the Engineer with any information, readings or computations for checking.
3) The regular checks will usually be made during work breaks, but in case of urgency, the Contractor shall restrict or stop the affected work.
4) Any checks by the Engineer shall not relieve the Contractor of his full responsibility for the accuracy of structures and parts of them with regard to their position and dimensions.

3.4 CONSTRUCTION DRAWINGS

The Construction Drawings shall completely define each architectural, structural and plant detail of the works to be realised.

The Construction Drawings shall be prepared in full respect of the Tender Design and technical specifications annexed to the contract or based on the additional Detailed Drawings provided by the Engineer.

The Construction Drawings shall include:

1. structures in reinforced concrete or precompressed reinforced concrete, including the shop drawings;
2. Hydro-Mechanical structures. These drawings shall contain the details regarding joints, connections, number and position of nuts and bolts, weldings, etc.;

The Drawings shall be accompanied by accurate technical reports.

3.5 MEASUREMENT AND PAYMENT

3.5.1 SURVEY AND GROUND CONTROL POINTS

No extra measurement for payment or payment will be made for Contractor's survey and setting-out work and the entire cost thereof shall be included in the Unit Prices for other items of the Works.

Table 3.1-Accuracy of Transverse Nets

	Traverse net for additional fixpoint	Traverse net for setting out
Number of azimuth courses azimuth checks not to exceed	n = 25	n = 50
Max. difference in cm between two measurements of the distance of two points (d = distance in m)	$d = 0.003\sqrt{d} + \frac{d}{5000}$	$d = 0.004\sqrt{d} + \frac{d}{5000}$
Azimuth closure at azimuth: check points not to exceed (centesimal degrees)	$\frac{c}{2}\sqrt{3}{n}$	$\frac{c}{3}\sqrt{3}{n}$
Closing error in position, after azimuth adjustment (d = distance in m) $f_s = \sqrt{f_y^2 + f_x^2}$ (cm)	$f_s = 0.001\sqrt{d} + 10cm$	$f_s = 0.002\sqrt{d} + 10cm$

3.5.2 CONSTRUCTION DRAWINGS

No extra measurement for payment or payment will be made for the above-mentioned drawings. The related cost is included in the Unit Prices for other items of the Works.

4 SITE INSTALLATIONS AND SERVICES

4.1 SCOPE OF WORK

4.1.1 TEMPORARY SITE INSTALLATION

1) The Contractor shall be responsible for providing construction equipment, materials and labour for the provision of all necessary Temporary Site Installations and facilities adequate for carrying out the Works under this Contract.
2) The Contractor shall design, furnish, install, operate and maintain the Site installation, workshops, warehouses, storage areas etc. including the related facilities.
3) Site installation carried out by the Contractor shall conform to the applicable standards, codes and sanitary requirements in force in Republic of Uganda for such purpose.
4) The design, construction, operation and maintenance of the Contractor's temporary installations shall be subject to inspection and approval by the Engineer.
5) All site installations and facilities provided by Contractor, shall at all times remain Contractor's property unless otherwise specified in the Contract or agreed by the Parties.
6) Unless otherwise agreed with the Employer, upon the Completion of Works, the Contractor shall dismantle and remove from the Site the site installations and facilities.

4.1.2 PERMANENT SITE INSTALLATIONS

1) The Contractor shall provide the following:
    a. the Workers' Camp;
    b. the Management's Camp;
    c. Offices.
2) The Contractor shall provide Construction Drawings.
3) The structures shall be used by the Contractor, the Engineer and the Employer during the construction phase.
4) The Contractor shall be responsible for the cleaning, security and maintenance of the camps during the construction period.
5) The Contractor shall be liable for any damage to or deterioration of the structures until the end of the works.
6) At the end of the works, the above structures shall be handed over to the Employer in perfect condition.

4.1.3 SERVICES

1) The Contractor shall be responsible for providing services to the Employer, the Engineer and Employer's other contractors working for the Kabuyanda Project.
2) The services will include the rent of vehicles, the use of the medical care facilities, the use of the communication systems, the use of survey equipment, the cleaning of offices, the disposal of garbage, the availability of site facilities (catering, recreation and commercial concessions), the use of the water supply, ventilation and illumination systems.

4.2 SUBMITTALS

1) Within 21 days from the date of issue of the Notice to Commence, the Contractor shall submit to the Engineer updated layout plans showing at adequate scale the locations and arrangement of all site installations along with the related facilities. These plans shall be consistent with the plan submitted by the Contractor with his Bid as well as with any amendments and additions subsequently agreed to by the Engineer and the Contractor, and shall include:
    a) camps and offices
    b) Parking areas, warehouses, storage areas, and medical care facilities
    c) Temporary roads
    d) Water supply, sewerage, sewage treatment and disposal
    e) Power supply and illumination, telephone and internet services

f) Equipment pools and mechanical workshops
g) Spoil areas, quarry and stockpile areas
h) Concrete aggregates processing plant
i) Concrete batching and mixing plant including cement storage
j) Explosives magazines
k) Security and safety arrangements

2) Within 28 days from the date of issue of the Notice to Commence, the Contractor shall submit to the Engineer the following:
   a) Detailed drawings at scale 1:500 showing the camps layout, buildings, roads, recreation areas, utilities, etc., and drawings at scale 1:50 showing typical construction details of all buildings;
   b) Detailed design of clinic\infirmary;
   c) Detailed design for industrial and potable water supply to the camps and working areas as well as sewerage systems, sewage treatment and disposal;
   d) Detailed layout drawings for electrical installations and distribution systems, at the Site, showing voltages, outlets, and routing of power lines;
   e) Detailed design and drawings including manufacturer's drawings and flow charts for the concrete and aggregate processing plant, in accordance with the requirements of the pertinent Sections of these Specifications.

4.3 SITE INSTALLATIONS

4.3.1 CAMPS

1) The Contractor shall construct, provide furnishings, maintain, and operate the camps necessary for his staff and labour as well as for the staff and labour of hissubcontractors.
2) The camps shall include offices, kitchens, dining rooms, recreation facilities, family dwellings, dormitories, sanitary facilities, medical service, shops, chapel and/or mosque, roadways, drainage, fire control, commercial facilities, and all utility services (potable water, power, lighting, ventilating, sewage treatment and disposal, cleaning and sanitation, garbage collection and disposal, etc.). The camps shall be large enough to accommodate the expected peak work force.
3) The areas approved by the Engineer will be put at the Contractor's disposal free of charge and in their natural conditions. The Contractor shall be responsible for the necessary topographical surveys, clearing, and earthwork required for the landscaping and to provide satisfactory foundations for buildings, streets and auxiliary facilities.
4) No camp construction shall commence until the Contractor's drawings and specifications have been approved by the Engineer.
5) All camp buildings shall be of sound construction and neat appearance and connected to all utility services.
6) Food handling, preparation and serving shall be arranged by the Contractor in properly equipped canteen buildings for all his, his subcontractors' employees, Engineer’s staff and the Employer.
7) The prices charged by the Contractor for food, beverages, etc., available in the camp shall be calculated on a non-profit basis.
8) The Contractor shall be responsible for keeping the camp, and the buildings within it, in good hygienic conditions. The standards and regulations presently in force in Republic of Uganda with regard to personnel treatment, sanitary conditions, and fire and accident prevention shall be duly taken into account.

4.3.2 AUXILIARY BUILDINGS AND STORAGE AREAS

1) The Contractor shall provide, equip and maintain, for his own and his subcontractors' use, main and secondary offices, warehouses, materials storage areas, fuel storage areas,

explosives magazines and other necessary auxiliary buildings.

2) Listed hereunder are the shops, warehouses, stores and stations expected to be required for the performance of the Works under this Contract, in addition to facilities explicitly specified elsewhere in these Specifications:
    a) Mechanical repair shop
    b) Electrical repair shop
    c) Metalwork and wood fabrication shop
    d) Main warehouse
    e) Bagged cement store
    f) Spare parts store
    g) Gasoline and oil stations
3) The Contractor is required at all times to have at the Site at least one month's minimum reserve of the following materials:
    a) Gasoline
    b) Diesel and lubricants
    c) Cementitious materials (unless any other reserve requirements are given elsewhere in these Specifications)
    d) Explosives
    e) Steel reinforcement
    f) Medical supplies
    g) Main foodstuff and beverages

4.3.3 MEDICAL CARE FACILITIES

1) The Contractor shall comply with laws and health standards presently in force in Uganda. In the event of illness of an epidemic nature breaking out, the Contractor shall carry out and comply with all orders, arrangements or regulations which may be issued by the Government or local authorities.
2) The Contractor shall construct, equip, and maintain at the Site, at least the following medical care facilities:
    a) One clinic/infirmary, with two ambulances and drivers:
    b) One first aid station, near the quarry
3) The clinic/infirmary shall be available and fully operational beginning of the Works. The construction of this facility shall be such as to provide reasonable quiet, privacy, communications, adequate ventilation, air conditioning system, light, hot and cold water, toilet facilities and electrical outlets.
4) The first aid station shall consist of cabinets equipped with apparatus and materials necessary for the treatment of minor injuries and the assistance for transferring the personnel that incurs in major accidents to the site clinic/infirmary.
5) The clinic/infirmary shall have separate rooms for normal and epidemic illnesses and shall be fully equipped and staffed to meet the requirements of the peak anticipated workload and labour force, taking into account the nature of the Works and its occupational hazards.
6) Medical services in the clinic/infirmary shall be under the direction of a licensed physician/surgeon on a 24-hour basis throughout the duration of the construction and shall be available, including drugs, free of charge to all persons and participants engaged in the Works and their families or dependents living at the Site.
7) Treatment facilities and care of seriously ill or injured patients shall be on an emergency basis until their transfer to an established hospital is made. Standing arrangements to this effect shall be made by the Contractor with the nearest general hospital, and the Engineer shall be notified accordingly.
8) Upon the Completion of Works, the Contractor shall hand over the medical care facilities to the Employer.

4.3.4 COMMERCIAL CONCESSIONS

1) Possible commercial concessions such as for laundry, catering, shops, etc., granted to a third party by the Contractor for the use of his personnel resident at the Site, shall be subject to approval by the Engineer. Any concession shall be revoked if the concessionaire violates the law or the provisions governing the granting of the concession. Concessions shall automatically terminate upon completion of the Works or in the event of the termination of the Contract.
2) No concession shall be granted for activities that are contrary to statutory regulations or are declared by the Engineer to be offensive to the community.
3) Concessionaires will be regarded as subcontractors of the Contractor.

4.3.5 STATIONARY PLANTS

1) The Contractor shall install and erect all plants necessary for production of filter material and for aggregate processing and concrete batching-mixing, of sufficient capacity to meet the planned peak requirements during construction. The plants shall be subject to approval by the Engineer and shall be designed and fabricated according to the modern technical criteria.
2) All plants shall be kept in good running order to ensure compliance with the materials quality specifications. All control and measuring equipment shall be regularly serviced and calibrated.
3) Basic characteristics of the required plants are given in the pertinent sections of these Specifications.

4.3.6 MATERIALS TESTING LABORATORY

1) The Contractor will be responsible of all tests for the Quality Control to be performed in connection with the concrete and other materials used for the construction of the Works.
2) The Contractor shall supply, install, operate, maintain and remove at the end of the Works a site laboratory that will have to function as Quality Control of the Works.
3) The laboratory shall be run by Contractor's personnel experienced in sampling and testing of materials, and quality control.
4) The Contractor’s laboratory shall be designed for performing all sampling and tests required in the Technical Specifications.
5) All sampling and testing to be undertaken shall be under the direct supervision of the Engineer.
6) Specialized testing may be required, and which cannot be performed in the site laboratory due to unavailability of proper equipment shall be assigned to independent organizations at Contract’s cost.
7) The Contractor shall be responsible for the handling and transport of all materials that will be required specialized testing.

4.3.7 COMMUNICATION SYSTEMS

4.3.7.1 Communications

1) The Contractor shall supply, install, operate and maintain a telephone switchboard, complete with standby power supply, to connect his offices with those of the Employer and Engineer, as well as campsite, laboratory, workshops, stores, aggregate plants, batching plants, medical care facilities and other work areas within the Site.
2) The Contractor shall furnish a directory of the telephones installed at the Site and make it available to the Engineer.
3) In addition to the local telephone system, the Contractor shall supply, install and maintain mobile two-way radio transceiver sets for the Engineer's and for his service vehicles for on-site communications.
4) Upon the Completion of Works, the Contractor shall dismantle and remove from the site the installed site communication. However, the Employer reserves the right to purchase

some or all of the equipment.

4.3.7.2 Long-Distance Communications

1) The Contractor shall supply, install, operate and maintain the access to the national and international telephone grid (Voice and Data).
2) The Employer will endorse the necessary license applications of the Contractor.
3) Upon the Completion of Works, the Contractor shall dismantle and remove from the Site the installed outside communications. However, the Employer reserves the right to purchase some or all of the equipment.

4.3.8 POWER SUPPLY AND ILLUMINATION

1) The Contractor shall provide, install and keep operational throughout the execution of the Works his own electric power generation equipment, with a capacity sufficient to satisfy the requirements of the Works, including electric powered construction equipment, camps, buildings, water supply, de-watering, safety and security systems etc.
2) The power generating station shall be fitted with devices that can automatically govern the operation of the sets according to the actual network load.
3) The Contractor shall install, operate and maintain the electrical distribution systems which he deems necessary, including all necessary transformers, circuit breakers, disconnect and safety switches, voltage regulators, transmission lines, poles, pole hardware, conductors and other equipment necessary for power distribution throughout the work areas and temporary facilities.
4) The Contractor shall ensure adequate illumination for all his working activities and at the camp, including illumination of the streets.
5) Upon the Completion of Works, the Contractor shall:
    - dismantle and remove all power generation and distribution facilities installed by him for the temporary camps;
    - overhaul and handover to the Employer all power generation and distribution facilities installed by him for the permanent camp.

4.3.9 WATER SUPPLY

1) The Contractor shall design, install, operate and maintain water supply facilities for the needs of the works and the camps.
2) Two separate water supply systems for raw water and potable water are foreseen.
3) The raw water will be used for construction activities and therefore it shall be treated to the extent necessary to meet specified requirements for concrete, mortars, aggregates, curing, etc.
4) The potable water will be used for the buildings. The potable water shall be of high-quality meeting official requirements for drinking water supply.
5) The water supply systems shall allow for the provision of water to the hydrants of the whole site for fire fighting.
6) The Contractor shall obtain the water from suitable natural local sources, free of contamination and unaffected by the Site construction work approved by the Engineer. For working areas with no natural sources, the Contractor shall provide sufficient number of water-tank trucks to cover the requirements on both the industrial as well as potablewater.
7) The Contractor shall furnish, install, operate and maintain all pumps, piping, fittings, valves, storage tanks, purification plant and chlorination for the water supply and distribution systems, adequate in quantity and pressure. There shall be no cross connections of any kind between the industrial and potable water supply systems.
8) Throughout the duration of the construction, the Contractor shall take regular samples from all water supplies to examine it for suitability and treatment required and make weekly the bacteriological tests from potable water systems.
9) Drinking points of potable water shall be provided by the Contractor for the use of

personnel in all working areas.

10) Upon the Completion of Works, the Contractor shall:
    - dismantle and remove all water supply systems installed by him for the temporary camps,
    - overhaul and handover to the Employer all water supply systems installed by him for the permanent camp.

4.3.10 SANITATION AND SEWERAGE

1) All offices, workshops, laboratory and other occupied work buildings shall be provided with toilets connected to properly constructed and regularly maintained septic tanks approved by the Engineer.
2) The camp sites shall be provided with a complete, properly maintained and operated sewerage system, including septic tanks, sewage treatment and disposal facilities. Facilities for washing clothes shall also be provided and linked to the sewerage system.
3) Portable chemical toilets shall be provided and maintained by the Contractor for the use of all personnel at all work locations which are remote from fixed sanitary facilities. The Contractor shall arrange for all chemical toilets to be attended to for proper sanitary disposal on a daily basis.
4) Upon the Completion of Works, the Contractor shall:
    - dismantle and remove all sanitation and sewerage systems installed by him for the temporary camps,
    - overhaul and handover to the Employer all sanitation and sewerage systems installed by him for the permanent camp.

4.3.11 WASTE AND GARBAGE DISPOSAL

1) The Contractor shall collect waste material and garbage from camp, offices and workshops on a daily basis and transport them to an area approved by the Engineer where it shall be incinerated and/or buried.
2) The Site shall be kept clean and free of refuse at all times. No waste shall be dumped in areas other than those approved by the Engineer for waste disposal. No waste of any kind shall be deposited in any watercourses.

4.3.12 FENCING AND SITE SECURITY

1) The Contractor's offices, workshops and storage compounds, campsites and all construction areas where exclusion of unauthorized personnel is necessary for safety and security, shall be adequately fenced, gated and guarded.
2) The Contractor shall employ an adequate force of properly trained security guards at the work site and at the construction camp on 24-hour duty including Sundays and holidays. Storage areas shall be fenced, lighted and regularly patrolled by security guards. Warehouse buildings and explosive magazines shall be kept locked and keys accounted for at all times.
3) All employees engaged in the execution and maintenance of the Works shall wear identification badges when at the work site.
4) The Contractor shall be responsible for the losses occurring in his installations.

4.3.13 INSPECTION BY THE EMPLOYER OR ENGINEER

The Employer and the Engineer have the right at any time to inspect any part of the Contractor's temporary facilities, without advance notification, and to require immediate rectification of any contravention of the specified requirements.

4.3.14 FINAL CLEAN-UP

1) Upon the Completion of Works, or when any plant has completed its functions, the Contractor shall dismantle and demobilize all temporary facilities erected by himself or his subcontractors, and remove all debris, objectionable material, and all other refuse which may have been deposited on Site during the construction period. Such materials may be deposited only in areas approved by the Engineer. The Contractor shall also remove from

the Site any plant and equipment which he finds at the commencement of the Works in accordance with the instructions of the Engineer.

2) All excavated areas shall be filled, graded and dressed in a clean and orderly condition acceptable to the Engineer. As far as possible, such areas should conform to the natural appearance of the landscape.
3) No demobilization or removal of temporary facilities and equipment shall be made without prior approval of the Engineer.

4.4 SERVICES FOR EMPLOYER AND ENGINEER

4.4.1 COMMUNICATION SYSTEMS

The Contractor shall make both the site and long-distance communications systems available to the Employer and the Engineer.

4.4.2 SURVEY EQUIPMENT

1) Surveying instruments shall be provided by the Contractor for exclusive use of the Employer's and Engineer's site staff. These instruments shall be brand new, of the latest design and manufactured by reputable manufacturer acceptable to the Engineer. The instruments shall include all items necessary for the Engineer to be able to establish horizontal and vertical control and to check the Contractor's surveying work.
2) The Contractor shall submit to the Engineer for approval the proposed make, type, and models with catalogues, prior to place the purchase order. The following minimum equipment shall be provided:
    - 1 No total station Make TRIMBLE, Model S9 0.5" Robotic, DR HP, Long Range FineLock (with an accuracy of 0.8 mm) or similar complete with all accessory items such as 2 No batteries, battery charger, memory card, power cable, carrying case and other standard accessories supplied with the instrument;
    - 3 No 360-degree TRIMBLE prism complete with telescopic range poles, circular bubbles, extension rods and carry bags;
    - 1 No TRIMBLE hardwood tripod to suit the total station;
    - 1 No TRIMBLE automatic level;
    - 1 No aluminium tripod to suit the automatic level;
    - 1 No, 4 metre long aluminium staff graduated at 0.005m intervals;
    - 2 No, 50 metre fibron tapes;
    - 3 No, 5 metre steel tapes.
3) The Contractor shall provide the Engineer with any additional surveying equipment and materials such as pegs, mallets, stakes, nails, paint, etc., as required for checking the Works. Any instrument which has been damaged or is non-operational shall be immediately replaced or repaired by the Contractor.
4) Upon the Completion of Works, all surveying equipment will be returned to the Contractor. However, the Employer reserves the right to purchase some or all of the equipment.
5) The Contractor shall make available to the Engineer any surveying instrument owned by his surveying department, but not included in the above list of equipment, which may be necessary for checking the Works.

4.4.3 VEHICLES

1) The Contractor shall provide, repair and maintain the following vehicles for the exclusive use of the Engineer within 56 days after the day of receipt of the Notice to Commence:
    a) 3 Nos Land Cruiser type, 4-wheel drive, minimum 5 passengers' capacity
    b) 3 Nos Pickup truck of 1.5 t capacity

    The vehicles shall be of the latest design of Rover, Toyota or other reputable manufacturer acceptable to the Engineer.

    These cars shall be supplied brand new, fully licensed and insured, and shall be replaced

by new ones in case of repeated breakdowns. The estimated number of vehicles and the number of months they will be required are given in the Bill of Quantities.

2) The above vehicles shall be assigned full time to the Engineer, for official and private use. In case of breakdown or if a vehicle is undergoing repair and maintenance at the workshop, the Contractor shall provide a replacement immediately.
3) All service vehicles shall be returned to the Contractor upon the Completion of Works. However, the Employer reserves the right to purchase some or all of the vehicles.

4.4.4 OFFICE CLEANING AND GARBAGE DISPOSAL

1) The Contractor shall provide personnel and perform daily cleaning of the Engineer's site offices.
2) The Contractor shall collect daily and dispose of, in a location and manner approved by the Engineer, all domestic waste and garbage from the Engineer's site offices and housing compound. Collection times shall be arranged for the convenience of the Engineer.

4.4.5 MEDICAL CARE FACILITIES

The Contractor's medical care facilities shall be made available for use by the Employer's and Engineer's site staff and their families or dependents living at the Site.

4.4.6 CATERING, RECREATION FACILITIES, AND COMMERCIAL CONCESSIONS

1) The Contractor's catering and recreation facilities including canteen, and commercial concessions shall be made available, **at a fee**, for use by the Employer's and Engineer's site staff and their families living at the Site.
2) The Contractor shall take care that these facilities and supplies available are suitable for expatriate personnel.
3) The Contractor’s canteen facilities shall be designed and operated in such a way that the Employer’s personnel may have meals which are prepared in accordance with Ugandan customs **at a fee**.

4.5 MEASUREMENT AND PAYMENT

4.5.1 SITE INSTALLATIONS

4.5.1.1 Camp, Auxiliary Buildings, Materials Testing Laboratory and Storage Areas

1) Payment for the camp, auxiliary buildings, materials testing laboratory, storage areas and appurtenant facilities will be made as Lump Sum entered in the Bill of Quantities.
2) Payment shall cover the entire cost of design, delivery, land preparation, earthmoving, fencing, tests, dismantling, removal from Site and reinstatement of the Site.
3) Payment will be made in two instalments. The first, of 85% will be made when the said facilities are, in the opinion of the Engineer, fully installed, commissioned and ready for use. The second, of 15% will be made:
    - for the temporary site installation: upon removal and Site reinstatement to the satisfaction of the Engineer;
    - for the permanent installation: after verification of the efficient working conditions of the installations by the Engineer.
4) Should the Contractor fail to execute the final clean-up to the full satisfaction of the Engineer, the second instalment of 15% will be retained. In the event that this amount proves to be insufficient for financing of the Site reinstatement, all extra costs shall be deducted from the money due to the Contractor.

4.5.1.2 Stationary Plants

1) Payment for the stationary plants (aggregate processing plant and concrete batching and mixing plants), including the related facilities, will be made at the Lump Sum price entered in the Bill of Quantities.
2) Payment shall cover the entire cost of design, delivery, earthmoving, installation and tests, dismantling, removal from Site and reinstatement of the Site.
3) Payment will be made in two instalments. The first, of 85% will be made when the said

facilities are, in the opinion of the Engineer, fully installed, commissioned and ready for use. The second, of 15% will be made upon removal and Site reinstatement to the satisfaction of the Engineer.

4) Should the Contractor fail to execute the final clean-up to the full satisfaction of the Engineer, the second instalment of 15% will be retained. In the event that this amount proves to be insufficient for financing of the Site reinstatement, all extra costs shall be deducted from the money due to the Contractor.

4.5.1.3 Exclusions

No separate payment will be made for, but not be limited to, the following Contractor's temporary installations and facilities and the entire cost thereof shall be included in the Unit Prices and Lump Sum of the Bill of Quantities:

a) Medical care facilities;
b) Commercial concessions;
c) Communication systems;
d) Power Supply and Illumination;
e) Water supply;
f) Sanitation and sewerage;
g) Waste and garbage disposal;
h) Fencing and site security.

4.5.2 SERVICES FOR EMPLOYER AND ENGINEER

4.5.2.1 Communication Systems

No separate payment will be made for the use of the Contractor’s communication systems, except for the long-distance telephone communications bills, which will be issued by the public service utility.

4.5.2.2 Survey Equipment

1) Payment for the rental and maintenance of survey equipment will be made as Lump Sum entered in the Bill of Quantities, which shall cover the entire cost of furnishing and maintaining of the equipment and accessories.
2) Payment for survey equipment will be made in two instalments. The first, equal to 90% of the Lump Sum, will be made when the complete equipment is handed over to the Engineer. The second, equal to 10%, will be made at the completion of the works.

4.5.2.3 Service Vehicles

1) Payment for the service vehicles will be made under two headings:
   a) Supply of each Vehicle
   b) Operation Cost of each Vehicle
2) Payment for supply of the vehicles will be made at the Lump Sum entered in the Bill of Quantities, at the time of delivery of the requested vehicle, fully licensed, insured and road worthy. The Lump Sum shall include the entire cost for supply, transport to site, taxes, duties and the driver’s salary. The driver’s salary shall include all compensation for night work, work on weekends or holiday, vacations, social and security contributions, and taxes as prescribed by the rules and laws of Uganda.
3) Payment for operation will be made at the unit price per kilometer entered in the Bill of Quantities, which shall cover the entire cost of servicing and maintaining of the vehicles. In particular the unit price shall include the supply of fuel, lubricants, spare parts and tires.

4.5.2.4 Medical Care Facilities

No separate payment will be made for the use of the Contractor’s medical care facilities, and the entire cost thereof shall be included in the Unit and Lump Sum Prices of the Bill of Quantities.

4.5.2.5 Catering, Recreation Facilities and Commercial Concessions

1) The Employer's and Engineer's employees will directly reimburse the Contractor for the use of Contractor's catering facilities.

2) Payment will be made at the unit price entered in the Bill of Quantities for every meal (breakfast, lunch and dinner) served in the canteen to Engineer's site staff or dependents living at the Site.

3) No separate payment will be made for the use of Contractor's recreation facilities and commercial concessions, and the entire cost thereof shall be included in the Unit and Lump Sum Prices of the Bill of Quantities.

4.5.2.6 Waste and Garbage Disposal

No separate payment will be made for the waste and garbage disposal service performed by the Contractor, and the entire cost thereof shall be included in the Unit and Lump Sum Prices of the Bill of Quantities.

5 CARE OF WATER DURING CONSTRUCTION

5.1 SCOPE OF WORK

1) The Contractor shall provide all labour, material, and equipment necessary to build and maintain the Temporary Works for protecting the Works under construction against flood flows in the rivers and creeks, and to design, build, install, operate, maintain and dismantle the temporary de-watering facilities required to remove service water and natural surface flow or groundwater seepage from the working areas.
2) The temporary works and facilities for the care of water during construction shall be designed by the Contractor, subject to the approval of the Engineer.
3) All such Temporary Works and dewatering facilities shall be removed at the end of the works, so as to give a slightly appearance and not to interfere in any way with the operation or usefulness of the permanent works, except different authorization of the Engineer.
4) The Contractor shall not interrupt or interfere with the flow of the Mishumba River or other streams for any purpose without the approval of the Engineer.
5) The areas of the temporary protection works shall be readily accessible at all times and the Contractor shall make continuous survey of floods to the satisfaction of the Engineer.
6) The hydrology of the Mishumba River and the discharge capacity of the main river diversion facilities shown in the drawings or in the Information for Bidders are to be regarded as merely indicative to aid the Contractor in his planning of the construction works.
7) The Employer and the Engineer do not guarantee the reliability or accuracy of this information and assume no responsibility for any interpretation or conclusion which may be made or drawn by the Contractor.
8) The Contractor shall be fully responsible for any damage or delay to the Works caused by failure of his protective works.
9) The Contractor shall also be responsible for and shall repair or reinstate at his expense any damage to foundations, excavation slopes or any other part of the Works caused by the failure of the protective works and/or pumping installation.

5.2 SUBMITTAL

1) The Contractor shall submit to the Engineer the design, including full details of equipment to be installed and all necessary construction details required for the de-watering purposes, at least 30 days prior to scheduled construction of the particular work.
2) This design shall be consistent with the outline description submitted by the Contractor with his Bid, and shall include the following:
    a) Design assumptions and calculations
    b) Layouts of diversion and drainage facilities
    c) Layout and capacity of pumps and pipes, sumps, drains, etc.
    d) Any other arrangements or installations the Contractor may propose for temporary protection of the Works and de-watering of the surface working areas

6 CONCRETE

6.1 GENERAL

1) The work under this Section includes all labour, materials, equipment and services related to the concrete work to be carried out by the Contractor under this Contract.
2) The concrete work shall be performed to the dimensions as shown on Detailed Design and/or Construction Drawings or as otherwise directed by the Engineer. Lift drawings shall be prepared by the Contractor.
3) The approval given by the Engineer to the Contractor's Equipment or their operation, or of any construction methods shall not relieve the Contractor of his full responsibility for the proper and safe execution of concrete work or any obligations under this Contract.

6.2 STANDARDS

1) Concrete materials, methods and procedures shall conform to the applicable standards of the American Society for Testing and Materials (ASTM) or, where not covered by ASTM Standards, shall conform to the applicable standards or recommended practices of the American Concrete Institute (ACI) and those contained in the US Bureau of Reclamation "Concrete Manual".
2) In cases of conflict between these Specifications and the above, these Specifications shall take precedence.

6.3 COMPOSITION AND CLASSES OF CONCRETE

1) Concrete shall be composed of cement, water, fine and coarse aggregate and possible admixtures.
2) The design of concrete mixtures will be aimed to securing a plastic, workable mixture suitable for the specific conditions at placement and, when properly cured, a product having durability and strength in accordance with all the requirements of the structures covered by the Contract Documents. The water content of all concrete mixtures shall be the minimum necessary to produce a workable mixture. Admixtures shall only be used with the approval of the Engineer.
3) According to the use of the different structures of the Works and the stresses expected to be acting upon them, various concrete classes have been designated. Denomination of concrete classes is based on the nominal cylinder compressive strength (in Newton per square mm) and maximum aggregate size.
4) The cylinder compressive strength is defined as the strength as measured on the test cylinders 150 mm diameter and 300 mm high tested at 28 days. The nominal strength is defined from a sequence of samples produced and used in standard conditions so that 85% of all samples exceed the nominal strength, assuming a normal statistical distribution for the majority of test values. No test value, however, may lie below a minimum, which is at 70% for concrete of less than 20 N/mm2, and at 85% for concrete of more than 20 N/mm2 of the corresponding nominal strength. With very large numbers of test values a 1-2% below the minimum will be acceptable, providing they do not compromise the safety of structure.
5) Concrete mixes with the indicated nominal compressive strengths and maximum aggregates sizes which will be required for the construction of the Permanent Works are indicated in the following Table. The class of concrete required to be used in any specific location shall be as shown on the Detailed Design and/or Construction Drawings, or as directed by the Engineer.

Class of Concrete	Characteristic Strength		Max. Size of Aggregates (mm)
	MP	2 kg/cm	
C15D32	15	150	32
C20D32	20	200	32

C20D76	20	200	76
C25D20	25	250	20
C25D32	25	250	32
C25D32 W(1)	25	250	32
C30D20	30	300	20
C30D32	30	300	32
C35D20	30	300	20
C35D32	30	300	32

Differs from previous by impermeability (letter W added)

6) The final design of concrete mixes will be established by the Engineer, at the Site laboratory. The execution of all testing on concrete and its constituent materials, both before and during placing, will be the responsibility of the Contractor.

6.4 SUBMITTAL

1) Submittal listed herein are related to items which require the consent of the Engineer and are to be made by the Contractor before the appropriate work may proceed.
2) Within 28 days from the date of issue of Notice to Commence, but before procuring or mobilizing to the Site the equipment, the Contractor shall submit to the Engineer updated and detailed plans and descriptions, consistent with those submitted with his Bid and any subsequent amendments and additions agreed to by the Engineer and the Contractor, of the following:
    a) Aggregates Processing Plant: description, flow diagrams and drawings in sufficient details to indicate layout, type and capacity of crushing, screening, washing, conveying and other aggregate processing and handling equipment
    b) Batching and Mixing Plants: description, flow diagrams, and drawings of the plants, and details of the equipment the Contractor intends to use to determine and control the amount of each separate concrete ingredient and mixing thereof into uniform mixture
    c) Transport and Placing of Concrete: full details of the equipment and methods for transporting the concrete from the concrete plant to the final point of placing, including numbers, type and capacity of transport vehicles a concrete pump, and details of standby plants to be installed
    d) Sampling and Testing of Materials: list and details of equipment for sampling and testing, detailed program for quality control of concrete work, and qualification and experience of the proposed personnel.
3) At least 28 days in advance of any concrete work being carried out at the Site, the Contractor shall submit to the Engineer following notifications based on the results of the preliminary material testing:
    a) Notification of the mill or mills from which cement will be obtained and whether cement will be ordered in bulk or bags. If cement is to be obtained from several factories, the estimated amount of cement from each factory and the proposed schedule of shipment shall be stated
    b) Notification of the source, analysis, method of delivery, and storage of water for concrete manufacture
    c) Notification of the admixtures which the Contractor will supply along with the catalogs and laboratory analyses. Should the Contractor intend to use admixtures in any concrete work for his own convenience, he shall give full details of the type, dosage, and influence on durability
    d) Details of the materials for formwork and surface finishes, treatment of

construction joints, and construction techniques which the Contractor proposes to use in order to achieve the required concrete surfaces and allowable tolerances

e) Notification of the factory or factories from which steel reinforcement will be obtained. If reinforcement is to be obtained from several factories, the estimated weight from each factory and the proposed schedule of shipment shall be stated.

4) At least 28 days prior to procuring or dispatch to the Site of the particular item of work to which the submittal relates, the Contractor shall submit to the Engineer the following:
   a) Details covering the properties and performance, including the certified copies of reports of all tests made by the manufacturers of waterstops, expansions joint fillers, and joint sealing compounds along with material samples of the products
   b) Details of curing compounds
   c) Details of epoxy mortar for concrete repair
5) Drawings showing the location of construction joints proposed by the Contractor which differ from those shown on the Detailed Design and/or Construction Drawings, including formwork and reinforcement details, shall be submitted to the Engineer at least 15 days prior to commencement of work on that particular structure.
6) During the performance of the concrete work, the Contractor shall keep a diary where he shall record the construction procedures related to concreting. This diary shall be made available to the Engineer upon request. The records shall contain at least the following:
   a) Commencement and termination of concreting of various parts of the structures
   b) Quantities and quality of aggregates and cement provided, and the storage from which they were drawn
   c) Temperature of air, water, cement, aggregates, and concrete
   d) Meteorological conditions and humidity of air
   e) Sampling and testing performed and summary of results
   f) Personnel employed during various stages of the concreting operation and name of the responsible inspector or foreman
   g) Equipment used
   h) Directives received from the Engineer
   i) Any special material or procedures employed
7) The Engineer reserves the right to require any additional information deemed necessary to be included in the submitted documents.

6.5 TESTING

6.5.1 TESTS PRIOR TO THE START OF CONCRETE WORK (TRIAL MIX STAGE)

6.5.1.1 General

1) At least 2 months prior to commencement of any concreting of Permanent Works, the Contractor shall start the testing of materials, propose the composition of concrete mixes and prepare trial mix of each of the proposed concrete class. The Contractor shall prepare the trial mixes using the cement, water, aggregates and admixtures intended for the work and which conform to the requirements specified in this Section.
2) This preliminary test program shall include the determination of following parameters:
   a) Cement properties
   b) Characteristics of aggregates
   c) Mix water properties
   d) Admixture properties
   e) Proportion of aggregate ranges in the mix
   f) Proportion of un-crushed to crushed aggregates
   g) Cement dosage
   h) Water-cement ratio (W/C)
   i) Workability of concrete mixes

j) Compressive and tensile strength
k) Entrained air
l) Density
m) Water tightness

3) These tests shall be carried out until the concrete mixes show appropriate strength, workability, density, and water tightness without the use of excessive cement.

6.5.1.2 Cement

1) Cement shall be sampled and tested for strength and physical properties, and chemical analysis under method EN 196.
2) The Contractor shall obtain the cement samples for testing at the cement mill as the bins are being filled. Tests for false set shall be made on samples taken at the latest time prior to shipment.

6.5.1.3 Aggregates

1) Aggregates shall be sampled and tested as set out in ASTM Specification C33.
2) Tests shall be made on samples that are representative of the grading that will be used in the concrete.

6.5.1.4 Water

1) The suitability of the water for concrete shall be evaluated and the permissible amount of silt or suspended solids established in accordance with ASTM Test Method C-1602/C-1602M-06.
2) Water which quality is questionable or suspected of having detrimental amounts of sulfates shall be chemically analyzed in a specialized laboratory designated by the Engineer.
3) For the examination of mixing water, the Contractor shall deliver to the laboratory at least one liter in a thoroughly cleaned and tightly sealed bottle.

6.5.1.5 Admixtures

1) Admixtures proposed by the Contractor shall be tested for their suitability with the cement and materials to be used in the Works and under proposed construction conditions.
2) Admixtures shall be sampled and tested as set out in ASTM Specification C494.
3) Air-Entraining admixtures shall be tested in accordance with ASTM Test Method C233.

6.5.1.6 Concrete

1) Concrete test cylinders shall be made and cured in accordance with ASTM Standard Method C31. Sixteen test cylinders 150 mm diameter, 300 mm high shall be made from each mix proposed for the different classes of concrete. Compressive strength of concrete shall be tested on four test cylinders at 3, 7, 14 and 28 and 90 days in accordance with ASTM Test Method C39.
2) Splitting tensile strength of concrete shall be tested in accordance with ASTM Test Method C496. Cylindrical beams of concrete for testing shall be made and cured in accordance with ASTM Standard Method C31.
3) The consistency of the proposed mixes shall be tested by means of slump test in accordance with ASTM Test Method C143. Specimen for slump tests shall be taken from each batch of concrete used to make the test cylinders and beams.
4) Time of setting of concrete mixes shall be determined in accordance with ASTM Test Method C-403.
5) Static modulus of elasticity and Poisson's ratio of concrete in compression shall be determined in accordance with ASTM Test Method C-469.
6) Prior to execution of large-scale concreting work at the Site, test shall be performed to determine the temperature development due to hydration within the concrete with various types of cement. The temperature rise shall be recorded, and corresponding diagrams established.
7) Air content shall be determined in accordance with ASTM test method C-231.

6.5.1.7 Aggregates Processing Plant and Concrete Plant

The performance of aggregates processing plant and concrete plant shall be tested by carrying out a trial concrete production run prior to any concreting of Permanent Works.

6.5.1.8 Waterstops

1) All types of waterstops shall be tested in a recognized laboratory prior to shipment to the Site. Test specimens shall be furnished by the manufacturer and the tests shall be carried out at the place of waterstop manufacture.
2) Waterstop shall be tested as to their tensile strength, elongation, duration, water absorption, specific gravity, effect of alkali and impact resistance.

6.5.2 TESTS DURING EXECUTION OF THE WORK

6.5.2.1 General

1) The Contractor shall carry out tests on materials and samples of concrete during the execution of work in order to provide proper quality control of the concrete production. The test program shall be as stipulated hereinafter, and the Contractor shall comply with the requirements and give all needed assistance in the performance of test program.
2) The Contractor shall keep records of test results which shall be presented to the Engineer upon request.
3) Should the Contractor wish to reduce his approved testing program he shall notify the Engineer of these changes 2 weeks in advance.
4) Aside from Contractor's testing program, the Engineer will make control test to the extent as he deems necessary. The Contractor shall give all required assistance in sampling and provide for the proper storage and transport of the specimens to be tested by the Engineer.
5) The Contractor shall make any arrangements needed or purchase new equipment, should the test results prove that changes in the aggregates or concrete plant are necessary to obtain the required concrete quality.

6.5.2.2 Cement

1) Cement shall be inspected for contamination and for lumps caused by moisture after arrival on the Site.
2) When cement is delivered in bags, sufficient checks shall be made to assure that the bag weights conform with the stated weight. Packages that vary more than 3% from the stated weight or when the average weight of 50 packages taken at random from any shipment is less than stated, the entire shipment may be rejected by the Engineer.
3) Cement shall be sampled and tested for strength and physical properties under method EN 196

6.5.2.3 Aggregates

Sampling and testing of aggregates in accordance with ASTM Specification C 33 shall be carried out at the frequency shown in the table below.

a) Coarse Aggregate

Test Description	ASTM Test No.	Frequency
Gradation	C 136	Not less than twice per week or per 500 Cum of concrete
Amount of material finer than 75 mm sieve	C 117	Not less than twice per week or per 500 Cum of concrete
Soundness	C 88	per 1,0000 Cum of concrete
Clay lumps and friable particles	C 142	per 1,0000 Cum of concrete
Lightweight Pieces in Aggregate	C 123	per 1,0000 Cum of concrete
Abrasion Test	C 131	per 5,000 m3 of concrete
Alkali Reactivity	C 289	Once for each source of aggregates
Petrographic Analysis	Designation 7 of USBR Concrete	Once for each source of aggregates

	Manual	
Specific Gravity of Coarse Aggregate	C 127	In early stages of work, and when changes in aggregates, but not less than every 10,000 Cum of concrete

b) Fine Aggregate

Test Description	**ASTM Test No.**	**Frequency**
Moisture Contents	C 70	Twice per shift or as necessary
Gradation	C 136	Twice per shift or as necessary
Amount of material finer than 75 mm sieve	C 117	Twice per shift or as necessary
Fineness Modulus	Designation 4 of USBR Concrete Manual	Twice per shift or as necessary
Organic Impurities	C 40	per 5 000 Cum of concrete
Soundness	C 88	Every 10,000 Cum of concrete
Clay lumps and friable particles	C 142	Every 10,000 Cum of concrete
Lightweight Pieces in Aggregate	C 123	Every 10,000 Cum of concrete
Alkali Reactivity	C 289	Once for each source
Petrographic Analysis	Designation 7 of USBR Concrete Manual	Once for each source
Specific Gravity of Fine Aggregate	C 128	In early stages of work, and when changes in aggregates, but not less than every 10,000 Cum of concrete

6.5.2.4 Water

Testing of water after the sources have been established shall be carried out at the frequency shown in the table below.

Test Description	**Standard Specifications**	**Frequency**
Total Suspended Solids	ASTM – C 602 M EN - 1008	Once per month or when necessary
Chemical Test: PH-Chloride-Sulphate-Ammonium-Magnesium-Total Hardness-Carbonate Hardness-Calcite Dissolution Capacity	ASTM -C-1602 M	Once per month or when necessary

6.5.2.5 Admixtures

Each shipment of admixtures to the Site shall have a quality certificate. The quality certificate inclusive of all the main tests performed shall be issued by the manufacturer.

6.5.2.6 Fresh Concrete

1) All concrete samples shall be obtained in accordance with ASTM Standard Method C172 for

sampling fresh concrete.

2) The Contractor shall make three sets of 3 cylinders from each 300 m3 of fresh concrete placed in the Works during the day (or shift), but not less than 6 cylinders for each class used for each day (or shift) of concreting. The test cylinders shall be 150 mm in diameter and 300 mm high.
3) Each set of cylinders shall be composed of a single batch of concrete and then cured in accordance with ASTM Standard Method C-31. The sets of cylinders shall be tested at 3, 7 and 28 days for concrete having the characteristic strength established at 28 days, and at 7, 28 and 90 days for concrete having the characteristic strength established at 90 days.
4) The Contractor shall take slump tests in accordance with ASTM Test Method C- 143 of each concrete class throughout the duration of concreting work with a frequency of one slump test each three mixer trucks at the batching plant and at the pouring location. Whenever a concreting operation is started, a slump test of the first two mixes shall be made for each class of concrete
5) Unit weight shall be determined for each concrete batch placed in the work or each day. The air content shall be determined according ASTM C-231 in principle once per week or when necessary the class of concrete to be tested shall be determined by the Engineer.
6) The Contractor shall furnish the batching plant laboratory with all facilities and apparatus to carry out all the prescribed tests. The sampling of the fresh concrete will be at the batching plant.

6.5.2.7 Placed and Hardened Concrete

1) Where considered necessary by the Engineer, in-situ characteristics of placed concrete shall be tested in accordance with ASTM Standard Method C 42. The Contractor shall obtain samples and perform such tests. Samples found to be defective shall not be deemed to be included in this amount and shall be replaced by new ones by the Contractor.
2) Holes left after the cutting or core drilling shall be carefully filled with dry-pack mortar or epoxy mortar as directed by the Engineer.
3) Specific gravity, absorption, and voids in hardened concrete shall be tested in accordance with ASTM Test Method C 642, and compressive strength in accordance with ASTM Test Method C 39.
4) When required by the Engineer, the Contractor shall test the placed and hardened concrete by means of "Schmidt Concrete Test Hammer".

6.5.2.8 Reinforcing Steel

Reinforcing steel shall be accompanied by a factory certificate and, when directed by the Engineer, tested in a recognized laboratory to demonstrate compliance with ASTM Specification A 615 M or ASTM Specification A 185.

6.5.2.9 Curing Compounds

Curing compounds shall be tested in accordance with ASTM Test Method C 156 to demonstrate compliance with ASTM Specification C 309 or EN 8656 when directed by the Engineer.

6.5.2.10 Concrete Plant

Monthly checks, or when requested by the Engineer, of the concrete plant's weight-batching accuracy, including the accuracy of any admixture dispenser, shall be made by the Contractor in the presence of the Engineer. When checked by standard weights and volumes its accuracy shall be within 0.5% or as specified by the manufacturer.

6.6 PRESCRIPTIONS TO BE FOLLOWED IN CASE THE STRENGTH IS NOT ATTAINED

1) When the results of the tests carried out do not comply with the specifications, the Engineer shall have the right to require that one or more of the following measures are taken:
    a) Extraction of a sufficient number of concrete samples (core taken with the rotary drilling method) from the structure for which a compressive test, or group of

compressive tests, have given unsatisfactory results. These samples shall be taken and tested according to ASTM C 42.

b) Performance of load tests, where possible, on the structure whose compression tests were found unsatisfactory.

c) Other tests ordered case by case.

2) If, after carrying out such investigations, the Engineer finds out 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 is prejudiced or whose strength is impaired, either by virtue of the faulty concrete or the remedial measures ordered.

3) The expenses borne for the above mentioned investigations and tests as well as for strengthening, demolition and reconstruction of defective works shall be at Contractor's expenses whenever it is proved that the concrete in place after 28 days has a strength less than the specified one for its class.

6.7 CONCRETE MATERIALS

6.7.1 CEMENT

1) The Contractor shall supply ordinary Portland cement Type I conforming to ASTM Specification C150. The use of other cements shall be subject to the approval of the Engineer and they shall be stored separately.
2) The alkali content of the cement shall not exceed 1% by weight.
3) Each consignment of cement delivered to the Site shall be accompanied by a test certificate issued by the manufacturer in quadruplicate. The Engineer will have the right to attend the sampling and testing at the manufacturer's plant at any time. If delivery is not directly from the manufacturer, the intermediate storage and delivery arrangements shall be subject to the approval of the Engineer.
4) Cement which does not comply with ASTM Specification C150 or is damaged in consignment, handling or storage shall be promptly removed from the Site.
5) All facilities for transport and storage of cement shall be subject to approval of the Engineer and shall be such that easy access for inspection is assured.
6) Bulk cement shall be transported from the port or factory to the Site in adequately designed weather-tight trucks, or other means where cement will be protected from exposure to moisture. Immediately upon receipt at the Site, cement shall be stored in a dry, weather-tight and properly ventilated structure with adequate provisions for the prevention of absorption of moisture and constructed in such a way that there will be no dead storage. The vents of the bins and silos shall be equipped with dust collectors to reduce loss of cement during handling and inconvenience to the personnel.
7) Cement bags shall be stored in weatherproof buildings with a raised, well ventilated wooden floor, and placed so that each consignment can be segregated if required and used in order of its age. Bags shall not be stacked more than 1.5 m high. Cement shall not be stored out of doors, except for immediate use, and in such event shall be protected during storage and handling by waterproof covers and a raised floor. Unused cement shall be placed back into the storage buildings.
8) Cement shall be used in approximately chronological order in which it has been received at the Site. Storage of cement shall be limited to 90 days in bags 150 days in bulk. Cement that has been in storage for longer than these periods or which may have absorbed moisture shall not be used unless it has been retested by the Contractor and approved by the Engineer. Cement that has become lumpy shall not be used. The cements coming from different mills or of different makes shall be stored separately.
9) The temperature of cement upon arrival to the Site shall not exceed 70°C and when entering

the mixers shall not exceed 50°C unless otherwise approved.

10) The maximum heat of hydration for Portland cement Type I shall not exceed 80 and 90 calories per gram at ages 7 and 28 days respectively, and 70 and 80 calories per gram at same ages for Portland cement Type II.
11) The Contractor shall keep and make available to the Engineer records of the date, amount, and storage location of each delivery of cement and of the part of the Works in which it was used and shall provide facilities for checking the stock of cement.
12) The Contractor is solely responsible for the timely supply of cement meeting the requirements of these Specifications and the Works. The delay due to the lack of suitable cement will not give the Contractor any right for the extension of time for the Completion of Works, or any claims resulting here from.

6.7.2 AGGREGATES

6.7.2.1 General

1) Fine and coarse aggregates shall conform to the requirements of ASTM Specification C 33. They shall consist of clean, hard, dense, durable and un-coated materials, and shall have a stable moisture content and grading when delivered to the batching plant. Aggregates shall not contain substances which may impair the quality of the concrete, attack reinforcing steel or reduce bond. The following substances are regarded as being harmful: loam, clay, pieces with large cavities, foam-like or vitreous pieces, and organic materials such as topsoil, roots, wood, coal, lignite, etc. The deleterious substances are defined in ASTM Standards C117, C142, C123, C40. In doubtful cases the effects of harmful substances shall be established by tests.
2) The shape of the particles shall be generally spherical or cubical. The amount of flat or elongated particles shall not exceed 25% by weight. A flat or elongated particle is defined as one in which the width to thickness, resp. length to width ratio is greater than 3.
3) The Contractor shall make provisions for crushing and processing of material in accordance with recommendations contained in ACI 221 R-61 "Selection and Use of Aggregates for Concrete" to meet the gradation and other requirements of these Specifications, in order to obtain the total amount of aggregate required for concrete manufacture. Crushing, screening and washing operations, bonification of aggregates, and blending of crushed and natural aggregates shall at all time be subject to the approval of the Engineer. The secondary crushers shall be of the cone type.
4) The optimum proportion of crushed to natural aggregate, and in particular the possibility to use crushed sand, shall be determined at trial mix stage. During the construction of the Works, the Contractor may use a greater proportion of crushed to natural aggregate than used in the approved trial mixes only with the consent of the Engineer, providing that no claim for reimbursement for additional cement used will be raised by the Contractor.
5) Natural and crushed aggregates shall be stockpiled and batched separately.
6) The handling, transporting, and stockpiling of aggregates shall be such that there will be a minimum amount of fines resulting from breakage and abrasion of material resulting from free fall and improper handling. Excess in any of fine or coarse aggregate sizes shall be disposed of in approved manner.

6.7.2.2 Source

1) Coarse and fine aggregates shall be produced from suitable material obtained from required excavation for Permanent and Temporary Works and from the approved quarry and borrow areas shown on the Final Design and described in the Information to Tenderers or from other sources as may be designed or approved in the course of the work.
2) The Contractor shall carefully clear and prepare the stockpile areas so that excavated materials are free of unsuitable materials and other objectionable matter. All materials removed from the area and not used in the work shall be disposed of as directed.
3) The disposal of excavated materials shall be selective. The suitable rock for aggregates shall be

unloaded in the approved stockpiles, while the rock not suitable for aggregates shall be unloaded in the approved disposal areas.

4) The suitability of the rock for aggregates shall be established with laboratory tests carried out by the Contractor.
5) Alternative sources developed by the Contractor shall be subjected to approval by the Engineer. The Contractor shall carry out tests to furnish satisfactory evidence that aggregates from such alternative sources comply with the requirements of this Section.
6) The approval of the sources shall not be construed as constituting the approval of all materials taken from the deposits. The Engineer reserves the right to reject certain localized areas, strata, or channels within the approved areas and zones, when the material is unsatisfactory for use.
7) The Contractor shall prepare and submit to the Engineer a detailed report concerning the quarry exploitation within 60 days from the date of issue of Notice Commence.

6.7.2.3 Fine Aggregate (Sand)

1) The term "fine aggregate" is used to designate aggregate in which the maximum size of particles is 4.75 mm.
2) The gradation of fine aggregate shall be as given below:

US Standard Sieve	Square Mesh Sieve Opening	Square Mesh Sieve Opening
No. 4	4.750 mm	95 - 100
No. 8	2.360 mm	80 - 100
No. 16	1.180 mm	50 - 85
No. 30	0.600 mm	25 - 60
No. 50	0.300 mm	10 - 30
No. 100	0.150 mm	5 - 15
No. 200	0.075 mm	0 - 5

3) Fine aggregate shall have a fineness modulus in a range between 2.5 and 3.0. The fineness modulus is calculated by adding the cumulative percentages retained on US Standard Sieves Nos. 4, 8, 16, 30, 50 and 100 and dividing the sum by 100. The grading shall be controlled so that at any time the fineness modulus of at least 9 out of 10 consecutive test samples of finished sand will not vary more than 0.20 from the average fineness modules of the 10 test samples.
4) The amount of deleterious substances in fine aggregate shall not exceed the limits given below:
   - Organic matter Limits: as per Table 9.2 of ASTM C40-04
   - Clay lumps and friable particles (as per Table 1 of ASTM C-33-03) 3 % by weight
   - Lightweight material 2 % by weight
   - Total of other deleterious substances 2 % by weight

   The sum of percentages of all deleterious substances shall not exceed 5 % by weight. The percentage passing the75 µm shall be limited in accordance with BS 882:1992 Section 5.4.
5) Sand producing a colour darker than the standard set out in the test for organic impurities (ASTM C 40) may be rejected.
6) Should the loss of weight of portion retained on No. 50 Sieve, when subjected to five cycles of soundness test by use of sodium sulfate (ASTM C 88), exceed 10% by weight, the fine aggregate may be rejected.

7) Fine aggregate, upon delivery to the batching plant, shall have a uniform and stable moisture content. The amount of moisture shall be less than 6% by weight and shall not vary by more than 0.5% per hour.
8) Fine aggregate shall be stored in such a manner as to avoid the inclusion of any foreign materials and segregation.
9) The Contractor shall provide suitable drainage facilities to secure that the sand delivered to the batching plant shall have uniform and stable moisture content. If required, two or three separate stockpiles shall be maintained, one for wet sand, eventually one in the process of draining, and one where the drained sand shall remain for a minimum 48 hours prior to the use.
10) No fine aggregate from the bottom 50 cm of the stockpile shall be used for mixing concrete.
11) The Contractor shall maintain at all times sufficient storage of fine aggregate to permit continuous placement of concrete.

6.7.2.4 Coarse Aggregate

1) The term "coarse aggregate" is used to designate aggregate which is retained on sieve No. 4 (4.75 mm). The coarse aggregate shall conform to ASTM Specification C-33. The coarse aggregate may be rejected if the specific gravity (bulk, saturated surface-dry basis) is not in accordance with ACI 207.1R (par. 2.5.5) and tested in accordance with ASTM Standard Test C-127.
2) The coarse aggregate shall be processed, stockpiled, and used in groups designated by the maximum size aggregate. The gradation of aggregate in each group shall be as given below unless site laboratory tests prove that a different gradation is more suitable for concrete mix:

US Standard Sieve (mm)	Percent by Weight Passing Individual Sieve		
	20 mm	32 mm	76 mm
76	-	-	100
50	-	100	90-100
37.5	-	90-100	20-45
25	100	22-45	0-10
19	90-100	0-10	0-5
9.5	30-55	0-5	-
4.75	0-5	-	-

3) The amount of deleterious substances in coarse aggregate shall not exceed the limits given below:
    - Organic matter Limits: as per Table 9.2 of ASTM C-40-04
    - Clay lumps and friable particles
    - (as per Table 1 of ASTM C-33-03) 1.0 % by weight
    - Material passing No. 200 sieve 1.5 % by weight
    - Lightweight material 2.0 % by weight
    - Total of other deleterious substances 1.0 % by weight

   The sum of the percentages of all deleterious substances in any category shall not exceed 3% by weight.
4) Should the loss by weight, when the aggregate is subjected to abrasion test by use of the Los Angeles machine (ASTM C131), exceed 10% at 100 revolutions or 40% at 500 revolutions, the coarse aggregate may be rejected.
5) Should the weighted average loss by weight exceed 10%, when the aggregate is subjected to

five cycles of soundness test by use of sodium sulfate (ASTM C88), the coarse aggregate may be rejected by the Engineer.

6) Coarse aggregates, upon delivery to the batching plant, shall have a uniform and stable moisture content.
7) The nominal maximum aggregate size in relation to the structure dimension shall not be larger than:
    a) 1/5 of the narrowest dimension between the side of forms
    b) 3/4 of the minimum clear spacing between the reinforcing bars
    c) 1/3 of the slab depth
8) Stockpiles of coarse aggregate shall be formed in such manner as to avoid the ingress of any foreign matter and to prevent segregation. Sufficient storage shall be maintained at all times to permit continuous placement of concrete.

6.7.3 WATER

1) Water for mixing and curing of concrete, mortar, plaster, and grout shall be taken from an approved source and shall be clean, colourless, free from deleterious substances including salt, oil, alkaline or organic matters, sugar compounds, and shall not have brackish or saline taste. When shaken no permanent foam may be formed.
2) The limits of the content of sulphates, chlorides, alkali and turbidity shall conform with ASTM C-1602/C-1602M-06.

6.7.4 ADMIXTURES

6.7.4.1 General

1) Water-reducing, water-reducing-retarding, air-entraining and super plasticizer admixtures shall be used for cast-in-situ and precast concretes. Only admixtures that have been commercially used with satisfactory service in a similar type of concrete work shall be considered for approval. All admixtures shall be manufactured by a reputable company(ies) such as Sika, Grace, Master Builders supported by a fully staffed technical service organization and research group.
2) Admixtures shall be stored and handled so as to avoid contamination or damage to their properties by temperature or moisture changes or other influences.
3) The quantity of admixture used, and the method of mixing shall be strictly in accordance with the manufacturer's printed instructions, or as required to produce specified results and approved by the Engineer.
4) The Contractor shall be held liable for any damages and difficulties resulting from the selection and use of admixtures such as delay in concrete placing or damage to concrete during forms removal and shall not be entitled to any time extension or claims resulting here from.

6.7.4.2 Accelerators

1) Only non-chloride accelerators meeting the requirements of ASTM Specification C 494, Type C may be used if permitted by the Engineer. The use of calcium chloride or other admixture in which chloride is added or serves as an active ingredient shall not be permitted.
2) Accelerators shall not be used in hot weather concreting.

6.7.4.3 Air-Entraining Admixtures

1) Air-entraining admixtures shall conform to the requirements of ASTM Specification C 260.
2) Air-entraining admixture shall be used to achieve the following air content in concrete:

Maximum size aggregate in concrete	Total air Percentage by volume of concrete
20 mm	6.0 ± 1
32 mm	4.5 ± 1
76 mm	3.5 ± 1

6.7.4.4 Water-reducing, Set-controlling Admixtures

1) Water-reducing, set-controlling admixtures shall conform to the requirements of ASTM Specification C 494, Type A, D, E, F or G.
2) The dosage to be used shall be within the range recommended by the manufacturer and as determined by tests or as directed by the Engineer, but type and quantities will vary with changing climatic conditions at the Site and/or other job conditions.

6.7.4.5 Combined Admixtures

Combined air-entraining, water-reducing admixtures shall be used where required to increase the water tightness and strength of the concrete (e.g. Plastocrete-DM of SIKA).

6.8 STEEL REINFORCEMENT

6.8.1 GENERAL

1) The Contractor shall furnish, fabricate, and install all reinforcement steel as shown on the Detailed Design and/or Construction Drawings and bar lists. The work shall further include the furnishing and installation of all tie wires, clips, supports, chairs, spacers, and other appurtenances necessary to produce finished concrete structures.
2) All reinforcing bars shown on the Detailed Design and/or Construction Drawings shall be identified on the bar lists and all bars shall be defined and given dimensions in a clear and unambiguous way. All bar lists shall be referenced to the relevant reinforcement drawings. The Contractor shall be responsible for the correctness of the reinforcement drawings and bar lists.
3) The Contractor shall submit to the Engineer prints and electronic files of the reinforcement drawings and bar lists.

6.8.2 QUALITY REQUIREMENTS

1) Reinforcing bars shall be Grade 60 (420 MPa) deformed billet-steel bars conforming to ASTM Specification A-615-M. Plain bars may only be used where shown on the Drawings. Minimum yield strength of the bars shall be 400 N/mm2 (4,077 kg/cm2).
2) Wire for tying reinforcement shall be smooth wire conforming to ASTM Specification A82.
3) Welded wire fabric for in-situ or sprayed concrete reinforcement shall be made from electrically welded smooth wire and shall conform to the requirements of ASTM Specification A185.

6.8.3 STORAGE

1) Reinforcement shall be stored at the Site and separate into the various sizes in such a manner that it is not contaminated with deleterious matter. Reinforcement coming from different manufacturers shall be stored separately.
2) Reinforcement fabric supplied in rolls shall be straightened into flat sheets before being placed.

6.8.4 CUTTING AND BENDING

1) Steel bars shall be accurately cut and bent to the dimensions and shapes as shown on the Detailed Design and/or Construction Drawings and Bar Lists.
2) The bars shall be bent cold at temperature greater than 5°C. Bending below that temperature or warm bending will only be permitted when adequate precautions are taken to comply with the corresponding direction issued by the steel manufacturer for such bending.
3) Temporary bending and subsequent straightening of bars partially embedded in concrete shall not be permitted, except when shown on the Detailed Design and/or Construction Drawings or with the written approval of the Engineer.
4) Should the necessity of welding of reinforcement arise, the provisions of the American Welding Society "Reinforcing Steel Welding Code" (AWS D 12.1) shall be followed.

6.8.5 SPLICING

Reinforcement bars, other than tie bars, shall not be spliced at points other than those shown on the Detailed Design and/or Construction Drawings without the consent of the Engineer. On occasions when it becomes necessary to alter the position of such splices, the new position and the type of splice shall be subject to the written approval of the Engineer.

6.8.6 PLACING

1) Reinforcing steel, before being positioned, shall be free from loose mill and rust scale, and from any coating that may destroy or reduce the bond between the steel and concrete.
2) As a rule, the same type of reinforcement from the same source shall be used in any one part of the structure.
3) Reinforcing steel shall be accurately positioned and secured against displacement by using ties made of annealed iron wire of not less than No. 16 gauge, dobies, or suitable clips at intersection.
4) The metal chairs, bar spacer and similar reinforcement support devices that touch the forms shall be galvanized or shall have plastic tips at the point where the support device touches the forms.
5) The bottom layer of reinforcing steel in slabs on the ground shall be supported by means of pre-cast concrete blocks (dobies). The concrete blocks shall have a horizontal surface approximately 7x10 cm and be of concrete quality at least equivalent to that which is to be placed. The upper layer of reinforcement in slabs on ground and all other slabs and in beams shall be supported by means of metal chairs. In all cases, sufficient supports for horizontal reinforcement shall be used so that there will be no sagging of the bars.
6) All reinforcement shall be inspected in place and approved by the Engineer before placing the concrete. Concrete placed in violation of this provision may be rejected and removal required.

6.8.7 CONCRETE COVER OF THE REINFORCEMENT

The cover of the reinforcement shall be as indicated below or as shown on the Detailed Design and/or Construction Drawings:

1) In-situ concrete:
   - Concrete cast directly against soil or rock and being permanently exposed to it
     60mm
   - Formed concrete permanently exposed to backfill or water 50 mm
   - Outside exposure 40 mm
   - Inside exposure 30 mm
2) Pre-cast concrete:
   - Outside exposure 40 mm
   - Inside exposure 30 mm

6.9 SURFACE FINISHES

6.9.1 GENERAL

1) The quality of the surface finish shall be appropriate to the classification as described hereunder. Generally it shall be free from areas of honeycombs, segregation, loss of cement or fine material, from damage due to stripping of forms, from bolt holes, abrupt irregularities caused by movement of forms or components, loose knots and similar features and bulges or depressions in the general plane of the surface.
2) Only one type of formwork shall be used for all parts of a concrete structure which is visible from any direction.
3) The classes of finish shall be as shown on the Detailed Design and/or Construction Drawings or as directed by the Engineer.

6.9.2 FORMED SURFACES

The classes of finish for formed surfaces are designated by the use of symbol F and the shape of the formwork panels required for concrete work shall be either plane (F1, F2, F3 and F4) or curved (F1C, F2C, F3C and F4C).

a) Finish F1, F1C: this finish shall be for surface concealed from view, including surface upon or against which backfill, or concrete is to be placed, formed surfaces of expansion and contraction joints, and blackouts for equipment embedding or other parts which are to be built in. It may be obtained by the use of properly designed formwork or molds of closely-jointed rough sawn boards. The surfaces will be imprinted with the grain of the sawn boards and their joints. Small blemishes caused by entrapped air or water may be expected, but the surface shall be free from voids, honeycombs, or other large blemishes. The surfaces require no treatment after formwork removal, with the exception of the filling of form-tie holes, correction of surface depressions deeper than 3 cm, the repair of defective concrete and curing as specified.

b) Finish F2, F2C: this finish shall be for all surfaces exposed to view not in contact with flowing water. It is achieved by the use of properly designed forms of closely jointed wrought boards. The surfaces will be imprinted with the slight grain of the wrought boards and their joints. Alternatively, steel or other suitable material may be used for the forms. Fascia boards consisting of 25x25 mm timber strips shall be fixed to the tops of forms to ensure the formation of straight and even horizontal construction joints. After removal of forms, the surface shall be improved by carefully removing all fins and other projections, thoroughly washing down, and then filling the most noticeable surface blemishes using methods described hereafter in "Repair of Defective Concrete". Form-tie holes shall be filled, and all voids, honeycombs, and other defective concrete repaired before curing as specified. When filling holes and repairing defective areas, every effort shall be made to match the colour of the concrete. The use of release agents which may permanently stain or discolour the finished surface will not be permitted.

c) Finish F3, F3C: this finish shall be for surfaces in contact with flowing water where cavitation, head loss, freeze/thaw or erosion are of concern. The standard of finish required is similar to an F2 finish, but with no surface bubbles or holes larger than 3 mm diameter allowed, and with more stringent tolerance requirements measured along a line parallel and transverse to the direction of flow. Variations in concrete colour as a result of concrete repairs or staining due to release agents will be allowed. Fascia boards will not be required.

d) Finish F4, F4C: this finish shall be for surfaces where plaster, stucco, or wainscoting is to be applied. Formwork shall consist of rough-faced form boards. Steel lining or steel sheathing shall not be permitted. No form oil may be used. Forms shall be removed as soon after pouring as conditions will permit. Surfaces shall be roughened with a heavy wire brush, cleaned of all materials that might prevent satisfactory bond and washed thoroughly. Immediately prior to plastering, concrete surfaces shall be recleaned and damped by means of a fog spray.

6.9.3 UNFORMED SURFACES

1) The classes of finish for unformed concrete surfaces are designated by the use of symbol U:

a) Finish U1 (screened finish): this finish shall be applied to unformed surfaces that will be covered by fill material or concrete. Finishing operations shall consists of sufficient leveling and screeding to produce even, uniform surfaces. Surface irregularities shall not exceed those specified for Finish F1. This finish is also the first stage of finishes U2 and U3.

b) Finish U2 (floated finish): this finish applies to unformed surfaces not permanently concealed by fill material or concrete. Finishing operations shall consist of sufficient leveling and screeding to produce even surfaces in which the surface irregularities shall not exceed those specified for Finish F2. Floating with hand or power-driven equipment shall be started as soon as the screeded surface has stiffened sufficiently, to produce a surface that is free from screed marks and is uniform in colour and

texture. This finish is also the second stage of finish U3. If finish U3 is to be applied, floating shall be performed until a small amount of mortar without excess water is brought to the surface, so as to permit effective trowelling.

c) Finish U3 (steel troweled finish): this finish shall be for surfaces in contact with flowing water where cavitation, head loss, freeze/thaw or erosion are of concern, as well as inside floors of buildings except where a bonded concrete finish or tile floor is foreseen. The standard of this finish is similar to U2, but with more stringent tolerance requirements parallel and transverse to the direction of flow. Steel troweling shall start when the floated surface has hardened sufficiently to prevent an excess of fine material from being drawn to the surface. It shall be performed with a firm pressure that will produce a dense, uniform surface free of blemish, ripples, and trowel marks.

d) Interior surfaces shall be sloped for drainage where shown on the Detailed Design and/or Construction Drawings. Exterior surfaces, which will be exposed to the weather, shall be sloped for drainage even if there is no such indication on the Detailed Design and/or Construction Drawings. In such case the slope shall be at least 1% but not exceed 3%.

6.10 TOLERANCES

6.10.1 CONCRETE

1) Concrete surface irregularities caused by the roughness of the formwork facing or by inaccurately aligned joints between the formwork panels shall not exceed the following tolerances:

Specified Finishes			Permissible Irregularities	
			Abrupt	Gradual
F1, F1C, U1			6 mm	12 mm
F2, F2C, F4, U2			3 mm	6 mm
F3, F3C, U3				
a)	Measured along direction	A line parallel to the flow	3 mm	6 mm
b)	Measured along flow direction	A line perpendicular to the flow	1 mm	3 mm

2) Abrupt irregularities are offsets caused by displaced or misplaced form sheathing or lining or form sections, or by loose knots in forms or otherwise defective form lumber. They shall be tested by direct measurements.
3) Gradual irregularities are all other irregularities and shall be tested by a 2 m long template. The templates will be a straight edge for plane surfaces or a "shaped" template for curved or warped surfaces.
4) Further limitation for allowable abrupt irregularities for surfaces of structures with high velocity water flow shall be as follows, if not otherwise shown on the Detailed Design and/or Construction Drawings or directed by the Engineer:
    a) Abrupt irregularities parallel to the flow direction shall be eliminated completely by grinding to bevel of 1 to 20 ratio of height to length.
    b) Abrupt irregularities transverse to the flow direction shall be eliminated

completely by grinding to bevel of 1 to 50 ratios of height to length.

5) Deviations of concrete structure outlines from the lines and grades shown on the Detailed Design and/or Construction Drawings shall not exceed 20 mm.
6) Variations in thickness of slab, columns and walls shall be within the limits 5 mm and +10 mm.
7) The Contractor shall repair hardened concrete which is not within specified tolerances as stipulated in "Repair of Defective Concrete" later in this Section. Such repair shall, however, be done only after consultation with the Engineer and after his consent.
8) Concrete surface which may be in contact with high velocity flow shall be, without exception, brought within the specified tolerances. Grinding shall be limited in depth so that no aggregate particles remain exposed more than 2 mm in cross section at the finished surface. Where grinding would cause exposure of aggregate greater than the above limit, concrete shall be removed from the area affected and replaced by new concrete.

6.10.2 REINFORCEMENT

1) The center-to-center distance between parallel bars shall be as shown on the Detailed Design and/or Construction Drawings, with a tolerance of 20 mm, or as directed by the Engineer.
2) In placing reinforcement steel, the tolerance from indicated protective cover shall be:
   - for 40 mm cover and less: ± 5 mm
   - for 50 mm cover and more: ± 10 mm

6.11 FORMWORK

6.11.1 DESIGN

1) The Contractor shall assume full responsibility for the adequate design of all formwork, falsework, and all accessories.
2) For the purpose of formwork and falsework design, the Contractor shall assume a value of 2.5 t/m3 for the density of concrete.
3) Formwork shall be designed to withstand the full hydrostatic head of concrete.

6.11.2 WORKMANSHIP

1) All forms shall be true to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete.
2) Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Forms shall be tight so as to prevent the loss of water, cement and fines during placing and vibrating of the concrete.
3) Any forms which in the opinion of the Engineer are unsafe or inadequate in any respect may, at any time, be rejected and the Contractor shall promptly remove the rejected forms from the Works and replace them.
4) An adequate number of temporary clean-out holes or short pipes shall be provided in the forms to secure the draining of rainwater.
5) All exposed finished edges of concrete shall be chamfered 20 mm (at 1:1) unless otherwise shown on the Detailed Design and/or Construction Drawings.
6) When a second lift is placed on hardened concrete, the number, location and tightening of ties at the top of the old lift and bottom of the new shall be such as to prevent any damage to concrete. The form of a new lift shall overlap the hardened concrete by 10 cm, to prevent abrupt irregularities.
7) Forms for sloping concrete surfaces shall permit their placing board-by-board or panel-by- panel immediately ahead of concrete placement so as to enable access for placement, vibration, and inspection of the concrete.

6.11.3 MATERIALS

1) Materials used for form sheathing and lining shall be of wood, steel, plywood, or fiberglass.

2) Forms for concrete surfaces exposed to flowing water shall be lined with sanded, un-coated, plywood veneer. Steel or impermeable plastic liners will not be permitted.
3) Except as expressly approved by the Engineer, all timber brought to the Site for use as forms, shoring or bracing shall be new material. Plywood for use as form shall be mill-oiled and edge-sealed.
4) Rough sawn boards may be used only for the lowest grade of surface finish (F1).
5) Where required, expanded metal fixed to the formwork shall be used in vertical construction joints.

6.11.4 FORM TIES

1) The type, number and positions of internal formwork supports, and ties shall be to the approval of the Engineer.
2) The whole or part of such formwork supports, and ties shall be removed without damage to the concrete so as to leave no part embedded nearer the surface of the concrete than the designed cover of the reinforcement or 50 mm in the case of un-reinforced concrete. Only metal portions of formwork support and ties shall be allowed to remain in place.
3) Through-bolts will not be permitted in water retaining walls.
4) Holes left after the removal of supports and ties shall be filled as described hereinafter in "Repair of Defective Concrete" and shall be finished off neatly to the standard of the concrete surface. Such filling shall be adequately cured.

6.11.5 MAINTENANCE OF FORMWORK

1) Forms shall be maintained at all times in good condition, particularly as to size, shape, strength, rigidity, tightness and smoothness or surface.
2) All timber forms shall be given a preliminary oil treatment by the manufacturer or shall be oiled by the Contractor at least 2 weeks in advance of their use.
3) The surface of the forms shall be free from encrustation of mortar, grout, or other foreign matter at the time of concrete placement.
4) Before concrete is placed, the forms shall be thoroughly cleaned and treated with a nonstinging mineral oil or other lubricant approved by the Engineer. Any excess lubricant shall be removed before placing the concrete. Care shall be exercised in keeping oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.
5) Forms may be reused provided that they are in good condition, and that the required concrete form and finish may be achieved with their use. The Engineer will, at any time, have the right to reject formwork which he considers to be no longer fit for such use.

6.11.6 REMOVAL OF FORMWORK

1) Removal of forms shall be performed with care so as to avoid injury to the concrete and as soon as permissible in order to avoid delay in curing and repair of surface imperfections. Forms shall not be removed without the consent of the Engineer.
2) Forms shall not be removed until the concrete has attained sufficient strength to prevent damage to concrete. Damaged concrete shall be repaired or treated by the Contractor as soon as possible, but not before the Engineer has inspected such damage and agreed to the remedial works.
3) The minimum period before the removal of formwork shall be in accordance with the following table:

Type of Formwork	Days	% of 28-day compressive strength
Vertical formwork to columns, walls and	2	40%
large beams		

Ceiling formwork to slab	7	70%
Props to slabs	12	85%
Ceiling formwork to beams	10	80%
Props to beams	14	90%

4) The minimum periods in days are only indicative. The governing rule to be observed is the percentage of the required 28-day compressive strength, which shall be determined by the cylinder test in addition to those required by the provisions as described in aforesaid "Test During Execution of the Work". When fixing the minimum period for formwork removal, the shrinkage and creep of the concrete shall be taken into consideration.

6.12 JOINTS IN CONCRETE STRUCTURES

6.12.1 CONSTRUCTION JOINTS

6.12.1.1 General

1) Concreting shall be carried out continuously up to construction joints, the arrangement and positions of which shall be as shown on the Detailed Design and/or Construction Drawings, or as approved by the Engineer. Also, whenever concreting is forced to be interrupted and placed concrete has become so hard that it does not permit the entry of a vibrator, a new construction joint shall be formed conforming to these Specifications.
2) The position of certain construction joints shown on the Detailed Design and/or Construction Drawings as mandatory may not be altered. The Contractor may propose for approval different locations of other construction joints for reasons of concrete placement. Necessary rearrangement of steel reinforcement arising from such modifications shall be to the Contractor's debit.
3) Construction joints shall be approximately horizontal or vertical. The joints shall appear as straight lines, produced by a board fixed to the formwork, at exposed faces.
4) The faces of vertical joints shall be shuttered with expanded metal or other approved rough material. The expanded metal shall be removed as far as possible, before the adjacent lift is poured. If required, the surface shall be cleaned by wet sandblasting and roughened by light bush-hammering.
5) The surface of construction joints upon or against which new concrete is to be placed and to which new concrete is to adhere shall be clean, rough, and free of water when covered with fresh concrete. The laitance, loose or defective concrete and foreign material shall be removed from the surface of existing concrete. The previous concrete lift shall be saturated by water but surface dry when the successive lift is placed.
6) The surface of the hardened concrete shall be cleaned and roughened by wet-sandblasting and washing thoroughly with air-water jet. Care shall be taken to prevent undercutting of aggregate in the concrete during sandblasting.
7) Wet-sandblasting equipment shall be operated at an air pressure of approximately 7 bars. Sand to be used for blasting shall be dense, hard, not easily broken and sufficiently dry.
8) In lieu of wet-sandblasting the Contractor may propose high-pressure water blasting utilizing pressures not less than 400 bars, provided that such high-pressure water blasting produce equivalent results to those obtainable by wet-sandblasting.
9) The horizontal surfaces of construction joints may be treated by cutting with an air-water jets ("green-cutting"). This shall be performed after the initial set has taken place but before the concrete has become too hard for effective cutting. The fresh concrete surface shall be cut with air-water jets to remove all laitance and to expose clean, sound aggregate. After cutting, the surface shall be washed with clean water. Care shall be taken that the treated surface does not become contaminated before new concrete is placed upon it. Should the surface become

contaminated that a satisfactory joint with new concrete is not ensured the Contractor shall clean it by means of wet sandblasting.

10) Water used in cutting, washing and rinsing of concrete surfaces shall be disposed of in such a way that it does not stain, discolour or affect exposed surfaces of the structures.
11) When necessary, as determined by the Engineer, structural concrete placement in forms shall be started with an over-sanded mix with 19 mm maximum size aggregate, an extra 50 kg of cement per cubic meter and a 10 cm slump. This mix will be referred to as a starter mix and shall be placed approximately 5 cm deep.
12) In the heavy concrete structures and mass concrete, the construction joint surface shall receive layer of mortar approximately 10 mm thick immediately prior to placing of the new lift. This mortar shall be of the same proportions as those in the concrete with coarse aggregate omitted and shall have the same air content, by volume.
13) The mix or mortar shall be spread over the whole surface except in case of permanently visible construction joints where it shall be kept 5 cm back from the exposed surface. It shall be worked thoroughly into all irregularities of the surface. In inaccessible locations it shall be spread by means of air-suction gun.
14) Concrete shall not be placed upon mortar which has dried out or become contaminated by water, debris or other deleterious material. Mortar which has been so contaminated or dried out shall be removed from the surface of the construction joint, the surface shall be re-cleaned, and a fresh layer of mortar spread on the surface prior to placing of a new concrete lift.
15) Where indicated on the Detailed Design and/or Construction Drawings, construction joints shall be formed with shear keys. The Contractor's proposed method for forming such keys shall be subject to the approval by the Engineer.
16) Where indicated on the Detailed Design and/or Construction Drawings or where directed by the Engineer, flexible PVC water stop shall be placed in construction joints.

6.12.1.2 Cold Joint

1) Cold joint is an unplanned joint which is the result of hardening of the concrete surface before the next batch is placed against it. Cold joints are undesirable and should be avoided. However, in the event of equipment breakdown, prolonged heavy rainfall, or other unforeseen prolonged interruption the continuous placing may not be reasonable.
2) When such event become apparent, and the unconsolidated concrete may harden to the extent that later vibration would not fully consolidate it, the Contractor shall immediately consolidate such concrete to a stable and uniform slope.
3) If delay in placement is short and it is still feasible to penetrate the underlying concrete, placement shall resume with care to thoroughly penetrate and re-vibrate the concrete surface placed before the delay.
4) If the concrete cannot be penetrated with the vibrator, the cold joint shall be treated as a construction joint, if the design requirements tolerate such joint. If such joint would impair the structural integrity of the structure, as determined by the Engineer, the concrete, or a part of it, shall be repaired or removed as directed by the Engineer.

6.12.1.3 Construction Joints for Stage Concreting

1) Constructions joints for stage concreting are joints, or joint systems where in-fill concrete or bays shall not be placed before one or two months after placing of the first stage concrete.
2) Where indicated in the Detailed Design and/or Construction Drawings or where directed by the Engineer, waterstops shall be provided in construction joints for stage concreting. Waterstops shall be joined and fixed in place strictly in accordance with manufacturer's recommendations.

6.12.2 MOVEMENT JOINTS

6.12.2.1 General

1) Movement joints in the concrete structures shall be constructed at such locations and to such dimensions as shown on the Detailed Design and/or Construction Drawings or as directed by

the Engineer. The Contractor shall supply and install the various joint components as specified herein, as shown on the Detailed Design and/or Construction Drawings and in accordance with the manufacturer's recommendations.

2) Expansion joints are joints provided in concrete structures to prevent transfer of forces from structure to structure or to accommodate volumetric changes due to temperature rise. Expansion joints may be comprised of the following elements:
    a) Flexible neoprene or PVC waterstop
    b) Concrete shear keys
    c) Expanded polystyrene joint filler (alternative: preformed expansion joint filler)
    d) Joint sealing compound
3) Contraction joints are joints placed in concrete to provide for volumetric shrinkage of a monolithic unit, or to allow movement between the units. No bond between the concrete surfaces is acceptable. Contraction joints may be comprised of the following elements:
    e) Flexible PVC waterstop
    f) Concrete shear keys

6.12.2.2 Materials

1) Waterstops shall be an Elastomer (an artifical rubber compound based on long chain polymers), cross linked to control their shape and deformation / movement under stress possibilities, by vulcanising them. The Elastomer waterstops shall have the following properties:

Physical Properties (DIN 7865 Part 2)			
No.	Property	DIN Standard	Performance level
1	Tensile Strength in N/mm²	53504	≥10
2	Elongation at break in %	53504	≥380
3	Shore-A-Hardness	53505	62±5
4	Tear Strength in N/mm²	53507	≥8
5	Behaviour at low temperatures (-20 °C), Shore-A-Hardness	53505	≥90
6	Dimensional stability when exposed to hot bitumen	7865	No change in shape
7	Metal adhesion	7865	Structural fracture in the Elastomer

2) Expanded polystyrene joint filler shall consist of panels 10 and 20 mm thick of specific weight approximately 20 kg/m3. They shall be waterproof and shall not absorb water.
3) Joint sealing compound shall be:
    a) Plasto-elastic, one-component, hot-poured sealant on bitumen/rubber for horizontal floor joints.
    b) Elastic two-component, non-sagging sealant on polyurethane-tar.

6.12.2.3 Construction

1) Where grouting is not required, the movement joints shall be formed with F1 finish. If grouting is required, joints shall be formed with F2 finish.
2) Waterstops shall be joined and fixed in place in accordance with manufacturer's recommendations to form a continuous watertight barrier. All cross-pieces, T pieces and corner-pieces shall be factory produced. All joints shall be welded with approved, thermostatically controlled electric heat equipment. The temperature at which the splices are made shall be sufficient to melt but not char the plastic material. All splices shall be neat with the ends of the joined waterstops in true alignment. A miter-box guide and portable knife shall be provided for cutting the ends to be joined to ensure good contact between joined surfaces. The Contractor

shall supply all necessary supports and ties required for placing the waterstop and shall position it so that its central axis coincides with the joint center. Care shall be taken that waterstop does not bend or deflect during concreting. Concrete adjacent to the waterstop shall be thoroughly worked to ensure full contact with the waterstop but without damaging it. Prior to commencement of concrete placing, the waterstops placed shall be inspected by the Engineer.

3) Before casting the second part of a movement joint, the whole surface will be covered with expanded polystyrene panels, bituminous roofing felt, bituminous coating, or other approved bond breaker as shown on the Detailed Design and/or Construction Drawings. The panels or felt shall be cut to the size and shape of the joint and shall be glued onto the joint face and tightly joined. Holes and joints in the filler shall be filled with mastic to prevent passage of mortar or concrete from one side to the other. Particular care shall be taken to ensure that all surfaces of the shear key are covered.
4) Before applying the joint sealant, the joint shall be raked out to a depth as specified. All laitance, dirt, oil and foreign matter shall be removed from the joint by sandblasting, compressed air, grinding discs, or other effective means, and the concrete surfaces coated with an approved suitable primer. Joint sealant shall be placed after the concrete curing period in accordance with manufacturer's instructions. The concrete surface temperature shall not be higher than 30°C at the time of placing, and the concrete shall be surface dry. After placing, the sealant shall be protected from the effects of water for a period of 10 hours.
5) Plastic tape shall be used to ensure that no bond develops between the sealant and the plastic foam joint filler.
6) Sealant that becomes un-bonded from the concrete, or cracks, or shows any other defects before final acceptance of the work, shall be replaced by the Contractor.

6.13 PREPARATION FOR CONCRETE PLACING

6.13.1 GENERAL

1) Concrete shall not be placed until all formwork, installation of embedded parts, reinforcing steel, and surfaces against which concrete is to be cast have been accepted by the Engineer.
2) All surfaces of forms and embedded items that have become encrusted with dried material from concrete previously placed shall be cleaned of all such material before the surrounding or adjacent concrete is placed.
3) Concrete shall not be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or diverted by pipes, or by other means, and carried out of the forms clear of the work. Water shall not be allowed to stand on any concrete surface until it has attained its initial set. Water flow over the concrete, which may injure the surface finish, will not be allowed.
4) Pipes, conduits, dowels and other items to be embedded in concrete shall be so positioned and supported prior to placement of concrete to be stable and provide sufficient clearance (min. 50 mm) between said items and steel reinforcement to allow proper concreting. Securing such items in position by wiring or welding to reinforcement will not be permitted.
5) Where excavated surfaces which are to form the foundations for structural concrete, are absorptive or likely to become otherwise unsuitable, or where shown on the Final Design and /or Construction Drawings, the Contractor shall place a 'blinding course' consisting of a layer of Class C15D32 concrete 5 to 10 cm thick, as directed by the Engineer, uniformly over the foundation such that the upper surface is at grade elevation. Blinding concrete shall be placed before installing reinforcement or formwork.
6) Immediately before concreting, the forms and all other surfaces which will be in contact with the fresh concrete shall be cleaned of all loose material and debris including shavings, wood chips, sawdust, pieces of wire, nails, fragments of hardened concrete and mortar. Clean-out holes which may be needed for this purpose shall subsequently be securely closed in order to obtain

the required surface finish.

7) The use of compressed air for cleaning will be allowed only if adequate precautions are taken to avoid the deposition of suspended oil on construction joint surfaces, reinforcement or other items which are to be bonded to concrete. The Contractor shall provide such personnel and equipment so that the performance of the concrete work is in a satisfactory manner. The transporting and placing equipment shall be clean and in good condition, adequate, and properly arranged to proceed with the placing without undue delays. The number and condition of vibrators for use and standby shall be ample for the requirements during placement. The lighting system shall be sufficient to illuminate the inside of the forms when concrete is placed at night.
8) The Contractor shall have protective coverings available for fresh concrete surfaces if there is a possibility of rain, hail or sleet.

6.13.2 CONCRETE ON EARTH FOUNDATION

All concrete placed on earth shall be placed upon clean, damp surface, free from standing or running water.

6.13.3 CONCRETE CAST AGAINST ROCK

1) Rock surfaces against which concrete is to be placed shall be clean and free from oil, standing or running water, mud, loose rock, objectionable coating, debris, and loose or unsound fragment. Faults, fissures and seams shall be cleaned to sound rock, and if directed, backfilled with dental concrete, shotcrete or dry pack as appropriate.
2) Immediately before concrete is placed, all surfaces shall be cleaned thoroughly by the use of high velocity air-water jets, brooming, wet sandblasting, bush-hammering, or other satisfactory means including combinations of the above.
3) Where gravel drains are used to control seepage water, the drains shall be covered with low slump concrete which shall be allowed to reach its final set before placement may begin.
4) Rock surface against which concrete is to be placed shall be kept wet for at least 12 hours during the 24-hour period prior to placing concrete and shall be in a damp condition at the time of placing, with all pools of water removed.

6.13.4 CONCRETE CAST AGAINST OR UPON PREVIOUSLY PLACED CONCRETE

Before any concrete is cast against previously placed concrete, the surface of the old concrete shall be prepared as described in aforesaid "Construction Joints".

6.14 PRODUCTION OF CONCRETE

6.14.1 CONCRETE MIXES

1) The mixes for different classes of concrete shall be selected jointly by the Engineer and the Contractor during the initial tests period (Trial Mix Stage).
2) During the progress of the work, the mixes may be adjusted whenever, in the opinion of the Engineer, such change is necessary or desirable to secure the required strength, workability, water tightness, density, economy, or to limit shrinkage. Adjustments of the mixes proposed by the Contractor will be subject to the Engineer's approval.
3) The consistency as measured by the slump test shall be determined according to its class, for which the range will be defined by laboratory tests. The slumps for the various classes of concrete, in principle, will be within the limits given in the following table:

Concrete Class	Slump (cm)
C15 D32	10 ± 3
C20 D32	10 ± 3
C20 D76	10 ± 3
C25 D32	12 ± 3

C30 D32	12 ± 3
C35 D32	12 ± 3
C25 D20	13 ± 3
C30 D20	13 ± 3

4) The value of slump will be defined by the site laboratory on the basis of requirements and the results obtained on strength. The above values may therefore be varied in accordance with laboratory and the Engineer instructions.
5) To maintain the proper consistency, the amount of water and sand batched for concrete shall be adjusted to compensate for variation in the moisture content or gradation of aggregates as they enter the mixer.

6.14.2 BATCHING

1) The Contractor shall provide, operate, and maintain at the Site automatic batching equipment to determine and control the amount of each individual material entering the concrete. Batching equipment shall be designed for such capacities which will permit performance of the concrete work in accordance with Contractual Construction Program and conforming to ASTM Specification C94.
2) Bulk Portland cement silos shall be plainly marked as to their contents. Delivery slips shall be reviewed by the plant operator prior to unloading of each material, and extreme care shall be exercised to see that these are unloaded into their respective silos.
3) The bulk cement, sand, and each size of coarse aggregate shall be weighted separately. Water shall be measured volumetrically or by weight as proposed by the Contractor. When cement in bags is used the weight will be measured by number of bags multiplied by stated bag weight. Powdered admixtures shall be measured by weight, paste or liquid admixtures by weight or volume.
4) Aggregate batch bins shall be self-cleaning during draw-down. Finish-screening of coarse aggregate will not be required provided that the aggregate meets the grading requirements stipulated in this Section. Coarse aggregate not meeting the grading requirements, shall be finish-screened over vibration screen connected to the batching plant or on the ground adjacent to the batching plant. The finish screens, if installed on the batching plant, shall be so mounted that the vibrations of the screens will not affect the accuracy of the batching scales. The finished products shall pass directly to the batching plant bins.
5) Each weighing unit shall be spring-less and will register the scale load at any stage of the weighing operation from zero to full capacity. For water measuring, two water meters shall be installed in parallel so that no delay due to faulty operation shall occur. No leakage may occur when the valves are closed. Liquid admixtures dispenser shall be of the visual type and shall be interlocked with the batching plant to prevent overdosing.
6) The Contractor shall provide standard test weights and any other equipment required for checking the operating performance of each scale or other measuring device. Periodic tests according to the manufacturer's instructions shall be made in the presence of the Engineer. Facilities for obtaining representative samples of concrete materials, between batch bins and the weighing hoppers or between the batch hopper and the mixer, shall be provided with the batching equipment. The Contractor shall make such adjustments, repairs, or replacements as may be necessary to meet the specified requirements for accuracy of measurement.
7) The scales shall be interlocked so that a new batch cannot be started until the weighing hoppers have been completely emptied of the last batch and the scales are in balance. Provisions for easy removal of excess materials, adjustment for compensating the weight variations of aggregates due to moisture content and changing the mix proportions shall be incorporated in

the equipment. All weight indicators shall be in full view of the operator.

8) The batching equipment shall be computerized and shall include a printer listing weights of all materials, or an accurate recorder for making a continuous visible combined record on a single chart of the separate measurement of each concrete ingredient, including all mixing water. Summary of material batched at the end of each shift or a day shall also be provided. The quantities recorder shall be located in an enclosed room adjacent to the batching and mixing plants where it can be viewed without interfering with batching operation and where it is isolated from vibration and dust. The capacity of the computer shall be to store a minimum of 20 mixes.
9) The batching plant shall be equipped with an instrument to check the consistency of the batch in the mixer, and the equipment shall be capable of adjustment to compensate for the varying moisture content of the sand and coarse aggregates and to adjust the mix proportions as needed.
10) Admissible errors in batching shall be as follows:

Material	Cement	Water and Ice (if any)	Admixtures	Aggregate
Error in Percent	1.5%	1%	3%	2%
Measured by	Weight or volume	Weight or volume	Weight	Weight

11) Conveying batched materials from weighing hoppers into the mixer shall be so constructed and operated that spillage of the batched materials and overlap of batches is prevented.
12) Construction and operation of the cement and pozzolan handling equipment shall be such that no noticeable dust will be raised during measuring and discharging of each batch of material.

6.14.3 MIXING

6.14.3.1 General

1) Concrete shall be mixed in a power-driven stationary batch mixer of approved type and size. They shall be kept clean and in proper working order. The mixing blades in the drum shall be replaced when worn by 10% of their design dimensions.
2) Movable truck mixers shall not be permitted for mixing concrete mixes.
3) Concrete mixing equipment shall be capable of combining the aggregate, cement, admixture and water into a uniform mixture within the time limit specified hereafter and of discharging this mixture without segregation. If more than one liquid admixture is used, these shall be discharged separately into the batch. The plant assembly shall be such as to facilitate the inspection of all operations at all times.
4) Batching and mixing of concrete shall not commence unless due notice, at least 24 hours in advance, has been given to the Engineer and written approval has been obtained for the placing arrangements, and for the preparation and accuracy of the part of the Works in which concrete is to be placed.
5) The quantity of material in each batch shall not exceed the normal continuous rated capacity of the mixer and the speed of rotation shall be within 1 rpm of the manufacturer's recommended speed.
6) Components shall be fed into the mixing drum so as to ensure the most efficient use of the mixing period and to avoid any loss of material. Into case shall the mixers be overloaded by more than 10% of their rated capacity recommended by the manufacturer. Uniformity in concrete consistency from batch to batch will be required.
7) Mixing is considered to have started when all solid materials are in the mixer drum, provided that all the mixing water is introduced within one fourth of the mixing time. The further addition of water shortly before completion of mixing and excessive over-mixing, requiring

addition of water to preserve the required concrete consistency, will not be permitted.

8) The first batch of concrete materials in the mixer shall contain sufficient excess of cement, sand and water to coat the inside of the drum without reducing the required mortar content of the mix. The entire content of the mixer shall be removed from the drum before materials for a succeeding batch are placed therein.
9) Mixing of concrete shall not commence without ensuring that the stocks of materials are adequate, with a reasonable safety margin, for the completion of the particular pour of concrete.
10) The mixing time of each batch shall be determined by the batching and mixing tests based on manufacturer's recommendations. Suggested mixing times for various mixer capacities are as follows:

Capacity of mixer	Mixing time
< 1.5 Cum	1½ minutes
2.0 Cum	2 minutes
3.0 Cum	2½ minutes
> 4.0 Cum	3 minutes

11) Each mixer shall be equipped with a mechanically operated timing and signaling device which will indicate and ensure the completion of the required mixing period and will count the batches.
12) The Engineer reserves the right to vary the mixing time or to limit the batch size when the batching and mixing operations fail to produce a concrete conforming to the requirements set out during the trial mix stage.

6.14.3.2 Trial Run and Performance Control

1) Prior to any Permanent Works concreting, the Contractor shall carry out a trial concrete production run.
2) All plants and materials used shall be those to be used for the actual production of concrete in the Permanent Works.
3) The Contractor shall make all adjustments necessary to produce concrete of the quality of the agreed trial mixes of each class. Only when this has been achieved will the Engineer give consent to proceed with Permanent Works concreting.
4) The performance of mixers shall be controlled in accordance with the provisions of ASTM Specification C94 and Designation 26 of USBR "Concrete Manual".

6.14.4 TRANSPORTING

1) The method and facilities for concrete transport shall be selected by the Contractor within the limitations of these Specifications, and he shall be responsible for adequacy and suitability of the transporting system. The time elapse between mixing and the initial set of the concrete shall be taken into consideration.
2) The concrete transporting methods and facilities shall be such that will prevent segregation of coarse aggregate, excessive loss of slump, and loss of ingredients. All equipment shall be kept clean and in good working condition.
3) Concrete mixed in central stationary mixers and transported by equipment others than truck mounted agitators, shall be placed within 30 minutes (of loading into the transport equipment) in its final position.
4) The capacity of bucket haulers shall be of the concrete batch size or a multiple thereof in order to prevent the splitting of batches. The dumping mechanism shall permit discharge of small portion of concrete in one place. Buckets shall be capable of prompt discharge of low- slump, lean-mix concrete with maximum aggregate size to be used.

5) Transportation of concrete by non-agitating cars or trucks shall be limited to a distance of 3 km unless remixing facilities are provided at the place of final placement. Free water shall not stand on the surface of concrete when delivered in cars or trucks.
6) If concrete is to be poured by tipping, chutes shall be used to keep it coherent, their ends being placed just above the placing point. The slopes of chutes for conveying fresh concrete shall be chosen so that the concrete with minimum water content flows in a steady stream without segregating. Effective end control that will produce a vertical drop and prevent segregation of ingredients shall be provided. The chutes and belt conveyors shall be protected from wind and sun.

6.14.5 COMMUNICATIONS

1) The Contractor shall furnish, install, maintain and operate a telephone system or radio, linking the points of placing concrete with the concrete batching and mixing plant. These facilities shall also be available to the Engineer at all times.
2) When placing the concrete by pumping, direct communication shall be maintained between the concrete placing crew and the pump operators.

6.15 TEMPERATURE OF CONCRETE

1) The Contractor shall make the necessary provisions in the concrete materials storage, handling and batching facilities, as required to comply with the hot weather concreting requirements. The proposed methods of temperature control shall be approved by the Engineer.
2) Hot weather conditions shall be considered to be in effect whenever the temperature is above 30°C and is expected to exceed this value over a prolonged period.
3) The temperature of concrete when being placed in hot weather shall be as follows, unless otherwise permitted by the Engineer:
    a) Mass concrete, thickness ≥ 3.00 m, not more than 28°C
    b) Structural concrete, not more than 30°C
4) To meet these requirements, the Contractor shall be prepared to undertake any, or all of the following measures:
    a) Carry out batching and placing operations at night,
    b) Supply cooler mixing water, or add ice to the concrete during mixing,
    c) Cool the fine and coarse aggregates before mixing operations,
    d) Spray the coarse aggregate stockpile with cool water,
    e) Prevent exposure of batching, mixing and conveying equipment to direct sunlight,
    f) Spray the forms and reinforcing steel with cool water.
5) Use of ice for mixing water shall be carefully controlled to ensure complete melting before mixing is terminated.

6.16 CONCRETE PLACING

6.16.1 GENERAL

1) No concrete shall be placed until the construction site, forms, reinforcement, and embedded parts have been inspected and a written approval given by the Engineer. This approval shall be obtained before each and every concrete pour.
2) Written approval shall consist of a triplicate "Concrete Pour Advice Form" prepared by the Contractor and approved by the Engineer, listing at least the following:
    a) Date and times of commencing and finish of placing
    b) Location
    c) Composition of concrete mix
    d) Volume placed
    e) Foreman in charge
    f) Equipment used
    g) Cleaning and preparation of foundation performed

h) Reinforcement placed
i) Formwork used
j) Reference drawings

3) Concrete shall be placed before initial set as per ASTM Test Method C 403 has occurred, i.e. 60 to 90 minutes after adding water to the mix.
4) No concrete shall be placed when the atmospheric conditions are, in the opinion of the Engineer, such that proper placing and hardening of the concrete are not guaranteed. Specifically, the Contractor shall have the responsibility for meeting the hot weather concreting requirements and for postponing concreting whenever such requirements cannot be met or, based on weather forecast, probably cannot be met. Even if the above requirements are fulfilled, the Contractor has the responsibility of delivering concrete product that meets specified requirements.
5) Concrete, which is found not to be in conformity with the requirements specified herein or has been placed without the knowledge and authorization of the Engineer, shall be rejected and removed from the Works and replaced by the Contractor.

6.16.2 CASTING SEQUENCES

1) The time between successive lifts and maximum permissible depth of concrete placed in one lift, unless otherwise directed or shown on the Detailed Design and/or Construction Drawings, shall be as follows:

Location	Maximum permissible depth of one lift	Minimum time between successive lifts
Mass concrete in massive structures	250 cm	72 hours
Walls and piers less than 5 m thick	400 cm	48 hours
Other structures	As approved by the Engineer	48 hours

2) The Engineer may change the minimum time elapsing between the pouring of successive lifts and/or the maximum permissible depth of one lift for temperature control purposes or similar reasons.
3) Concrete for beams, slabs and similar members shall be poured to the full depth in a single operation.
4) Outdoor concreting shall not be started during rain. If concreting is already in progress during the rain, it shall be suspended if the rain adversely affects the quality of the placed concrete.
5) Concrete that has been allowed to harden to the extent that additional concrete placed on it will not satisfactorily bond shall be treated as a construction joint. When stoppage of concreting operations occurs for any reason, construction joints shall be placed either horizontally or vertically as needed.

6.16.3 PLACING AND COMPACTION

1) Concrete shall be carefully placed in position. Where dense reinforcement or deep forms may cause segregation of concrete while placing, chutes shall be used to prevent segregation. The free fall of concrete shall not exceed 1.5 m for structural concrete and 3.0 m concrete walls and piles.
2) Concrete shall be placed directly in its permanent position and shall not be worked along the forms to that position. Vibrators shall not be used to move concrete laterally.
3) The addition of water into concrete after batching to compensate for stiffening of the concrete before placing shall not be permitted. Concrete corrections to the batching plant are permitted keeping unmodified the design parameters (i.e. W/C ratio).

4) All concrete shall be placed in continuous approximately horizontal layers. The thickness of the layers shall not exceed 40 cm for mass concrete, and 50 cm for structural and all other concrete. Each layer shall be soft when a new layer is placed upon it so that no seams or planes of weakness within the section can form, and the two layers shall be made monolithic by penetration of vibrators.
5) The Engineer reserves the right to order a reduced thickness of layers where the layers as stated above cannot be placed in accordance with the requirements of these Specifications.
6) Each layer of concrete while being placed shall be compacted by mechanical vibration to form a dense, homogeneous material free from voids. The concrete shall be worked up hard against adjoining surfaces. Each concrete layer shall be vibrated completely before another layer of concrete is placed upon it.
7) Vibration of concrete shall be carried out by means of immersion-type vibrators, supplemented if necessary, by external vibrators of suitable design and capacity. Immersion vibrators, having head diameters equal to or less than 100 mm, shall have a minimum speed of 7,000 vibrations per minute when immersed in concrete. Those with head diameters more than 75 mm shall have a minimum speed of 6,000 vibrations per minute when immersed in concrete. Formwork vibrators shall operate at not less than 8,000 vibrations per minute when vibrating concrete.
8) Immersion vibrators shall penetrate the full depth of the layer and shall enter the underlying layer so as to ensure proper integration of successive layers. They shall be inserted in a near-vertical position at sufficiently close intervals for long enough time to ensure proper compaction and shall be withdrawn slowly to prevent the formation of voids. The concrete shall be vibrated until it presents a compact reflecting surface and the bubbles of entrapped air cease to escape. Over-vibration causing segregation, surface laitance, or leakage through formwork shall be avoided. Vibrators shall not be allowed to come into contact with formwork and contact between vibrators and the reinforcement is to be avoided.
9) Vibrators shall be operated by experienced workers only. A spare vibrator of the appropriate type and capacity shall be available and shall be tested to ensure that it is working before concreting commences. At least one spare vibrator shall be available at each concrete pour, and a minimum of one spare for each 5 vibrators in service at each construction site.
10) The Contractor shall modify his vibrating equipment if it does not perform satisfactorily under operating conditions.
11) Internal struts, stays and braces, serving temporarily to hold the forms in correct shape and alignment impeding the placing of concrete, shall be removed when the concrete placing has reached an elevation rendering their service unnecessary.
12) The Contractor shall take care to prevent formation of cold joints during placing concrete in any part of the Works. His concrete-placing rate shall be such that the concrete is placed while the previously placed adjacent concrete is still plastic and the concrete can be made monolithic by normal use of vibrators.

6.16.4 PUMPING CONCRETE

1) Positive displacement pumping or other approved methods may be used to place concrete in locations approved by the Engineer. The type and arrangement of equipment shall be subject to approval by the Engineer, and the equipment shall be operated only by experienced persons. Pneumatic placing will not be allowed.
2) The equipment and its method of operation shall allow the concrete to enter the forms at a low velocity.
3) Concrete pumps and auxiliary equipment shall be in good condition and shall be maintained as such throughout the duration of the work. Thorough washing down of all parts that come in contact with concrete shall be performed after each concreting operation.
4) Pump lines shall consist of rigid steel pipe or flexible pipe made of rubber, spiral-wound flexible metal or plastic, or combination of both. Use of aluminum pipe for pump lines shall not be

permitted. Couplings shall be leak-proof and strong enough to withstand handling during erection and poor support along the lines. They shall provide a full internal cross section with no constrictions of the smooth flow of concrete.

5) Immediately prior to the start of all concrete pumping, the pump and pump lines shall be primed by pumping an approved grout mixture through the equipment.
6) Concrete pumping operations shall be planned in such a way that concrete does not set before the succeeding layer is place thereon. An adequate supply of fresh concrete shall be provided at all times.

6.17 PROTECTION AND CURING

6.17.1 PROTECTION

1) The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, over-stress, or any other cause until final acceptance by the Engineer.
2) Fresh concrete shall be protected from damage such as due to drying, sunshine, rain, hail, sleet, and traffic. The Contractor shall provide such protection while the concrete is still plastic and whenever such precipitation, either periodic or sustaining, is imminent or occurring.
3) Care shall be taken not to disturb the concrete by direct or indirectly loading, striking of forms or otherwise, until it has hardened sufficiently.
4) Construction loads shall not be allowed on beams, decks or slabs until the concrete has attained its design strength, nor shall the Contractor impose loads exceeding the design loading.
5) All fresh concrete surfaces shall be protected from contamination and from foot traffic until the concrete has hardened. Surfaces which have received the U2 or U3 finishes shall be protected by covering with protective mats, plywood, or other effective means approved by the Engineer.

6.17.2 CURING

6.17.2.1 General

All concrete shall be moist cured for a period of not less than 14 consecutive days by an approved method or combination of methods applicable to local conditions. The Contractor shall have on hand, and ready to install, all equipment needed for adequate curing of concrete before actual concrete placement of each pour begins. The curing medium and method, or the combination of mediums and methods, will be subject to approval of the Engineer.

6.17.2.2 Water Curing

1) Water used for curing shall meet the requirements of mixing water, free of deleterious materials and substances that will stain or discolour the concrete.
2) Water curing shall start as soon as the concrete has hardened sufficiently to prevent damage by erosion and shall continue for the duration of the entire curing period or until covered with fresh concrete. All surfaces shall be kept continuously wet during curing. Wetting the surfaces only periodically will not be permitted.
3) Water curing shall be carried out by following methods:
    a) Spraying or sprinkling by a system of perforated pipes, lawn sprinklers, soaking hoses or by other approved methods. Intermittent sprinkling will not be acceptable
    b) Covering the concrete surfaces with burlap, cotton mats, or rugs which will hold water on the surface either horizontal or vertical. The covering materials shall be kept continuously water-saturated during the curing period
    c) Covering the horizontal construction joints and finished surfaces with a minimum thickness of 50 mm of sand which shall be kept uniformly distributed and continuously saturated during the curing period.

6.17.2.3 Membrane Curing by Sealing Compound

1) Sealing compounds shall be used for concrete curing only if approved in writing by the Engineer. Sealing compounds will generally be accepted on manufacturer's certification of compliance with specifications, but such acceptance shall in no way relieve the Contractor of the

responsibility for furnishing a compound which meets the requirements of these Specification. Sealing compounds will be subject to sampling and testing.

2) The liquid membrane-forming compounds for curing concrete shall conform to the requirements of ASTM Specification C309. The compounds shall be of uniform consistency and quality within each container and from shipment to shipment. When approved, the membrane curing shall be performed by application of the sealing compound which forms a water-retaining membrane on the surfaces of the concrete. The sealing compound shall be white-pigmented except that compound used on surfaces that will be exposed permanently to view shall be a gray-pigmented sealing compound.
3) Sealing compound shall not be used on concrete surfaces to which additional concrete, paint or tile is to be bonded, unless the Contractor has demonstrated that the membrane can be satisfactorily removed before subsequent application or can serve satisfactorily as a base for the application.
4) When sealing compounds are used on unformed concrete surfaces, application of the compounds shall commence immediately after finishing operations are completed. When sealing compounds are to be used on formed concrete surfaces, the surfaces shall be moistened with a light spray of water immediately after the forms are removed and shall be kept wet until the surfaces will not absorb more moisture. As soon as the surface film of moisture disappears but while the surface still has a damp appearance, the sealing compound shall be applied.
5) Special care shall be taken to ensure ample coverage with the compound at edges, corners, and rough spots of formed surfaces. After application of the sealing compound has been completed and the coating is dry to touch, any required repair of concrete surfaces shall be performed. Each repair, after being finished, shall be moistened and coated with sealing compound in accordance with the foregoing requirements.
6) Equipment for applying sealing compounds and the method of application shall meet with the approval of the Engineer. Traffic and other operations by the Contractor shall be such as to avoid damage to coatings of sealing compounds for a period of not less than 14 days. Any sealing membrane that is damaged or that peels from concrete surfaces, within 28 days after application, shall be repaired without delay.
7) Sealing compounds used for surfaces exposed to view shall degrade completely when exposed to air for more than 3 months. They are to remain at least 80% impermeable for 1 month after application.

6.18 REPAIR OF DEFECTIVE CONCRETE

6.18.1 GENERAL

1) Concrete which is damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established position, line or grade, or which, for any other reason, does not conform to these Specifications, shall be satisfactorily repaired, or removed and replaced with acceptable concrete by the Contractor.
2) The Contractor shall correct all imperfections on the concrete surface as necessary to produce the specified finish within the time as specified below:
    a) Minor formed surface repairs, such as surface grinding, shall be completed within 2 hours after form removal
    b) Concrete replacement less than 25 cm thick, mortar and dry-pack repairs shall be completed within 7 days after the original concrete placement
    c) Concrete replacement more than 25 cm thick, epoxy-resin bonding repairs, and all other repairs shall be completed after 7 days, but before 56 days after the original placement.
3) All repair work shall be finished to the same standard as the surrounding concrete and shall be

adequately cured. Plastering or rendering of surfaces to produce a smooth surface finish shall not be permitted.

4) No repair work shall be carried out before the Engineer has inspected the defective area and given consent in writing for remedial work to begin.
5) Concrete requiring F1, F1C, U1, F2, F2C or U2 finish that is honeycombed, fractured, that contains surface depressions which exceed the allowable tolerance specified in this Section or that is otherwise defective shall be cut back to a minimum depth of 25 mm into sound concrete in all directions, and the edges undercut. The area to be removed shall be outlined to a depth of 15 mm with a diamond or Carborundrum saw prior to removing the defective concrete. The fresh concrete surface shall then be cleaned, washed down and thoroughly soaked with water until the concrete becomes saturated. The concrete surface should be damp. Repairs to the surface shall then be carried out using the materials and methods described hereafter.
6) For bonding new concrete to older one, a bonding medium of epoxy, formulated for this purpose, shall be used in accordance with manufacturer's instructions. Alternatively, a neat cement paste may be used. A paste of Portland cement and water mixed to a thick cream consistency shall be applied to damp, clean concrete. The concrete shall have no free water on the surface.
7) Concrete requiring F3, U3 or U3C finish that is honeycombed, fractured, that contains surface depressions which exceed the allowable tolerances specified in this Section or that is otherwise defective shall be repaired as follows:
    a) Minor areas of defective concrete: The Contractor shall drill a hole of such diameter in the defective area into sound concrete, that the defective concrete is completely removed. The minimum diameter of such hole shall be 50 mm, the minimum depth shall be equal to the diameter of the hole drilled and the maximum depth shall be 70 mm. The hole shall then be reamed out such that the diameter at the bottom of the hole is at least 20 mm larger than the hole at the surface. Finally, the hole shall be cleaned and washed out, the surplus water removed, and then filled with concrete incorporating a non-shrink agent approved by the Engineer.
    b) Large areas of defective concrete: concrete which contains defective areas too large to be repaired as described above shall be cut to the far face of surface reinforcement or further if necessary, to remove all the defective material, and the edges undercut. The fresh concrete surface shall then be cleaned, washed down and thoroughly soaked with water until the concrete becomes saturated. The concrete surface should be damp. Finally, the hole shall be filled with concrete which may incorporate a non-shrink agent approved by the Engineer.
8) Concrete which will be exposed to public view shall be repaired in a manner which will result in a concrete surface with a uniform appearance.

6.18.2 DRY-PACK MORTAR

1. The dry-pack mortar shall consist of 1-part cement to 2½ parts of sand, by volume, that will pass a US Standard Sieve No. 16 (1.18 mm). Only enough water shall be used to produce a mortar which will stick together when molded into a ball by a slight pressure of the hands and will not exude water but will leave the dry pack in thin layers.
2. Dry-pack mortar shall be placed and packed in layers. Each layer shall be solidly compacted over its surface by use of a hardwood stock and hammer.
3. Dry-pack mortar shall be used for filling holes having at least one surface dimension less than the hole depth, for narrow slots cut for repair of cracks, for redrilled grout holes and grout pipe recesses, and for tie-rod fastener recesses.
4. Dry-pack mortar shall not be used for filling behind reinforcement or for filling holes that extend completely through the concrete section.

6.18.3 MORTAR FILLING

1. Mortar to be used for repair work shall have the same sand, cement and air proportions as the mortar in the mix of the concrete to be repaired. The Contractor shall place mortar filling with a mortar gun or by hand.
2. Mortar filling shall be used to repair defects which are too wide for dry pack filling and too shallow for concrete filling and no deeper than the far side of the reinforcement that is nearest the surface.
3. Mortar filling in concrete surfaces destined to be in contact with flowing water shall be used only together with the application of epoxy coatings using a procedure approved by the Engineer.

6.18.4 CONCRETE FILLING

1. Concrete filling shall be used for holes extending entirely through concrete sections, for holes in which no reinforcement is encountered and which are greater in area than 0.1 m2 and deeper than 100 mm and for holes in reinforced concrete which are greater in area than 0.05 m2. Holes in reinforced concrete which extend beyond the reinforcement shall be enlarged as necessary to permit satisfactory filling of the hole with concrete.
2. Concrete filling shall be tightly packed and completely bonded to the surfaces of the holes. The mix proportions of the filling materials shall be such as to provide a strong, dense repair which will avoid colour variations in surfaces exposed to view.
3. On surfaces permanently exposed to view, and where required by the Engineer, the Contractor shall supply white cement in sufficient amount, as determined by trial, which when blended with normal cement, will produce a finish of similar appearance to the adjacent concrete. Non-shrink agent shall be used where a watertight joint is required. The surface of patches shall be smooth and flush with the surrounding concrete.

6.18.5 EPOXY-RESIN BONDING

1. Any repairs made more than 7 days after the original concrete placement for thicknesses less than 25 cm thick shall utilize epoxy-resin bonding system. The locations where epoxy-resin will be used will be determined by the Engineer, who will approve the type and brand to be used.
2. The method of repair shall be as recommended by the manufacturer. The product used may contain no toxic elements.
3. In areas exposed to public view, the concrete surfaces repaired with epoxy-resin bonded system shall be lightly ground to eliminate gloss of the finished epoxy mortar surface and to produce a surface colour and texture that closely matches the surrounding concrete surface.

6.18.6 STAINS AND DISCOLOURATION

Stains or discolouration of exposed (Class F2, F2C and U2) concrete surfaces shall be removed. The procedure or method or removing the stains and/or discolouration will be subject to approval. The removal of stains or discolouration shall not be started until the work that originally caused the stains or discolouration is completed.

6.19 PARTICULAR REQUIREMENTS FOR INDIVIDUAL CONCRETE STRUCTURES

6.19.1 CONCRETE GRAVITY STRUCTURES

1) Concrete used for the construction of mass concrete gravity structures shall be class C20D76 unless otherwise approved or directed by the Engineer. However, concrete surface exposed to weathering, freezing/thawing, and standing or flowing water shall be constructed of higher strength concrete as indicated on the Final Design and /or Construction Drawings. Where such higher strength concrete is used, part of each lift will normally be composed of two classes of concrete. Water-cement ratio shall not exceed 0.52.
2) Reinforcement shall be provided at the surfaces in contact with standing or flowing water and at all openings in mass concrete.
3) Mass concrete of gravity structures shall be water cured for at least 7 days unless otherwise

directed by the Engineer. When curing compound is used as a bond breaking membrane at contraction joints, it shall be also be considered acceptable in meeting the curing requirements.

6.19.2 POROUS CONCRETE

1) Porous Concrete shall be placed where free drainage is required and shall be produced by gap grading or single size aggregate grading.
2) The strength requirements for porous concrete shall be as for class C15D32 concrete. The porosity shall be such that water will pass through a slab 30 mm thick at a minimum rate of 500 l/min/m2 with a constant depth of water on the slab of 10 cm.
3) Porous concrete shall not be vibrated but only placed and lightly rammed. Formed surfaces shall be Class F1 finish. Exposed surfaces of the porous concrete shall be sealed in an approved manner, such as the use of polyethylene or rendering with sand and cement, before structural concrete is placed against it.

6.19.3 PRE-CAST CONCRETE

6.19.3.1 General

1) The Contractor shall investigate the possibility of obtaining and utilizing standard pre-cast concrete products available in the local market, before commencing any such production on his own.
2) When producing on his own, the pre-cast concrete units shall be manufactured and cured in a properly equipped casting yard or shop. The facilities shall be subject to the Engineer's inspection and approval.
3) The quality of the materials used in the manufacture of precast concrete units shall conform to the applicable requirements of these Specifications.
4) Details of the design, concrete components and mixes, and test results shall be made available to the Engineer.
5) Precast units which will be used in composite construction shall contain interlocking devices welded or formed into the steel member for connection with the subsequently cast-in-situ concrete to prevent a slip between the two materials and normal steel reinforcement. Such connections shall be designed so that they can resist 1.8 times the working load to which they will be subjected and that the ensuing movements cause no distress to the joint. The Contractor shall submit design details and calculations for approval before commencing any production.
6) Each unit is to be cast in one continuous operation and no construction joints will be permitted unless expressly approved by the Engineer.
7) Care shall be taken during storage, hoisting and handling of precast units to prevent cracking or damage. Units damaged by improper storing or handling shall be replaced by the Contractor.
8) Pre-cast units shall remain undisturbed until the concrete has developed at least 70% of the required compressive strength at 28 days and shall not be installed until the unit has developed the full required strength at 28 days, unless explicitly approved by the Engineer.

6.20 MEASUREMENT AND PAYMENT

6.20.1 CONCRETE

6.20.1.1 General

1) Measurement for payment of concrete, unless specified otherwise hereafter, will be of the volume placed within the lines, grades, and pay-limits shown on the Final Design and /or Construction Drawings or as established at the Site by the Engineer.
2) Unless otherwise stated, no payment will be made for concrete placed outside these limits, other than in additional excavation directed by the Engineer, and the measurement shall not include any filling of overbreak unless recognized as due to geological conditions conforming to the limits defined in other Sections of these Specifications.
3) Payment will be made at the Unit Prices for different structures of concrete entered in the Bill of Quantities, which shall include, but not be limited to, the following:

a) Drilling, blasting, loading, transportation, stockpiling, crushing, screening, washing, blending, and storage of aggregates
b) Batching, supply of mixing water, mixing, transportation, placing, and compacting the concrete
c) Labour, tools and equipment for cleaning, and preparing surfaces prior to concreting
d) Forming and treatment of construction joints including furnishing and spreading of mortar layers, or starter mixes before concrete placing
e) Surface finishing
f) Attaining the concrete temperature as specified, and hot weather precautions
g) Protection and curing of concrete
h) Repair of defective concrete
i) Communication system connecting the points of placing concrete with the relevant mixing plant or delivery equipment
j) Provision of material samples and all activities required in connection with the performance of the tests including their transportation to the testing laboratory
k) Removal and disposal of waste concrete and test samples.
l) Preparation of contact surfaces for second stage concrete and block outs for equipment embedding.

4) No separate payment is provided in the Bill of Quantities for second stage concrete and concrete in block outs for equipment embedding as the unit prices of each structure include first stage, second stage and block outs.

6.20.1.2 Backfill Concrete Directed by the Engineer

1) Where backfilling with concrete is directed by the Engineer, payment will be made for concrete placed as backfill in geologically accepted overbreak, dental excavation and in additional excavation directed by the Engineer.
2) Payment will be made at the Unit Price entered in the Bill of Quantities for the specific backfill concrete or for the structure with which it is associated.

6.20.1.3 Slush Grout

1) Measurement for payment of slush grout will be of the area of the foundation surface treated accordingly.
2) Payment will be made at the unit price per square meter entered in the Bill of Quantities.

6.20.1.4 Placing Concrete in Water

Payment for concrete placed in water will be made at the Unit Price for the specified concrete class plus additional Unit Price per cubic meter entered in the Bill of Quantities, which shall cover the entire cost of labour equipment and additional cement required for placement of concrete underwater.

6.20.1.5 Non-shrink Grout

Measurement for payment for the non-shrink grout will be as specified in Section "Miscellaneous and Ancillary Works".

6.20.1.6 Pre-cast Concrete

1) Measurement for payment for pre-cast concrete units will be by the volume in cubic meters of the units installed, as determined from the Final Design and /or Construction Drawings.
2) Payment will be made at the Unit Price per cubic meter entered in the Bill of Quantities, which shall include, in addition to works included under "General", the entire cost of curing, storage, transportation and erection. Cement, admixtures and reinforcing steel will be paid for separately as specified here below.

6.20.1.7 Exclusions

No extra measurement for payment or payment will be made for the following:

1) Any rounded or beveled edges, fillets, scoring, chamfers, or any deduction made for voids or

embedded items which are either less than 0.10 m3 in volume or 0.05 m2 in cross section. No allowance will be made for approved temporary openings, drains, embedded pipes, or recesses created by the Contractor for his own convenience during construction provided they are filled as directed

2) Any collecting of seepage water or water inflow from rock surfaces and diverting it into the drainage systems as specified in the Section "Care of Water During Construction"
3) Any defective and wasted concrete. Concrete which has to be removed and replaced due to Contractor's noncompliance with the Specifications or Engineer's directions, and all related cost shall be at the Contractor's expense.
4) Any pre-cast concrete unit produced by the Contractor in excess of the number required, damaged before the installation or otherwise rejected by the Engineer.
5) Any concrete which the Contractor places or uses for his own installations or for his own convenience
6) Developing alternative sources of aggregates by the Contractor and the resulting additional material testing

6.21 CEMENT

1) Measurement for payment for Portland cement used for concrete will be of the quantities, by weight, of cement approved for the different classes of concrete specified and computed on the basis of the number of cubic meters of concrete measured and approved for payment. The amount of cement required per cubic meter of concrete of each class will be as established at trial mix stage or the approved modifications thereof as established by the Engineer in the course of concrete work.
2) Payment will be made at the Unit Price per metric ton entered in the Bill of Quantities, which shall include the entire cost of supply, delivery, transportation, storage and mixing, and test for complying with all requirements specified.
3) No measurement for payment or payment will be made for cement used for:
    a) Contractor's own convenience
    b) Used for defective and wasted concrete
    c) Concrete placed outside of the concrete pay-lines (e.g. for filling the overbreak other than approved overbreak due to geological conditions) or required as a result of careless excavation
    d) Any additional cement required due to usage of greater proportion of crushed aggregate than established at trial mix stage for a specified concrete class

6.21.1 ADMIXTURES

1) Measurement for payment for air-entraining, water-reducing, water-reducing-retarding and super plasticizer admixtures will be of the weight or volume of the agreed dosages established at trial mix stages or the approved modifications thereof, for different classes of concrete, and computed on the basis of the number of cubic meters of concrete measured and approved for payment.
2) Payment will be made at the applicable Unit Price per kilogram entered in the Bill of Quantities, which shall include the entire cost of supply, handling, storage, dispersing and tests for complying with all requirements specified.
3) No extra measurement for payment or payment will be made for concrete admixtures used for Contractor's convenience such as accelerators and non-shrink agents.
4) No payment will be made for admixtures used for Contractor's convenience only.

6.21.2 STEEL REINFORCEMENT

1. Measurement for payment for reinforcing bars will be of the weight of reinforcing steel, including splices, as stated in the bar lists approved by the Engineer in the course of the work. The weight entered in the bar lists will be computed using the nominal weight per lineal meter

of different bar diameters based on the specific weight of 7,850 kg/m3.

2. Payment will be made at the Unit Price per metric ton entered in the Bill of Quantities, which shall include the entire cost of supply, storage, cutting, bending, placing, wire clips, ties, separators, and any other fastening devices.
3. No extra measurement for payment or payment will be made for the following:
    a. Wire for tying reinforcement
    b. Any additional reinforcement or splices required when Contractor's casting sequences differ from construction joints shown on the Final Design and /or Construction Drawings
    c. Any reinforcing steel placed by the Contractor for his own convenience in addition to those shown on the Final Design and /or Construction Drawings and entered in the bar lists
    d. Any reinforcing steel delivered for testing

6.21.3 FORMWORK

No Payment will be made towards form work. The cost thereof shall be included in the applicable Unit Price for concrete in the structure with which it is associated.

6.21.4 MOVEMENT JOINTS

1) Measurement for payment will be made for the following items in the units stated:
    e) Water stops : per linear meter placed
    f) Joint Sealing Compound (including primer and plastic tape): per dm3 placed
    g) Joint Filler Panels: per square meter
2) Payment will be made at the appropriate Unit Price entered in the Bill of Quantities, which shall include the entire cost of all materials, plant and labour for furnishing and constructing movement joints as specified, and all temporary protection of the joints from damage.
3) Payment will only be made for the movement joints shown on the Final Design and /or Construction Drawings or directed by the Engineer. Additional joints for Contractor's convenience may be approved by the Engineer, but no payment will be made for materials used in such joints.

6.21.5 TESTS

1) All cost associated with testing as described in this Section shall be borne by the Contractor, who shall make allowance for such expense in the Unit Prices for the concrete work. These shall include, but not be limited to, the following:
    a) The costs for all tests to be carried out prior to the start of concrete work, whether carried out at Site or elsewhere
    b) Routine tests for quality control during the execution of the concrete work carried out by the Contractor as specified herein and as directed
    c) Other tests required during execution of the work to be carried out by an approved test laboratory(ies)
    d) Preparation, storage, handling, curing and delivery of additional samples to the site laboratory, if so, required for additional testing.

2) Should the Contractor fail to adhere to his testing program, all test deemed necessary by the Engineer to check concrete work will be performed by the Engineer at the site laboratory or at an independent laboratory assigned by him, at Contractor's expense.

7 ROAD WORKS

7.1 GENERAL

1) The dam site area is accessible from Mbarara by a road of 90 km approximately length. The first 65 Km stretch is the road Mbarara-Kikagati, which is paved and in fair conditions and seems indicated for heavy vehicle traffic. The Contractor must build a permanent road of approximately 24 km long within command area.
2) The Contractor must also build the additional temporary roads that he deems necessary and maintain the road system for the entire duration of the works.

7.2 PERMANENT ROADS

7.2.1 GENERAL

1) Permanent roads relevant to this Contract are shown on the Detailed Design and include:
    a) The Contractor must build a permanent road of approximately 24 km long within command area.
    b) build the temporary roads deemed necessary for the execution of the works;
    c) maintain these roads for the entire duration of the work.
2) The detailed design of the additional permanent roads shall be prepared by the Contractor, on the basis of general arrangement drawings shown on the Detailed Design and submitted to the Engineer for approval.

7.2.2 SCOPE OF WORK

1) This section covers all labour, materials, equipment and services required for the construction of the permanent roads.
2) Work related to the roads, such as excavation, culverts, drain ditches, retaining walls, slope protection etc. is covered by the respective sections of these Specifications.
3) Work for the pavement construction shall include the following elements:
    a) Excavations and construction of the road embankment
    b) Construction of sub-base
    c) Construction of base course

7.2.3 CONSTRUCTION MATERIAL SOURCES

1) The materials for sub-base and base course shall be obtained from the excavation of the works and from the approved borrow and quarry areas. Materials shall be composed of hard, dense, durable particles in conformity with the quality specified for concrete aggregates.
2) All sub-base and base materials shall be approved by the Engineer.

7.2.4 SUB-BASE MATERIAL

1) The material shall meet the following grade requirements:

US Standard Sieve	Percentage by Weight Passing
3"	100
2½	90-100
No.4	35-70
No.200	0-20

2) If the material does not contain a sufficient quantity of natural cementitious material to bond readily under the action of traffic, there shall be added to, and incorporated in it, a binder consisting of rock screening or other cementitious materials. The sources from where the binder will be obtained, together with the method to be used for adding it to the sub-base material, will be approved by the Engineer.

7.2.5 BASE COURSE MATERIAL

1) The material shall meet the following grade requirements:

US Standard Sieve	Percentage by Weight Passing
1½	100
¾	50-75
No.4	25-50
No.200	0-12

2) If the material does not contain a sufficient quantity of natural cementitious material the Contractor shall add a binder as previously specified for the sub-base.

7.2.6 SUB-GRADE PREPARATION AND COMPACTION

1) The areas to be covered with aggregate shall be carefully cleaned so that no objectionable material shall be incorporated in the future aggregate course.
2) If necessary, the surface which will be in contact with the aggregate course shall be so treated as to fill the fissures, cavities, pockets, hollows and depressions.
3) The sub-grade shall be made to conform to prescribed lines and grades, and the loose material for a thickness of 30 cm shall be compacted to 95% of the maximum dry density, or as directed by the Engineer.

7.2.7 PLACING

1) The surfacing materials shall be spread on the prepared sub-grade to such depth that, when thoroughly compacted, it will conform to the prescribed grades and dimensions. Segregation of coarse and fine particles shall be avoided, and any segregation material shall be remixed by harrowing and blading.
2) The depositing and spreading of the material shall start at the point nearest to the point of loading and the Contractor shall route the hauling equipment over the surfacing material already in place and shall distribute the travel evenly over the entire width of the surfacing so as to distribute the compacting effect of the equipment.
3) The hauling and spreading shall be accompanied by blading and/or dragging, and the surfacing shall be free from corrugations and waves. If necessary, to produce proper compaction, water shall be incorporated with the surfacing material, either at the source or after it is spread on the roadway, at the option of the Contractor.
4) The method of incorporating water in the surfacing material shall be subject to the approval of the Engineer.
5) Immediately following final spreading and grading, each layer shall be compacted to full width by means of smooth wheel power rollers or pneumatic tired rollers.
6) The compaction corresponding to each layer of compacted sub-base and base material shall not be less than obtained with 5 complete passes of a smooth-wheel vibrating roller of 8 tons minimum weight.
7) Rolling shall progress gradually from the sides to the center and shall continue until the whole surface has been rolled. Any irregularities or depressions that develop shall be corrected by loosening the material at these places and adding or removing material until the surface is smooth and uniform. Along curbs, header and walls and at all places not accessible to the roller the base material shall be tamped thoroughly with mechanical tampers.

7.3 MAINTENANCE

1) The Contractor shall be responsible for the maintenance of all permanent and temporary roads on the Site that he will construct or improve until the completion of the Works.
2) The Contractor shall maintain the roads in such a way that the surface never has undulations,

hollows ruts or other damages which limit the speed of the vehicles.

3) Unpaved roads shall be frequently sprayed with water during the dry weather season to prevent the formation of dust clouds.

7.4 TEMPORARY ROADS

1) The Contractor shall design, construct and maintain all temporary roads, bridges, parking areas and other access facilities within the site that he deems necessary for the construction of the Works, including all borrow, quarry and stockpile areas. Where necessary, the roads shall be wide enough to allow heavyweight traffic in both directions. To prevent excessive erosion, no steeper longitudinal slopes than 10% shall be designed, except when specifically approved by the Engineer.
2) Except where rock is encountered, the back slopes of cut banks shall be stable and compatible with existing topography and shall be flattened and rounded as far as practicable into natural ground surface.
3) The Contractor shall construct suitable drainage structures in sufficient numbers to prevent accumulation of excessive water and erosions along the roadways.
4) Roads shall be frequently sprayed with water during the dry weather season to prevent the formation of dust clouds. Site roads shall be graded as necessary to ensure a firm and even surface.
5) Upon Completion of Works the temporary construction roads shall be turned over to the Employer. Those roads which the Employer does not choose to keep shall be made impassable to vehicular traffic and the surfaces shall be scarified and left in a condition which will facilitate growth of natural vegetation, removing the granular material, if any.

7.5 MEASUREMENT AND PAYMENT

7.5.1 PERMANENT ROADS CONSTRUCTION

7.5.1.1 Earthmoving and Structures

1) Measurement and payment for the clearing, grubbing, excavation, fills, backfill, concrete works, culverts, supports and slope protections will be made in accordance with the corresponding sections of these Specifications.
2) All costs of de-watering and keeping the sub-grade surface dry during construction will be included in the unit price for excavation.
3) No extra payment will be made for the preparation of the sub-grade and protection or maintaining excavated surfaces in satisfactory conditions until the sub-base is placed, and the cost thereof shall be deemed to be included in the unit prices for the materials to be placed upon it.

7.5.1.2 Sub-base and Base Course

1) Measurement for payment of sub-base and base granular material, including that for shoulders, will be of the in-situ volume of the material placed and compacted.
2) Payment will be made at the appropriate unit prices per cubic meter entered in the Bill of Quantities, which shall include the entire cost of, but not limited to, the following:
    a) Excavation in the borrow and quarry areas including all clearing, grubbing and stripping in, and trimming, levelling and draining thereof, as stipulated in the Section "Excavation and Filling"
    b) Provision of all labour, equipment and materials required for the preparation, segregating, grading, blending and mixing, wetting or drying of the materials in order to obtain the required gradation, moisture content and other properties
    c) Loading the materials in the borrow and quarry areas, processing plants, or in stockpiles including any rehandling of suitable materials from the required excavations
    d) Transport of materials from the source to the final location
    e) Provision of all labour, equipment and materials required for the placing, spreading,

compacting watering or reduction of the water content as needed of the materials

f) Quality control and performance of tests as required
g) Surveying, setting-out, checking of profile and alignment, and any subsequent rectification works resulting from undue or incorrect surveys, provision of suitable equipment for, and delays due to carrying out this work.

7.5.1.3 Exclusions

No extra payment will be made for the following:

a) Extra work caused by the Contractor's negligence in setting out the structures and slopes
b) Rectification, removal and replacement of the materials which during the placement or afterwards have been contaminated with foreign matters, mixed with unsuitable materials, or lost due to erosion
c) Extra work or material required to repair damages to the temporary or final surfaces caused by erosion or travel of the construction equipment
d) Stockpiling, rehandling, reloading and transport of materials which cannot be directly placed in the final locations after being excavated
e) Damages to concrete structures caused by Contractor's operations
f) Additional passes of the compacting equipment ordered by the Engineer if he determines that a higher degree of compaction than specified is required.

7.5.2 PERMANENT ROADS MAINTENANCE

Payment for permanent road maintenance will be made at the unit price entered in the Bill of Quantities per month, which shall cover all labour, construction equipment and materials for satisfactorily maintain all roads.

7.5.3 TEMPORARY ROADS CONSTRUCTION

1) Payment for construction of the temporary roads will be made as Lump Sum entered in the Bill of Quantities, which shall cover all labour, construction equipment and materials for carrying out all necessary works.
2) Payment of the Lump Sum will be made according to the actual construction progress obtained dividing the total amount by the total length shown on the Contractors approved drawings and multiplying for the works done in the month corresponding to the statement of account.

7.5.4 TEMPORARY ROADS MAINTENANCE

1) Payment for maintenance of the Temporary Roads will be made at the Lump Sum entered in the Bill of Quantities, which shall cover all labour, construction equipment and materials.
2) Payment of the Lump Sum for maintenance will be made in equal monthly installments for each of the month during which the facility is maintained by the Contractor according to the Contractor's approved detailed construction schedule. Each monthly installment will be calculated as the total Lump Sum divided by the number of months of maintenance according to the Contractor's approved construction schedule.
3) In the event that the Contractor is entitled to an extension of time for the Completion of Works, the payment will continue at the same rate per month as stipulated above.

8 PIPES AND PIPING

8.1 SCOPE OF WORK

The scope of the work under this package comprises of

1. The work under this section includes all labour, materials, equipment and services related to the supply and installation and tests of pipes and fittings for:
   a. the pipeline irrigation network comprising of Primary, secondary and tertiary distribution lines reaching the different zones in the command area up to block hydrant (20ha) shown in the Detailed Design and/or required by the Engineer.
2. In detail the works shall include, but not necessarily be restricted to, the following:
   a. Steel pipes with minimum Yield strength of 248 MPa and Grade of steel ASTM A36/A36M
   b. Mild Steel (MS) pipes are provided for 1000mm and more diameters
   c. Internal coating of Mild steel Pipes is with solvent free good grade epoxy coating and gun-iting for external lining
   d. Butterfly valves confirming to BS EN 593 with pressure rating of PN 6 & 10 (Double flanged type valve with bypass arrangement) at appropriate locations for isolation purpose at an interval of about 5 Km or wherever required with size of about 80% main pipe dia. for the MS pipelines.
   e. Ductile Iron (DI) Pipes varying from 300 to 900mm dia. Confirming to BS EN 545-2010 or ISO: 2531.
   f. Internal lining of the DI pipe will be with cement mortar lining and external lining will comprise a layer of metallic zinc, covered by a finishing layer of a bituminous product or synthetic resin compatible with zinc.
   g. Butterfly valves confirming to BS EN 593 with pressure rating of PN 6 & 10, Double flanged valve with short body for DI pipes from 700mm to 900mm dia. and wafer type valve for 300mm to 600mm dia. with size equivalent to pipe dia for the DI pipelines.
   h. Scour/Gate valves to drain out the silt accumulated in the pipeline and to empty the pipeline whenever required. The size of scour valve shall be 1/4 to 1/5 of pipe dia. confirming to BS 1952/3464 with pressure rating of PN 6 & 10.
   i. Air valves to exhaust air from pipe automatically when pressure rises in pipe and supply air to pipe when pressure drops in pipe to avoid damage of pipe. The size of Air valve shall be 1/4th to 1/5th of pipe dia confirming to BS EN 1074-4 with pressure rating of PN 6 & 10.
   j. High Density Polyethylene (HDPE) pipes and fittings below 300mm confirming to ISO 4427:1996 & DIN:8074/8075:1999.
   k. Auxiliary structures comprising of Thrust blocks, Butterfly Valve and Scour Valve Chambers, Road crossings and stream crossing structures.
   l. Installation of pressure and flow control valves at 20Ha block & water meter at 1 Ha.
   m. Installation of Filtration unit (100microns) at dam intake on MS Pipe.
   n. Temporary & Permanent Roads:

      The roads foreseen in this project comprise accesses to:

      Command area, Management's camp, workers' camp and offices;

8.2 GENERAL REQUIREMENTS

8.2.1 Excavation for Pipe Line Trenches

8.2.1.1 Site Clearance

The pipe line alignment shall be cleared of all bushes, shrubs, roots, grass, weeds and if required trees, coming in the alignment of pipe line in the trench width portion. The rates for excavation shall cover all such site clearance work and no extra payment will be allowed on this account.

8.2.1.2 Alignment marking

After the work site is cleared as above, pipe line alignment with required trench width shall be marked on the ground with apex points, curves etc, as shown on the drawings or as directed by the Engineer-in-Charge in charge for the stretch where the work is to be started. The contractor shall provide all labour, survey instruments, and materials such as strings, pegs, nails, bamboos, stones, mortar, concrete etc. required for setting out and establishment of benchmarks. The contractor shall be responsible for the maintenance of benchmarks and other marks and stakes as long as they are required for the work in the opinion of the Engineer-in-Charge.

8.2.1.3 Working survey

Working survey of the pipeline alignment shall be carried out by the contractor before start of the excavation work. The contractor shall provide all the instruments such as leveling instruments, steel tape, ranging rods, strings, pegs etc. for carrying out the survey. Based on the working survey, the alignments, L-section (depth of laying), grade, and location of specials, valves and chambers shall be finalized and got approved from the competent authority. The gradient and alignment shall be such that minimum horizontal and vertical bends shall be required.

8.2.1.4 Use of Machinery

All excavations shall be carried out by mechanical equipments / machinery unless, in the opinion of the Engineer-in-Charge, the work involved and time schedule permit manual excavation.

8.2.1.5 Trench Width and Depth

All buried pipelines shall be minimum 1.2 meter below ground level.

The trench width for respective pipe diameters permissible as required are as per the drawings.

The trench width shall be constant throughout the trench depth, which will provide a clearance of about minimum 0.30 m on either side of the pipe line.

The contractor may, for the facility of work or similar other reasons, excavate and also backfill later, if so, approved by the Engineer-in-Charges, at his own cost, outside the allowable trench width specified in drawings. Should any excavation be taken below the specified trench bottom, contractor shall fill it up to required level, at his own cost, with the same material available at the trench bottom including watering and compaction.

The excavation shall be taken down to such depths as shown in drawings. Excavation for extra depth equal to the thickness of proposed pipe bedding shall be done below pipe soffit level for providing bedding below pipe line. The trench bottom shall be excavated to proper grade as shown on drawings. The contractor shall provide site rails and leveling instruments required for checking the grade during excavation, bottom bedding and pipe laying Projections in rock excavation shall be removed by chipping.

The contractor shall carryout extra excavation at the pipeline joints to be welded, as required (minimum 0.6 m deep and 0.9 m lengthwise, all around the pipe), for facilitating proper welding of the bottom joint from outside. The work of trench excavation should be commensurate with laying and jointing of the pipe line. It should not be dug in advance for a length greater than 500 m ahead of work of laying and jointing of pipeline unless otherwise permitted by the Engineer-in-Charge.

The minimum cover on pipe is to be maintained 1.2 meter. However, the cover on pipe may be modified to suite gradients and site conditions as per direction of Engineer-in-Charge.

The excavation in hard rock will have to be carried out either by controlled blasting or chiseling, wedging or by mechanical means and the tendered rate is supposed to cover all other means.

8.2.1.6 Barricading and Guarding

To protect persons from injury and to avoid damage to property, adequate barricades, construction signs, red lanterns and guards as required shall be placed and maintained during the progress of work, till filling of the trenches after pipes are laid and jointed. The lighting, barricading, guarding of the trenches and the maintenance of watchman shall be done by the contractor at his cost.

All precautions shall be taken during excavation and laying operation to guard against possible damage to any existing structures, underground cables, pipe lines of water, gas, sewage etc. Any damage done to such properties will have to be repaired / rectified by the contractor at his cost. The Contractor has to ensure the following:

safety protections as mentioned above have to be incorporated in the work process hindrances to the public have to be minimized

the trench must not be eroded before the pipes are laid

- the trench must not be filled with water when the pipes are laid
- the trench must not be refilled before laying of the pipes

The bed for the laying of the pipes has to be prepared according to the L-Section immediately before laying of the pipes.

8.2.1.7 Reuse of surface material

All surface materials, which in the opinion of the Engineer-in-Charge, are suitable for reuse in restor ing the surface shall be kept separate from the general excavation material, as directed by the Engineer-in-Charge.

8.2.1.8 Stacking of excavated material

All excavated materials shall be stacked in such a manner that it does not endanger the work and avoids obstructing foot paths and roads. Hydrants under pressure, surface boxes, fire and other utility controls shall be left unobstructed and accessible until the work is completed. Gutters shall be kept clean or other necessary provisions made for street drainage and natural water courses shall not be obstructed. All the excavated material shall be the property of the Employer and shall be stacked or disposed off as directed by the Engineer-in-Charge.

8.2.1.9 Maintenance of traffic

The work of excavation and pipe laying shall be carried in such a manner that it causes the least interruption to traffic and the road / street may be closed in such a manner that it causes the least interruption to the traffic. Where it is necessary for traffic to cross open trenches, suitable bridging arrangement shall be provided. When the street is closed for traffic, suitable signs indicating that street is closed shall be placed and necessary detour signs for proper maintenance of traffic shall be provided.

8.2.1.10 Structure protection

Temporary support, adequate protection and maintenance of all underground and surface structures, drains, sewers and other obstructions encountered in the progress of work shall be furnished under the direction of the Engineer-in-Charge. The structures which have been disturbed shall be restored upon completion of work.

8.2.1.11 Protection of property

Trees, shrubbery fences, poles and all other property shall be protected unless their removal is allowed by the Engineer-in-Charge. When it is necessary to cut roots and tree branches, such cutting shall be done under the supervision and direction of the Engineer-in-Charge.

8.2.1.12 Avoidance of existing services

As far as possible, the pipeline shall be laid below existing services, such as water and gas pipes, cables, cable ducts and drains but not below sewers. Excavation of the trenches shall be carried out to the required depth accordingly. If it is unavoidable, the pipeline shall be suitably protected and lesser trench depth in such cases can be allowed. A minimum clearance of 150 mm shall be provided between the pipeline and such other services. When thrust or auger boring is proposed for laying pipeline across roads, railway or other utilities, larger clearance as required shall be provided. Adequate arrangements shall be made to protect and support the other services during excavation and pipe

laying operations. The work shall be so carried out as not to obstruct access to the other services for inspection, repair and replacement. When such utilities are met with during excavation, the authority concerned shall be intimated and arrangements made to support the utilities in consultation with them.

8.2.1.13 Bailing out of Water

During the excavation if subsoil water is met with, contractor shall provide necessary equipment and labour for dewatering the trenches. If pumping out subsoil water is found necessary, contractor shall provide enough pumps for the same. The tendered rate shall cover all costs for bailing out of water including hire charges of pumps, cost of diesel and labour etc and hence, no extra payment shall be allowed.

8.2.1.14 Disposal of loose boulders etc

All loose boulders, semidetached rocks, (along with earthy stuff which might move therewith), not directly in the excavation but close to the area to be excavated, as to be liable, in the opinion of the Engineer-in-Charge, to fall or otherwise endanger the workman equipment's, or the work etc., shall be stripped off and removed away from the area of the excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion which was originally sound and safe.

8.2.1.15 Disposal of Excavated Material

All the excavated surplus material shall be disposed off on muck area with due consultation of Engineer in Charge.

8.2.1.16 Earth Murum / Sand Bedding below Pipeline

In case of hard rock before lowering of the MS pipes in trenches, a layer of selected earth murum/sand, shall be provided below the MS pipe line to act as bedding. The bedding shall be compacted properly including required watering and the thickness of well compacted layer shall not be less than 150 mm. The bedding shall be provided for full trench width with proper grade as shown on drawings.

8.2.2 Refilling the trenches

8.2.2.1 Use of selected excavated material

Filling of excavated material in trenches shall be commenced as soon as the joints of pipes and specials have been tested and passed. The backfilling material shall be properly consolidated by watering and ramming, taking due care that no damage is caused to the pipes and the outer coating.

Selected surplus spoils from excavated material shall be used as backfill. Fill material shall be free from clods, salts, sulphate, organic or other foreign material. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murum or earth to fill up the voids and the mixture used for filling.

8.2.2.2 Back Filling

All excavations shall be back filled to the level of the original ground surfaces unless otherwise shown on the drawings or ordered by the Engineer-in-Charge in Charge, and in accordance with the requirements of the specification. The material used for backfill, the amount thereof, and the manner of depositing and compacting shall be subject to the approval of the Engineer-in-Charge in Charge, but the Contractor will be held responsible for any displacement of pipe or other structures, any damage to their surfaces, or any instability of pipes and structures caused by improper depositing of backfill materials.

The back filled layers shall be wetted and compacted to a density of not less than 90 percent of the maximum dry density at optimum moisture content of the surrounding material. Any deficiency in the quantity of material for backfilling the trenches shall be supplied by the Contractor at his expense.

The Contractor shall at his own expense make good any settlement of the trench backfill occurring after backfilling and until the expiry of the defects liability period.
On completion of pressure and leakage tests exposed joints shall be covered with approved selected backfill placed above the top of the pipe and joints in accordance with the requirements of the above specifications. The Contractor shall not use backfilling for disposal as refuse or unsuitable soil.

8.2.2.3Fillings of the trench excavated in rock

In case of excavation of trenches in rock, the filling up to a level of 30 cm above the top of the pipe shall be done with fine materials, such as soft soil, murum etc. The filling up of the level of the centre line of the pipe shall be done by hand compaction in layers not exceeding 15 cm, whereas the filing above the center line of the pipe shall be done by hand compaction or mechanical means in layers not exceeding 15 cm. The filling from a level of 30 cm above the top of the pipe to the top of the trench shall be done by mechanical methods with broken rock filing of size not exceeding 15 cm mixed with fine material as available to fill up the voids.

8.2.2.4 Consolidation

The consolidation of the filled material shall be done to attain not less than 90 percent of the maximum dry density. The density of the filled and compacted material shall be tested regularly, and record maintained accordingly.

8.2.2.5 Materials

All pipes, couplings, gaskets, lubricants, seals, coupling machinery etc., necessary for the proper construction of the pipe works as detailed in the Bill of Quantities and drawings shall be supplied by the Contractor.
The Contractor shall be responsible for ensuring that the pipes, couplings and other fittings laid or installed on each section of the work are of the standard and pressure classification specified as appropriate to the circumstances and are manufactured of the specified materials.
The Engineer reserves his right to refuse any materials that in his opinion is inferior.
The Engineer has the right to test any material upon delivery, and materials found defective shall be replaced forthwith by the Contractor.
If the Contractor procures materials of different specifications in respect of flanges and threads etc. (imperial units-metric units), he shall at his own cost provide all adaptors and other fittings necessary to make connections to the satisfaction of the Engineer.
All materials shall be marked as specified in the relevant current AWWA or British or ISO Standards for easy identification on site.
Pipes shall be supplied in standard lengths unless otherwise shown on the Drawings.
Specials shall be fabricated to the details shown on the Drawings, using, where applicable, the same materials, welding procedures and protective linings and coatings as are specified for the corresponding straight pipes.
Satisfactory temporary end covers shall be provided for the protection of threads, flanges and the prepared ends of pipes, fittings and specials, and for the prevention of damage to internal linings during transportation and during handling on Site.

8.2.2.6 Handling and Storing Materials

The method of transportation, handling and storing of pipes and fittings shall be in accordance with the manufacturer's recommendations.
Pipes, valves, specials and other materials shall be handled, moved, lifted or lowered with the least possible impact. Handling equipment shall be of approved type. In slinging pipes only flat slings shall be used and the use of chain slings, hooks or other devices working on scissors or grab principles shall not be permitted. Pipes shall be slung from two or more points as the engineer may direct and the slinging, lifting and lowering shall be in the hands of a competent and experienced man.

Subject to the requirements of inspection before acceptance, protective bolsters, caps or discs on the ends of flanges or pipes or specials shall not be removed until the pipes or specials are about to be lowered into the trench. Every precaution shall be taken to prevent damage to internal Linings or external coatings.

Pipes in storage shall be supported clear of the ground on approved supports and adequately braced to prevent rolling. They shall not be stacked more than four tiers high without the approval of the engineer. Materials of different classification shall be stored separately.

All pipes and associated material shall always be protected from sun and weather to the satisfaction of the Engineer.

The spindle shall not be used to lift the valves.

No valves, fittings or specials shall be stacked more than one tier high without the permission of the Engineer, and they shall not be stored in a dirty place or condition and shall not be allowed to become embedded in earth, sand, stone, aggregate, water, fuel, or any other deleterious matter. Great care shall always be taken to keep the faces and seats of all valves clean and free from dirt and grit of any kind. No valve shall be closed without at first wiping the faces with a clean cloth dipped in clean oil. The cavity beneath the valve doors shall be thoroughly cleaned by hand. In the event of accidental spilling of bitumen, cement or other matter, they shall be either dissolved or carefully removed by methods that do not involve scraping of the faces.

Valves and their ancillary equipment shall be protected before and after erection against collapse of earthworks, falls of materials, concrete and cement droppings, wood and other matter.

Shortly before laying or fixing any valve, pipe or fitting the Contractor shall in the presence of the Engineer or his representative carefully examine each valve, pipe and fitting to ascertain damage or defect occasioned to the valves, pipes and fittings during loading, unloading, handling, storage and transportation. All damage and all defects revealed by this examination shall be repaired and remedied by the Contractor.

8.2.3 Laying and Jointing

8.2.3.1 Pipes and Fittings

The bottom of the trench or surface of the bed shall be finished to a smooth even surface at the correct level to permit the barrel of the pipe to rest on the surface throughout its whole length between joint and sling holes. If considered necessary by the engineer, fine screened material shall be placed and consolidated in the trench bottom to provide such a bed.

In general, the preparation of the trench bottom and bed shall be completed for a length of one pipe in advance of the pipe-laying.

The bottom of the trench and pipe bed shall be inspected by the engineer and only when passed as satisfactory shall pipe laying commence.

Each pipe shall be laid accurately to line, level and gradient so that except where otherwise directed, the finished pipeline shall be in a straight line both in horizontal and vertical plans.

The levels and gradients shown on the drawings shall be rigidly adhered to unless otherwise ordered by the Engineer.

Where lines of pipes are to be constructed the Contractor shall provide and fix, at such points as may be directed properly painted and securely positioned sight rails, the levels and positions of which shall be examined and checked by the Engineer before the rails are used and as often thereafter as may be necessary.

There shall at no time be less than three sight rails in position on each length of pipeline under construction to any one gradient, and the sight rails shall be situated vertically above the line of pipes, or immediately adjacent thereto.

Pipes shall be lowered singly into the trench, brought to the correct alignment and inclination bedded throughout their length, and properly jointed strictly in accordance with the manufacturer's instructions.

Notwithstanding any flexibility provided in pipe joints, pipes must be securely positioned to prevent movement during and after the making of a joint. On screw and socket joints threads shall be coated with an approved tape to ensure water tightness.

Long radius curves in the pipeline shall be negotiated by deflections taken up in the joints or pipes of one or more lengths of pipes. The deflection at each of the various types of joint of pipes used in the works shall not exceed the manufacturer's specifications.

The Contractor shall take care that all pipes and couplings are clean and free of foreign matter before subsequent sections are jointed.

The Contractor shall obtain from the manufacturer or other approved supplier the necessary tackle required for the proper jointing of the pipes.

The Contractor shall make himself and his employees acquainted with and comply with the instructions issued by the manufacturers of the various types of proprietary joints and couplings for incorporation in the works. The Contractor shall be responsible for obtaining copies of such instructions.

No person shall be employed on the jointing of pipes that is not thoroughly experienced and skilled in the particular work in hand.

Pipes shall not be cut without the permission of the Engineer.

The cut shall be made with an approved mechanical pipe cutter and the edges of the cut shall be clean true and square. Threading of steel pipes shall be done with an approved device if required.

The normal continuity of construction may have to be interrupted at joints on the pipelines pending the delivery of certain valves or specials. The exact extent of the temporary gap to be left in such instances shall be predetermined, but shall not be fixed without reference to the Engineer to whom the Contractor shall submit for approval a sketch with dimensions showing details of the pipe and jointing arrangement to be adopted to effect ultimate closure. Special care shall be exercised to preserve the accurate alignment of the pipeline over the extent of the temporary gaps which it may be necessary to leave.

Subject to the permission of the Engineer, pipes shall be covered over with approved fill material upon successful completion of laying and joining. Fill for surrounding and cushioning shall consist of uniformly readily compactable material free from tree roots, vegetable matter, building rubbish and excluding clay lumps retained on a 75 mm sieve and stone retained on a 25 mm sieve.

The materials for bedding shall, where ordered, consist of suitable selected materials obtained from the excavations or from approved borrow pits and transported to the location where they are required.

Adequate precautions shall be taken by way of back-filling or other means to anchor each pipe securely to prevent floatation of the pipeline in the event of the trench being flooded or during concreting.

8.2.3.2 Valves and Specials

Unless otherwise directed all valves, flow-meters, fittings and specials shall be individually supported and their weight shall not be borne by the pipeline, joints or couplings etc.

All supports for valves and fittings shall be of concrete Class C35 or as specified on the drawings.

Where air valves are to be placed the Contractor shall ensure that the highest point in the main is determined by levelling instrument.

Air valves shall be checked before the main is charged to ensure that the balls and faces are not scored or split, and that there is no dirt or other deleterious materials in the cavities of the body. All air nozzles shall be probed to see that they are clear. No air valve shall be stored before erection in the open in sunlight, or upside down to expose the balls and air cavities.

Scour valves shall be installed at low points in the pipelines as shown on the Drawings. The Contractor shall agree with the Engineer on the exact position of scour valves in particular situations.

Scour valves shall, where possible, discharge in the direction of natural drainage and at such a distance from the Works as to preclude erosion effects.

Unless otherwise directed the controlling valve for a scour shall be installed not more than 1.5 m from the main pipeline.
Ends of all scours shall be protected from intrusion of animals and other foreign matter by suitable screening securely fixed to the pipe end.
Valves and other fittings shall be securely fixed and where required extension spindles and head-stocks shall be properly aligned and fixed in a vertical position unless otherwise directed. They shall be tested for ease of operation and water tightness and valve lands shall be repacked where necessary. Any damaged protective coating shall be made good and they shall be left clean in all respects.
Before each valve is put into service all gears, bearings and spindles shall be oiled with approved oil as recommended by the valve manufacturer. Oil baths shall be topped up to the appropriate levels and all grease nipples charged with grease of approved manufacturer. No deleterious matter shall be allowed to come into contact with the working faces and oil sumps shall be maintained clean.
All valves, fittings, specials shall be fixed with proper sealing tube, gaskets, washers etc. as necessary to the satisfaction of the Engineer.

8.2.3.3 Field Hydraulic testing of the pipelines

After laying and jointing the pipeline shall be tested for tightness of barrels and joints, and stability of thrust blocks in sections approved by the Engineer-in-Charge in Charge. The length of the sections depends on the topographical conditions. Preferably the pipeline stretches to be tested shall be between two chambers (Isolation Valve, Scour valve or other chambers). At the beginning, the Contractor shall test stretches for suitable lengths to suit the site requirements. The hydraulic testing shall have to be commenced immediately after laying and jointing.
The water required for testing shall be arranged by the contractor himself. The Contractor shall fill the pipe and compensate the leakage during testing. The Contractor shall provide and maintain all requisite facilities, instruments, etc. for the field testing of the pipelines. The testing of the pipelines generally consists in three phases: preparation, pre-test/saturation and test, immediately following the pre-test. Generally, the following steps are required which shall be monitored and recorded in a test protocol.

- Complete setting of the thrust blocks.
- Partial backfilling and compaction to hold the pipes in position
- Opening of all intermediate valves (if any)
- Fixing the end pieces for tests and after temporarily anchoring them against the soil (not against the preceding pipe stretch)
- At the lower end with a precision pressure gauge and the connection to the reciprocating pump for establishing the test pressure
- At the higher end with a valve for air outlet
- If the pressure gauge cannot be installed at the lowest point of the pipeline, an allowance in the test pressure to be read at the position of the gauge has to be made accordingly
- Slowly filling the pipe from the lowest point(s).
- The water for this purpose shall be reasonably clear and free of solids and suspended matter
- Complete removal of air through air valves along the line.
- Closing all air valves and scour valves.
- Slowly raising the pressure to the test pressure while inspecting the thrust blocks and the temporary anchoring.
- Keeping the pipeline under pressure for the duration of the pre-test / saturation of the lining by adding make-up water to maintain the pressure at the desired test level. Make up water to be arranged by Contractor himself at his own cost.

- Start the test by maintaining the test pressure at the desired level by adding more make-up water; record the water added carefully and the pressure in intervals of 15 minutes at the beginning and 30 minutes at the end of the test period.

The pipeline stretch will pass the test if the water added during the test period is not exceeding the admissible limits. No section of the pipe work shall be accepted by the Engineer-in-Charge in Charge until all requirements of the test have been obtained.

8.3 STEEL PIPE AND FITTINGS

8.3.1 GENERAL

Scope of Work: Provide and install steel pipe of the sizes and in the locations shown on the Plans and as specified herein.

8.3.2 QUALITY ASSURANCE

8.3.2.1 Commercial Standards

Unless otherwise stated, the latest edition for any commercial standards and all manufacturing tolerances referenced, therein shall apply.

- ANSI/AWS D1.1: Structural Welding Code- Steel
- ANSI/AWS B2.1: Specification for Welding Procedure and Performance Qualification
- ANSI/AWWA C200: Steel Water Pipe – 6 In. (150 mm) and Larger
- ANSI/AWWA C205: Cement-Mortar Protective Lining and Coating for Steel Water Pipe – 4 In. (100 mm) and Larger- Shop Applied
- ANSI/AWWA C206: Field Welding of Steel Water Pipe
- ANSI/AWWA C207: Steel Pipe Flanges for Waterworks Service – Sizes 4 In. Through 144 In. (100 mm through 3,600 mm)
- ANSI/AWWA C208: Dimensions for Fabricated Steel Water Pipe Fittings
- ANSI/AWWA C209: Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipe
- ANSI/AWWA C210: Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
- ANSI/AWWA C214: Tape Coating Systems for the Exterior of Steel Water Pipelines
- ANSI/AWWA C215: Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines
- ANSI/AWWA C216: Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fitting
- ANSI/AWWA C222: Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings
- ASME Section IX: International Boiler & Pressure Vessel Code: Welding and Brazing Qualifications
- STM A1011: Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
- ASTM A1018: Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot- Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, and High-Strength Low- Alloy with Improved Formability
- AWWA M11: Steel Water Pipe: A Guide for Design and Installation

8.3.2.2 Qualifications

1. Manufacturers who are fully experienced, reputable, and qualified in the manufacture of the products to be furnished shall furnish all steel pipe and fittings. The pipe and fittings shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these specifications as applicable.

2. Pipe cylinders, coating, lining and fabrication of specials shall be the product of one manufacturer that has not less than 5 years successful experience manufacturing pipe of the particular type and size indicated. The Pipe Manufacturer must have a certified quality assurance program. This certified program shall be ISO 9001:2000 or other equivalent nationally recognized program as approved by the Engineer.

8.3.3 SUBMITTALS

8.3.3.1 Shop Drawings

Drawings shall be submitted to the Engineer for approval and shall include the following:

1. Pipeline layout showing stations and elevations.
2. Details of standard pipe, joints, specials and fittings.

8.3.3.2 Design

1. Calculations for pipe design and fittings reinforcement and/or test data.
2. Details of joint bonding and field welded joint restraint calculations.

8.3.3.3 Certifications

1. The Contractor shall furnish a certified affidavit of compliance that meets or exceeds the requirements of these specifications for all pipe and fittings furnished.
2. Linings for potable piping shall be NSF certified.

8.3.4 VERIFICATIONS

8.3.4.1 Inspections

1. All pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of AWWA C200 and AWWA coating and lining standard as supplemented by the requirements herein. The preshipment inspection, standard verification and approval costs are part of the unit price of the pipe.

8.3.4.2 Tests

1. Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of AWWA C200 and AWWA coating and lining standards.
2. The Contractor shall perform required tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor; provided, that the Contractor's schedule is not delayed for the convenience of the Engineer.

8.3.4.3 Welding Requirements

All welding procedures used to fabricate pipe shall be qualified under the provision of AWS B2.1 or ASME Section IX.

8.3.4.4 Welder Qualifications

Skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used shall do all welding. Welders shall maintain current qualifications under the provisions of AWS B2.1 or ASME Section IX. Machines and electrodes similar to those in the work shall be used in qualification tests. The Contractor shall furnish all material and bear the expense of qualifying welders.

8.3.5 HANDLING, STORAGE AND SHIPPING

1. Pipe shall be stulled as required to maintain roundness of +/- 1% during shipping and handling.
2. Coated pipe shall be shipped on padded bunks with nylon belt tie-down straps or padded banding located approximately over stulling.
3. Coated pipe shall be stored on padded skids, sand or dirt berms, sand bags, old tires or other suitable means so that coating will not be damaged.
4. Coated pipe shall be handled with wide belt slings. Chains, cables or other equipment likely to cause damage to the pipe or coating shall not be used.
5. Prior to shipment, dielectrically coated pipe shall be visually inspected for coating damage by the following procedure:

a. When visual inspection shows a dielectric coating, system has sustained physical damage, the area in question shall be subjected to an electrical holiday test. Voltage shall be per AWWA C214.
b. When the area is tested and there are no holidays or no tearing of the material, (wrinkling or bruising of tape may be permitted) then the area shall be noted "OK" and shipped with no patching required.
c. When the damaged area does show damage going clear to the steel from either a visual inspection or a jeep from a holiday detector, the area shall be repaired in accordance with Section 2.02 of these specifications and per manufacturer's recommendations.

6. Markings
The Contractor shall legibly mark all pipes and specials in accordance with the laying schedule and marking diagram. Each pipe shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. All special pipe sections and fittings shall be marked at each end with top field centerline. The word "top" or other suitable marking shall be painted or marked on the outside top spigot end of each pipe section.

8.3.6 MATERIALS

8.3.6.1 Pipe

a. Steel pipe shall conform to AWWA C200. Steel plate used in the manufacture and fabrication of steel pipe shall meet the requirements of ASTM A1011 or A1018. All longitudinal and girth seams, whether straight or spiral, shall be butt-welded using an approved electric-fusion-weld process.
b. Pipe shall be designed for maximum working pressure comprising surging pressure as per design calculations. Pipe design shall be in accordance with AWWA M11.
c. Pipe shall be bedded and backfilled per the Plan details or manufacturer's recommendations utilizing an E' value for design check per AWWA M11 Chapter 6.
d. Pipe is to be furnished principally in not less than 6m net laying lengths with shorter lengths, field trim pieces and closure pieces as required by Plan and profile for location of elbows, tees, reducers and other in-line fittings or as required for construction. The pipe fabricator shall prepare a pipe laying schedule showing the location of each piece by mark number with station and invert elevation at each bell end.

8.3.6.2 Fittings

a. Unless otherwise shown on the Plans, all specials and fittings shall conform to the dimensions of AWWA C208. Pipe material used in fittings shall be of the same material and pressure class as the adjoining pipe. The minimum radius of elbows shall be 2 1⁄2 times the pipe diameter and the maximum miter angle on each section of the elbow shall not exceed 11 1⁄4-degrees (one cut elbow up to 22 1⁄2-degrees). If elbow radius is less than 2 1⁄2 times the pipe diameter, stresses shall be checked per AWWA M11 and the pressure class increased if necessary.
b. Fittings shall be equal in pressure class design as the adjoining pipe. Specials and fittings, unless otherwise shown on the Plans, shall be made of segmentally welded sections from hydrostatically tested pipe, with ends compatible with the type of joint or coupling specified for the pipe. All welds made after hydrostatic testing of the straight sections of pipe shall be tested per the requirements of AWWA C200 Section 5.2.2.1.

8.3.6.3 Joints

a). Welding

The pipes shall be manufactured by shop welding from steel plates, butt welded spirally or longitudinally by automatic submerged arc welding process using at least two runs, one of which shall be on the inner side of the pipes. Welding shall be so done that there will be through fusion

and complete penetration and shall be free from cracks, oxides, and slag inclusion and gas pockets.

Longitudinally welded pipes shall have circumferential weld at not less than 1.8 m center to center. Longitudinal weld shall be staggered. Minimum distance between spiral welds should be 1.5 m.

b). Radiographic / Ultrasonic test

Three percent of all seams of pipes, welded in the fabrication shop, shall be radio graphed at the end of pipe to render visible inspection of any internal defects such as blow holes, slag, inclusion of cracks. If any defects are detected, the metal at the location shall be chipped out and re-welded. In addition to the radiography of the joints, 100 percent testing by ultrasonic equipment shall also be done for welding tests. Any defects found out shall be rectified free of cost. Welds found deficient in quality shall be removed by chipping or melting and remade as per specifications. Chipping or cutting the weld shall not extend to the base metal.

c). Flanges

Flanges shall be in accordance with AWWA C207 Class D for operating pressures to 175 psi on 4-inch through 12-inch diameter, and operating pressures to 150 psi on diameters over 12-inches. Flanges shall be AWWA C207 Class E for operating pressures over 150 psi to 275 psi or shall be AWWA C207 Class F for pressures to 300 psi (drilling matches ANSI B 16.5 Class 250). Shop lining and coating shall be continuous to the end of the pipe or back of the flange. Flange faces shall be shop coated with a soluble rust preventive compound.

d). Bolts and Nuts for Flanges

Bolts for flanges shall be carbon steel, ASTM A 307, Grade B for Class B and D flanges and nuts shall be ASTM A 563, Grade A heavy hex. Bolts for Class E and F flanges shall be ASTM A 193, Grade B7 and nuts shall be ASTM A 194, Grade 2H heavy hex

All unwelded pipe joints shall be bonded for electrical continuity in accordance with the Pipe Manufacturer's recommendations unless otherwise specified in the Plans.

8.3.7 Hydraulic Test at Works

Each pipe shall be hydraulically tested at manufacturer's works before applying any coating/ lining.

8.3.8 Sampling and testing

Sampling and conformity criteria for various tests shall be as per AWWA or British or ISO standards. The test samples shall be cut from pipes in the final condition of supply. Tests for tensile strength, percentage elongation, guided bend test, shall be carried out and the test values shall be in conformity with those specified in AWWA or British or ISO standards.

8.3.9 Inspection

The pipes ready in the manufacturer's work yard shall be inspected and tested before dispatch, by the employer and or inspecting agency appointed by the employer. All the tests including hydraulic test shall be carried out on specified number of samples from each lot in presence of the inspecting agency. The internal painting shall be applied to the pipes only after the inspecting agency is satisfied regarding the test results, which shall be in conformity with the limits specified in AWWA or British or ISO standards.

8.3.10 Linings and Coatings

8.3.10.1 Internal Epoxy coating

- Epoxy coating is proposed for internal surface in all conditions and for external surface of the MS pipes laid above ground on pedestals and outer surface of tees, manholes, covers and eccentric reducers.

- The coating shall have one coat of two-part, chemically cured inhibitive Epoxy primer and two coats of a different two-part, chemically cured, solvent free, and spray applied epoxy paint. The coating system shall meet the performance requirements of AWWA C-210 standard.

Surface preparation

- Prior to abrasive blast cleaning, the external surface shall be cleaned to remove oil, grease or other foreign matter. Only approved solvents that do not leave a residue shall be used for cleaning.
- The surface shall be abrasive blast cleaned to achieve a white metal surface. Prior to blast cleaning, any sharp protuberances, surface laminations, weld spatter, etc shall be removed by through cleaning and grinding. The abrasive used should be capable of producing a minimum profile of 50-75 microns corresponding to "medium" in accordance with BS: 7079 part C4 or equivalent AWWA.

Application of Epoxy coating

- Prepared surfaces must be completely cleaned of dust and dirt by brush or vacuum cleaner and shall be thoroughly dry. Coating shall not be applied in the following atmospheric conditions.
  - Relative humidity exceeding 85%
  - When the surface to be coated is less than 3^0C above the due point
  - The surface temperature is less than 7^0C or greater than 50^0C.
- After application of the first coat, the next coat shall be applied within the time limits, surface conditions, and temperature recommended by the manufacturer.
- Final thickness of the coating shall not be less than 400micron DFT. The coating shall be applied leaving 15 cm at the edge of pipes / specials for welding of the joint. Coating on this portion shall be applied after welding the joint.
- The temperature of mixed coating and that of the pipe at the time of application shall not be lower than 10^0C. Preheating of the coating material, the use of inline heaters to heat the coating material; or heating of the pipe, fittings or specials may be used to facilitate the application. Heating shall confirm to the recommendations of the coating material manufacturer.
- The finished coating shall be inspected for damage or reduced thickness. Any such areas shall be repaired by thoroughly degreasing the surface and abrading using 180 grade abrasive papers, the abraded areas shall extend from the edge of the damage for 50–75 mm on to surrounding sound coating. The prepared surface can then be re-coated.
- Enough curing period shall be allowed after application of the coating as per standards for the coating to gain required strength. The epoxy applied pipes; specials shall be stored for curing in accordance with the durations given in the specifications.
- The joint portion shall be cleaned thoroughly as stated above and coated in required coats for same thickness i.e. 400micron DFT.

8.3.10.2 Cement mortar coating (guniting) for external surface of MS pipes

- The outside surface of the MS pipes and bends shall be provided with reinforced cement mortar coating for 25mm thickness, 1:3 proportions, applied by mechanical / pneumatic placement.

Material

- The reinforcement shall consist of BRC (British Reinforcement Company Ltd) fabric mesh of size 100 mm x 100 mm. x 3 mm. Reinforcement shall be free of oil, grease and other contaminants that may reduce the adherence between the coating and reinforcement. The BRC fab-

ric mesh shall be placed in the middle third of the coating. Mortar cover blocks shall be provided to place the BRC fabric mesh properly. Splicing for fabric reinforcement, if required, shall have minimum 100 mm overlap.

- Ordinary Portland cement.
- Sand shall consist of inert materials having hard, strong, durable uncoated grains.
- The water used for guniting shall be clean, colour less, and free from injurious quantities of organic matter, alkali and salt. The maximum water cement ratio shall not exceed 0.45:1.
- The mortar applied by mechanical or pneumatic process shall consist 3 parts of sand and 1 part of cement by weight. The water in the mixture shall be carefully controlled so that the mortar will not run, sag or segregate. The soluble chloride-ion (Cl) content of the cement mortar mix shall not exceed 0.15 percent, expressed as a percentage of cement weight. Rebound not exceeding one fourth of the total mix weight may be used as replacement material for fine aggregate only. Rebound not used within 1 hour shall be discarded.
- The outer surface shall be cleaned for oil grease etc. The dust shall be removed by compressed air or vacuum cleaner before placement of reinforcement. The BRC fabric reinforcement shall then be placed with required cover on the pipe surface.
- The pipe shall be supported on wooden logs at the ends to keep bottom clearance and to facilitate easy rotation while applying the coating. The mortar coating shall be applied in one or more continuous applications for achieving required thickness. If applied in more than one course, the interval between the first and last course shall not be more than 2 hours. The mortar shall be projected at high velocity against the exterior surfaces of the pipe with a pressure of 2.1 to 2.8 kg / cm^2 to produce a hard, tight adhering coating of specified thickness. The coating shall not be applied on ends of pipes for 100 mm length. Ends of coating shall be uniform and square to the longitudinal axis of the pipe. The rebound material unused shall be disposed off within a lead of 50m.
- The temperature of the cement mortar mix shall not be less than 40^0C, nor shall the surface temperature of the MS pipe be greater than 35^0C at the time of placement.
- After the initial set of the cement mortar coating has taken place, the mortar coating shall be cured by the moist curing method. The coating shall be kept continuously moist by intermittent or continuous spraying of water for a period of at least 7 days.
- If any sand pockets or porous spots occur, they shall be completely cut out and replaced by mechanical / pneumatic placement or hand application of mortar in proportion of 2 parts of sand and 1 part of cement, by weight.
- Care shall be taken to minimize the occurrence of cracks in the mortar coating. However, hairline cracks need not be repaired. The cracks, if developed, shall be repaired by brushing or wiping of neat cement into the cracks, or painting of the cracks with epoxy coating or a combination of these methods shall be adopted.

8.3.11 Lowering, laying and jointing of MS pipes

8.3.11.1 Standards

Except as otherwise specified in this technical specification, AWWA or British or ISO Standards shall be adhered to for the, handling, laying, installation, and site testing of all material and works.

8.3.11.2 Tools and equipment

The contractor has to provide all the tools and equipment required for the timely, efficient and professional implementation of the work as specified in the various sections of the contract and as specified by the instructions of manufacturers of the pipes and other material to be handled under this contract. On demand he shall provide to the Engineer-in-Charge a detailed list of tools and equipment available. If in the opinion of the Engineer-in-Charge the progress or the quality of the work cannot be guaranteed by the available quantity and type of tools and equipment the contractor has

to provide additional ones to the satisfaction of the Engineer-in-Charge. The Contractor will always have a leveling instrument on site.

8.3.11.3 Handling, transportation of pipes and specials

The Contractor has to transport the pipes and other materials from manufacturer or site store yard / guniting yard to the site of laying as indicated by the Engineer-in-Charge in Charge. Pipes should be handled with care to avoid damage to the surface, deformation or bending. Pipes shall not be dragged along the ground or the loading bed of a vehicle. Pipes shall be transported on flat bed vehicles/trailers. The bed shall be smooth and free from any sharp objects. The pipes shall rest uniformly on the vehicle bed in their entire length during transportation. Pipes shall be loaded and unloaded by suitable mechanical means without causing any damage to the stacked pipes.

The transportation and handling of pipes shall be made as per the standards. Handling instructions of the manufacturers of the pipes shall be followed. All precautions set out shall be taken to prevent damage to the protective coating, damage of the jointing surfaces or the ends of the pipes.

Whatever method and means of transportation are used, it is essential that the pipes are carefully placed and firmly secured against uncontrolled movement during transportation to the satisfaction of Engineer-in-Charge in charge.

Cranes or chain shall be used for loading and un-loading of heavy pipes. However, for pipes up to 400 mm nominal bore, skid timbers and ropes may be used. Where using crane hooks at sockets and spigot ends, hooks shall be broad and protected by rubber or similar material, in order to avoid damage to pipe ends and lining / coating. Damage to lining / coating must be repaired before pipe laying according to the specifications mentioned elsewhere and as per instructions of the Engineer-in-Charge in charge. Pipes shall not be thrown directly on the ground.

When using mechanical handling equipment, it is necessary to employ sufficient personnel to carry out the operation efficiently with safety. The pipes should be lifted smoothly without any jerking motion and pipe movement shall be controlled by the use of guide ropes in order to prevent damage caused by pipes bumping together or against surrounding objects.

Rolling or dragging pipes along the ground or over other pipes already stacked shall be avoided.

8.3.11.4 Stringing of pipes along the alignment

The pipes shall be laid out properly along the proposed alignment in a manner that they do not create any significant hindrance to the public and that they are not damaged. Stringing of the pipes end to end along the working width should be done in such a manner that the least interference is caused in the land crossed. Gaps should be left at intervals to permit the passing of equipment across the working area. Pipes shall be laid out that they remain safe where placed and that no damage can occur to the pipes and the coating until incorporated in the pipeline. If necessary, pipes shall be wedged to prevent accidental movement. Precautions shall be taken to prevent excessive soil, mud etc. entering the pipe.

8.3.12 Laying and jointing of pipes- following Specifications are detailed herein for laying and jointing - Laying of pipes below ground

8.3.12.1 General

After the trench is made ready with bedding, and after the jointing pits are excavated at the joint position, the gunited and lined pipes shall be lowered in the trenches.

The MS pipe ends shall be cleaned with special care to ensure that they are free from dirt and unwarranted projections. The whole of the pipes shall be placed in position singly and shall be laid true to profile and direction of slope indicated on longitudinal sections. The pipes shall be laid without deflection in a straight alignment between bends and between high and low points. The alignment and levels shall be checked by the contractor with suitable equipment.

Before pipes are jointed, they shall be thoroughly cleaned of all earth lumps, stones, or any other objects that may have entered the interior of the pipes.

Pipes and the related specials shall be laid according to the instructions of the manufacturers and using the tools recommended by them.

Cutting of pipes shall be reduced to a minimum required to conform to the drawings. Cutting has to be made with suitable tools and according to the recommendations of the manufacturer without damage to the external coating and internal lining. While assembling the pipes the ends shall be brought close enough to leave a uniform gap not exceeding 3 mm. Marginal cutting shall be done if found necessary, for which no extra payment shall be admissible. There shall be no lateral displacement between pipe faces to be jointed. After the pipes are properly assembled and checked for the correct line and level, tack welding for the pipe joint shall be done. Final welding of the joint from inside and outside shall be done thereafter.

8.3.12.2 Straps

Whenever the pipe laying work proceeds from two ends and if gap remained between two faces is less than 30 cm, such gap shall be bridged by providing a strap. Strap shall also be provided during fixing of expansion joint for above ground pipeline. Such strap shall be fabricated on site by cutting a piece from the pipe. This piece shall be split longitudinally and stepped over the gap. A minimum overlap of 2 times of the thickness shall be provided on both the pipe ends to be connected. The strap shall be welded with pipe ends with required number of fillet welds from inside and outside. The gap between ends of the strap shall be butt welded longitudinally.

8.3.12.3 Distance piece

Distance piece shall be provided when the gap between pipe faces to be jointed is more than 30 cm. Distance pieces shall be cut from pipe pieces for required length either on site or in factory. All specials like bends, tees etc. and appurtenances like sluice or butterfly valves etc. shall be laid in synchronization with the pipes. The Contractor has to ensure that the specials and accessories are ready in time to be installed together with the pipes.

At the end of each working day and whenever work is interrupted for any period of time, the free ends of laid pipes shall be protected against the entry of dirt or other foreign matter by means of approved plugs or end caps.

When pipe laying is not in progress, the open ends of installed pipe shall be closed by approved means to prevent entrance of trench water and dirt into the line. No pipe shall be laid in wet trench conditions that preclude proper bedding, or when, in the opinion of the Engineer-in-Charge, the trench conditions or the weather are unsuitable for proper installation. The pipe line laid should be absolutely straight unless planned otherwise. The accuracy of alignment should be tested before starting refilling with the help of stretching a string between two ends of the straight stretch of pipes to rectify possible small kinks in laying.

8.3.13 Laying of pipes above ground

8.3.13.1 General

Above ground pipe line shall have epoxy coating on inner and outer surfaces.

Laying of pipeline shall be started only after sufficient number of chairs / pedestals have been casted as per design which shelled not be less than 0.6 m in width to required level and have achieved their final strength including fixing of the bearing plates and roller bearings.

The contractor shall lay the pipeline to the exact line and level as shown on the drawings, or as directed by the Engineer-in-Charge.

8.3.13.2 Laying procedure

The pipe laying shall start from the successive fixity points towards expansion joint, if proposed in that stretch. Depending upon the distance between the successive chairs, and the length of the pipes fabricated, two pieces may be welded on site before laying so that after laying the pipe rests on next chair and overhangs for at least half the length of pipe.

Normally not more than one pipe shall be aligned, tacked and kept in position on the chairs at a time. During assembly, the pipes shall be additionally supported on adequate wooden sleepers or scaffolding as necessary, kept between the chairs / pedestals. While assembling the pipes, the ends shall be brought to leave a uniform gap not exceeding 3 mm. The ends shall be tack welded to align the pipe properly.

Full welding of the circumferential joint shall be done only after the Engineer-in-Charge has checked the correctness of the alignment and level. Further laying of pipes shall not be undertaken unless full welding of the circumferential joints of the piped laid earlier is completed. Expansion joint shall be fixed at the location shown on drawing or as directed by the Engineer-in-Charge.

8.3.14 Welding the joints

8.3.14.1 General

Before aligning, assembling and welding, the pipe faces shall be cleaned by scrapping with wire brushes or by any other approved method.

Welding of pipes in field shall confirm to standard of practice for use of metal arc welding for general construction in mild steel. Electrodes used for welding shall comply with standards. Welders shall be qualified and well experienced and shall be approved by the Engineer-in-Charge. Contractor shall remove such of the welders from the job whose work is not satisfactory.

The contractor shall keep record of the welding for each circumferential joint. It shall contain the name of the welder, date of completion of the welding runs internal as well as external.

8.3.14.2 Gouging and chipping

MS pipes to be jointed are large in diameter and hence the joints shall be welded with required numbers of runs from one side and a sealing run from other side. External sealing run shall be done only after internal welding is completed. Before starting the external welding, the weld material in the joint shall be cleaned by chipping out loose scales. Gauging shall be done before rectification of any defective welding wherever necessary and as directed by Engineer-in-Charge.

Gauging and chipping shall not be paid separately and the rate for welding shall be deemed to include the cost of gauging and chipping.

8.3.14.3 Electrodes

Welding electrodes shall confirm to AWWA. The contractor shall use electrodes depending on thickness of the plates to be welded and the type of joint. The contractor shall use standard current and AC voltage required for the machine as per manufacturer's directions.

8.3.14.4 Type of joints

The circumferential joints of the pipes shall have butt welded with required number of runs externally and internally. All the fillet welds / lap welds shall have throat thickness not less than 0.8 times the thickness of the pipe to be welded.

8.3.14.5 Testing of welded joints

Welded joints shall be tested as per the standards. At least one test specimen shall be taken out for testing for every 50 field joints. Test pieces shall be taken out from the places pointed out by the Engineer-in-Charge. These shall be machined and tested as early as possible.

The shape of the test pieces removed for testing shall be such that it shall give the specimen of the required dimensions with the weld in the middle of the specimen. It must ensure good butt weld.

Tensile test & Bend test shall be carried out as per the standards on test specimen.

Non-destructive testing of the completed weld shall be carried out on pipelines by radiographic method or ultrasonic method. Non-destructive test for every 50 joints shall be carried out.

8.3.14.6 Procedure on failure of test specimen

If the test specimen fails in either tensile or bent test or in both, two additional test specimens shall be taken out from the section and shall be tested again for both the tests. If any one of them fails, extensive gouging and repairing shall be carried out for the welded joints in that section to the full satisfaction of the Engineer-in-Charge in charge. However, if both the samples give satisfactory results, the joint from which the original sample was taken and had failed, shall be repaired at contractor's cost.

Welder who has done the welding of the joint that has failed shall be solely held responsible for bad workmanship and failure. Since all other factors like electrodes, current, arc voltage, etc. are already controlled; negligence on the part of the welder only is responsible for such failure. For first such failure, the welder shall be warned and if the failure is repeated, he shall be removed from the job.

8.3.15 Anchoring of the pipeline

Concrete thrust blocks with nominal reinforcement shall be provided at each bend, tee, taper, end piece to prevent undue movements of the pipeline under pressure. They shall be constructed as per design & drawings done considering the highest-pressure during operation or testing of the pipes, the safe bearing pressure of the surrounding soil and the friction coefficient of the soil.

8.3.16 Road and Stream crossings

Reinforced Concrete encasement shall be provided at road and stream crossings to protect the plipe from external loads and buoyancy. They shall be constructed as per drawings.

8.3.17 Valve Chambers

Valve chambers shall be constructed at location of Isolation valves, scour valves and pressure and control valves etc., as per drawings

8.3.18 Field Quality Control

1. Perform hydrostatic pressure test in the presence of the Engineer. Field test pressure should not exceed 120% of the pipes rated pressure class as measured at the lowest elevation for the section being tested. Leakage allowance shall be per AWWA M11 Chapter 12.
2. Provide all necessary piping between the reach being tested and the water supply, together with all required materials and equipment.
3. Provide dished heads, blind flange or bulkheads as necessary to isolate and test pipeline.
4. Methods and scheduling of tests to be approved by the Engineer.
5. Protect pipes and provide thrust restraint as required to complete test.
6. Provide for proper legal disposal of test water.

8.4 DUCTILE IRON PIPELINES

8.4.1 Material

The pipes will be Ductile Iron Pipes for Water confirming to the BS EN 545-2010 or ISO: 2531. The pipes used will be either with push on joints (Rubber Gasket Joints) or Flanged joints. The class of pipe to be used shall be of the class K-7. It is proposed to use for diameter of pipe from 300 to 900mm.

The pipes shall be coated with metallic Zinc covered by a finishing layer of a bituminous product or synthetic resin compatible with zinc and have factory provided cement mortar lining in the inside as per the clause 4.5.2 of BS EN 545-2010.

The pipes will be supplied in standard length of 5.50 and 6.00meters length with suitably rounded or chamfered ends. Each pipe of the push on joint variety will also be supplied with a rubber EPDM gasket. The Engineer will approve any change in the stipulated lengths.

The manufacturer of the pipes shall also supply the gaskets. The manufacturer of the pipes should preferably manufacture them. In case they are not, it will be the responsibility of the manufacturer of the pipes to have them manufactured from a suitable manufacturer under its own supervision and have it tested at his/sub-Contractors premises as per the contract. The pipe manufacturer will however be responsible for the compatibility and quality of the products.

The flanged joints will confirm to the Clause 5.4 of BS EN 545-2010. The pipe supply will also include one rubber gasket for each flange.

8.4.2 Inspection and Testing

The pipes will be subjected to following tests for acceptance:

- Visual and dimensional check as per Clause 6.1 and 6.2 of BS EN 545-2010
- Tensile and Brinell Hardness tests as per Clause 6.3 and 6.4 of BS EN 545-2010
- Hydrostatic Test as per Clause 6.5 of BS EN 545-2010
- Coatings as per clause 6.7 and 6.8 of BS EN 545-2010

The test reports for the Elastomeric(rubber) gaskets shall be as per acceptance tests of the EN 681-1. Flanged gaskets may be one of any type given in EN 1514(all parts).

8.4.3 Marking of pipes, fittings and accessories

All pipes will be marked as per Clause 4.7 of BS EN 545-2010 and show as below:

All pipes and fittings shall be legibly and durably marked and shall bear at least the following information:

- The manufacturer's name or mark;
- The identification of the year of manufacture;
- The identification as ductile iron;
- The DN;
- The PN rating of flanges for flange components;
- The reference to this European Standard, i.e. EN 545;
- The pressure class designation of centrifugally cast pipes.

The first five markings given above shall be cast-on or cold stamped; the other markings can be applied by any method, e.g. painted on the casting.

All accessories shall be legibly and durably marked and shall bear at least the following information:

- The manufacturer's name or mark;
- The identification of the year of manufacture;
- The DN;
- The PN rating of flanges for flange components;
- The reference to this European Standard, i.e. EN 545;
- The PFA for couplings and saddles.

These markings should be cast on or cold stamped but where impracticable can be applied by painting or labelling or attached to the packaging.

8.4.4 Transport

The pipes should be preferably transported by road from the port and stored as per the manufacturer Specifications to protect damage.

8.4.5 Specials for Ductile Iron Pipes

- ***General***

This section covers the general requirements for Ductile Iron (DI) fittings suitable for Tyton joints to be used with Ductile Iron pipes with flanged and Tyton jointing system.

- ***Types of Specials***

The following types of DI fittings shall be manufactured and tested in accordance with BS EN 545-2010.

- Flanged socket
- Flanged spigot
- Double socket bends (90degrees, 45degrees 22 /12degrees, 11 ¼degrees)
- Double socket branch flanged tee
- All socket tees
- Double socket taper
- All flanged tee
- All flanged taper

- ***Supply***

All the DI fittings shall be supplied with one rubber ring for each socket. Flanged fittings shall be supplied with one rubber gasket per flange and the required number of nuts and bolts. The DI fittings shall be DI fittings should preferably be manufactured by the manufacturer of the pipes or from the same group company of the pipe manufacturer. The pipe manufacturer will ensure the compatibility of the pipes and fittings with its own pipes or outsourced fittings from its group company. Therefore, Ductile Iron fittings should be sourced from manufacturer of the pipes.

8.4.6 Lubricant for Ductile Iron Pipes and Specials

The characteristics of lubricant for the assembly of Ductile Iron pipes and specials suitable for Tyton push-in rubber ring joints are as follows.

- Must have a paste like consistency and be ready for use
- Has to adhere to wet and dry surfaces of DI pipes and rubber rings
- To be applied in hot and cold weather; ambient temperature 0 – 50 degrees C, temperature of exposed pipes up to 70 degrees C
- Must be non-toxic
- Must be water soluble
- Must not affect the properties of the drinking water carried in the pipes
- Must not have an objectionable odour
- Has to inhibit bacterial growth
- Must not be harmful to the skin
- Must have a shelf live not less than 2 years

8.4.7 Packing

All the DI fittings shall be properly packed with jute cloth. Rubber rings shall be packed in polyethylene bags. Rubber rings in PE bags and nuts, bolts, etc. shall be supplied in separate jute bags.

The manufacturer of the pipes shall also supply the fittings. The manufacturer of the pipes should preferably manufacture them. In case they are not, it will be the responsibility of the manufacturer of the pipes to have them manufactured from a suitable manufacturer under its own supervision and have it tested at his/ sub-contractors' premises as per the contract. The pipe manufacturer will however be responsible for the compatibility and quality of the products.

8.4.8 Coating and Lining

8.4.8.1 General

All pipes shall be delivered with an external coating and an internal lining.

The basic coating specification of pipes shall be with an external metallic zinc coating with finishing layer in accordance with 4.5.2, and an internal lining of cement mortar in accordance with 4.5.3 of BS EN 545-2010.

The joint areas are generally coated as follows:

- external surface of spigot ends: same as external pipe coating;
- flanges and sockets (face and internal surface): bituminous paint or synthetic resin
- paint, alone or as a supplement to a primer or zinc coating.

Pipes with cast flanges may be coated as fittings in accordance with 4.6 of BS EN 545-2010.

8.4.8.2 External coating of zinc with finishing layer

The external coating of centrifugally cast ductile iron pipes shall comprise a layer of metallic zinc, covered by a finishing layer of a bituminous product or synthetic resin compatible with zinc. Both layers s hall be works applied.

The zinc shall be applied on oxide-surfaced pipes after heat treatment or blast-cleaned. Prior to application of the zinc, the pipe surface shall be dry and free from rust or non-adhering particles or foreign matter such as oil or grease.

Coatings characteristics

The metallic zinc coating shall cover the external surface of the pipe and provide a dense, continuous, uniform layer. It shall be free from such defects as bare patches or lack of adhesion. The uniformity of the coating shall be checked by visual inspection. When measured in accordance with 6.6 of BS EN 545-2010, the mean mass of zinc per unit area shall be not less than 200g/m2. The purity of the zinc used shall be at least 99,99 %.

The finishing layer shall uniformly cover the whole surface of the metallic zinc layer and be free from such defects as bare patches or lack of adhesion. The uniformity of the finishing layer shall be checked

by visual inspection. When measured in accordance with 6.7 of BS EN 545-2010, the mean thickness of the finishing layer shall be not less than 70 µm and the local minimum thickness not less than 50 µm.

Repairs

Damage to coatings where the area of total removal of zinc and finishing layer has a width exceeding 5 mm and areas left uncoated (e.g. under test token) shall be repaired.

Repairs shall be carried out by:

- metallic zinc spray or application of zinc-rich paint containing at least 90 % zinc by mass of dry film and with a mean mass of applied paint not less than 220 g/m2 and
- application of a finishing layer.

8.4.8.3 Internal lining of cement mortar

General

The cement mortar lining of ductile iron pipes shall constitute a dense, homogeneous layer covering the total internal surface of the pipe barrel. Prior to application of the lining, the metal surface shall be free from loose material and oil or grease.

The cement mortar mix shall comprise cement, sand and water. If admixtures are used, they shall comply with 4.1.4 of BS EN 545-2010, and they shall be declared. The ratio by mass of sand to cement shall not exceed 3,5. At the mixing stage, the ratio by mass of total water to cement depends on the manufacturing process and shall be determined such that the lining is in accordance with 4.5.3.2 and 4.5.3.3 of BS EN 545-2010.

The cement shall be one of those listed in accordance with EN 197-1. The water used in the mortar mix shall be deemed to comply with Drinking Water Directive 98/83/EC. High alumina cement may be used to carry raw water, subject to national regulations, or for specific applications.

After application of the fresh lining, controlled curing shall be carried out so as to provide sufficient hydration to the cement.

Strength of the lining

The compressive strength of the cement mortar after 28 days of curing shall be not less than 50 MPa.

Thickness and surface condition

The nominal thickness of the cement mortar lining and its tolerance shall be as given in Table below. The surface of the cement mortar lining shall be uniform and smooth. Trowel marks, protrusion of sand grains and surface texture inherent to the method of manufacture are acceptable. However, there shall be no recesses or local defects which reduce the thickness to below the minimum value given in Table.

DN (mm)	Thickness (Nominal Value) (mm)
40 to 300	4
350 to 600	5
700 to 1200	6
1400 to 2000	9

Cement mortar linings at pipe ends may have a chamfer of maximum length 20 mm and a maximum height of the lining thickness.

Repairs

Repairs to areas of damaged linings shall be carried out by the use of either cement mortar or a compatible polymer mortar; application may be by handheld implement.

Prior to the application of the repair mortar, the damaged area shall be cut back to the sound lining or to the metal surface and all loose material shall be removed.

8.4.8.4 Coatings for fittings and accessories

General

All fittings, accessories and pipes not centrifugally cast shall be delivered externally and internally coated either by a paint coating in conformity with 4.6.2 of BS EN 545-2010 or by an epoxy coating in

conformity with EN 14901; fittings may also receive an internal lining of cement mortar, machine or hand applied, as a supplement to or as a replacement of the above paint coating.
All finished internal linings shall comply with 4.1.4 of BS EN 545-2010.

Paint coating

For components the coating material shall be a bitumen or synthetic resin base. Appropriate additives (such as solvents, inorganic fillers, etc.) to allow easy application and drying are permitted. Prior to application of the coating, the casting surface shall be dry, free from rust or non-adhering particles or foreign matter such as oil or grease. The coating shall be works-applied.

Coating characteristics

The coating shall uniformly cover the whole surface of the casting and have a smooth regular appearance. Drying shall be sufficient to ensure that it will not stick to adjacent coated pieces.
The mean thickness of the coating shall be not less than 70 µm and the local minimum thickness shall be not less than 50 µm.

8.4.9 Laying and jointing of pipes

The pipes will be cleaned in the whole length with special care of the spigot and sockets on the inside/ outside to ensure that they are free from dirt unwarranted projections. The whole of the pipes shall be placed in position singly and shall be laid true to profile and direction of slope indicated on longitudinal sections. The pipes shall be laid without deflection in a straight alignment between bends and between high and low points. Vertical and horizontal deflections between individual pipes need the approval of the Engineer.
Before pipes are jointed, they shall be thoroughly cleaned of all earth lumps, stones or any other objects that may have entered the interior of the pipes, particularly the spigot end and the socket including the groove for the rubber ring. End caps are removed only just before laying and jointing.
Pipes and the related specials shall be laid according to the instructions of the manufacturers and using the tools recommended by them.
Cutting of pipes shall be reduced to a minimum required to conform to the drawings. Cutting has to be made with suitable tools and according to the recommendations of the manufacturer. The spigot end has to be chamfered again at the same angle as the original chamfered end. Cutting shall be perpendicular to the center line of the pipe. In case of ductile iron pipes, the cut and chamfered end shall be painted with two coats of epoxy paint. If there is no mark for the insertion depth on the spigot ends of the (cut) pipe it shall be marked again according to the instructions of the manufacturer.
All specials like bends, tees etc. and appurtenances like sluice or butterfly valves etc. shall be laid in synchronization with the pipes. The Contractor has to ensure that the specials and accessories are ready in time to be installed together with the pipes.
At the end of each working day and whenever work is interrupted for any period of time, the free ends of laid pipes shall be protected against the entry of dirt or other foreign matter by means of approved plugs or end caps.
When pipe laying is not in progress, the open ends of installed pipe shall be closed by approved means to prevent entrance of trench water and dirt into the line.

No pipe shall be laid in wet trench conditions that preclude proper bedding or when, in the opinion of the Engineer, the trench conditions or the weather are unsuitable for proper installation.
The pipeline laid shall be absolutely straight unless planned otherwise. The accuracy of alignment should be tested before starting refilling with the help of stretching a string between two ends of the straight stretch of pipes to rectify possible small kinks in laying.
Pipes shall be lowered into be trench with tackle suitable for the weight of pipes. For smaller sizes, up to 200 mm nominal bore; the pipe may be lowered by the use of ropes but for heavier pipes suitable mechanical equipment have to be used.

All construction debris shall be cleared from the inside of the pipe either before or just after a joint is made. This is done by passing a pull-through in the pipe, or by hand, depending on the size of the pipe. All persons should vacate any section of trench into which the pipe is being lowered.
On gradients of 1:15 or steeper, precautions should be taken to ensure that the spigot of the pipe being laid does not move into or out of the socket during the jointing operations. As soon as the joint assembly has been completed, the pipe shall be held firmly in position while the trench is back filled over the barrel of the pipe.
The designed anchorage shall be provided to resist the thrusts developed by internal pressure at bends, tees, etc.
Where a pipeline crosses a watercourse, the design and method of construction should take into account the characteristics of the watercourse to ascertain the nature of bed, scour levels, maximum velocities, high flood levels, seasonal variation, etc. which affect the design and laying of pipeline. The pipe shall be laid accordingly with adequate protection.
The assembly of the pipes shall be made as recommended by the pipe manufacturer and using the suitable tools.
The socket and spigot end of the pipes shall be brushed and cleaned. The chamfered surface and the end of the spigot end have to be coated with a suitable lubricant recommended by the manufacturer of the pipes. Oil, petroleum bound oils, grease or other material, which may damage the rubber gasket, shall not be used as lubricant. The rubber gasket shall be inserted into the cleaned groove of the socket. It has to be checked for correct positioning.
The two pipes shall be aligned properly in the trench and the spigot end shall be pushed axially into the socket either manually or with a suitable tool specially designed for the assembly of pipes and as recommended by the manufacturer. The spigot has to be inserted up to the insertion mark on the pipe spigot. After insertion, the correct position of the socket has to be tested with a feeler blade.
Deflection of the pipes – if any – shall be made only after they have fully been assembled. The deflection shall not exceed 75% of the values indicated by the pipe manufacturer.
Flanged specials shall be supplied with required nuts, bolts and rubber gaskets. The nuts and bolts shall be of best quality carbon steel, machined on the shank and electro-galvanized.

8.5 HDPE PIPE LINE

8.5.1 Scope

This specification covers the requirements for successfully designing, manufacturing, supplying, laying, jointing and testing at works and site of High Density Polyethylene Pipes used for water supply. Use of HDPE Pipes shall be Pressure class of minimum PN 6 or above.
It is proposed to use for diameter of pipe below 300mm.

8.5.2 Pipes manufacturing requirements

Pipes will be manufactured according to the DIN 8074/8075:1999 & ISO 4427:1996. Pipes manufacturer shall have manufacturing and quality control facilities capable of producing and assuring the quality of the pipes and fittings required by tender specifications.

8.5.3 Designation

Pipes shall be designated according to the grade of material, followed by pressure rating and nominal diameter, for example, PE 100 PN 10 DN 200 indicates a pipe pertaining to material grade 100 having a pressure rating 1.0 MPa and outside nominal diameter 200 mm.
All DIN/ISO specifications shall apply to HDPE pipes and they shall be tested by reputed institutions for the standards required for HDPE pipes

8.5.4 Appearance

The color of the pipe shall be black. Pipes surface shall be smooth, free from scoring, pinholes and any other surface defects. Pipes ends must be cut clean and perpendicular to the axes of the pipes. Ends

caps at pipes extremities are required in order to prevent unwanted matter entering the pipe during storage.

8.5.5 Materials

The material used for the manufacturer of pipes should not constitute toxicity hazard, should not support microbial growth, should not give rise to unpleasant taste or odour, cloudiness or discoloration of water. Pipe manufacturers shall obtain a certificate to this effect from the manufacturers of raw material by any reputed organization as per the satisfaction of the Engineer-in-Charge in charge.

8.5.6 Raw Material

The polyethylene compounds used in the manufacture of products furnished under this specification shall be made from compounded pellets obtained by the addition of the correct type and amount of carbon black and necessary antioxidants and other additives to protect the pipe during extrusion and assure the life expectancy of the pipe. Pipe produced by the addition of black master batch to polyethylene is strictly forbidden. Polyethylene pipes shall be manufactured from approved raw materials in conformity with EN 12201. 160mm 140mm 110mm 90mm 75mm 63mm 50mm pipes will be produced from PE 100 (HDPE) material.

8.6 Anti-oxidant

The percentage of anti-oxidant used shall not be more than 0.3 percent by mass of finished resin. The anti-oxidant used shall be physiologically harm less and shall be selected as per DIN/ISO codes.

8.7 Maximum Ovality of Pipe

The outside diameter of pipes, tolerance on the same and ovality of pipe shall be as given in table 2 of IS 4984. Ovality shall be measured as the difference between maximum outside diameter and minimum outside diameter measured at the same cross section of the pipe, at 300 mm away from the cut end. For pipes to be coiled the ovality shall be measured prior to coiling. For coiled pipes, however, re-rounding of pipes shall be carried out prior to the measurement of ovality.

8.8 Detectability

HDPE Pipes should be detectable when buried underground, by providing a copper wire of 1.20mm +/- 0.2 mm Ø, co-extruded along the entire length of pipe.

8.9 Length of Straight Pipe

The length of straight pipe used shall be more than 6 m or as agreed by Engineer-in-Charge in charge or as per site conditions. Short lengths of 3 meter (minimum) up to a maximum of 10% of the total supply may be permitted.

8.10 Coiling

The pipes supplied in coils shall be coiled on drums of minimum diameter of 25 times the nominal diameter of the pipe ensuring that kinking of pipe is prevented. Pipe beyond 110mm dia shall be supplied in straight length not less than 6m.

8.11 Workmanship / Appearance

Pipes shall be free from all defect including indentations, delaminating, bubbles, pinholes, cracks, pits, blisters, foreign inclusions that due to their nature degree or extent detrimentally affect the strength and serviceability of the pipe. The pipe shall be as uniform as commercially practicable in colour opacity, density and other physical properties as per relevant codes. The inside surface of each pipe shall be free of scouring, cavities, bulges, dents, ridges and other defects that result in a variation of inside diameter from that obtained on adjacent unaffected portions of the surface. The pipe ends shall be cut clearly and square to the axis of the pipe.

8.12 Handling, Transportation Storage and Lowering of pipes

During handling, transportation, storage and lowering, all sections shall be handled by such means and in such a manner that no distortion or damage is done to the section or to the pipes as a whole.
The following procedures should be followed so as to eliminate potential damage to pipes and fittings and to maintain maximum safety during unloading, lifting and lowering.

- Pipes must not be stored or transported where they are exposed to heat sources likely to exceed 60oC.
- Pipes shall be stored such that they are not in contact with direct sunlight, lubricating or hydraulic oils, petrol, solvents and other aggressive materials.
- Scores or scratches to a depth of greater than 10% or more of wall thickness are not permissible; any pipes having such defects should be strictly rejected.
- PE pipes should not be subjected to rough handling during loading and unloading operations. Rollers shall be used to move, drag the pipes across any surface.
- Only polyester webbing slings should be used to lift heavy PE (>315mm) pipes by crane. Under no circumstances, chains, wire ropes and hooks are used on PE pipes.
- Pipes shall not be dropped to avoid impact or bump. If any time during handling or during installation, any damage, such as gouge, crack or fracture occurs, the pipe shall be repaired if so permitted by the competent authority before installation.
- During coiling care should be taken to maintain the coil diameter at or above the specified minimum to prevent kinks. Coiling shall be done when the pipe attains the ambient temperature from the extruder. In uncoiling or recoiling care should be taken that sharp objects do not scour the pipe.
- When releasing coils, it must be remembered that the coil is under tension and must be released in a controlled manner. The end of the coil should be retained at all times, then the straps released steadily, one at a time. If the coil has bands at different layers of the coil, then they should be released sequentially starting from the outer layers. The amount of the energy locked up in the coil will depend on the size of the pipe, the SDR of the pipe, and the size of the coil.
- Straight lengths should be stored on horizontal racks giving continuous support to prevent the pipe taking on a permanent set
- Bare coils shall be wrapped with hessian cloth for long distance (> 300Kms) transportation. The truck used for transportation of the PE pipes shall be exclusively used of PE pipes only with no other material loaded – especially no metallic, glass and wooden items. The truck shall not have sharp edges that can damage the Pipe.
- Pipes manufactured at factory are to be carried to the site of work directly or stacked suitably and neatly along the alignment/road side/elsewhere near by the work site or as directed by the Engineer-in-Charge.
- Damages during transit, handling, storage will be to the Contractor’s account and replacement for such pipes has to be made by the Contractor without any extra cost as directed by the Engineer-in-Charge.

8.13 Lowering, Laying of Pipes

- Each pipe shall be thoroughly checked for any damages before laying and only the pipes which are approved by the Engineer-in-Charge shall be laid.
- While installing the pipes in trenches, the bed of the trench should be level and free from sharp edged stones. In most cases, the bedding is not required, as long as the sharp and protruding stones are removed, by sieving the dug earth, before using the same a backfill material. While laying in rocky areas suitable bed of sand or gravel should be provided. The fill to about 10 to 15 cm above the pipe should be fine sand or screened excavated material.

- As PE pipes are flexible, long lengths of jointed pipes having joints made above ground can be rolled or snaked into narrow trenches. Such trenches can be excavated by narrow buckets.
- During the pipe laying of continuous jointed systems, due care and allowance should be made for the movements likely to occur due to the thermal expansion/contraction of the material. This effect is most pronounced at end connections to fixed positions (such as valves etc.) and at branch connections. Care should be taken in fixing by finishing the connections at a time the length of the pipe is minimal (lower temperature times of the day).
- For summer time installations with two fixed connection points, a slightly longer length of PE pipe may be required to compensate for contraction of the pipe in the cooler trench bottom.
- The final tie-in connections should be deferred until the thermal stability of the pipeline is achieved.
- The flexibility of polyethylene pipes allows the pipe to be cold bend. Thus, the total system enables directional changes within the trench without recourse to the provision of special bends or anchor blocks. However, the pipe should not be cold bend to a radius less than 25 times the OD of the pipe.
- The Installation of flanged fittings such as connections to sluice/air/gate valves and hydrant tees etc., requires the use of stub ends (collars/flange adaptors complete with backing rings and gaskets. Care should be taken when tightening these flanges to provide even and balance torque.
- Provision should be made at all heavy fittings installation points for supports (such as anchoring of the flange in the soil) for the flange joint to avoid the transfer of valve wheel turning torque on to the PE flange joint.
- PE pipe is lighter than water. Hence care should be taken for normal installations where there could be a possibility of flooding of the trench thus the trench shall be kept free of water till the jointing has been properly done.
- When flooded, some soils may lose cohesiveness, which may allow the PE pipe to float out of the ground. Several design checks are necessary to see if groundwater flotation may be a concern. Obviously, if the pipeline typically runs full or nearly full of liquid, or if groundwater is always below the pipe, flotation may not be a significant concern.
- However, weights by way of concrete blocks (anchors) are to be provided so that the PE pipe does not float when suddenly the trench is flooded and the soil surrounding the pipe is washed away. Thus, site conditions study is necessary to ensure the avoidance of flotation.
- Pipe embedment backfill shall be stone-free excavated material placed and compacted to the 95% maximum dry density.

8.14 Jointing of Pipes

The pipe shall jointed that shall provide for fluid tightness for the intended service conditions.

8.15 Bedding

In case of sandy strata, no separate bedding is required. However, the bottom face / trench bed where pipe shall be placed shall be compacted to provide a minimum compaction corresponding to 95% of maximum dry density. The pipe bedding should be placed so as to give complete contact between the bottom of the trench and the pipe.

8.16 Back Filling

Backfilling should be placed in layers not exceeding 15cm thickness per layer and should be compacted to a minimum of 95% maximum dry density. The refilling should be done on both sides of pipe together & height difference in earth fill on each side should not be more to cause lateral movement of pipe.

Most coarse-grained soil is acceptable. This may comprise of gravel or sand. However silty sand, clayey sand, silty and clayey gravel shall not be used unless proposed to be used in conjunction with

gravel or clean sand.
It is very important that the pipe zone backfill material does not wash away or migrate into the native soil. Likewise, potential migration of the native soil into the pipe zone backfill must also be prevented. Heavy earth moving equipment used for backfilling should not be brought until the minimum cover over the pipe is 90 cm in the case of wide tracked bulldozers or 120 cm in the case of wheeled roaders or roller compactors.

8.17 Fittings & Specials

All HDPE fittings/ specials shall be of minimum PN 6 or above Pressure class, fabricated in accordance with ISO 4427/EN 12201/IS: 8360 (Part I & III). PE Injection moulded fittings shall be as per ISO 580/IS: 8008 (Part I to IX). All fittings/specials shall be fabricated or moulded at factory or at site to suite the site conditions. Fittings will be welded on to the pipes.

8.18 Bends

HDPE bends shall be plain square ended conforming to ISO 4427/EN 12201/IS: 8360 Part I & III Specifications. Bends shall be moulded or fabricated.

8.19 Tees

HDPE Tees shall be plain square ended conforming to ISO 4427/EN 12201/IS: 8360 Part I & II Specifications. Tees may be equal tees or reduced take off tees. Tees shall be moulded or fabricated.

8.20 Reducers

HDPE Reducers shall be plain square ended conforming to ISO 4427/EN 12201/IS: 8008 Part I & VII Specifications. Reducer must be moulded or fabricated.

8.21 Flanged HDPE Pipe Ends

HDPE Stub ends shall be square ended conforming to ISO 4427/EN 12201/IS: 8008 Part I & VI Specifications. Stub ends will be welded on the pipe. Flange will be of slip on flange type as described below.

8.22 Slip-On Flanges

Slip-on flanges shall be metallic flanges covered by epoxy coating or plastic powder coating. Slip-on-flanges shall be conforming to standard mating relevant flange of valves, pipes etc. Nominal pressure rating of flanges will be PN10.

8.23 Welding Procedure

Jointing between HDPE pipes and specials shall be done as per the latest ISO 21307/IS: 7634 part II. Method of jointing between the pipes to pipes and pipes to specials shall be by butt welding.
Normally Electro/Butt fusion welding shall include following activities:

- Aligning of pipe on welding M/C
- Surface preparation for welding.
- Heating of pipes/ ends
- Holding pipes for welding
- Cooling etc.

8.24 Site Fabrication of PE Fittings

Two or more PE specials coming at one place (like PE Tee, Reducer, Flanged end etc.,) shall be jointed at contractor's workshop and transported to the site of works for final installation with proposed PE pipelines

8.25 Training

The Contractor shall provide on-site training on PE pipe laying, jointing, testing and maintenance etc., to the personnel authorized by EMPLOYER.

8.26 Manuals

Technical Manual on PE pipes including precautions to be taken during operation of the pipeline.

8.27 Flanges

All flanges employed in the project must be compatible whatever material used

8.28 Marking

All pipes shall be marked at maximum interval of 1 m.
The marking shall indicate at least the following information.

- Manufacturer's name & / or trademark.
- The dimensions (nominal outside diameter X nominal wall thickness)
- The outside diameter tolerance (A or B)
- The designation of pipes material (PE 100, PE 80 etc)
- The nominal pressure (PN)
- The production period (date or code)
- The number of the International standard.
- The word "Water" shall also be included.

8.29 Packing & Transport

The pipes should be preferably transported by road from the factory and stored as per the manufacturer specifications to protect damage.

8.30 Special Test

Notch hydraulic Test for the HDPE pipe made from PE-100 grade raw material as per ASTM 1474 OR ISO 13479 at manufacturers laboratory or independent laboratory and should pass the Hydraulic test for a minimum 165 Hours. The test reports shall not be more than three months old. Pipe shall convey water under variable temperature conditions ranging from 4 degree centigrade to 45 degree centigrade. The pipe supplied should have passed the acceptance tests as per clause given in specified standards. The manufacturer should provide the test certificates for the tests conducted, as required in specified standards along with the supply of pipes. These acceptance tests can be performed in the in-house laboratory of the pipe manufacturer. The Employer will depute one person to be positioned at the pipe manufacturing facility of the successful Contractor. This deputed person will check and approve each lot of the pipes manufactured before they leave the factory after ensuring that they are meeting the required specifications.

8.31 Field Hydraulic testing of the pipelines

8.31.1.1 Sectional tests

After laying and jointing the pipeline shall be tested for tightness of barrels and joints, and stability of thrust blocks in sections approved by the Engineer-in-Charge in Charge. The length of the sections depends on the topographical conditions. Preferably the pipeline stretches to be tested shall be between two chambers (air valve, scour valve, bifurcation, other chamber). At the beginning, the Contractor shall test stretches not exceeding 1 km. After successful organization and execution of tests the length may be extended to more than 1 km after approval of the Engineer-in-Charge in Charge. The hydraulic testing shall have to be commenced immediately after laying and jointing of 1km reach is completed. The water required for testing shall be arranged by the contractor himself. The Contractor shall fill the pipe and compensate the leakage during testing. The Contractor shall provide and maintain all requisite facilities, instruments, etc. for the field testing of the pipelines. The testing of the pipelines generally consists in three phases: preparation, pre-test/saturation and test, immediately following the pre-test.

8.31.1.2 Flushing and disinfecting of pipelines

After testing and commissioning the contractor shall flush the pipes with a velocity not less than 1 m/s or as approved by the Engineer-in-Charge in Charge. Disinfection of drinking water pipelines should be

done by Contractor.

8.31.1.3 Field Hydraulic Test

a. The Sectional Hydraulic Test shall be carried out after the pipeline section to be tested has been laid jointed and backfilled to a depth sufficient to prevent floatation

b. Each length of the pipeline to be tested shall be capped or blanked off at each end and securely strutted or restrained to withstand the forces which will be exerted when the test pressure is applied.

c. Proposals for testing where thrusts on structures are involved, even where thrust flanges on the piping are installed, shall be with the prior approval of the Engineer.

d. The proper method of filling the pipeline with water shall be used. The length under test shall be filled making certain that all air is displaced through an air valve or any other appropriate mechanism. The test length shall then remain under constant moderate pressure.

e. water required to built up allowable drop in pressure during test will be treated as a makeup water.

f. The maximum allowable test pressure shall be 1.5 times the system design pressure or pipe rating whichever is higher

g. Notwithstanding the satisfactory completion of the hydraulic test, if there is any discernible leakage of water from any pipe or joint, the Contractor shall, at his own cost, replace the pipe, repair the pipe or re-make the joint and repeat the hydraulic test with cost including the cost of water.

h. Test pressures are to be measured in kg/cm2 at the center of the blank flange situated at the lowest end of the pipeline under test.

8.32 INSTALLATION OF VALVES

General

The installation of valves shall be made according to the instructions of the manufacturer and the Engineer.

Butterfly/Sluice valves shall be installed between flanges according to the instructions of the manufacturer.

Valves shall be placed on a support of concrete so that no shear stress is in the flanges. In case of axial thrust due to closure of a valve against pressure the valve shall be anchored in the support in a suitable manner to transfer the thrust into the floor slab of the chamber.

Air valves shall be installed on top of air valve tees.

8.32.1 BUTTERFLY VALVES

a. Butterfly valves shall be of double eccentric and resilient sealed type generally as per BS EN 593, BS 5155 and IS 13095. Valves shall be installed in valve chambers. Valves shall be provided with stainless steel extension spindle so that valves can be operated from ground level and without entering the chamber.

b. Material of construction of butterfly valves shall comply with following requirements:

Item	**PN 1.0 Valves**
Body	Ductile IRON DIN 1693 – GGG40/spheroidal graphite icon IS 1865 Gr 400/12
Disk	Ductile IRON DIN 1693 – GGG40/spheroidal graphite icon IS 1865 Gr 400/12
Shaft	Stainless steel BS 970 Grade 431 S 29
Body Seat	Nickel weld overlay micro finished
Disc Seal	EPDM
Seal retaining ring	Ductile Iron DIN 1693 – GGG40
Shaft bearing	Bronze with EPDM ‘O’ ring seal

Internal Fasteners	Stainless steel SS 316
Nuts, Bolts & washers for pipe flanges	High Tensile steel hot dip galvanized for valve in chamber. Stainless steel SS 316 for buried valves
Coating	Internal and external with power of liquid epoxy coating with minimum dry film thickness of 250 microns

c. Butterfly valves shall be suitable for mounting in any position. The valve shall be free from induced vibration.
d. Butterfly valve shall be suitable for bi-directional pressure testing with dead tight shut off even after long period of operation of 5 years. The valves shall be of double flanged long type.
e. The valve seal shall be of replaceable design. When the valve is fully closed, the seal shall seat firmly. The seat surfaces shall be machined smooth to provide a long life for the seal. All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.
f. The shaft shall be stainless steel with bronze or equivalent seal with self lubricating bearings. Disc pin shall be stainless steel. Ring shall be Tenderirectional seal adjusting suitable for pressure and vacuum service. Removal and replacement of steel shall be possible without removing the operating mechanism, valve shaft and without removing the valve from the pipeline. Valve shaft shall be of one piece unit extending completely through the valve disc hubs.
g. All valve spindle and head wheels shall be positioned to give access for operational personnel. Valves shall be provided with enclosed gear arrangement for ease of operation. The gear box shall be worm and worm wheel design type totally enclosed grease filled and weather proof. The operation with gearing shall be such that they can be opened and closed by one man against an unbalanced head of 1.15 times the specified ratings. Valves and gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 200 N. The valve disc shall be 90 deg turn.
h. The disc shall be designed to withstand the maximum pressure differential across the valve in either direction of flow. The disc shall be contoured to ensure the lowest possible resistance to flow and shall be suitable for throttling operation.
i. It should be possible to open the valve with upstream pipe fully filled and down stream pipe fully empty. The shaft shall be designed to withstand the maximum torque that will be imposed by the operator. It shall be secured to the disc by tapered stainless steel cotter pins.
j. Valve shall be provided with mechanism position indicator to show the position of the disc mounted on the driven shaft end.
k. Rigid adjustable stop mechanism shall be provided within the gear box or elsewhere on the valve to prevent movement of the disc beyond the fully opened or closed position (i.e. set points).
l. Valve shall be capable of closing against the maximum flow that can occur in practice. The break way torque against maximum differential head conditions shall be within the manufacturer’s limits.
m. All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.
n. All hand wheels shall be provided with an internal locking device to prevent operation device by authorized person.

8.32.2 Gate Valves

The main features (general information, materials and corrosion protection) of each type of valve envisaged in the project are indicated hereafter:

- General information

Sealing	Metallic in accordance with EN 1171 (DIN 3352 - Part 2)
Flange connections dimensions	according to EN 1092 stuffing box adjustable
Drain	threaded drain plug;

- Material

Body:	Ductile cast iron EN-JS 1030 (GGG-40)
Bonnet:	Ductile cast iron EN-JS 1030 (GGG-40)
Wedge:	Ductile cast iron EN-JS 1030 (GGG-40)
Bonnet bolts:	Stainless steel A4 (DIN EN ISO 3506) Body wedge seat rings: Zinc-free bronze (waste-water resistant) and
Stem:	Stainless steel 1.4057
Stem nut:	Zinc-free bronze (wastewater resistant)
Bonnet screws and washers:	Stainless steel grade 316

- Corrosion protection

Inside and outside epoxy coated.

8.32.3 AIR VALVES

- General information

Seated	Resilient
Functions	triple functions
Flange connections dimensions	according to EN 1092

- Materials

Body	Welded steel S235
Bonnet	Welded steel S235
Bonnets bolts:	stainless steel A4
Inner parts	stainless steel 1.4301
Bolts	stainless steel A4
Body	ductile iron EN-JS 1030 (GGG-40)
Body of shut off valve	ductile iron EN-JS 1030 (GGG-40)
Stem	stainless steel 1.4301

- Test and Approval

  Final inspection test according to EN 12266
- Corrosion protection

  Internally and externally epoxy coated

8.32.3.1 TESTING AND PERFORMANCE

a) When tested, the air passage and the function of ball floats in a valve shall be satisfactory, and the valve shall work smoothly.
b) Hydrostatic test of valve body, there shall be no leakage through pressure sustaining components and joints. There shall be no permanent deformation of any part.
c) Valve seat and cock, when tested shall not show any leakage.
d) Function and Performance Test

d.1 The valve shall be fitted on a test bench. The pressure of the water in pipe shall be developed to working pressure, and the main valve shall be gradually opened to check the air release and float function. Compressed air shall then be slowly put into the valve through underside of the valve and check the function of floats.

d.2 High Pressure Orifice Seat Test

Subsequent to high pressure orifice performance test, hydraulic pressure shall be reduced up to

half of the working pressure to check leakage of orifice seat for a duration of three minutes.

d.3 Low Pressure Orifice Seat Test

Subsequent to high pressure orifice performance test, hydraulic pressure shall be reduced up to half of the working pressure to check leakage of orifice seat for a duration of three minutes.

d.4 Body Test

The valve body (without cover and ball floats) shall be covered by a blank flange, keeping isolating valve open. Hydrostatic pressure of 1.5 times the pressure class of the valve shall be applied for duration of 5 minutes to check the water tightness of the body.

8.32.4 Pressure sustaining valves / regulating valves.

Suitable size of pressure regulating or sustaining valves to be provided at pump house.

These valves shall be suitable to relief the excess pressure built in the pipe line in the event of some outlet chaks are closed and while pumps are in operation. Or these valves shall safeguard the pipe line by maintaining the defined operating pressure range.

These valves shall be auto regulated type by the pipe line pressures and shall be hydraulically operated by the flowing media, and the bleed of water shall be routed back to the sump / forebay.

8.32.5 Painting Specification for Valves

Final coating on internal and external surface of the Valve shall be carried out after satisfactory testing, prior to dispatch.

Before inspection: Each valve shall be cleaned and surface shall be prepared by Sand blasting to SA 2½ Grade – Near white blast cleaning, and suitably protected by applying one coat of two component high build polyamide cured re-coatable zinc phosphate epoxy primer.

After inspection: One coat of two component high build polyamide crude re-coatable epoxy coating shall be applied to achieve DFT 150 micron, followed by one coat of two component aliphatic polyurethane finish to achieve DFT 80 micron.

8.32.6 Spare Parts

The Contractor shall supply for each valve the spare parts listed here below which are to be considered as a minimum requirement:

1) one (1) complete set of valve seals (for each type of valve);
2) one (1) complete set of gaskets (for each type of valve);
3) one (1) complete set of bearings (for each type of valve);
4) two (2) limit switches of each type used;
5) ten (10) percent of all nuts and bolts used;
6) one (1) position indicator of each type used;
7) minor items to ensure the operation for not less than five years from the Taking Over.

8.32.7 Dismantling Joints

Double flanged Dismantling joints shall be of Cast Iron in such a manner that valves (300 mm and above dia) can be dismantled without stress to the joints. These shall be for working pressures of 10 kg/cm2 (1 Mpa) and shall be completely leak proof with proper gasket arrangement. Flanged specials shall be supplied with required nuts, bolts and rubber gaskets. The nuts and bolts shall be of best quality carbon steel, machined on the shank and electro-galvanized. The dismantling pieces shall provide minimum clearance of + 25 mm (total distance 50 mm. The dismantling joint shall be internally and externally coated with hot applied (dip) bituminous paint.

8.33 Filtration / Strainers

Online filters / strainers of 100 microns (outlet water quality) has to be provided near to the dam on MS Pipe line.

Strainers shall be of Duplex or simplex to suite for online application and without shutting down the pump, strainers have to be cleaned with automatic cleaning facility or back wash facility or self-

cleaning facility.

Any of the arrangement for cleaning of the strainers shall be fully Strainers shall be sized to suite the pump discharges and pressures. Strainers shall be fabricated with MS material.

Strainers shall be pressure tested at manufacturer works for 1.5 times of the pump shut of head.

Strainers shall be provided with drain facility to remove the accumulated muck / particles and the drain has to be properly routed to dispose at site and should not be connected back to the sump / forebay. Any valves used in the system shall meet the requirements of the relevant specifications and to the best of engineering practices.

Differential pressure transmitter or required instrumentation shall be equipped for the strainers to monitor the healthiness of the strainers.

8.34 Valve Chambers

Valve chambers shall be constructed according to the typical drawings suitable for the respective valve and special arrangement if any shall be approved by Engineer. They shall be constructed in concrete as shown in the drawing. The chambers shall be constructed after the laying of the pipes and the assembly of specials and valves. The size of the chambers shall be according to the following criteria/ as per direction of Engineer.

- Minimum distance of flanges from walls: 45 cm
- Minimum distance of sockets from walls: 45 cm
- Minimum distance between highest point of equipment and roof slab: 30 cm
- Maximum distance between highest point of equipment and roof slab: 50 cm

The work shall include excavation, consolidation, leveling, lean concrete as per drawing in foundations, finishing, refilling. It shall include all labour and material required for the complete chamber.

8.35Thrust Blocks

The thrust blocks shall be of plain/reinforced cement concrete on site as per design and drawings to be given by the Contractor and approved by the Engineer in Charge. The thrust blocks shall be cast directly against the undisturbed soil.

8.36 OTHER SERVICES

Contractor shall take the necessary precautions to avoid the damage to other services such as water supply lines, telephone cables, electrical cables, storm water drains etc. In case of any damages to any of the services, contractor shall be responsible for restoring the facilities in bare minimum time at his own cost.

8.37 Reinstating the road surface

Road restoration should be done just after proper backfilling of trenches. About 100 mm thick layer of stone dust should be filled in trenches and making with adjacent road. Any settlement in trench should be immediately filled with stone dust. WBM/Bituminous surface shall be made as directed by Engineer- In-Charge.

9 Payment for Pipes & Valves shall be made as under

i) 50% of the amount for supply of goods (for price including all taxes and duties) shall be paid on receipt of goods at site based on certificate prepared by Engineer in charge and supplier's representative, on the basis of various items received in accordance with the contract agreement.

ii) 25% of the amount shall be paid on erection of equipment on pro-rata contact value of the work completed as per the agreed construction schedule and on certification by the by Engineer in charge and supplier's representative.

iii) 15% of the amount shall be paid on successful testing and commissioning of each unit equipment.

iv) Final 10% of the amount shall be paid after payment of the final bill.