Construction of Eight (08) Classroom School Building

Herat Province, Afghanistan

RFP Number : RFP/COK/026/2020

CONSTRUCTION SPECIFICATION

August 30, 2020

1.1 OVERVIEW - GENERAL DESCRIPTION OF WORK:

1.2 LOCATION OF THE WORK: vii

1.3 GOVERNING CODES: vii

1.4 Formwork: 1

1.4.1 System Description: 1

1.4.1.1 Strength: 1

1.4.1.2 Stiffness: 1

1.4.1.3 Impact Resistance: 1

1.4.1.4 Durability: 1

1.4.1.5 Weight: 1

1.4.1.6 Accuracy: 2

1.4.1.7 Compatibility: 2

1.4.1.8 Insulation: 2

1.4.3 Form Releasing Agents: 2

1.4.4 Installation: 2

1.4.5 Form Removal: 3

1.4.5.1Time for removal of Formwork: 3

2 CAST IN PLACE CONCRETE: 3

2.1 Concrete Mix Design: 3

2.2 Portland Cement: 4

2.3 Water: 4

2.4 Aggregates: 4

2.5 Delivery: 4

2.6 Execution: 4

2.6.1 Sub-grade under Foundations and Footing: 5

2.7 Pumping: 5

2.8 Vibration: 5

2.9 Placing Concrete in Forms: 5

2.10 Placing Slabs Concrete: 6

2.11 Curing and Protection: 6

2.11.1 Curing Periods: 6

2.11.2 Curing Methods: 6

2.11.2.2 Wet coverings of columns: 7

2.12 Defects: 7

2.13 Testing: 7

2.13.1 Slump Test: 7

2.13.1.1 Applications of Slump Test: 7

2.13.2 Compressive Strength Test: 8
2.13.2.1 Compressive Strength results of Different Grades of Concrete at 7, 14 and 28 Days: 8
2.13.3 Preparing of material for Cube test: 8
2.13.3.1 Casting of specimen: 8
2.13.3.2 Compaction: 8
2.13.3.3 Age of test: 8
2.13.3.4 Number of specimens: 8
2.14 Construction Joints: 8
2.14.1 Construction Joints in Walls: 9
2.15 Joint Materials: 9
2.15.1 Joint Fillers, Sealers, and Waterstops: 9
2.16 FILL MATERILAS: 9
2.16.1 Step to Step procedure for Backfilling: 9
3 REINFORCING STEEL: 9
3.1 Placement: 9
3.2 Splicing: 9
3.2.1 Bar Positioners: 10
3.2.2 Reinforcement Steel Bars and Rods: 10
4. MASONRY: 10
4.1 Stone Masonry: 10
4.1.1 Materials for stone masonry: 10
4.1.2 Placing of Stone Masonry: 10
4.1.3 Pointing of Stone Masonry: 11
4.1.4 Curing and Repair: 11
4.2 Solid Clay or Shale Brick: 11
4.3 Masonry Mortar: 11
4.3.1 Admixtures for Masonry Mortar: 11
4.3.2 Cement: 11
4.4 Grout and Ready-Mixed Grout: 12
4.5 Admixtures for Grout: 12
4.6 Expansion-Joint Materials: 12
4.6.1 Preparation: 12
4.6.2 Protection: 12
4.6.3 Stains: 13
4.6.4 Loads: 13
4.6.5 Surfaces: 13
6.0 Fabrication: 15

6.1 Stainless Steel Railing and Handrails: 15
6.2 Execution: 15
6.3 Connections: 15
6.4 Welding: 15
7 electrical work SUMMARIES: 15
7.1 General: 15
7.2 Products: 16
7.3 Execution: 16
7.4 Quality Control: 16
8 general: 16
8.1 Objective: 16
8.2 References: 16
8.3 Submittals: 17
8.3.1 Shop drawings: 17
8.3.2 Test Reports: 17
8.4 Quality Control Plan for Electrical Works: 17
8.5 Safety Plan for Electrical Works: 17
8.6 Storage, Delivery and Handling: 17
9 Utilities and Tools: 17
10 Information to be provided by the Contractor: 18
11 Work Progress Report and Meetings: 18
12 EXECUTION: 18
12.1 Earthing: 18
12.2 Cable Installation: 18
12.2.1 Cable color standard: 18
12.2.2 Wiring Installation Using Cable Trunking: 19
12.2.3 Cable connection in junction box: 19
13 Check List for Acceptance of Installations 19
13.1 Panels, circuit breakers and main switches: 19
13.2 Main power cables: 20
13.3 Earth: 20
13.4 Sockets: 20
14 plumbing SUMMARY: 20
14.1 general: 20
14.2 Products: 20
14.3 Execution: 20
15 general: 21
15.1 Objective: 21

15.2 References: 21
15.3 Submittals: 21
15.3.1 Design ‘C’: 21
15.3.2 Data sheets ‘C’: 22
15.3.3 Samples ‘C’: 22
15.3.4 Quality Control Plan ‘C’: 22
15.3.5 Test Reports (Tests, Flushing and Disinfection) ‘C’: 22
15.3.6 Operation and Maintenance Data ‘C’: 22
15.4 Warranty: 23
15.5 Storage, Delivery and Handling: 23
15.6 Safety: 23
16 products: 23
16.1 General: 23
16.2 PVC: 23
16.3 valves: 23
16.3.1 Gate Valves: 24
16.3.2 Check Valves: 24
16.4 Distribution Manifolds: 24
16.5 Backflow Preventers: 24
16.6 Drains: 24
16.6.1 Area Drains: 24
16.6.2 Floor and Shower Drains: 24
16.6.3 Roof Drains: 25
16.7 Pipe Joint: 25
16.8 Plumbing Fixtures: 25
16.8.1 General: 25
16.8.2 European type (seat type) and Eastern type (squat type) water closet: 25
16.8.3 Hand Wash (Corner) Sink: 26
16.8.4 Shower: 26
16.8.5 Laboratory Sink: 26
16.8.6 Kitchen Sink: 26
16.8.7 Service Sink: 26
16.8.8 Accessory Items: 26
16.8.8.1 Mirrors, Glass (MG): 26
16.8.8.2 Soap Holder (SH): 26
16.8.8.3 Towel Bar (TB): 26
16.8.8.4 Towel Pin (TP): 26
16.8.8.5 Stainless Steel Toilet Paper Holder: 27

16.9 Miscellaneous Materials: 27
17 execution: 27
17.1 Design: 27
17.2 General: 27
17.2.1 Utilities: 27
17.2.2 Cutting and Repairing: 28
17.2.3 Mains, Branches, and Runouts: 28
17.3 Embedded Pipes: 28
17.4 Corrosion Protection for Buried Pipe and Fittings: 28
17.5 Penetrations and Fixing: 28
17.6 Pipe Sleeves and Flashing: 28
17.6.1 Flashing Requirements: 28
17.6.2 Waterproofing: 29
17.6.3 Optional Counter Flashing: 29
17.6.4 Pipe Penetrations of Slab on Grade Floors: 29
17.7 Joints: 29
17.7.1 Plastic Pipe: 29
17.8 Supports: 29
17.8.1 General: 29
17.8.2 Pipe Hangers, Inserts, and Supports: 30
17.9 Pits: 30
17.10 Valve Boxes: 30
17.11 Pipe Drains: 30
17.12 Pipe Cleanouts: 30
17.13 Protection: 31
17.14 Cleaning: 31
18. quality control: 31
18.1 Quality Control Plan: 31
18.2 Testing: 31
18.2.1 Flow Test and Pressure Test: 31
18.2.2 Flushing Test: 32
18.2.2.1 During Flushing: 32
18.2.2.2 After Flushing: 32
18.2.3 Operational Test: 32
18.2.4 Disinfection: 33
18.3 Defective Work: 33

TECHNICAL SPECIFICATIONS
June 2020

1.1 OVERVIEW - GENERAL DESCRIPTION OF WORK:

The following specifications are for the Construction of 08-classroom school building as per governing codes. However, the specified codes sections in these technical specs referred of ICC, ASCE, ACI, NEC or any other international codes compliance supersedes the client approved code adaptation and RFP specified and submitted Bill of Materials.

1.2 LOCATION OF THE WORK:

Kahdistan PARR, Herat Province, Afghanistan

1.3 GOVERNING CODES:

- International Building Code - 2009 Edition - IBC2009
- Manual of Standard practice for Detailing Reinforced Concrete Structures - ACI-315
- Specifications for Structural Concrete for Buildings - ACI-301
- Concrete Measuring, Mixing, Transporting, etc. - ASTM-C94
- Recommended practice for Concrete Formwork - ACI-347
- International Mechanical Code – 2009 Edition – IMC 2009
- International Energy Conservation Code – 2009 Edition – IECC 2009
- National Electrical Code 2008 (NEC) – NFPA 70
- Life and Safety Code - NFPA 101
- Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) Standards
- National Electrical Manufacturers Association (NEMA)

1.4 Formwork:

1.4.1 System Description:

In the selection of materials for formwork, the three general principles of quality, safety and economy must be paramount. Material quality can ensure safety, and significantly contributes to the achievement of economy. Formwork failure can result in loss of life and always causes catastrophic financial loss.

Some general guidelines can be given for form face and framing materials, and for the associated components. These can be covered under the headings of

- Strength
- Stiffness
- Impact Resistance
- Durability
- Weight
- Accuracy
- Compatibility
- Insulation

1.4.1.1 Strength:

The material strength must be adequate to resist the forces anticipated. This is not only a structural design requirement, but also an essential safety aspect.

1.4.1.2 Stiffness:

The structural movement under load must be small and predictable. These deformations and deflections can be a significant part of the total deviations in the formed concrete surface. When the formwork designer is planning the formwork system, decisions must be made on the total deviation that will be acceptable, and to what extent workmanship errors and structural deformation will each contribute to this. To ensure that the total deviations do not exceed the tolerances, the material stiffness and the workmanship accuracy must be consistent.

1.4.1.3 Impact Resistance:

The forms must be built to ensure that the damaged form, although unserviceable, does not generate falling debris. It follows, that the way in which the formwork materials fails, will determine this. To comply with this important safety aspect, materials exhibiting ductile failure are far superior to those that fail in a precipitate and brittle manner.

1.4.1.4 Durability:

In the interests of economy, and the achievement of quality concrete product at each reuse of the formwork, its materials must be durable. Formwork is almost always built and used out in the open. Between re-uses, its materials and components are commonly stored out in the weather. Ideally, framing, components and form face materials should be resistant to the ravages of the environment. They should have a slow rate of deterioration under the effects of sun, wind and rain. Their resistance to deterioration can be enhanced by proper care and maintenance. Material durability is not only important for the achievement of good quality concrete surface finishes, but also to ensuring that formwork structures are always safe.

1.4.1.5 Weight:

In the assembly of formwork, most individual members and components are moved into position by hand. This occurs even when the completed formwork assembly is so heavy that it can only be moved and positioned by crane. Ideally, for efficiency and economy, framing members, formwork components and form face materials, should be sized such that their weight is within the lifting ability of one form worker. If the weight exceeds that which can be carried by two personnel, crane handling is called for. The next level of formwork weight restrictions is set by the lifting limitations of the on-site crane.

1.4.1.6 Accuracy:

For economy, it should be possible to assemble formwork with the minimum of fitting and cutting of materials. Consistency of size of materials, plywood sheets and framing members, is important to this aim. The accuracy of plywood sheets and the sizing of timbers for consistent dimensions are discussed later in this chapter.

1.4.1.7 Compatibility:

The materials of the formwork must not be incompatible with either the fluid concrete or the hardened concrete. At the form face the constituents of the form materials must not react with the hydrating cement of the concrete. For example, some timbers contain wood sugars that break down the cement. After the concrete hardens some timbers, such as eucalypts, can severely stain the concrete. When water runs over this timber and onto the concrete, dark brown stains usually results.

1.4.1.8 Insulation:

Extremes of heat and cold present problems in the choice of form materials and their protection. The rate of setting of concrete and subsequent strength gain is slowed by low temperatures, and if the water in the mix becomes frozen, the formation of ice will destroy the chemical bonding within the concrete matrix. In situation where concrete must be placed at low temperatures, aggregate storage bins and mixing water can be heated to produce warm concrete that will not cool during the initial setting period, while its own internal heat builds up.

For all forms, the placing of the fluid concrete, particularly with crushed rock aggregate, can cause some abrasive damage to the form face at first use and each reuse. When the concrete has hardened, the forms are stripped, and this can contribute to surface damage. Abrasion will occur if the forms are permitted to slide on the concrete face.

Secondly moisture absorption at the form face must be minimized. Moisture loss from the concrete into the form face causes hydration staining of the concrete, with severely darkened surface patches. For high quality concrete surfaces, where colour control is specified, this is totally unacceptable. For any concrete surface, hydration staining means poor cement hydration, weak concrete and low surface durability.

The design, engineering, and construction of the formwork is the responsibility of the Contractor. Contractor shall design formwork in accordance with methodology of ACI-347 for anticipated loads, lateral pressures, and stresses, and capable of withstanding the pressures resulting from placement and vibration of concrete. Monitor the adequacy of formwork design and construction prior to and during concrete placement as part of the Contractor's approved Quality Control Plan.

1.4.3 Form Releasing Agents:

Form releasing agents shall be commercial formulations that will not bond with, stain or adversely affect concrete surfaces. Agents shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds. If special form liners are to be used, the Contractor shall follow the recommendation of the form coating manufacturer.

1.4.4 Installation:

Forms shall be constructed true to the structural design and required alignment. Forms shall be mortar tight, properly aligned and adequately supported to produce concrete surfaces meeting the surface requirements and conforming to construction tolerance. Continuously monitor the alignment and stability of the forms during all phases to assure the finished product will meet the required surface specified. Failure of any supporting surface either due to surface texture, deflection or form collapse shall be the responsibility of the Contractor as will the replacement or correction of unsatisfactory surfaces. Where concrete surfaces are to have an exposed finish, joints in form panels shall be arranged as approved. When forms for continuous surfaces are placed in successive units, care shall be taken to fit the forms over the completed surface to obtain accurate alignment of the surface and to prevent leakage of mortar. Forms shall not be re-used if there is any evidence of defects which would impair the quality of the resulting concrete surface. All surfaces of used forms shall be cleaned of mortar and any other foreign material before reuse. Form ties that are to be completely withdrawn shall be coated with a non-staining bond breaker.

All exposed joints, edges and external corners shall be chamfered by molding placed in the forms unless the drawings specifically state that chamfering is to be omitted or as otherwise specified. Chamfered joints shall not be permitted where earth or rock-fill is placed in contact with concrete surfaces. Chamfered joints shall be terminated 300 mm outside the limit of the earth or rock-fill so that the end of the chamfers will be clearly visible. Forms for exposed finished surfaces shall be coated with a form releasing agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's printed or written instructions

Forms and embedded items shall be inspected in sufficient time prior to each concrete placement in order to certify to the Contracting Officer that they are ready to receive concrete.

1.4.5 Form Removal:

Forms shall not be removed without approval. The minimal time required for concrete to reach a strength adequate for removal of formwork without risking the safety of workers or the quality of the concrete depends on a number of factors including, but not limited to, ambient temperature, concrete lift heights, type and amount of concrete admixture, and type and amount of cementations material in the concrete. It is the responsibility of the Contractor to consider all applicable factors and leave the forms in place until it is safe to remove them. Evidence that concrete has gained sufficient strength to permit removal of forms shall be determined by tests on control cylinders. All control cylinders shall be stored in the structure or as near the structure as possible, so they receive the same curing conditions and protection methods as given those portions of the structure they represent.

Formwork for walls, columns, sides of beams, gravity structures, and other vertical type formwork not supporting the weight of concrete shall not be removed in less than 24 hours after concrete placement is completed. Formwork supporting weight of concrete and shoring shall not be removed until structural members have acquired enough strength to safely support their own weight and any construction or other superimposed loads to which the supported concrete may be subjected.

1.4.5.1Time for removal of Formwork:

In normal circumstances (generally where temperature is above 20C), and where ordinary cement is used, forms may be struck after expiry of following periods depending upon the type of structural member.

S.No	Structural Member	Time of Removal
1	Walls, columns and vertical sides of beam	24-48 hours
2	Slabs (props left under)	3 days
3	Beam soffits (props left under)	7 days
4	Removal of props to slabs · Span<= 4.5m · Span > 4.5m	14 days
5	Removal of props to beams and arches · Span<=6m · Span >6m	21 days

2 CAST IN PLACE CONCRETE:

2.1 Concrete Mix Design:

Thirty days minimum prior to concrete placement, the contractor should submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolans, ground slag, and admixtures; and applicable reference specifications. Provide mix proportion data using at least three different water-cement ratios for each type of mixture, which

produce a range of strength encompassing those required for each class and type of concrete required. If source material changes, resubmit mix proportion data using revised source material. Provide only materials that have been proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted.

2.2 Portland Cement:

Provide cement that conforms to ASTM C 150/C 150M, Type I, IA, II, or II-A. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

2.3 Water:

Minimize the amount of water in the mix. The amount of water must not exceed 45 percent by weight of cementations materials (cement + pozzolans), and in general, improve workability by adjusting the grading rather than by adding water.

2.4 Aggregates:

Furnish aggregates for exposed concrete surfaces from one source. Provide aggregates that do not contain any substance which may be deleteriously reactive with the alkalizes in the cement. Uniformly graded and as follows: Nominal maximum aggregate size of 25 mm. A combined sieve analysis must indicate a well graded aggregate from coarsest to finest with not more than 18 percent and not less than 8 percent retained on an individual sieve, except that less than 8 percent may be retained on coarsest sieve and on No. 50 (0.3mm) sieve, and less than 8 percent may be retained on sieves finer than No. 50 (0.3mm). Provide sand that is at least 50 percent natural sand.

2.5 Delivery:

Do not deliver concrete until vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. Protect materials from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags removed. Batching equipment must be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch ticket information for each load of ready mix concrete.

Reduce mixing time and place concrete within 60 minutes if the air temperature is greater than 29 degrees C (84 degrees F) 84 degrees F except as follows: if set retarding admixture is used and slump requirements can be met, limit for placing concrete may remain at 90 minutes. Additional water may be added, provided that both the specified maximum slump and water-cement ratio are not exceeded. When additional water is added, an additional 30 revolutions of the mixer at mixing speed is required.

Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

2.6 Execution:

Do not begin installation until substrates have been properly constructed; verify that substrates are plumb and true. If substrate preparation is the responsibility of another installer, notify Architect/Engineer of unsatisfactory preparation before processing. Check field dimensions before beginning installation. If dimensions vary too much from design dimensions for proper installation, notify Architect/Engineer and wait for instructions before beginning installation.

Surfaces against which concrete is to be placed must be free of debris, loose material, standing water, snow, ice, and other deleterious substances before start of concrete placing. Remove standing water without washing over freshly deposited concrete. Divert flow of water through side drains provided for such purpose.

Place concrete as soon as practicable after the forms and the reinforcement have been inspected and approved. Do not place concrete when weather conditions prevent proper placement and consolidation; in uncovered areas during periods of precipitation; or in standing water. Prior to placing concrete, remove

dirt, construction debris, water, snow, and ice from within the forms. Deposit concrete as close as practicable to the final position in the forms. Do not exceed a free vertical drop of 1 m from the point of discharge. Place concrete in one continuous operation from one end of the structure towards the other. Position grade stakes on 3 m centers maximum in each direction when pouring interior slabs and on 6m centers maximum for exterior slabs.

Deposit concrete continuously or in layers of such thickness that no concrete is placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as specified. Perform concrete placing at such a rate that concrete which is being integrated with fresh concrete is still plastic. Deposit concrete as nearly as practical in its final position to avoid segregation due to re-handling or flowing. Do not subject concrete to procedures which cause segregation. Concrete to receive other construction must be screened to proper level to avoid excessive skimming or grouting. Do not use concrete which becomes non-plastic and unworkable or does not meet quality control limits as specified or has been contaminated by foreign materials. Use of re-tempered concrete is permitted. Remove rejected concrete from the site.

Concrete for footings may be placed in excavations without forms upon inspection and approval by the engineer in charge. Excavation width must be a minimum of 100 mm greater than indicated on the drawing.

2.6.1 Sub-grade under Foundations and Footing:

When sub-grade material is semi-porous and dry, sprinkle sub-grade surface with water as required to eliminate suction at the time concrete is deposited. When sub-grade material is porous, seal sub-grade surface by covering surface with specified water barrier sub-grade cover; this may also be used over semi-porous, dry sub-grade material instead of water sprinkling.

2.7 Pumping:

Pumping must not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment must not exceed 50 mm. Do not convey concrete through pipe made of aluminum or aluminum alloy. Avoid rapid changes in pipe sizes. Limit maximum size of coarse aggregate to 33 percent of the diameter of the pipe. Limit maximum size of well-rounded aggregate to 40 percent of the pipe diameter. Take samples for testing at both the point of delivery to the pump and at the discharge end.

2.8 Vibration:

Furnish a spare, working, vibrator on the job site whenever concrete is placed. Consolidate concrete slabs greater than100 mm in depth with high frequency mechanical vibrating equipment supplemented by hand spading and tamping. Consolidate concrete slabs 100 mm or less in depth by wood tampers, spading, and settling with a heavy leveling straightedge. Operate internal vibrators with vibratory element submerged in the concrete, with a minimum frequency of not less than 6000 impulses per minute when submerged. Do not use vibrators to transport the concrete in the forms. Insert and withdraw vibrators approximately 500 mm apart. Penetrate the previously placed lift with the vibrator when more than one lift is required. Place concrete in 500 mm maximum vertical lifts. Use external vibrators on the exterior surface of the forms when internal vibrators do not provide adequate consolidation of the concrete.

2.9 Placing Concrete in Forms:

Deposit concrete placed in forms in horizontal layers not exceeding 600 millimeter. Remove temporary spreaders in forms when concrete placing has reached elevation of spreaders. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Design vibrators to operate with vibratory element submerged in concrete and maintain a speed of not less than 9,000 impulses per minute when submerged in concrete. Provide vibrating equipment adequate in number of units and power of each unit to properly consolidate concrete. Vibration of forms and reinforcement is not permitted. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced points not farther apart than visible effectiveness of machine. Do not insert vibrator into lower courses of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of concrete mix. Do not start placing of concrete in supporting elements

until concrete previously placed in columns and walls is no longer plastic and has been in place a minimum of 2 hours.

2.10 Placing Slabs Concrete:

Place and consolidate concrete for slabs in a continuous operation, within the limits of approved construction joints until placing of panel or section is completed. During concrete placing operations, consolidate concrete by mechanical vibrating equipment so that concrete is worked around reinforcement and other embedded items and into corners. Consolidate concrete placed in beams and girders of supported slabs and against bulkheads of slabs on ground by mechanical vibrators as specified. Consolidate concrete in remainder of slabs by vibrating bridge screeds, roller pipe screeds, or other approved method. Limit consolidation operations to time necessary to obtain consolidation of concrete without bringing an excess of fine aggregate to the surface. Concrete to be consolidated must be as dry as practical and surfaces thereof must not be manipulated prior to finishing operations. Bring concrete correct level with a straightedge and struck-off. Use bull floats or derbies to smooth surface, leaving it free of humps or hollows. Sprinkling of water on plastic surface is not permitted. Provide finish of slabs as specified.

2.11 Curing and Protection:

Unless otherwise specified. Begin curing immediately. Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, and any other activity resulting in ground vibrations. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period. Provide moist curing for those areas receiving liquid chemical sealer-hardener or epoxy coating.

Protect freshly placed concrete from premature drying and cold or hot temperature and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of cement and proper hardening of concrete. Start initial curing as soon as free water has disappeared from surface of concrete after

Placing and finishing. Keep concrete moist for minimum 72 hours. Final curing must immediately follow initial curing and before concrete has dried. Continue final curing until cumulative number of hours or fraction thereof (not necessarily consecutive) during which temperature of air in contact with the concrete is above 10 degrees C has totaled 168 hours. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, final curing may be terminated when the average compressive strength has reached 70 percent of the 28-day design compressive strength. Prevent rapid drying at end of final curing period.

2.11.1 Curing Periods:

Curing periods must be 28 days for concrete that is in full-time or intermittent contact with seawater, salt spray, alkali soil or waters. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing are subject to approval by the engineer in charge from UNHCR/partner.

2.11.2 Curing Methods:

2.11.2.1 Ponding for slabs:

This method is adopted in floor slabs. Small ponds on slabs are made, and these ponds are filled with water continuously for 14 days for curing concrete and then keeping the concrete moist through water spraying for the next 14 days.

2.11.2.2 Wet coverings of columns:

This type of method is adopted for columns, footings and bottom surface of slabs where ponding is not possible. Impermeable coverings like gunny bags or hessian are used to cover the concrete; these membranes are wetted to keep concrete moist.

2.12 Defects:

Repair formed surfaces by removing minor honeycombs, pits greater than 600 square mm 1 square inch surface area or 6 mm 0.25-inch maximum depth, or otherwise defective areas. Provide edges perpendicular to the surface and patch with non-shrink grout. Patch tie holes and defects when the forms are removed. Concrete with extensive honeycomb including exposed steel reinforcement, cold joints, entrapped debris, separated aggregate, or other defects which affect the serviceability or structural strength will be rejected, unless correction of defects is approved. Obtain approval of corrective action prior to repair. The surface of the concrete must not vary more than the allowable tolerances of ACI/MCP-4. Exposed surfaces must be uniform in appearance and finished to a smooth form finish unless otherwise specified.

Contractor is required to repair and retest any floors not meeting specified tolerances. Prior to repair, Contractor must submit and receive approval for the proposed repair, including product data from any materials proposed. Repairs must not result in damage to structural integrity of the floor. For floors exposed to public view, repairs must prevent any uneven or unusual coloring of the surface.

2.13 Testing:

2.13.1 Slump Test:

Take concrete samples during concrete placement. The maximum slump may be increased as specified with the addition of an approved admixture provided that the water-cement ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every16 cubic meters (maximum) of concrete.

2.13.1.1 Applications of Slump Test:

- The slump test is used to ensure uniformity for different batches of similar concrete under field conditions and to ascertain the effects of plasticizers on their introduction.
- This test is very useful on site as a check on the day-to-day or hour- to-hour variation in the materials being fed into the mixer. An increase in slump may mean, for instance, that the moisture content of aggregate has unexpectedly increases.
- Other cause would be a change in the grading of the aggregate, such as a deficiency of sand.
- Too high or too low a slump gives immediate warning and enables the mixer operator to remedy the situation.
- This application of slump test as well as its simplicity, is responsible for its widespread use.

Degree of workability	Slump		Compacting Factor	Use for which concrete is suitable
	mm	in		
Medium	50-100	2-4	0.92	Medium workability mixes; manually compacted flat slabs using crushed aggregates. Normal reinforced concrete manually compacted and heavily reinforced sections with vibrations.
High	100-175	4-7	0.95	High workability concrete; for sections with congested reinforcement. Not normally suitable for vibration

2.13.2 Compressive Strength Test:

Make seven test cylinders for each set of tests in accordance with ASTM C 31/C 31M. Take precautions to prevent evaporation and loss of water from the specimen. Test two cylinders at 7 days, two at 14 days and two more cylinders at 28 days and hold one cylinder in reserve. Take samples for strength tests of each concrete placed each day not less than once a day, nor less than once for each 120 cubic meters of concrete, nor less than once for each 500 square meters of surface area for slabs or walls. For the entire project, take no less than seven sets of samples and perform strength tests for each mix design of concrete placed. Each strength test result must be the average of two cylinders from the same concrete sample tested at 28 days. If the average of any three consecutive strength test results is less than f'c or if any strength test result falls below f'c by more than 3 MPa take a minimum of three ASTM C 42/C 42M core samples from the in-place work represented by the low test cylinder results and test. Concrete represented by core test is considered structurally adequate if the average of three cores is equal to at least 85 percent of f'c and if no single core is less than 75 percent of f'c. Retest locations represented by erratic core strengths. Remove concrete not meeting strength criteria and provide new acceptable concrete. Repair core holes with non-shrink grout. Match color and finish of adjacent concrete.

2.13.2.1 Compressive Strength results of Different Grades of Concrete at 7, 14 and 28 Days:

Concrete Grade	Compressive strength in N/mm^2 at 7 days	Compressive strength in N/mm^2 at 14 days	Compressive strength in N/mm^2 at 28 days
M15	10	13.5	15
M20	13.5	18	20
M25	17	22.5	25

2.13.3 Preparing of material for Cube test:

All the material must be brought and stored to an approximate temperature of 27 ±3 degree Celsius. Cement must be uniformly mixed with a trowel in order there exist no lumps.

2.13.3.1 Casting of specimen:

The casting molds are chosen to be made of cast iron and must be rubbed with grease on inner side for easy removal of cubes. The specimen must be cast in 3 layers (5cm each) and properly compacted in order that honeycombing formation does not take place.

2.13.3.2 Compaction:

In compacting through tamping bar, 35 strokes must be done in all parts of a cube for proper compacting. This tamping bar has the dimension of diameter 16mm and length of 0.6m.

2.13.3.3 Age of test:

The cube test for Compressive strength can be done on 7, 14 and 28 days. In some cases, the strength of greater ages is required which is performed from 13 to 52 weeks.

2.13.3.4 Number of specimens:

It is mandatory to have at least 3 specimens for testing from different batches. The mean of compressive strength achieved by this specimen is used to determine actual strength of the batch.

2.14 Construction Joints:

Make and locate joints as shown in the drawing and if not indicated locate so as not to impair strength and appearance of the structure, as approved. Provide keyways at least 40 millimeter deep in construction joints in walls and slabs and between walls and footings; approved bulkheads may be used for slabs. Joints

must be perpendicular to main reinforcement. Reinforcement must be continued across construction joints. Locate construction joints as follows:

2.14.1 Construction Joints in Walls:

Construction joints in walls, columns, beams and slab should as indicated in the drawings and as per the instruction of engineer in charge.

2.15 Joint Materials:

2.15.1 Joint Fillers, Sealers, and Waterstops:

Materials for expansion/construction joint fillers and waterstops shall be in accordance with ASTM C1193 – 0 to C1193-16 (Standard Guide for Use of Joint Sealants), or other approved standards/materials available in the market.

2.16 FILL MATERILAS:

In construction, backfill replaces soil that is removed during building construction, and it is used to strengthen and support a structure's foundation. The materials should be as indicated in the BoQ. The backfills are of different types which are used according to the requirement.

2.16.1 Step to Step procedure for Backfilling:

- Before beginning with back fill, the foundations should be cured for 5 consecutive days to avoid future cracking.
- Determine the types of material you will use for foundation back fill. A mixture of various materials such as rocks, soil and stone are commonly used. Some soil can retain too much moisture that is not good for your foundation. Please see the requirements on BoQ.
- Filling materials should be compacted in layers not exceed 15cm each.
- 95% compaction should be assured.

3 REINFORCING STEEL:

Reinforcing steel shall be deformed bars conforming to ASTM-A 615, grades and sizes as indicated. Cold drawn wire used for spiral reinforcement shall conform to ASTM-A 82. Welded wire fabric shall conform to ASTM-A 185.

Reinforcement shall be fabricated to shapes and dimensions shown in the drawings and shall conform to the requirements of ACI-318. Reinforcement shall be cold bent unless otherwise authorized. Bending may be accomplished in the field or at the mill. Bars shall not be bent after embedment in concrete. Safety caps shall be placed on all exposed ends of vertical concrete reinforcement bars that pose a danger to life safety. Wire tie ends shall face away from the forms.

3.1 Placement:

Reinforcement shall be free from loose rust and scale, dirt, oil, or other deleterious coating that could reduce bond with the concrete. Reinforcement shall be placed in accordance with ACI-318 at locations shown plus or minus one bar diameter. Reinforcement shall not be continuous through expansion joints and shall be as indicated through construction or contraction joints. Concrete coverage shall be as indicated or as required by ACI-318. If bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits or embedded items, the resulting arrangement of bars, including additional bars required to meet structural requirements, shall be approved before concrete is placed.

3.2 Splicing:

Splices of reinforcement shall conform to ACI-318 and shall be made only as required or indicated. Splicing shall be by lapping only. Lapped bars shall be placed in contact and securely tied or spaced transversely

apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 150 mm.

3.2.1 Bar Positioners:

Bar positioners, used to prevent displacement of reinforcing bars during the course of construction, shall be factory fabricated from 9 gauge steel wire or equivalent, and coated with a hot-dip galvanized finish. Not more than one wire shall cross the cell. Telescoping bar positioner shall be manufactured from AISI 1065 spring steel and coated in accordance with ASTM B633.

3.2.2 Reinforcement Steel Bars and Rods:

Reinforcing steel bars and rods shall conform to ASTM A615/A615M, Grade 60.

4. MASONRY:

4.1 Stone Masonry:

4.1.1 Materials for stone masonry:

- Stone should be procured from approved sources. The stones to be used is from boulders or rock quarrying of granite, quartzite, or similar materials having a minimum specific gravity of 2.4. The compression strength is not less than 400 kg/cm2unless otherwise approved by the Engineer.
- For use in masonry work, the stone should hard, tough compact and durable, free from faults and cleavage.
- Stone masonry is dressed to the size and shape as shown on the Drawings or as required by the Engineer to fit the size of the wall lining or slab in the configuration as shown on the Drawings.
- Special Cement: Special cement should conform to the applicable standards.
- Sand: Sand for mortar used in the construction of stone masonry for walls, lining, paving etc. should be furnished by the Contractor in accordance with the provision of and in complete conformity with the stipulations and requirements for sand specified.
- Water: The water used for the preparation of mortar is free from objectionable quantities for silt, organic matter, alkali, sulfates, and other salts and other impurities, and will be subject to the approval of the Engineer.
- Mortar Composition and Mixing:
- Mortar for stone masonry should, except where otherwise directed by the Engineer, consist of one part Portland cement and three parts of damp loose mortar sand, by volume and sufficient water to produce the proper consistency for the intended use.
- Methods and equipment used for mixing mortar should such as will accurately determine and control an amount of each separate ingredient entering into the mortar and should subject to the approval of the Engineer. If a mixer is used, it is of approved design and the mixing time after all ingredients are in the mixer, except for the full amount of water, is not less than two minutes.
- Mortar is mixed only in quantities sufficient for immediate use, and all mortar not used within 30 minutes after adding water to the mix are discarded. Retempering of mortar is not allowed. Mixing troughs and pans are thoroughly cleaned and washed at the end of each day's work.

4.1.2 Placing of Stone Masonry:

- Stone used in masonry should properly be cleaned before placing and is approved by the Engineer.
- Stone should not be placed during rains sufficiently heavy or prolonged to wash the mortar from the masonry. Mortar already spread which becomes diluted by rain is removed and replaced before continuing with the work. Loads are not allowed on the stone before it is fully set.
- Stone to be used in masonry with mortar joints is moistened with water from three to four hours before they are used, or by a method which should ensure that each stone is thoroughly and uniformly wetted.
- Stone masonry are placed on properly prepared and firm foundations and in accordance with the Drawings or directions of the Engineer. Foundations used is approved by the Engineer before placing the masonry.
- Walls should uncoursed but include a bond stone of at least 0.3 m2 area showing on the exposed face and continuous through the wall for every m2 of the projected face.

- Full mortar coverage is provided on all non-exposed stone faces.
- Stone masonry constructed for a waterway are of the best standards of workmanship and objectionable matters in the masonry surface is removed by and at the expense of the Contractor. The smoothest practicable finished surface of the masonry is required whenever it is a part of a waterway, if not otherwise directed by the Engineer.

4.1.3 Pointing of Stone Masonry:

- Where shown on the Drawings or directed by the Engineer, the Contractor should point masonry surfaces. Mortar for pointing, except as otherwise directed by the Employer's Representative, is of the same composition as used for placing the masonry.
- In preparation of the pointing work, the joints at the exposed surface of stone masonry are raked out (before the mortar is set) or chiseled out. The surface is cleaned by wire brush and is moistened. Subject to the Engineer directions, the pointing is carried out as follows;
- Inside pointing should consist of a filling of joints to about 1 cm average depth from the face of the stone.
- Flat pointing should consist of joints to about 1 cm depth and height flush with the face of the stone.
- Raised pointing should consist of filling of joints to about 1 cm depth and height not less than 1 cm above the face of the stone.
- After raking the joints should be compressed with a printing tool. All tooling of joints should be done after the mortar has partially set but is still sufficiently plastic to bond. Stones with mortar voids visible beyond the depth of the raking is removed and re-laid with fresh mortar unless such voids can be completely filled by other methods as approved by the Engineer.

4.1.4 Curing and Repair:

- Stone masonry including pointing is cured by water curing or other acceptable methods as approved by the Engineer.
- When curing by water the stone masonry is kept wet continuously for at least 4 days, unless otherwise specified by the engineer. Water used for curing shall meet the requirements of the specification for water used for mortar.
- If after completion, any stone masonry is out of alignment or not level or does not conform to lines and grades shown on the Drawings, it should be removed and replaced by the Contractor at his expense, unless the Engineer grants permissions in writing to patch or replace part of the defective area to his satisfaction.

4.2 Solid Clay or Shale Brick:

Solid clay or shale brick shall conform to [ASTM C62] [ASTM C216. Brick size shall be modular, and the nominal size of the brick used shall be 70mm thick, 110mm high, and 220mm long.

4.3 Masonry Mortar:

Type M mortar shall conform to ASTM C270 and shall be used for foundation walls. Mortar Type [S] [N] shall conform to the proportion specification of ASTM C270. When masonry cement ASTM C91/C91M is used the maximum air content shall be limited to 12 percent and performance equal to cement-lime mortar shall be verified. Verification of masonry cement performance shall be based on ASTM C780 and ASTM C1072.

4.3.1 Admixtures for Masonry Mortar:

In cold weather, a non-chloride based accelerating admixture may be used subject to approval. Accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C494/C494M, Type C. Submit the required certifications.

4.3.2 Cement:

Portland cement shall conform to ASTM C150/C150M, Type I,[IA,] II,[IIA,] or III[, IIIA]. Masonry cement shall conform to ASTM C91/C91M, Type [N][S][M]. Containers shall bear complete instructions for proportioning and mixing to obtain the required types of mortar. Incorporate to the maximum extent, without conflicting with other requirements of this section, up to 40 percent fly ash, up to 70 percent slag, up to 10 percent cenospheres, and up to 10 percent silica fume. When masonry cement is used, submit the manufacturer's printed instructions on proportions of water and aggregates and on mixing to obtain the type of mortar required.

4.4 Grout and Ready-Mixed Grout:

Grout shall conform to ASTM C476, [fine] [coarse]. Cement used in grout shall have a low alkali content. Grout slump shall be between 200 and [250] [280] mm 8 and [10] [11] inches. Minimum grout strength shall be 14 MPa 2000 psi in 28 days, as tested by ASTM C1019. Use grout subject to the limitations of Table III. Do not change proportions and do not use materials with different physical or chemical characteristics in grout for the work unless additional evidence is furnished that the grout meets the Specified requirements. Ready-Mixed grout shall conform to ASTM C94/C94M.

4.5 Admixtures for Grout:

In cold weather, a non-chloride based accelerating admixture may be used subject to approval; accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C494/C494M, Type C. In general, air-entrainment, anti-freeze or chloride admixtures shall not be used except as approved by the Contracting Officer. Submit required certifications.

4.6 Expansion-Joint Materials:

Backer rod and sealant shall be adequate to accommodate joint compression equal to 50 percent of the width of the joint. The backer rod shall be compressible rod stock of polyethylene foam, polyurethane foam, butyl rubber foam, or other flexible, no absorptive material as recommended by the sealant manufacturer. Sealant shall conform to Section 07 92 00 JOINT SEALANTS, and shall be penetrating [with a maximum volatile organic compound (VOC) content of 600 grams/liter]. Submit one piece of each type of material used.

4.6.1 Preparation:

Prior to start of work, masonry inspector shall verify the applicable conditions as set forth in ACI 530/530.1, inspection. The Contracting Officer will serve as inspector or will select a masonry inspector.

4.6.2 Protection:

Ice or snow formed on the masonry bed shall be thawed by the application of heat. Heat shall be applied carefully until the top surface of the masonry is dry to the touch. Sections of masonry deemed frozen and damaged shall be removed before continuing construction of those sections.

- a. Air Temperature 4 to 0 degrees C 40 to 32 Degrees F: Sand or mixing water shall be heated to produce mortar temperatures between 4 and 49 degrees C 40 and 120 degrees F
- b. Air Temperature 0 to minus 4 degrees C 32 to 25 Degrees F, Sand and mixing water shall be heated to produce mortar temperatures between 4 and 49 degrees C 40 and 120 degrees F, Temperature of mortar on boards shall be maintained above freezing.
- c. Air Temperature minus 4 to minus 7 degrees C 25 to 20 Degrees F. Sand and mixing water shall be heated to provide mortar temperatures between 4 and 49 degrees C 40 and 120 degrees F. Temperature of mortar on boards shall be maintained above freezing. Sources of heat shall be used on both sides of walls under construction. Windbreaks shall be employed when wind is in excess of 24 km/hour 15 mph.
- d. Air Temperature minus 7 degrees C 20 Degrees F and below. Sand and mixing water shall be heated to provide mortar temperatures between 4 and 49 degrees C 40 and 120 degrees F. Enclosure and auxiliary heat shall be provided to maintain air temperature above 0 degrees C 32 degrees F. Temperature of units when laid shall not be less than minus 7 degrees C 20 degrees F. 3.1.2 Completed Masonry and Masonry Not Being Worked On a. Mean daily air temperature 4 to 0 degrees C 40 to 32 degrees F. Masonry shall be protected from rain or snow for 24 hours by covering with weather-resistive membrane.
- b. Mean daily air temperature 0 to minus 4 degrees C 32 to 25 degrees F. Masonry shall be completely covered with weather-resistant membrane for 24 hours.
- c. Mean Daily Air Temperature minus 4 to minus 7 degrees C 25 to 20 degrees F. Masonry shall be completely covered with insulating blankets or equally protected for 24 hours.
- d. Mean Daily Temperature minus 7 degrees C 20 degrees F and Below. Masonry temperature shall be maintained above 0 degrees C 32 degrees F for 24 hours by enclosure and supplementary heat, by electric heating blankets, infrared heat lamps, or other approved methods.

4.6.3 Stains:

Protect exposed surfaces from mortar and other stains. When mortar joints are tooled, remove mortar from exposed surfaces with fiber brushes and wooden paddles. Protect base of walls from splash stains by covering adjacent ground with sand, sawdust, or polyethylene.

4.6.4 Loads:

Do not apply uniform loads for at least 12 hours or concentrated loads for at least 72 hours after masonry is constructed. Provide temporary bracing as required.

4.6.5 Surfaces:

Clean surfaces on which masonry is to be placed of laitance, dust, dirt, oil, organic matter, or other foreign materials and slightly roughen to provide a surface texture with a depth of at least 3 mm 1/8 inch. Sandblast, if necessary, to remove laitance from pores and to expose the aggregate.

5.0 Finish Work:

5.1 Codes:

- ASTM C926 Standard Specification for Application of Portland Cement-Based Plaster.
- BS EN 998-1 Specification for mortar for masonry – Part 1: Rendering and plastering mortar.
- IS 383 Specification for coarse and fine aggregates for natural sources for concrete.
- IS 1542 Specifications for sand for plaster
- IS 2645 Specifications for integral cement waterproofing compound
- IS 8112 Specification for 43 grade OPC
- IS 269 Specification for 33 grade OPC
- IS 1489 Specification for Portland Pozzolana Cement

5.1.1 Plastering on Concrete surfaces:

Plastering of concrete surface is the application of lean mortar to enhance the appearance of the surface. Different methods are used to plaster concrete surfaces such as dense concrete, low-weight concrete and mixed concrete surfaces.

5.1.1.1 Preparation of Concrete Surface:

Prior to the plastering work, the surface of the concrete to be plastered is to be cleaned from peeling paint, flaking bits of old plaster and should be free from paint, oil, and dust so that the plaster can bond properly.

5.1.1.2 Treating with Slurry:

The texture of the concrete wall must be rough enough to hold the plaster. To achieve this, a slurry is applied on the concrete surface. Slurry or dash is prepared by mixing 1 part cement to 1 and 1/2 parts coarse sand with the quantity of water sufficient to obtain a runny consistency.

5.1.1.3 Mixing of Plaster:

The mix/proportion of mortar should be as indicated in the design or as per ASTM C926 Standard Specification for Application of Portland Cement-Based Plaster.

5.1.1.4 Apply the Plaster:

A base coat of plaster is applied over the layer of dash with a steel trowel. The layer should be in the range of 10 to 15 mm thick. Apply it in small strokes, making sure it is level and uniform.

If the plastering is done in only 1 layer, then the thickness of the plaster must be not more than 10 to 15 mm. Remember the thickness of the top coat should be 5 to 10mm.

5.1.1.5 Curing of Plaster:

Once the plaster is hard and set, curing must be started and continued till 7 days. After the plastered concrete walls have dried, you can paint them or apply wallpaper.

5.1.1.6 Plaster Thickness:

The thickness of the undercoat used in conjunction with Thistle Bond-it or other bonding agents should not exceed 11mm for walls and 8mm for soffits. The thickness of the finish coat applied over the undercoat should be 2mm.

5.1.2 Procedure of Plastering Work on Brick Masonry Walls:

5.1.2.1 Preparation of Masonry Surface for Plastering:

- Keep all the mortar joints of wall rough, so as to give a good bonding to hold plaster.
- Roughen the entire wall to be plastered.
- Clean all the joints and surfaces of the wall with a wire brush, there should be no oil or grease etc. left on wall surface.
- If there exist any cavities or holes on the surface, then fill it in advance with appropriate material.
- If the surface is smooth or the wall to be plastered is old one, then rake out the mortar joint to a depth of at least 12 mm to give a better bonding to the plaster.
- Wash the mortar joints and entire wall to be plastered, and keep it wet for at least 6 hours before applying cement plaster.
- If the projection on the wall surface is more than 12 mm, then knock it off, so as to obtain a uniform surface of wall. This will reduce the consumption of plaster.

5.1.2.2 Groundwork for Plaster:

- In order to get uniform thickness of plastering throughout the wall surface, first fix dots on the wall. A dot means patch of plaster of size 15 mm * 15 mm and having thickness of about 10 mm.
- Dots are fixed on the wall first horizontally and then vertically at a distance of about 2 meters covering the entire wall surface.
- Check the verticality of dots, one over the other, by means of plumb-bob.
- After fixing dots, the vertical strips of plaster, known as screeds, are formed in between the dots. These screeds serve as the gauges for maintaining even thickness of plastering being applied.

5.1.2.3 Applying Under Coat or Base Coat:

- In case of brick masonry, the thickness of first coat plaster is in general 12 mm and in case of concrete masonry this thickness varies from 9 to 15 mm.
- The ratio of cement and sand for first coat plaster varies from 1:3 to 1:6.
- Apply the first coat of plaster between the spaces formed by the screeds on the wall surface. This is done by means of trowel.
- Level the surface by means of flat wooden floats and wooden straight edges.
- After leveling, left the first coat to set but not to dry and then roughen it with a scratching tool to form a key to the second coat of plaster.

5.1.2.4 Applying Finishing Coat:

- The thickness of second coat or finishing coat may vary between 2 to 3 mm.
- The ratio of cement and sand for second coat plaster varies from 1:4 to 1:6.
- Before applying the second coat, damp the first coat evenly.
- Apply the finishing coat with wooden floats to a true even surface and using a steel trowel, give it a finishing touch.
- As far as possible, the finishing coat should be applied starting from top towards bottom and completed in one operation to eliminate joining marks.

5.1.2.5 Curing of Plastering works:

- After completion of the plastering work, it is kept wet by sprinkling water for at least 7 days in order to develop strength and hardness.
- Use of gunny bags or other materials is used to keep the plastering works wet in external works.
- Improper curing may lead to cracks formation or efflorescence in plaster work.

5.1.3 Care be taken after Completion of Plaster Work:

- Cleaning of doors or frame and floor area is necessary at the completion of work.
- Curing should be started as soon as the plaster has hardened sufficiently and must be cured for at least 7 days.
- Curing shall commence, 24 hours after the plaster is laid.

5.1.3.1 Personal Protection for Plastering:

- Ventilate the area of work. If dust cannot be controlled, wear a half face mask to EN 149 Class FFP1.

- Wear impermeable gloves, protective overalls and safety footwear to avoid prolonged or repeated wet contact.
- Apply a barrier cream to the hands to reduce the effect of skin contact.
- Wear safety goggles to BS EN 166 type 2A5 if plaster powder or splashes are likely.

6.0 Fabrication:

Provide Railings and Handrails detail plans and elevations at not less than 1 to 12 scale 1 inch to 1 foot. Provide details of sections and connections at not less than 1 to 4 scale 3 inches to 1 foot. Also detail setting drawings, diagrams, templates for installation of anchorages, including concrete inserts, anchor bolts, and miscellaneous metal items having integral anchors. Use materials of size and thicknesses indicated or, if not indicated, of required size and thickness to produce adequate strength and durability in finished product for intended use.

6.1 Stainless Steel Railing and Handrails:

Design handrails to resist a concentrated load of 490 N in any direction at any point of the top of the rail or 290 N/m applied horizontally to top of the rail, whichever is more severe. Provide the same size rail and post as shown in the drawings. Provide pipe collars of the same material and finish as the handrail and posts as per design. Provide steel handrails, including inserts in concrete. Install in pipe sleeves embedded in concrete and filled with non-shrink grout or quick setting anchoring cement with anchorage covered with standard pipe collar pinned to post as indicated in the drawings.

6.2 Execution:

Adjust railings prior to securing in place to ensure proper matching at butting joints and correct alignment throughout their length. Space posts not more than shown in the drawings. Plumb posts in each direction. Secure posts and rail ends to building construction.

6.3 Connections:

Except as modified in this section, connections not detailed shall be designed in accordance with AISC-360. Build connections into existing work. Do not tighten anchor bolts set in concrete with impact torque wrenches.

6.4 Welding:

Conform the design of welded connections to AISC-360, unless otherwise indicated or specified. Material with welds will not be accepted unless the welding is specified or indicated on the drawings or otherwise approved. Perform welding as specified in this section, except where additional requirements are shown on the drawings or are specified in other sections. Do not commence welding until welding procedures, inspectors, nondestructive testing personnel, welders, welding operators, and tuckers have been qualified and the submittals approved by the Contracting Officer. Perform all testing at or near the work site. Each Contractor performing welding shall maintain records of the test results obtained in welding procedure, welder, welding operator, and tucker performance qualifications.

Conform workmanship and techniques for welded construction to the requirements of AWS-D1.1 and AISC-360.

7 electrical work SUMMARIES:

7.1 General:

The CONTRACTOR shall execute the work conform to the highest in the country common standards and use high skilled workers. The descriptions and standards are international guidelines, which can deviate from the country's best practice. In these cases, the CONTRACTOR shall inform UNHCR and apply the country's best practice after approval.

The approval of UNHCR of materials or execution methods shall not relieve the CONTRACTOR from his responsibilities and obligations, regarding to the quality of work, time schedule, costs or safety.

The whole of the specifications contained in this section shall be read as incorporated in all subsequent sections of the Bills of Quantities and the contractor shall include in his rates for complying therewith. This document only includes specifications for electrical works.

It is assumed that the contractor's supervisory and estimating staff is fully conversant with the normal standards of good workmanship and relevant publications of trade and technical organizations.

This document directs the contractor to the relevant information necessary for pricing the Bills. It is therefore essential that the text contained therein be read in conjunction with the measured items, which shall be priced accordingly.

Any specified material, product or service may be substituted only with the approval of the Project Manager/ Supervising Officers

Should it occur that any part or parts of the drawings or specifications should not be clearly intelligible to the contractor, or that the materials or methods of execution to be used in the works be considered insufficiently described or inappropriate, then the Project Manager/ Supervising Officers shall be requested in writing, to make clear, also in writing, his requirements or amendments.

7.2 Products:

All electrical material used shall comply with international standards or be from the best quality available in the country and approved by UNHCR.

7.3 Execution:

The work shall be executed by highly skilled and experience workers. The workers shall be well equipped and work in good and safe conditions. The procedures and manner of execution shall be discussed and approved by UNHCR.

7.4 Quality Control:

The result shall be tested and controlled. The contractor shall repair or rebuild the work if the results does not meet the quality standards agreed on. The following shall be tested:

- Ground test 25Ohm or listen
- Cable insulation test
- Light test
- Panel test etc.

8 general:

8.1 Objective:

Provide high quality works including, materials, installation, workmanship, fabrication, assembly, erection, inspection, quality control, and testing shall be provided.

8.2 References:

The publications listed below form a part of this specification to the extent referenced. The publications are referred to the text by basic designation only.

- BS7671:2008
- ANSI-C2 National Electrical Safety Code
- IEEE Std-142 Grounding of Industrial and Commercial Power Systems
- IEEE Std-446 Emergency and Standby Power Systems for Industrial and
- Commercial Applications
- IEEE Std-602 Electric Systems in Health Care Facilities
- IEEE Std-1100 Powering and Grounding Electronic Equipment
- Illuminating Engineering Society (IES) Lighting Handbook Reference and Application, 9th Edition
- MIL-HDBK-419 Grounding, Bonding, and Shielding for Electronic Equipment and Facilities
- MIL-HDBK-1004/1 Electrical Engineering Preliminary Design Considerations

- MIL-HDBK-1004/2 Power Distribution System
- ABB Switchgear manual
- IEC 60439-1 Low Voltage Switchgear and Control gear Assemblies – Part 1 Type Tested and
- Partially Type Tested Assemblies
- IEC 60529 Degrees of Protection Provided by Enclosures
- IEC 60598-1 Luminaries: Part 1, general Requirements and Tests
- IEC 60598-2-22 Luminaries Part 2-22, Particular Requirements – Luminaries for
- NFPA 70 National Electrical Code
- NFPA 72 Fire Protection Systems
- NFPA 99 Health Care Facilities
- NFPA 101 Life Safety Code
- NFPA 110 Emergency and Standby Power Systems
- NFPA 780 Lightning Protection Code
- TM 5-811-1 Electrical Power Supply and Distribution
- UFC 3-520-01 Design: Interior Electrical Systems
- UFC 3-501-03N Electrical engineering preliminary considerations
- UFC 4-021-01 Design And O&M: Mass Notification Systems
- UFC 3-501-01 Electrical Engineering
- USACE Transatlantic Program Canter Design Instructions Manual
- AED-N Electrical Design Requirements
- UFG-33 7002

8.3 Submittals:

UNHCR approval is required for submittals with a 'E' designation. Submittals not having a 'E' designation are for information only. The following shall be submitted:

8.3.1 Shop drawings:

The Contractor should submit shop drawings in case there is a change in any parts of electrical design prior starting work at site.

8.3.2 Test Reports:

The test result and reports should be submitted to UNHCR for review and record.

8.4 Quality Control Plan for Electrical Works:

Description, schedules and checklists explaining:

- The way of testing
- The minimal test results
- Who will do the testing
- The frequency of testing
- When testing will be done

8.5 Safety Plan for Electrical Works:

H&S plan for electrical works should be submitted to UNHCR for review.

8.6 Storage, Delivery and Handling:

Materials shall be delivered, handled, stored, and protected to avoid chipping, breakage, and contact with soil or contaminating material.

9 Utilities and Tools:

- The Contractor shall need to make his own arrangements of the tools and other utility services as deemed necessary for the works area and the execution of works.
- The Contractor shall provide the basic safety apparatus for their workers, e.g. safety glass, gloves, masks etc.
- The contractor must use suitable material to partition the working areas

10 Information to be provided by the Contractor:

The followings are required to be provided by the contractor at site:

- Organization chart showing the names and ranks of the staff to be engaged in the project. The organization chart shall also show the telephone number of the staff to enable the Engineer or his representative to have efficient contact with any member of staff as mentioned in the organization chart during any stage of the project. The Engineer shall be informed immediately if there is any change in such chart.
- The programme of work. The document shall show clearly the commencement and completion dates for different areas. The Contractor shall inform the Engineer for approval if there are adjustments of the schedule during the project.
- Sample board containing samples of all compact-sized materials to be used in the project for the Engineer's acceptance.
- Prior to the completion of the project:
- A list of materials with detailed quantities and areas where these materials are installed.

11 Work Progress Report and Meetings:

The Engineer shall call engineer in charge in his office or at the site, as he deems necessary for the control of the Contract. Normally these meetings will be conducted daily. In the meeting, the Contractor is required to describe the progress of the project, scheduling for any anticipated delay or other relevant information against each activity. The Contractor shall arrange his approved site representative or other responsible person to attend such meetings.

12 EXECUTION:

12.1 Earthing:

All metal works associated with the electrical installation shall be bonded together and shall be effectively earthed.

Earth rods shall be installed in locations as shown on the drawings as far as practicable. Suitable earth cable clamp and earth cable shall be used to connect the grounding system to the electrical panels.

As per drawings the building has two ground rods and these two ground rods need to be connected.

All ground wires of the cable shall be properly terminated in the electrical panels.

12.2 Cable Installation:

Junction boxes shall be installed for connecting the cables and rubber grommets shall be used for all cable entries.

Cable entries into a building shall be sealed by approved means to prevent the ingress of moisture through PVC conduits as specified.

Each cable shall be clearly labeled in accordance with the drawings. All wiring terminations shall be finished in a neat and approved manner and shall each be separately identified by a wiring code number.

When cables pass through walls, a piece of PVC sleeve of adequate size shall be inserted into the wall and the cables shall be drawn therein. Holes so created around the sleeves shall be fitted up with cement.

Rubber grommets shall be used to protect the cables passing through metal covers of panel boxes.

Straight joints in cables should be avoided and Tee-joints in protective conductors with suitable connectors are acceptable.

12.2.1 Cable color standard:

- Blue as Neutral and connected at the left side of the breakers except the RCCB which has its neutral at the right side
- Red or Black or Brown or grey as phase
- Yellow/green as ground

12.2.2 Wiring Installation Using Cable Trunking:

Individual pieces of trunking shall be independently supported by means of at least two fixed points per piece where required. On straight runs, supports for trunking shall be fixed at regular intervals of around 0.5m. For runs with bends, supports should be fixed as near to the bend as practicable.

The trunking shall be fixed by screws and washers should be used under the head of screw.

Holes in trunking should be drilled, punched or cut by appropriate tools. After cutting, burrs and sharp edges on the trunking should be removed to prevent abrasion of cables.

All trunking and appliance (socket, switch, and light) should be fixed on the wall with plastic anchor

Each piece of trunking shall be properly cut and the gap between each piece shall be kept to a minimum. White adhesive silicon rubber shall be used to fill the gaps after the installation.

12.2.3 Cable connection in junction box:

Cable connection inside the junction box must be made with "WAGO" clamps (see picture) not with tape.

13 Check List for Acceptance of Installations

At the completion of the work, the Engineer or his representative will check the installation performed by the Contractor using the following checklist. The Contractor shall rectify all the outstanding items discovered before the final acceptance.

13.1 Panels, circuit breakers and main switches:

(i) No visible damage to impair safety

(ii) Every circuit breaker, main switch and RCCB is provided with legible labels giving their ratings.

(iii) Every panel, circuit breaker and main switch is provided with a legible and durable identification label.

(iv) All accessible live parts are screened with insulating plate or earthed metal.

(v) All exposed conductive parts are effectively earthed.

(vi) Cables at the panel are terminated with adequate cable lugs.

(vii) Circuits connected to circuit breakers are in accordance with the schematic diagram.

(viii) Exposed cables are protected by suitable means.

(ix) All surface trunking and conduits are properly supported.

13.2 Main power cables:

(i) No visible damage to impair safety
(ii) Cables protected against mechanical damage
(iii) Correct phase identification provided at both ends of the cable.
(iv) Cables and ducting are adequately supported.

13.3 Earth:

(i) Grounding system is connected with appropriate earthling conductor and connectors.

13.4 Sockets:

(i) Socket outlets for all classrooms shall be installed 1.20m from the floor or as appropriate, the normal sockets at 60 cm and for the corridor at 80 cm from the floor
(ii) Ground wire must be properly connected to the socket earth pin
(iii) No socket outlet is installed closed to water tap, gas tap or cooker.
(iv) Switches and Socket outlets in bathrooms and toilets should be water proof.
(v) Sockets shall be mechanically held in position during the insertion and the removal of the power plugs.
(vi) Cover of the sockets shall be tightly attached to the body and there shall be no gap for the ingress of water and moisture.

14 plumbing SUMMARY:

14.1 general:

The CONTRACTOR shall execute the work conform the highest in the country common standards and use high skilled workers. The descriptions and standards are international guidelines, which can deviate from the country's best practice. In these cases, the CONTRACTOR shall inform UNHCR and apply the country's best practice after approval.

The approval of materials or execution methods shall not relieve the CONTRACTOR from his responsibilities and obligations, regarding to the quality of work, time schedule, costs or safety.

14.2 Products:

Material used shall comply with international standards or be from the best quality available in the country and approved by UNHCR Responsible focal point.

Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening. Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

14.3 Execution:

The work shall be executed by highly skilled and experienced workers. The workers shall be well equipped and work in good and safe conditions. The procedures and manner of execution shall be discussed and approved by UNHCR.

15 general:

15.1 Objective:

The CONTRACTOR shall provide and install all piping, instruments, valves and fittings, which are necessary for the plumbing system described in the design package. All pipping, instruments, valves and fittings shall be properly selected based on the pipe material and their availability.

15.2 References:

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ANSI Z21.22 (1999)	Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply...
ASTM D 2241 (2000)	Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464 (1999)	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466 (2001)	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467 (2001)	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564 (1996a)	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2665 (2000)	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2672 (1996a)	Joints for IPS PVC Pipe Using Solvent Cement
ASTM D 2855 (1996)	Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and…
ASTM D 3138 (1995)	Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-…
ASTM D 3139 (1998)	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3212 (1996a)	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3308 (2001)	PTFE Resin Skived Tape
ASTM D 3311 (1994)	Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM E 1 (2001)	ASTM Thermometers
ASTM F 1760 (2001)	Coextruded Poly (Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having…
ASTM F 477 (1999)	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 493 (1997)	Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe…
AWWA B300 (1999)	Hypochlorites
AWWA B301 (1999)	Liquid Chlorine
AWWA C203 (1997)	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines –…
AWWA C606 (1997)	Grooved and Shouldered Joints
AWWA D100 (1996)	Welded Steel Tanks for Water Storage
AWWA EWW (1998)	Standard Methods for the Examination of Water and Wastewater
AWWA M20 (1973)	Water Chlorination Principles and Practices

15.3 Submittals:

The CLIENT approval is required for submittals with a 'C' designation. submittals not having a 'C' designation are for information only. The following shall be submitted.

15.3.1 Design 'C':

Design analysis, calculations and methodology used in the design for the plumbing system. Detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operations of each system. Detail drawings for the complete plumbing system including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection diagrams. Detail drawings shall indicate clearances required for maintenance and operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support methods. Mechanical drawing plans, elevations, views, and details shall be drawn to scale.

Before starting the respective portions of the installation, submit the following for approval from UNHCR:

- Embedded services: Proposed method for embedding services in concrete walls or floors or chasing into concrete or masonry walls.
- Fixing of services: Typical details of locations, types and methods of fixing of services to structure.
- Inaccessible services: If services will be enclosed and not accessible after completion, submit proposals for location of service runs and fittings.
- Proposals for location of exposed piping.

15.3.2 Data sheets 'C':

Manufacturer's data, including execution manuals and material characteristics, of:

- Local/Regional Materials
- Environmental Data
- Pipe and Fittings
- Pipe Hangers, Inserts, and Supports
- Valves
- Plumbing Fixtures
- Backflow Preventers
- Cleanouts
- Pumps
- Water Pressure Booster System
- Water Service Meter
- Plumbing System

15.3.3 Samples 'C':

Samples of:

- Piping
- Valves
- Drains
- Traps
- cleanouts

15.3.4 Quality Control Plan 'C':

Description, schedules and checklists explaining:

- The way of testing
- The minimal test results
- Who will do the testing?
- The frequency of testing
- When testing will be done

15.3.5 Test Reports (Tests, Flushing and Disinfection) 'C':

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system.

15.3.6 Operation and Maintenance Data 'C':

Provide six copies of the operation manual outlining the step-by- step procedures required for system startup, operation and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Provide copies of the maintenance manual listing routine maintenance procedures, possible breakdowns and repairs. The manual shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed.

15.4 Warranty:

Manufacturer's standard performance guarantees or warranties that extend beyond a 1-year period shall be provided.

15.5 Storage, Delivery and Handling:

The CONTRACTOR shall carefully examine all pipes for defects, cuts, abrasions, cracks, fading color, or blemishes. There shall be no cracks or heavy deformations of the pipes. Fittings and manifolds shall be checked for any signs of abuse. Any damaged tubing or fittings shall be rejected.

PVC pipes shall be stored, if possible, at the job site in the unit packages provided by the manufacturer. Caution shall be exercised to avoid compression, damage or deformation to the bell ends of the pipe. Pipe shall be stored on level ground. When exposure to direct sunlight for an extended period is unavoidable, PVC pipe shall be covered with opaque material while permitting adequate air circulation above and around the pipe as required preventing excessive heat accumulation. The interior as well as all sealing surfaces of pipe, fittings and other accessories shall be kept free from dirt and foreign matter. Gaskets shall be protected from exposure to heat, direct sunlight, oil and grease.

15.6 Safety:

The CONTRACTOR shall ensure that all work and practices comply with the health and safety section of the contract documents and that full consideration is given to the health.

16 products:

16.1 General:

Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Plastic pipe, fittings, and solvent cement shall meet NSF 14 or equivalent DIN, IEC, BS, or EN standards and shall be listed or qualified for the service intended.

Plastic pipe, fittings, and solvent cement used for potable hot and cold-water service shall bear the seal or other identification for potable water use.

Pipe threads (except dry seal) shall conform to ASME B1.20.1 or equivalent DIN, IEC, BS, or EN standards.

Material or equipment containing lead shall not be used in any potable water system.

In line devices such as water meters, building valves, check valves, meter stops, valves, fittings and back flow preventers shall comply with PL 93-523 and NSF 61, Section 8 or equivalent DIN, IEC, BS, or EN standards.

End point devices such as drinking water fountains, lavatory faucets, kitchen and bar faucets, residential ice makers, supply stops and end point control valves used to dispense water for drinking must meet the requirements of NSF 61, Section 9 or equivalent DIN, IEC, BS, or EN standards. Where locally produced materials that meet requirements are available, use these before imported materials.

16.2 PVC:

PVC pipes used for the main distribution of potable and sanitary water shall be at least pressure class PN10 or above. Gaskets and lubricants to be used with PVC pipes shall be made from materials that are compatible with PVC and with each other but will not support the growth of bacteria or adversely affect, in any way, the quality of the potable water to be transported. PVC connections fittings shall be made in accordance with the manufacturer’s installation instructions.

16.3 valves:

Valves shall be provided on supplies to equipment and fixtures. Valves shall have rising stems and shall open when turned counter clockwise. Valves 65 mm (2-1/2 inches) and smaller shall be bronze with threaded bodies for pipe. Valves 65 mm (3 inches) and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Valves shall conform to the following standards or equivalent DIN, IEC, BS, or EN standards

16.3.1 Gate Valves:

- Bronze Gate Valves: MSS SP-80 or equivalent BS, DIN, EN standard, 50 mm 2 inches and smaller, wedge disc, inside screw type not less than Class 150.
- Steel Gate Valves: ASME B16.34 or equivalent BS, DIN, European standard, provide with open stem and yoke type with solid wedge or flexible wedge disc and heat and corrosion- resistant steel trim.
- Cast Iron Gate Valves: MSS SP-70, 65 mm 2 ½ inches and larger, open stem and yoke type with bronze trim.

16.3.2 Check Valves:

- Bronze Check Valves: MSS SP-80 or equivalent BS, DIN, European standard, 50 mm 2 inches and smaller, regrinding swing check type, Class 150.
- Steel Swing Check Valves: [ASME B16.34] or equivalent BS, DIN, European standard, regrinding swing check type, Class 150.
- Cast Iron Check Valves: ASME B16.34 or equivalent BS, DIN, European standard, 65 mm 2 ½ inches and larger, bronze trim, non-slam, eccentric disc type for centrifugal pump discharge service.

16.4 Distribution Manifolds:

The water distribution manifolds shall be manufactured of copper, brass, bronze or cross-linked polyethylene, based on the availability. The manifold shall be provided with balancing and flow control valves and shall be installed within a box with coverlid, securely anchored to the wall. Manifolds shall be installed in an area that will allow easy access for piping as well as future access for maintenance.

16.5 Backflow Preventers:

Backflow preventers shall be approved and listed by the Foundation for Cross-Connection Control & Hydraulic Research or equivalent DIN, IEC, BS, or EN standards. Reduced pressure principle assemblies, double check valve assemblies, atmospheric (no pressure) type vacuum breakers, and pressure type vacuum breakers shall be tested, approved, and listed in accordance with FCCCHR-CCC Manual-9 or equivalent DIN, IEC, BS, or EN standards. Backflow preventers with intermediate atmospheric vent shall conform to ASSE 1012 or equivalent DIN, IEC, BS, or EN standards. Reduced pressure principle backflow preventers shall conform to ASSE 1013 or equivalent DIN, IEC., BS, or EN standards. Hose connection vacuum breakers shall conform to ASSE 1011 or equivalent DIN, IEC., BS, or EN standards. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001 or equivalent DIN, IEC., BS, or EN standards. Pressure vacuum breaker assembly shall conform to ASSE 1020 or equivalent DIN, IEC, BS, or EN standards. Air gaps in plumbing systems shall conform to ASME A112.1.2 or equivalent DIN, IEC, BS, or EN standards.

16.6 Drains:

Drains and backwater valves installed in connection with waterproofed floors or shower pans shall be equipped with bolted type device to securely clamp flashing.

16.6.1 Area Drains:

Area drains shall be plain pattern with polished stainless steel perforated or slotted grate and bottom outlet. The drain shall be circular or square with a 300 mm (12 inch) nominal overall width or diameter and 250 mm (10 inch) nominal overall depth. Drains shall be cast iron with manufacturer's standard coating. Grate shall be easily lifted out for cleaning. Outlet shall be suitable for inside caulked connection to drain pipe. Drains shall conform to ASME A112.21.1M or equivalent DIN, IEC, BS, or EN standards.

16.6.2 Floor and Shower Drains:

Floor and shower drains shall consist of a galvanized body, integral seepage pan, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar. Floor drains shall be cast iron except where metallic waterproofing membrane is installed. Drains shall be of double drainage pattern for embedding in the floor construction. The seepage pan shall have weep holes or channels for drainage to the drainpipe. The strainer shall be adjustable to floor thickness. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane shall be provided when required. Drains shall be provided with threaded connection. Between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C 564 or equivalent DIN, IEC, BS, or EN standards may be installed, provided that the drain is

specifically designed for the rubber gasket compression type joint. Floor and shower drains shall conform to ASME A112.21.1M or equivalent DIN, IEC., BS, or EN standards.

16.6.3 Roof Drains:

Roof drains shall conform to ASME A112.21.2M or equivalent DIN, IEC., BS, or EN standards, with dome and integral flange, and shall have a device for making a watertight connection between roofing and flashing. The whole assembly shall be galvanized heavy pattern cast iron. For aggregate surface roofing, the drain shall be provided with a gravel stop. On roofs other than concrete construction, roof drains shall be complete with underdeck clamp, sump receiver, and an extension for the insulation thickness where applicable. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or membrane shall be provided when required to suit the building construction. Strainer openings shall have a combined area equal to twice that of the drain outlet. The outlet shall be equipped to make a proper connection to threaded pipe of the same size as the downspout. An expansion joint of proper size to receive the conductor pipe shall be provided. The expansion joint shall consist of a heavy cast-iron housing, brass or bronze sleeve, brass or bronze fastening bolts and nuts, and gaskets or packing. The sleeve shall have a nominal thickness of not less than 3.416 mm (0.134 inch). Gaskets and packing shall be close-cell neoprene, Oaring packing shall be close-cell neoprene of 70 durometer. Packing shall be held in place by a packing gland secured with bolts.

16.7 Pipe Joint:

- Plastic Solvent Cement for PVC Plastic Pipe: ASTM D 2564 and ASTM D 2855 or equivalent DIN, IEC, BS, or EN standards.
- Plastic Solvent Cement for CPVC Plastic Pipe: ASTM F 493 or equivalent DIN, IEC, BS, or EN standards.
- Flanged fittings including flanges, bolts, nuts, bolt patterns, etc., shall be in accordance with ASME B16.5 class 150 or equivalent DIN, IEC, BS, or EN standards and shall have the manufacturer's trademark affixed in accordance with MSS SP-25 or equivalent DIN, IEC, BS, or EN standards.
- Flange material shall conform to ASTM A 105/A 105M or equivalent DIN, IEC, BS, or EN standards.
- Blind flange material shall conform to ASTM A 516/A 516M cold service and ASTM A 515/A 515M for hot service or equivalent DIN, IEC, BS, or EN standards.
- Bolts shall be high strength or intermediate strength with material conforming to ASTM A 193/A 193M or equivalent DIN, IEC, BS, or EN standards.

16.8 Plumbing Fixtures:

16.8.1 General:

Fixtures shall be water conservation type, in accordance with ICC IPC. Fixtures for use by the physically handicapped shall be in accordance with ICC A117.1. Provide vitreous china fixtures that are nonabsorbent, hard-burned, and vitrified throughout the body. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Equip fixtures with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Internal parts of flush and/or flushometer valves, shower mixing valves, shower head face plates, [may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years] [shall be copper alloy with all visible surfaces chrome plated].[Plastic in contact with hot water shall be suitable for 82 degrees C 180 degrees F water temperature.] Maximum allowable lead content in wetted surfaces of pipes, pipe fittings, plumbing fittings and fixtures, as determined by a weighted average shall not exceed 0.25 percent.

16.8.2 European type (seat type) and Eastern type (squat type) water closet:

The closet shall be of white color, made of porcelain, without decorations and easy to clean. Each closet shall be provided with all accessories necessary to its proper installation and use. The water cistern shall be in PVC or porcelain, 3- or 6-liters capacity and dual flush type. In each closet shall be installed a bidet shower (or health faucet).

16.8.3 Hand Wash (Corner) Sink:

They shall be of white color, made of porcelain, without decorations and easy to clean. Each sink shall be provided with all accessories necessary to its proper installation and use.

Each sink shall be equipped with a push tap, either basin or wall mounted, that closes automatically after a certain period. The push tap shall have a minimum working pressure of 0.1 bars.

16.8.4 Shower:

Showers shall not have a shower pan. The tile floor will drain to the floor drain. Shower spaces shall have a marble threshold at the entrance.

Each shower shall be equipped with a fixed showerhead and push tap that closes automatically.

16.8.5 Laboratory Sink:

They shall be made of stainless steel or porcelain (depending on the availability), without decorations and easy to clean. Each sink shall be provided with all accessories necessary to its proper installation and use.

Each sink shall be equipped with a long neck tap.

16.8.6 Kitchen Sink:

They shall be made of stainless steel without decorations and easy to clean. Each sink shall be provided with all accessories necessary to its proper installation and use.

Each sink shall be equipped with a long neck tap.

16.8.7 Service Sink:

They shall be made of stainless steel or porcelain (depending on the availability), without decorations and easy to clean. Each sink shall be provided with all accessories necessary to its proper installation and use.

Each sink shall be equipped with a long neck tap.

16.8.8 Accessory Items:

Accessory items shall conform to the requirements specified in the tender package.

16.8.8.1 Mirrors, Glass (MG):

Glass for mirrors shall be Type I transparent flat type, Class 1- clear. Glazing Quality q1 5 mm thick conforming to ASTM C 1036 or equivalent DIN, BS, or EN standards. Size shall be 600mm X 900mm, unless otherwise indicated on Drawings. Glass shall be coated on one surface with silver coating, and mirror backing paint. Silver coating shall be highly adhesive pure silver coating of a thickness which shall provide reflectivity of 83 percent or more of incident light when viewed through 6 mm thick glass and shall be free of pinholes or other defects. Mirror backing paint shall consist of two coats of special scratch and abrasion-resistant paint and shall be baked in uniform thickness to provide a protection for silver coatings which will permit normal cutting and edge fabrication.

16.8.8.2 Soap Holder (SH):

Soap holder shall be surface mounted stainless steel. Separate supports shall be stainless steel.

16.8.8.3 Towel Bar (TB):

Towel bar shall be stainless steel with a minimum thickness of 0.38 mm. Bar shall be minimum 19 mm diameter, or 16 mm square. Finish shall be satin. Acceptable Products: Armin, Model D205 or equal.

16.8.8.4 Towel Pin (TP):

Towel pin shall have concealed wall fastenings, and a pin integral with or permanently fastened to wall flange. Maximum projection shall be 100 mm. Design shall be consistent with design of other accessory items. Finish shall be satin. Acceptable Products: Armin, Model B06054 or equal.

16.8.8.5 Stainless Steel Toilet Paper Holder:

Toilet Paper holder shall be stainless steel, surface mounted with one roll of standard tissue mounted horizontally. Cabinet shall be stainless steel, satin finish.

16.9 Miscellaneous Materials:

- Hose Clamps: SAE J1508 or equivalent DIN, IEC, BS, or EN standards.
- Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M or equivalent DIN, IEC, BS, or EN standards.
- Metallic Cleanouts: ASME A112.36.2M or equivalent DIN, IEC, BS, or EN standards.
- Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material shall be nonvolatile no asphaltic and contain germicide and provide watertight, gastight, odor proof and vermin proof properties.
- Gauges - Pressure and Vacuum Indicating Dial Type – Elastic Element: ASME B40.1 or equivalent DIN, IEC, BS, or EN standards.
- Thermometers: ASTM E 1 or equivalent DIN, IEC, BS, or EN standards. Mercury shall not be used in thermometers.

17 execution:

17.1 Design:

The design, engineering and construction of the plumbing system is the responsibility of the CONTRACTOR. CONTRACTOR shall design the plumbing system in accordance with national regulations, codes and applicable standards. The design shall anticipate on all loads, pressures and stress which may occur during the assembly and the user phase. The CONTRACTOR is responsible to monitor the correct execution and assembly according the design.

Services and equipment shall be located and arranged so that:

- Failure of plant and equipment (including leaks) does not create a hazard for the building occupants and causes a minimum or no damage to the building, its finishes and contents.
- Maintenance operations can be carried out in a safe and efficient manner, with a minimum of inconvenience and disruption to building occupants and without damaging adjacent structures, fixtures or finishes.

17.2 General:

Provide the accessories and fittings necessary for the proper functioning of the systems, including piping, valves, outlets, pressure and temperature control devices, strainers, gauges and pumps.

Isolating valves: provide valves so that isolation of parts of the system in the event of leaks or maintenance causes a minimum of inconvenience to the building occupants.

Install piping in straight lines, plumb and to uniform grades. Arrange and support the piping so that it remains free from vibration and water hammer, while permitting movement in both structure and services. Keep the number of joints to a minimum. Prevent direct contact between incompatible metals.

Concealment: If practicable, conceal piping and fittings requiring maintenance or servicing so that they are accessible within non-habitable enclosed spaces such as roof spaces, subfloor spaces and ducts. Provide at least 25 mm clearance between adjacent pipelines (measured from the piping insulation where applicable).

Cover plates: Where exposed piping emerges from wall, floor or ceiling finishes, provide cover plates of stainless steel or non-ferrous metal finished to match the piping.

Pipe support materials: To be the same as the piping or galvanized or non-ferrous metals, with bonded PVC or glass fiber woven tape sleeves where needed to separate dissimilar metals.

17.2.1 Utilities:

The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves, which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering

with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, showerheads, and flushing devices shall be anchored to prevent movement.

17.2.2 Cutting and Repairing:

The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

17.2.3 Mains, Branches, and Runouts:

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a enough distance from other work and other services to permit not less than 12 mm between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific accepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 100 mm (4 inches) and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

17.3 Embedded Pipes:

Do not embed pipes that operate under pressure in concrete or surfacing material of a building without prior written approval. If embedding is approved:

- Install in continuous lengths without fittings wherever possible.
- Do not lay across joints between adjoining sections of concrete through which reinforcement does not extend.
- Pressure test and rectify leaks before the concrete is poured.

17.4 Corrosion Protection for Buried Pipe and Fittings:

Steel pipe, joints, and fittings shall be cleaned, coated with primer, and wrapped with tape. Pipe shall be cleaned, coated, and wrapped prior to pipe tightness testing. Joints and fittings shall be cleaned, coated, and wrapped after pipe tightness testing. Tape shall conform to AWWA C203 or equivalent DIN, BS, EN, or IEC. standards and shall be applied with a 50 percent overlap. Primer shall be as recommended by the tape manufacturer.

17.5 Penetrations and Fixing:

Limitations: Do not penetrate or fix to the following without prior approval:

- Structural building elements including external walls, fire walls, fire doors and access panels, other tested and rated assemblies or elements, floor slabs and beams.
- Membrane elements including damp-proof courses, waterproofing membranes and roof coverings.

Fire rated building elements: Seal penetrations with a system that maintains the fire rating of the element.

Membranes: If approval is given to penetrate membranes, provide a waterproof seal to the approval of the CLIENT between the membrane and the penetrating component.

17.6 Pipe Sleeves and Flashing:

17.6.1 Flashing Requirements:

Pipes passing through roof shall be installed through a 4.9 kg per square meter (16 ounce) copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend

not less than 200 mm from the pipe and shall be set over the roof or floor membrane in a solid coating of bituminous cement.

The flashing shall extend up the pipe a minimum of 250 mm. For cleanouts, the flashing shall be turned down into the hub and caulked after placing the ferrule. Pipes passing through pitched roofs shall be flashed, using lead or copper flashing, with an adjustable integral flange of adequate size to extend not less than 200 mm from the pipe in all directions and lapped into the roofing to provide a watertight seal. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Flashing for dry vents shall be turned down into the pipe to form a waterproof joint. Pipes, up to and including 250 mm (10 inches) in diameter, passing through roof or floor waterproofing membrane may be installed through a cast-iron sleeve with caulking recess, anchor lugs, flashing-clamp device, and pressure ring with brass bolts. Flashing shield shall be fitted into the sleeve clamping device. Pipes passing through wall waterproofing membrane shall be sleeved as described above. A waterproofing clamping flange shall be installed.

17.6.2 Waterproofing:

Waterproofing at floor-mounted water closets shall be accomplished by forming a flashing guard from soft-tempered sheet copper. The center of the sheet shall be perforated and turned down approximately 40 mm to fit between the outside diameter of the drainpipe and the inside diameter of the cast-iron or steel pipe sleeve. The turned-down portion of the flashing guard shall be embedded in sealant to a depth of approximately 40 mm; then the sealant shall be finished off flush to floor level between the flashing guard and drainpipe. The flashing guard of sheet copper shall extend not less than 200 mm from the drainpipe and shall be lapped between the floor membrane in a solid coating of bituminous cement.

17.6.3 Optional Counter Flashing:

Instead of turning the flashing down into a dry vent pipe, or caulking and sealing the annular space between the pipe and flashing or metal-jacket-covered insulation and flashing, counter flashing may be accomplished by utilizing the following:

- A standard roof coupling for threaded pipe up to 150 mm (6 inches) in diameter.
- A tack-welded or banded-metal rain shield around the pipe.

17.6.4 Pipe Penetrations of Slab on Grade Floors:

Where pipes, fixture drains, floor drains, cleanouts or similar items penetrate slab on grade floors, except at penetrations of floors with waterproofing membrane as specified in paragraphs FLASHING REQUIREMENTS AND WATERPROOFING, a groove 6 to 13 mm wide by 6 to 10 mm deep shall be formed around the pipe, fitting or drain. The groove shall be filled with a sealant.

17.7 Joints:

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

17.7.1 Plastic Pipe:

PVC pipe shall have joints made with solvent cement elastomeric, threading, (threading of Schedule 80 Pipe is allowed only where required for disconnection and inspection; threading of Schedule 40 Pipe is not allowed), or mated flanged.

17.8 Supports:

17.8.1 General:

Hangers used to support piping 50 mm (2 inches) and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers.

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Threaded sections of rods shall not be formed or bent.

17.8.2 Pipe Hangers, Inserts, and Supports:

Installation of pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69 or equivalent DIN, IEC, BS, or EN standards.

- Inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used.
- C-clamps shall be torqued per MSS SP-69 or equivalent DIN, IEC, BS, or EN standards and shall have both locknuts and retaining devices furnished by the manufacturer. Field fabricated C-clamp bodies or retaining devices are not acceptable.
- Horizontal pipe supports shall be spaced as specified in MSS SP-69 or equivalent DIN, IEC, BS, or EN standards and a support shall be installed not over 300 mm from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1.5 m apart at valves
- Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 4.5 m nor more than 2 m from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.
- Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

17.9 Pits:

Location: Install below-ground control valves in concrete access pits with removable pit covers.

Internal dimensions: To give 300 mm clear space all around the fittings in the pit. Concrete: Grade M-200, 100 mm thick, with reinforcement fabric.

Pit covers: To be minimum of 5mm thick steel covers with finger holes for easy removal.

Installation: Grade floor to a point on one side and drain to the storm water drainage system. Carry the pit walls up to 50 mm above finished ground level. Cast in the pit cover frame flush with the top. Trowel the top smooth.

17.10 Valve Boxes:

Location: Install underground isolating valves in concrete access pits with removable pit covers. Identification: Mark the box covers with the name of the service.

17.11 Pipe Drains:

Pipe drains indicated shall consist of 20 mm (3/4 inch) hose bibb with renewable seat and gate or ball valve ahead of hose bibb. At other low points, 20 mm (3/4 inch) brass plugs or caps shall be provided. Disconnection of the supply piping at the fixture is an acceptable drain.

17.12 Pipe Cleanouts:

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 100 mm (4 inches) will not be required. Cleanouts in connection with pipe, where indicated, shall be T pattern, 90-degree branch drainage fittings with plastic plugs. Plugs shall be the same size as the pipe up to and including 100 mm (4 inches). Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building.

Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 450 mm of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless-steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing

screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall.

Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be plastic.

17.13 Protection:

All installed products shall be protected until the completion of the project. All damaged or broken items shall be repaired or replaced before Practical Completion.

Materials, and Equipment Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

17.14 Cleaning:

Prior to practical completion, the CONTRACTOR shall remove all temporary installed items, waste material and equipment from the area and leave the works in a condition acceptable to UNHCR.

18. quality control:

18.1 Quality Control Plan:

At least two weeks before the start of the work, the CONTRACTOR shall submit a quality control plan for approval by UNHCR. The quality control plan shall at least have:

- list of name, frequency and timing from tests
- description of test and minimal results
- names and contact information of suggested laboratories
- checklists for onside control and testing

18.2 Testing:

The execution of the work conforms the design package and the highest in the country common standards is the responsibility of the CONTRACTOR. The CONTRACTOR shall do all tests and controls which are needed to ensure the quality. The tests done by the CONTRACTOR shall not be restricted to the required tests below. The required testing and the result shall not relieve the CONTRACTOR from his responsibilities regarding the quality of the work.

The CONTRACTOR shall notice UNHCR at least one week before every test to enable being present during the test or control.

The following tests shall be performed on the plumbing system in accordance with ICC Intl Plumbing Code or equivalent DIN, IEC, BS, or EN standards.

18.2.1 Flow Test and Pressure Test:

The final test shall include a flow test for drainage and vent system and pressure test for the domestic hot and cold-water piping. After completing the work, the CONTRACTOR shall demonstrate that all plumbing systems operate to fully satisfy the function for which these systems have been designed. The CONTRACTOR shall test, adjust, balance and regulate the system and its controls as necessary until the required designed conditions are met. Test all hot and cold-water piping at not less than 125 psig.

Piping imbedded in floors, walls or other building parts shall be tested before and after pouring concrete or imbedding in another material.

Do not apply insulation prior to completion of pressure testing. Testing to be applied in whole or in parts, as directed by the CLIENT. After system testing, completely flush all piping with water to remove all foreign materials. Provide all tools and equipment required for testing and make all temporary required connections. Promptly notify UNHCR of any defects developed during testing and, if piping was provided under this contract, repair leak and repeat test to prove installation tight. No caulking of screwed joints, cracks or holes permitted. Repair leaks if required in screwed joints by replacing defective pipe, fittings, or both, with new material. Specific attention is directed to obtaining approval from local inspectors and UNHCR of all plumbing piping prior to concealment. Failure to do so may require reopening of construction when directed by Engineer. All such work of opening and closing, if required, to be executed to the satisfaction of CLIENT and be paid for by this CONTRACTOR without cost of UNHCR. After all tests are complete, the entire domestic hot and cold-water distribution system shall be disinfected.

18.2.2 Flushing Test:

18.2.2.1 During Flushing:

Before operational tests or disinfection, potable water piping system shall be flushed with potable water. Sufficient water shall be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 1.2 meters per second (4 fps) through all portions of the piping system. In the event that this is impossible due to size of system, the CLIENT shall specify the number of fixtures to be operated during flushing. CONTRACTOR shall provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. CONTRACTOR shall be responsible for any flood damage resulting from flushing of the system. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration.

18.2.2.2 After Flushing:

System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the CONTRACTOR's failure to properly clean the piping system shall be repaired by the CONTRACTOR. When the system flushing is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation. Lead levels shall not exceed limits established by 40 CFR 50.12 Part 141.80 or equivalent DIN, IEC, BS, or EN standards. The water supply to the building shall be tested separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.

18.2.3 Operational Test:

Upon completion of flushing and prior to disinfection procedures, the CONTRACTOR shall subject the plumbing system to operating tests to demonstrate satisfactory functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

- Time, date, and duration of test.
- Water pressures at the most remote and the highest fixtures.
- Operation of each fixture and fixture trim.
- Operation of each valve, hydrant, and faucet.
- Pump suction and discharge pressures.
- Temperature of each domestic hot-water supply.
- Operation of each floor and roof drain by flooding with water.
- Operation of each vacuum breaker and backflow preventer.
- Complete operation of each water pressure booster system, including pump start pressure and stop pressure.
- Compressed air readings at each compressor and at each outlet. Each indicating instrument shall be read at ½ hour intervals. The report of the test shall be submitted in quadruplicate. The CONTRACTOR shall furnish instruments, equipment, and personnel required for the tests; the CLIENT will furnish the necessary water and electricity.

18.2.4 Disinfection:

After operational tests are complete, the entire domestic hot- and cold-water distribution system shall be disinfected. System shall be flushed as specified, before introducing chlorinating material. The chlorinating material shall be hypochlorites or liquid chlorine. Water chlorination procedure shall be in accordance with AWWA M20 or equivalent DIN, IEC, BS, or EN standards. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million(ppm).

A properly adjusted hypochlorite solution injected into the main with a hypo chlorinator, or liquid chlorine injected into the main through a solution-feed chlorinator and booster pump, shall be used. The chlorine residual shall be checked at intervals to ensure that the proper level is maintained. Chlorine application shall continue until the entire main is filled. The water shall remain in the system for a minimum of 24 hours.

Each valve in the system being disinfected shall be opened and closed several times during the contact period to ensure its proper disinfection. Following the 24-hour period, no less than 25 ppm chlorine residual shall remain in the system.

Water tanks shall be disinfected by the addition of chlorine directly to the filling water. Following a 6-hour period, no less than 50 ppm chlorine residual shall remain in the tank. If after the 24 hour and 6 hour holding periods, the residual solution contains less than 25 ppm and 50 ppm chlorine respectively, flush the piping and tank with potable water, and repeat the above procedures until the required residual chlorine levels are satisfied.

The system including the tanks shall then be flushed with clean water until the residual chlorine level is reduced to less than one part per million. During the flushing period each valve and faucet shall be opened and closed several times. Samples of water in disinfected containers shall be obtained from several locations selected by the Government. The samples of water shall be tested for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA EWW or equivalent DIN, IEC, BS, or EN standards.

The testing method used shall be either the multiple-tube fermentation technique or the membrane-filter technique. Disinfection shall be repeated until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

18.3 Defective Work:

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

19.0 MISCELLANEOUS:

- Throughout the construction period, open ends of all installed pipelines shall be kept closed by temporary plug
- A temporary fire protection system at site office and stores shall be provided by the Contractor during the construction period. This shall be of enough capacity to put out any fire that may break out at the sites.
- A temporary potable water supply shall be available to construction workers, site office staff of the contractor and the Engineer.
- A temporary human Excreta Disposal System shall be provided by the Contractor to serve the workers during the construction period, site office staff of the contractor and the Engineer.