TECHNICAL SPECIFICATIONS

PART 1
CIVIL, STRUCTURAL AND ARCHITECTURAL

TABLE OF CONTENTS CHAPTER

Lebanese Standard

CHAPTER ONE

SITE PREPARATION & DEMOLITION

CHAPTER ONE
SITE PREPARATION & DEMOLITION

PART 1 - GENERAL

SCOPE OF WORK

The work comprises of the rehabilitation of the Building.

SITE PROTECTION

The contractor should take all measures to protect the site and to protect the users during the rehabilitation period as per the Engineer instructions.

- The contractor should not allow or add any load to the existing body to avoid any risk in construction works.
- At the beginning of the works, the contractor should clean the site and the surrounding from all obstacles and remove all debris to outside the site.
- After the completion of works, the contractor should clean the site and works location and make good all places related to his works.

DEMOLITION

SUMMARY

A. This Section includes the following:

1. Demolition and removal of structures.
2. Demolition and removal of site improvements adjacent to a building or structure to be demolished.
3. Disconnecting, capping or sealing, and abandoning in place or removing site utilities.

DEFINITIONS

A. Remove and Salvage: Carefully dismantle and/or detach from existing construction. Store, protect, and transport and deliver to Employer.

SUBMITTALS

A. Proposed Dust-Control and Noise-Control Measures: Submit statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate.

B. Schedule of Building Demolition Activities: Indicate the following:

1. Detailed sequence of demolition and removal work, with starting and ending dates for each activity.
2. Interruption of utility services.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Locations of temporary protection and means of entry and exit for Contractor, and occupants affected by building demolition operations.
5. Coordination of continuing occupancy of adjacent buildings and partial use of premises.

C. Pre-demolition Photographs: Take photographs to show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by building demolition operations. Submit before Work begins.

D. Inventory: After building demolition is complete, submit lists of components and items that have been removed and salvaged or removed for re-use.

E. Pre-demolition Meeting: Conduct meeting at Project site to review methods and procedures related to building demolition including, but not limited to, the following:

1. Inspect and discuss condition of construction to be demolished.
2. Review structural load limitations of existing structures.
3. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review and finalize protection requirements.

CHAPTER THREE

CONCRETE WORKS

CAST IN PLACE CONCRETE

PART 1 - GENERAL

SUMMARY

A. Extent of cast in place concrete work is shown on Drawings.

PROJECT CONDITIONS

A. Protect adjacent finish materials against spatter during concrete placement.

B. Protection of fresh concrete against hot weather: Cover completed fresh concrete with temporary cover as required to protect newly cast elements from direct sun light in hot weather - above 35 deg. C; maintain cover for time period until curing starts.

C. Protect surfaces from rain, wind and sun, detention and physical damage.

D. Protect immature concrete from physical shock, movement, thermal shock and cold water.

PART 2 - PRODUCTS

REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615; BS 4449, 4461

B. Steel Wire: ASTM A 82, plain, cold-drawn steel.

C. Welded Wire Fabric: ASTM A 185; BS 4483

D. Supports for Reinforcement; Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place.

1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected or stainless steel protected.

CONCRETE MATERIALS

A. Ordinary Portland cement: ASTM C 150 Type I; BS12.

B. Sulphate-Resisting Portland cement: ASTM C 150 Type V; BS 4027

C. Use one brand of cement throughout project, unless otherwise acceptable to Engineer.

D. Normal Weight Aggregates: ASTM C 33; BS 882 and as herein specified. Provide aggregates from a single source for exposed concrete.

1. Do not use fine or coarse aggregates containing sapling - causing deleterious substances and this should have a sand equivalent more than 70.

2. Local aggregates not complying with the standards stated but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to Engineer.

E. Hourdi Blocks for hollow concrete suspended slabs: Machine made vibrated hollow concrete (cement and fine sand aggregate) blocks, withstanding compressive force applied at the ends of 40kg/cm2 based on the gross sectional area of the block (without deducting voids).

F. Water: Potable, free from foreign material in amounts harmful to concrete or embedded steel.

RELATED MATERIALS

A. Epoxy Adhesive: ASTM C 8891, two component material suitable for use on dry or damp surfaces. Provide material "Type", "Grade", and "Class" to suit project requirements.

PROPORTIONING AND DESIGN OF MIXES

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to Engineer for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing.

B. For information, submit written reports to Engineer of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until the acceptability of each mix has been adequately substantiated by the Contractor according to ACI 301, as judged by the Engineer.

C. Design mixes in accordance with the following table. Ensure quantity of water used does not exceed that required to produce a concrete with sufficient workability to be placed and compacted where required.

DESIGNED MIXES

Class of Concrete	**AA**	**A**	**B**	**C**
Minimum cement quantity per m3 of concrete (kg)	**450**	**400**	**350**	**250**
Water cement ratio	**0.48**	**0.48**	**0.49**	**0.58**
Preliminary Test Cylinders: Minimum Compressive Strength at 28 Days (kg/cm2)	**400**	**350**	**280**	**180**
Works Test Cylinders Minimum: Compressive Strength at 28 Days (kg/cm2)	**350**	**300**	**250**	**175**
Method of compacting of concrete when placed	**Vibrated**	**Vibrated**	**Vibrated**	**Rodded, or Tamped**

Keep slump to the minimum compatible with approved placing requirements.

D. Adjustment to Concrete Mixes: Mix design adjustments may be requested from Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to Employer and as accepted by Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Engineer before using in work.

E. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:

1. Ramps, slabs, and sloping surfaces: Nor more than 100mm.

2. Reinforced foundation systems: Not less than 25 mm and not more than 125 mm.

3. Concrete containing HRWR admixture (super-plasticizer): Not more than 230 mm after addition of HRWR to site-verified 50-75 mm slump concrete.

CONCRETE MIXING

A. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

B. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as herein specified.

C. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required and shall be subject to the Engineer's approval.

PART 3 - EXECUTION

GENERAL

A. Coordinate the installation of joint materials and water proofing membranes with placement of forms and reinforcing steel.

FORMS

A. Design, erect, support, brace, and maintain formwork to support vertical and lateral, static, and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structures are of correct size shape, alignment, elevation, and position. Maintain formwork construction tolerances complying with ACI 347.

B. Design formwork to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent materials.

C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, regrets, recesses, and the like, to prevent swelling and for easy removal.

D. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.

PLACING REINFORCEMENT

A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.

1. Avoid cutting or puncturing water proofing membranes during reinforcement placement and concreting operations.

B. Clean reinforcement of loose rust and mill scale, earth, and other materials, which reduce or destroy bond with concrete

C. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.

D. Place reinforcement to obtain at least minimum coverage for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surface.

E. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

JOINTS

A. Construction Joints: Locate and install construction joints as indicated or, if not indicated, locate so as not to impair strength and appearance of the structure, as acceptable to Engineer.

1. Where specific slab-on-ground construction joints are not shown on Drawings, cast slab on ground in strips, each strip width not to exceed 5 m or the typical bay width whichever is less.

2. Construction joint spacing in basement walls and slabs on ground should not exceed 8m unless acceptable to Engineer.

3. Locate construction joints in framed slabs within the middle third of any slab or beam span length, unless otherwise indicated on drawings.

4. Lightly roughen face to expose coarse aggregate unless otherwise instructed. Wet and cover with 1:1 cement and sand grout immediately prior to placing fresh concrete. Stop roughening 25 mm form arises to surfaces exposed to view in finished work. Remove small mortar lips from exposed arises with carborundum stone. Face is to be clean and damp before fresh concrete is placed against it.

B. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints, except as otherwise indicated.

C. Water stops: Provide water stops in construction joints as indicated. Install water stops to form continuous diaphragm in each joint. Make provisions to support and protect exposed water stops during progress of work. Fabricate field joints in water stops in accordance with manufacturer's printed instruction.

D. Isolation Joints in Slabs-on-Ground: Construct isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

1. Joint filler and sealant materials are specified in elsewhere in the specifications.

CONCRETE PLACEMENT

A. Replacement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other trades to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.

1. Apply temporary protective covering to lower 600 mm of finished walls adjacent to poured floor slabs and similar conditions, and guard against spattering during placement.

B. General: Comply with ACI 304 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete", and as herein specified.

C. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.

D. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 600 mm and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

E. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.

F. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not further than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 150 mm into preceding layer. Do not insert vibrators into lower layers 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 mix.

G. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.

H. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.

I. Bring slab surfaces to correct level with straightedge and strike off. Use bull floats or derbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.

J. Maintain reinforcing in proper position during concrete placement operations.

K. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.

L. When air temperature has fallen to or is expected to fall below 36 deg F (2 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C), and not more than 80 deg F (27 deg C) at point of placement.

M. Do not use-frozen material or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

N. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.

O. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

P. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg (32 deg C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.

Q. Cover reinforcing steel with water-soaked burlap it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

R. Fog spray forms, reinforcing steel, and sub grade just before concrete is placed.

S. Use water-reducing retarding admixture (Type D) when required by high temperatures, low humidity, or other adverse placing conditions.

CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from direct exposure to wind, from premature drying and from excessive cold or hot temperatures.

B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Keep continuously moist and covered for not less than 7 days.

C. Begin final curing procedures immediately following initial curing and before concrete have dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.

D. Curing methods: Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified.

E. Provide moisture curing by following methods.

1. Keep concrete surface continuously wet by covering with water.

2. Continuous water-fog spray.

3. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 100 mm lap over adjacent absorptive covers.

F. Cover concrete surfaces with moisture retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 74 mm and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

G. Provide membrane curing and sealing compound to exposed interior slabs and to exterior slabs, walks, and curbs, as follows:

1. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours). Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

H. Do not use membrane curing compounds on surfaces which are to be covered with coating material applied directly to concrete, liquid floor hardener, waterproofing, damp proofing, membrane roofing, flooring (such as ceramic or quarry tile, glue-down carpet), painting and other coatings and finish materials, unless otherwise acceptable to Engineer.

I. Curing Formed Surfaces: Cure formed concrete surfaces, including undersides of beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above as applicable.

J. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by application of appropriate curing method.

K. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise directed.

SHORES AND SUPPORTS

A. Comply with ACI 347 for shoring and re-shoring in multistory construction, and as herein specified.

B. Remove shores and re-shore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate re-shoring to safely support work without excessive street or deflection.

C. Keep shores in place a minimum of 15 days after placing upper tier, and longer if required, until concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

REMOVAL OF FORMS

A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at no less than 50 deg F (10 deg C) for 36 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days and not until concrete has attained 28 day design strength unless authorized by Engineer. Determine potential compressive strength of in place concrete by testing field-cured specimens representative of concrete location or members.

C. Form facing material may be removed 4 days after placement, only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

RE-USE OF FORMS

A. Clean and repair surfaces of forms to be re-used in work. Split, frayed, delaminated, or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to Engineer.

MISCELLANEOUS CONCRETE ITEMS

A. Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer machines and equipment.

D. Grout base plates and foundations as indicated, using specified non-shrink grout. Use non-metallic grout for exposed conditions, unless otherwise indicated.

E. Steel Pan Stairs: Provide concrete fill for steel pan stair treads and landings and associated items. Cast-in-safety inserts and accessories as shown on drawings. Screed, tamp, and finish concrete surfaces as scheduled.

QUALITY CONTROL TESTING DURING CONSTRUCTION

A. The Contractor will employ a testing laboratory approved by the Engineer to perform tests and to submit test reports.

B. Sampling and testing for quality control during placement of concrete may include the following, as directed by Engineer.

C. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.

1. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.

2. Concrete Temperature: Test hourly when air temperature is 40 deg F (4 deg C) and below, and when 80 deg F (27 degC) and above; and each time a set of compression test specimens is made.

3. Compression Test Specimen: ASTM C 31; one set of 6 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field - cured test specimens are required.

4. Compressive Strength Tests: ASTM C 39, one set for each day's pour exceeding 4 cu.m plus additional sets for each 40 cu.m over and above the first 20 cu.m of each concrete class placed in any one day; two specimens tested at 7 days, three specimens tested at 28 days, and one specimen retained in reserve for later testing if required.

5. When frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.

6. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

7. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results exceed 10% of specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 3.5 MPa (500 psi)

D. Test results will be reported in writing to. Engineer within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

F. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Engineer. Testing service may conduct test to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such additional tests.

CONCRETE TOPPING

PART 1 – GENERAL

SUMMARY

A. Section Includes:

1. Decorative stamped concrete floor topping.

ACTION SUBMITTALS

A. Product Data: product indicated.

INFORMATIONAL SUBMITTALS

A. Product test reports.

PART 2 - PRODUCTS

CONCRETE FLOOR TOPPINGS

A. Stamped-Aggregate Concrete Floor Topping: Factory-prepared and dry-packaged mixture of containing mineral oxide; Portland cement; plasticizers; and other admixtures to which only water needs to be added at Project site.

1. Products: Subject to compliance with requirements, provide available products that may be incorporated into the Works and which are deemed in the market.
   a. Compressive Strength (28 Days): 4000 psi; ASTM C 109/C 109M
   b. Slump in concrete shall not exceed 10 cm

CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately (305 g/sq. m) when dry.
C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
D. Water: Potable.
E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 25 percent solids content, minimum.
F. Apply a color hardener at the minimum 30 kg / 10 sq.m

RELATED MATERIALS

A. Semi-rigid Joint Filler: Two-component, semi-rigid, 100 percent solids, [epoxy resin with a Type A Shore durometer hardness of 80] per ASTM D 2240.
B. Joint-Filler Strips: [ASTM D 1751, asphalt-saturated cellulosic fiber].
C. Portland Cement: ASTM C 150, Type I or II.
D. Sand: ASTM C 404, fine aggregate passing No. 16 (1.18-mm) sieve.
E. Water: Potable.
F. Acrylic-Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
G. Epoxy Adhesive: ASTM C 881/C 881M, Type V, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements.

MIXING

A. Bonding Slurry: Mix Portland cement with water to a thick paint consistency.

B. Bonding Slurry: Mix 1 part Portland cement and [1-1/2] parts sand with water [and an acrylic-bonding agent according to manufacturer's written instructions] to a thick paint consistency.

C. Floor Topping: Mix concrete floor topping materials and water in appropriate drum-type batch machine mixer or truck mixer according to manufacturer's written instructions.

PART 3 - EXECUTION

PREPARATION

A. Existing Concrete: Remove existing surface treatments and deteriorated and unsound concrete. Mechanically abrade base slabs to produce a heavily scarified surface profile with amplitude of (6 mm).

1. Prepare and clean existing base slabs according to concrete floor topping manufacturer's written instructions. Fill voids, cracks, and cavities in base slabs.

2. Saw cut contraction and construction joints in existing concrete to a depth of (35-50 mm) and fill with semi-rigid joint filler.

3. To both sides of joint edges and at perimeter of existing base slab [mechanically remove a (100-mm-) wide and (0- to 25-mm-) deep, tapered wedge of concrete and retexture surface].

B. Install joint-filler strips where topping abuts vertical surfaces.

FLOOR TOPPING APPLICATION

A. Start floor topping application in presence of manufacturer's technical representative.

B. Monolithic Floor Topping: After textured-float finish is applied to fresh concrete of base slabs specified in Division 03 Section "Cast-in-Place Concrete," place concrete floor topping while concrete is still plastic.

C. Deferred Floor Topping: Within 72 hours of placing base slabs, mix and scrub bonding slurry into dampened concrete to a thickness of (1.6 to 3 mm), without puddling. Place floor topping while slurry is still tacky.

D. Existing Concrete: Apply epoxy-bonding adhesive, mixed according to manufacturer's written instructions, and scrub into dry base slabs to a thickness of (1.6 to 3 mm), without puddling. Place floor topping while adhesive is still tacky.

E. Place concrete floor topping continuously in a single layer, tamping and consolidating to achieve tight contact with bonding surface. Do not permit cold joints or seams to develop within pour strip.
   1. Screed surface with a straightedge and strike off to correct elevations.
   2. Slope surfaces uniformly where indicated.
   3. Begin initial floating using bull floats to form a uniform and open-textured surface plane free of humps or hollows.

F. Finishing: Consolidate surface with power-driven floats as soon as concrete floor topping can support equipment and operator. Straighten, cut down high spots, and fill low spots. Repeat float passes and straightening until concrete floor topping surface has a uniform, smooth, granular texture.

1. Hard Trowel Finish: After floating surface, apply first trowel finish and consolidate concrete floor topping by power-driven trowel without allowing blisters to develop. Continue troweling passes and straighten until surface is smooth and uniform in texture.

G. Construction Joints: Construct joints true to line with faces perpendicular to surface plane of concrete floor topping, at locations indicated or as approved by Architect.

1. Coat face of construction joint with epoxy adhesive at locations where concrete floor topping is placed against hardened or partially hardened concrete floor topping.

H. Contraction Joints: Form weakened-plane contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut (5-mm) wide joints into concrete floor topping when cutting action will not tear, abrade, or otherwise damage surface and before random contraction cracks develop.

1. Form joints in concrete floor topping over contraction joints in base slabs, unless otherwise indicated.
2. Construct contraction joints for a combined depth equal to topping thickness and not less than one-fourth of base-slab thickness.
3. Construct contraction joints for a depth equal to one-half of concrete floor topping thickness, but not less than (13 mm) deep.

PROTECTING AND CURING

A General: Protect freshly placed concrete floor topping from premature drying and excessive cold or hot temperatures.

B Evaporation Retarder: Apply evaporation retarder to concrete floor topping surfaces in hot, dry, or windy conditions before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or dirtying floor topping, but before float finishing.

C Begin curing immediately after finishing concrete floor topping. Cure by one or a combination of the following methods, according to concrete floor topping manufacturer's written instructions:
1. Moisture Curing: Keep surfaces continuously moist for not less than 7 days.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete for not less than seven days.
3. Curing Compound: Apply uniformly in two coats in continuous operations by power spray or roller according to manufacturer's written instructions.

JOINT FILLING

A Prepare and clean contraction joints and install semi-rigid joint filler, according to manufacturer's written instructions, once topping has fully cured.

B Install semi rigid joint filler full depth of contraction joints. Overfill joint and trim semi-rigid joint filler flush with top of joint after hardening.

REPAIRS

A Defective Topping: Repair and patch defective concrete floor topping areas, including areas that have not bonded to concrete substrate.

CHAPTER FOUR
MASONRY

UNIT MASONRY

PART 1 - GENERAL

DESCRIPTION OF WORK

A. Extent of each type of masonry work is indicated on Drawings.

B. Types of masonry work required include:

1. Concrete unit masonry.

QUALITY ASSURANCE

A. Unit Test Methods: Test the following materials by sampling and batch methods indicated

1. Concrete Masonry Units: Batch test sample blocks for compressive strength whenever required by the Engineer. Each test will comprise the destructive testing of twelve sample blocks selected by the Engineer. The minimum compressive strength for the gross area of any hollow block shall be 20 kg/cm2, and the average compressive strength for the gross area of all twelve blocks together shall be not less than 35 kg/cm2. If a test does not meet the compressive strength requirements, the entire batch from which the samples were selected will be rejected and removed from the site.

2. Mortars and Grouts: Test no less frequently than is required to evaluate mortars and grouts used to install each batch of masonry units from which samples are taken for testing.

PART 2 – PRODUCTS
MASONRY UNITS

A. General: Comply with referenced standards and other requirements indicated below:

1. Provide concrete masonry unit special shapes where required for corners, jambs, sash, control joints, headers, bonding and other special conditions.

   a. Provide square-edged units for outside corners, except where indicated otherwise.

B. Concrete Blocks: Provide units complying with characteristics indicated below:

1. Manufacture: produce blocks from cement and sand 1:5 mix (300 kg cement to 1m3 sand) in vibrated pressure machine moulds. Adjust the mix as necessary to achieve compressive strength requirements.
2. Size: Manufacturer's standard units with nominal face dimensions of 400mm long x 200 mm high, of thicknesses indicated.
3. Type: unless otherwise shown on the drawings, concrete masonry units shall be hollow blocks of a design approved by the Engineer.

C. Fireclay bricks: provide bricks made from fireclay containing a high percentage of silica and suitable for the conditions of proposed use.
1. Obtain bricks from a manufacturer approved by the Engineer.
2. Obtain fireclay cement from the brick manufacturer.

MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I; BS 12.

B. Hydrated Lime: ASTM C 207, Types S; BS 890 class B.

C. Sand Aggregate: ASTM C 144; BS 1200 Table I, washed and mechanically graded.

D. Water: Clean and potable.

JOINT REINFORCEMENT AND TIES

A. Materials: Comply with requirements indicated below and obtain approval of the Engineer for each type of joint reinforcement and tie for size and other characteristics.

B. Wall Ties: galvanized steel ties conforming to BS. 1243.

C. Joint Reinforcement: Provide approved galvanized steel welded-wire units prefabricated with deformed continuous side rods and plain cross roads into straight lengths of not less than 3000 mm, with prefabricated corner and tee units, and complying with requirements indicated below:

1. Width: Fabricate joint reinforcement in units with widths of approximately 50 mm less than nominal width of walls and partitions as required to provide mortar coverage of not less than 16 mm on joint faces exposed to exterior and 12 mm elsewhere.

2. Wire Size: 4 mm diameter.

3. Type: Ladder design, single side rods with perpendicular cross roads spaced not more than 400mm overall centers.

MISCELLANEOUS MASONRY ACCESSORIES

A. Reinforcing Bars: Deformed steel, ASTM A 615, Grade 60; BS. 4449, 4461.

B. Remolded Control Joint Strips: Material designed to fit standard sash block and to maintain lateral stability in masonry wall; sizes and configuration as required and approved.

C. Bond Breaker Strips: Asphalt-saturated organic roofing felt.

D. Weep holes: Medium density polyethylene plastic tubing, outside diameter and length as required.

MORTAR AND GROUT MIXES

A. General: Do not add admixtures including coloring pigments, air-entraining agents, accelerators, retarders, water repellent agents, anti-freeze compounds or other admixtures, unless otherwise indicated.

   1. Do not use calcium chloride in mortar or grout.

B. Mixing: Combine and thoroughly mix cementations, water and aggregates in a mechanical batch mixer; comply with ASTM or BS standards for mixing time and water content.

C. Mortar for Unit Masonry: Comply with ASTM or BS; Proportion mixes, for types of mortar required, unless otherwise indicated.

   1. Limit cementations materials in mortar to Portland cement-lime.

D. Grout for Unit Masonry: Comply with ASTM or BS for grout used in construction of reinforced and non-reinforced unit masonry. Use grout of consistency indicated or if not otherwise indicated, of consistency (fine or coarse) at time of placement which will completely fill all spaces intended to receive grout.

PART 3 - EXECUTION

INSTALLATION, GENERAL

A. Do not wet concrete masonry units.

B. Cleaning Reinforcing: Remove ice and other coatings from reinforcing before placing.

C. Thickness: Build masonry construction to the full thickness shown. Build single-wither walls (if any) to the actual thickness of the masonry units, using units of nominal thickness indicated.

D. Build chases and recesses as shown or required for the work of other trades. Provide not less than 200 mm of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.

E. Leave openings for equipment to be installed before completion of masonry work. After installation of equipment, complete masonry work to match work immediately adjacent to the opening.

F. Cut masonry units using motor-driven saws to provide clean, sharp, unshipped edges. Cut units as required to provide continuous pattern and to fit adjoining work. Use full-size units without cutting where possible.

1. Use dry cutting saws to cut concrete masonry units.

LAYING MASONRY WALLS

A Layout walls in advance for accurate spacing of surface bond patterns with uniform joint widths and to accurately locate openings, movement-type joints, returns and offsets. Avoid the use of less-than-half-size units at corners, jambs and wherever possible at other locations.

B Lay-up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other work.

C Pattern Bond: Lay exposed masonry in the bond pattern shown or, if not shown; lay in running bond with vertical joint in each course centered on units in courses above and below. Lay concealed masonry with all units in a Wythe in running bond or bonded by lapping not less than 50 mm. Bond an interlock each course of each Wythe at corners. Do not use units with less that nominal 100 mm horizontal face dimensions at corners or jambs.

D Stopping and Resuming Work: Rack back 1/2-unit length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly (if required) and remove loose masonry units and mortar prior to laying fresh masonry.

E Built-in Work: As the work progresses, build-in items specified under this and other sections of these specifications. Fill in solidly with masonry around built-in items.

1. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.

2. Where built-in items are to be embedded in cores of hollow, concrete masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.

3. Fill cores in hollow concrete masonry units with grout 3 courses under bearing plates, beams, lintels, posts and similar items, unless otherwise indicated.

MORTAR BEDDING AND JOINTING

A. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course on footings and in all courses of piers, columns and pilasters, and where adjacent to cells or cavities to be reinforced or filled with concrete or grout. For starting course on footings where cells are not grouted, spread out full mortar bed including areas under cells.

B. Maintain joint widths shown, except for minor variations required to maintain bond alignment. If not shown, lay walls with 9 mm joints.

C. Cut joints flush for masonry walls, which are to be concealed or to be covered by other materials, unless otherwise indicated.

D. Rake out joints on faces of block work, which are to be rendered or plastered, to a depth of 10 mm, as the work proceeds.

E. Tool exposed joints slightly concave using a jointer larger than joint thickness, unless otherwise indicated, as the work proceeds.

F. Remove masonry units disturbed after lying; clean and reset in fresh mortar. Do not pound corners or jambs to shift adjacent stretcher units, which have been set in position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.

G. Collar Joints: After each course is laid, fill the vertical longitudinal joint solidly and with mortar for the following masonry work:
   1. Non-loadbearing interior walls or partitions where metal ties or horizontal reinforcing are required for structural bonding and nominal thickness of wall or partition is required to meet code requirements for height-to-thickness ratio.

ANCHORING MASONRY WORK

A. General: Provide anchor devices of types indicated and required.

B. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:

   1. Anchor masonry to structural concrete members with metal ties (cast into concrete) embedded in masonry joints.

   2. Space ties as required, but not more than 600 mm vertically and 1000mm horizontally.

LINTELS

A. Install steel lintels where indicated.

B. Provide cast in place reinforced concrete lintels, minimum 200mm deep x full width of wall. Temporarily support lintels.

C. Provide minimum lintel bearing of 200 mm at each jamb, unless otherwise indicated.

EXTERIOR STONEWORK

PART 1 - GENERAL

SUMMARY

A Extent of stonework is indicated on Drawings.

B Types of stonework in this section include:

1. Exterior stone veneers and facings.

C Interior stone facing and flooring is specified in the Finishes section of the Specification.

SYSTEM DESCRIPTION

A. General: Fabricate and install stonework to withstand normal loads from wind, gravity, movement of building structure, and thermally induced movement, as well as to resist deterioration under conditions of normal use including exposure to weather, without failure.

B. Provide stonework, which is designed, fabricated and installed, based on the safety factors applied to minimum physical properties of the different stones indicated.

C. Provide hand-set stone anchoring system which results in attachments developing the capability to sustain the following forces generated by the supported element (individual member or assembly) acting separately, based on the yield strength of the material:

1. A total force of 4 times the dead weight of the element supported, applied vertically downward through the element's center of gravity, combined with loads caused by thermal movements.

2. A total force of 3 times the dead weight of the element applied horizontally outwards through the center of gravity of the element, combined with loads caused by thermal movements.

QUALITY ASSURANCE

A. Single Source Responsibility for Stone: obtain each color, grade, finish, type and variety of stone from a single quarry with resources to provide materials of consistent quality in appearance and physical properties, including the capacity to cut and finish material without delaying the progress of the work.

PART 2 - PRODUCTS

MATERIALS, GENERAL

A. Comply with relevant standards and other requirements indicated, as applicable to each type of material required.

B. Provide matched blocks from a single quarry for each type similar to existing or where applicable, variety, color and quality of stone required. Extract blocks from a single bed of quarry stratum, unless stones from randomly selected blocks are acceptable to Engineer for aesthetic effect.

C. Provide stones, which are free from vents, cracks, fissures, discoloration or other surface defects, which may adversely affect strength or appearance.

STONE FABRICATIONS

A. General: fabricate stonework in sizes and shapes required to comply with requirements indicated, including details on Drawings and final shop drawings.

B. Cut and drill sink ages and holes in stones for anchors, fasteners, supports and lifting devices as indicated or needed to set stonework securely in place; shape beds to fit supports.

C. Cut stones to produce pieces of thickness, size and shape indicated or required and within fabrication tolerances recommended by applicable codes or standards or, if none, stone source, for faces, edges, beds, and backs.

   1. Quirk-miter corners, unless otherwise indicated; provide for cramp anchorage in top and bottom bed joints of corner pieces.

D. Finish exposed faces and edges of stones to comply with requirements indicated for finish under each type and application of stone required and to match approved samples.

PART 3 - EXECUTION

EXAMINATION

A. Examine surfaces to receive stonework and conditions under which stonework will be installed. Do not proceed with installation until surfaces and conditions comply with requirements indicated in specifications or elsewhere for execution of other work, which affects stonework.

SETTING STONE, GENERAL

A. Execute stonework by skilled masons, and stone fitters at the site to do necessary field cutting, as stones are set.

   1. Use power saws to cut stones; for exposed edges, produce edges, which are cut straight and true.

B. Contiguous Work: Provide chases, reveals, regrets, openings and other spaces as required for accommodating contiguous work. Close-up openings in stonework after work is in place with stonework which matches that already set.

C. Set stones to comply with requirements indicated on drawings and final shop drawings. Install anchors, supports, fasteners and other attachments indicated or necessary to secure stonework on place. Shim and adjust anchors, supports and accessories to set stones accurately in locations indicated with uniform joints of widths indicated and with edges and faces aligned according to established relationship and indicated tolerances.

D. Construction Tolerances: set stones to comply with the following tolerances:

   1. Variation from Plumb: For lines and surfaces of columns, walls and arises, do not exceed 6mm in 3m, 10mm in a story height or 6m maximum, nor 15mm in 12m or more. For external corners, expansion joints and other conspicuous lines, do not exceed 6mm in any story or 6m maximum, nor 15mm in 12m or more.

   2. Variation from Level: for grades indicated for exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed 15mm in any bay or 6m maximum, or 20mm in 12m or more.

   3. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls and partitions, do not exceed 15mm in any bay or 500mm maximum, nor 20mm in 12m or more.

   4. Variation in Cross-Sectional Dimensions: For columns and thickness of walls from dimensions indicated, do not exceed minus 6mm nor plus 15mm.

ADJUSTING AND CLEANING

A. Remove and replace stonework of the following description:
   1. Broken, chipped, stained or otherwise damaged stones.
   2. Defective joints.
   3. Stones and joints not matching approved samples.
   4. Stonework not complying with other requirements indicated.

B. Replace in manner which results in stonework matching approved samples, complying with other requirements and showing no evidence of replacement.

C. Clean stonework not less than 6 days after completion of work, using water and stiff bristle fiber brushes. Do not use wire brushes, acid-type cleaning agents, cleaning compounds with caustic or harsh fillers, or other materials or methods which could damage stone.

PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Engineer, which ensures stonework being without damage or deterioration at time of final handing over.

CHAPTER FIVE
METAL WORKS

METAL FABRICATIONS

PART 1 - GENERAL

SUMMARY

A. Definition: Metal fabrications includes components and assemblies from ferrous and non-ferrous metal shapes, plates, bars, strips, tubes, pipes and castings which are not a part of structural steel or other metal systems specified elsewhere.

B. Extent of metal fabrications is indicated on drawings, and includes but is not necessarily limited to the following:

1. Ladders
2. Floor drain covers
3. Water tank access covers
4. Steel gates
5. Aluminum handrails and railing systems
6. Miscellaneous steel pipe railings
7. Miscellaneous checker plate fabrications
8. Miscellaneous supports for overhead doors and the like.

PROJECT CONDITIONS

A. Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit, by accurate field measurements before fabrications; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.

1. Where field measurements cannot be made without delaying the work, guarantee dimensions and proceed with fabrication of products without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

PART 2 - PRODUCTS

MATERIALS

A. Ferrous Metals

1. Metal Surfaces, General: For fabrication of miscellaneous metal work which will be exposed to view, use only materials which are smooth and free of surface blemishes and including pitting, seam marks, roller marks, rolled trade names and roughness.

2. Steel Plates, Shapes and Bars: ASTM A 36 or BS 1449.

3. Rolled Steel floor plates: ASTM A 786.

4. Steel Bar Grating: ASTM A 569 or ASTM A 36.

5. Steel Tubing: Cold formed, ASTM A 500; or hot-rolled, ASTM A 501, BS 4848, or BS 2994.

6. Structural Steel Sheet: Hot-rolled, ASTM A 570; or cold-rolled ASTM A 611, of grade required for design loading.

7. Galvanized Structural Steel Sheet: ASTM A 446, of grade required for design loading. Coating designation as indicated, or if not indicated, G90.

8. Steel Pipe: ASTM A 53 or BS 4848. Type and grade as selected by fabricator and as required for design loading; black finish unless galvanizing is indicated; standard weight (schedule 40), unless otherwise indicated.

9. Grey Iron Castings: ASTM A 48, Class 30, or BS 1452.

10. Malleable Iron Castings: ASTM A 47, grade as selected by fabricator.

11. Brackets, Flanges and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.

12. Concrete Inserts: Threaded or wedge type, galvanized ferrous castings, either malleable iron, ASTM A 47, or cast steel, ASTM A 27. Provide bolts, washers and shims as required, hot-dip galvanized, ASTM A 153.

B. Aluminum

1. All aluminum works should be as manufactured by Sidem Type 2000

C. Grout

1. Non-Shrink Non-Metallic Grout: Pre-mixed, factory-packaged, non-staining, non-corrosive, non-gaseous grout. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified and required.

D. Fasteners

1. General: Provide stainless steel fasteners for exterior use or where built into exterior walls. Select fasteners for the type, grade and class required.

2. Bolts and Nuts: Regular-hexagon head type.
   Lag Bolts: Square head type.
   Machine Screws: Cadmium plated steel.
   Wood Screws: Flat head carbon steel.
   Plain Washers: Round, carbon steel.
   Anchorage Devices: Drilled in expansion anchor bolts.
   Toggle Bolts: Tumble-wing type, class and style as required.
   Lock Washers: Helical spring type carbon steel.

E. Paint

1. Shop Primer for Ferrous Metal: Manufacturer's or fabricator's standard, fast-curing, lead-free, "Epoxy" primer; selected for good resistance to aggressive atmospheric corrosion, for compatibility with finish paint systems indicated and for capability to provide a sound foundation for field applied topcoats despite prolonged exposure.

2. Galvanizing Repair Paint: High zinc dust content paint for galvanizing welds in galvanized steel.

3. Bituminous Paint: Cold applied asphaltic mastic.

4. Zinc Chromate Primer.

F. Stainless Steel

Where stainless steel is specified it shall be what is known to the trade as Austentic 18-8, type 316, with a content of from 17% to 19% chrome, 7% to 9% nickel and a maximum, carbon content of 0.11%.

Stainless steel shall be free from scale and all surfaces shall be polished to a No.4 commercial finish where specified.

PART 3 - EXECUTION

PREPARATION

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

INSTALLATION

A. General:

1. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including, threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required.

2. Cutting, Fitting and Placement: Perform cutting drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plus, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items, which are to be built into concrete masonry or similar construction.

3. Fit exposed connections accurately together to form tight hairline joints. Weld connections, which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind exposed joints smooth and touch-up shop paint coat. Do not weld, cut or abrade the surfaces of exterior units, which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

4. Field welding: Comply with relevant codes for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.

5. Corrosion Protection: Coat concealed surfaces of Aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint or zinc chromate primer.

B. Railings and Handrails:

1. Adjust railing prior to anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated, or if not indicated, as required by design loadings. Plumb posts in each direction. Secure posts and railing ends to building construction as indicated on drawings and as required.
   a. Anchor posts in concrete by means of pipe sleeves preset and anchored into concrete. After posts have been inserted into sleeves, fill annular space between post and sleeve solid with non-shrink, non-metallic grout, mixed, placed and sealed to comply with grout manufacturer's directions.

2. Secure handrails to wall with wall brackets and end fittings. Provide bracket with not less than 37mm clearance from inside face of handrail and finished wall surface. Locate brackets as indicated, or if not indicated, at spacing required for design loading. Secure wall brackets and wall return fittings to building construction as required.

ADJUST AND CLEAN

1. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

2. For galvanized surfaces: Clean field welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780, or BS 729.

ROUND HANDRAIL DIAMETER 40 MM

DESCRIPTION

Round handrail with antibacterial PVC sheath with a diameter of 40 mm. The rail consists of an aluminum section covered by a sheath of smooth and antibacterial PVC achieving Bs2d0 fire rating with solid color. A protective film is specified to minimize cleaning before acceptance. The section comprises a groove into which brackets, accessories and matching closers slide and lock.

Perforated brackets are curved, 40 mm deep and made of satin silver anodized aluminum. Overall projection and depth are 80 mm. Accessories made of smooth antibacterial PVC achieving Bs2d0 fire rating (wall returns, round or flat and caps, external and internal 90° angle pieces or made-to-measure from 90° to 165°) are fitted on the section and fixed with locking screws accessories.

Bactericidal joints are provided for the junctions between profile sections and accessories. All technical solutions are available to ensure continuity around corners (90° or made-to-measure), in staircases across service ducts (Quick-removable assembly wedge and articulated elbow and around curved sections.

ENVIRONMENT

No heavy metals are used in its formulation, including lead or tin (insignificant levels, less than 50 ppm) or any CMR Cat. 1 or 2 substances. The calcium-zinc thermal stabilization process is used. The emission level of volatile substance in inside air has been tested according to ISO 16000 and is very low (A+) according to the French regulation (23 March 2011 No. 2011-321 Decree and 19 April 2011 Order). 100% of the product are recyclable.

COLOR

Selected by Architects from manufacturer’s standard range.

INSTALLATION METHOD

Upper edge of section 0.90 m max. above floor level. Fixes to 2 – point self-locking perforated aluminum brackets at 1.20 m centers (0.80 m centers in heavy traffic areas and on light partitions like plasterboard).

PLEXIGLAS CORRUGATED SHEETS

DESCRIPTION

Plexiglas corrugated sheet is a colorless form and a crystal clear (with a transparency equal to optical glass), lightweight material having outstanding weather ability, high impact resistance, good chemical resistance, and excellent thermoform ability and machinability.

Plexiglas corrugated sheet is made by a cell-cast process. Plexiglas sheet to conform to ASTM D-4802, A-1 material, finish 1, and is supplied as a shrunk sheet. This means that when heated to forming temperatures, it will shrink about 2% in length and width, and will increase in thickness by about 4%.

Plexiglas corrugated sheet have excellent resistance to most chemicals, including solutions of inorganic alkalis and acids.

Plexiglas acrylic sheet will expand and contract with changes in temperature and humidity. Different temperature and/or humidity conditions on the inner and outer surfaces of Plexiglas sheet may cause it to bow slightly in the direction of the higher temperature and/or humidity. However, this type of bowing is reversible. The sheet will return to its original flat state when the temperature and humidity differentials become zero.

In construction, Plexiglas sheet is often used with other materials that undergo less expansion and contraction.

To ensure good performance in environments where temperature varies widely, Plexiglas sheet should be installed in a channel frame that permits the sheet to expand and contract freely. The channel frame should be deep enough for the sheet to contract fully and still stay within the frame.

INSTALLATION

Support spacing

Plexiglas corrugated sheets are installed on statically supporting structures (purlins or crossbars) that are positioned at right angles to the direction of slope or water flow. Given average snow loads and wind pressure, it is sufficient to install the crossbars or purlins at spaces of approx. 850 mm. The spacing should be reduced if greater loads apply.

Allowance for expansion

Plexiglas corrugated sheets expand due to heat and moisture. An allowance of approx.
6 mm/m sheet length and width therefore has to be made for expansion. The required distance from walls owing to the allowance for expansion can be bridged using suitable wall connecting systems.

Installation direction

Plexiglas corrugated sheets should be installed with the textured side facing downwards. The smooth surface keeps the sheet clean longer and is much easier to clean.

Material/Preventing heat buildup

The supporting structure must be non-warping and consist of laminated timber beams or metal. Dark colored surfaces heat up to a greater extent and faster than light-colored surfaces.

It is therefore very important to provide all structural surfaces facing the sheets with a durable white or reflective coating (e.g. light-resistant emulsion paint). The coating of the supporting structure must be allowed to dry properly before installing the sheets.

Cutting to size

High-speed circular (hand) saws with unset, multi-tooth carbide-tipped blades are most suitable for cutting the Plexiglas corrugated sheets to size.
We advise against the use of cutting disks to avoid possible damage to the sheets (subsequent stress cracking).

Drilling

Drilling should be performed using a conical drill that provides drill holes of 10, 12 and 13 mm in diameter. Corrugated sheets that overlap horizontally are drilled together. The holes in the lower sheet may need to be drilled open a few more millimeters (after lifting off the topmost sheet) so that the two sheets can expand against each other. Make sure the edges of the drill holes are smooth and clean.

Installing longer roofs with cutout corners

If two or more sheets have to be installed with a longitudinal overlap, for example on very long roofs, the sheet corners should be cut at the points where there is a multiple overlap so that they can lie next to each other.

Fastening Points

The Plexiglas corrugated sheets should always be fastened point wise to the supporting structure. On roofs, fastening is always performed at the crest of the corrugation.
When doing so, make sure to allow for expansion of the sheets, i.e. provide adequately dimensioned drill holes.

Fastening elements, screw fastening

The sheets are fastened to the supporting structure using façade screws, J-bolts etc., ideally in combination with calottes.
The most common way to fasten corrugated sheets is by means of special commercially available screws (6.5 mm Ø) for wood or metal (in some cases self-tapping), complete with an adequately sized washer. Owing to the superior material thickness and rigidity of Plexiglas corrugated sheets, there is no need to place shims beneath the crest of the corrugation (such as are required for thin or soft corrugated plastic sheets).

Fastening elements, J-bolts

Other items suitable for fastening the corrugated sheets, particularly to tubular purlins, are commercially available J-bolts with a 6mm thread and screw at the upper end, since these allow the plastic to move in an ideal manner.
Screws should only be tightened until initial resistance is encountered. J-bolts can also be used in conjunction with aluminum calottes.

Sealing caps

PE sealing caps are suitable for use with J-bolts.
The sealing caps should be compatible with Plexiglas corrugated sheets, seal the drill hole against water from the outside, distribute the bolt pressure and act as a spacer between the bolt and the edge of the drill hole.

CHAPTER SIX

WOOD WORKS

JOINERY

PART 1 - GENERAL

SUMMARY

A. Types of joinery and architectural woodwork included in this Section include the following:

1. Wood casework.
2. Plastic laminate clad casework.
3. Countertops, including stonework counter tops.
4. Hardware, ironmongery, accessories and miscellaneous trim incorporated into joinery in accordance with Drawings.

B. "Rough Carpentry" for grounds, blocking, framing, furring, and other carpentry work that is not exposed to view is specified elsewhere.

C. Wood Doors are specified elsewhere.

QUALITY ASSURANCE

A. Manufacturer Qualifications: Firm experienced in successfully producing joinery and architectural woodwork similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in the Work.

B. AWI Quality Standard: Comply with applicable requirements of "Architectural Woodwork Quality Standard" published by the Architectural Woodwork Institute (AWI) except as otherwise indicated.

C. Hardware Coordination: Distribute copies of approved schedule for cabinet hardware to manufacturer of joinery and architectural woodwork; coordinate cabinet shop drawings and fabrication with hardware requirements.

D. Except for stonework, proprietary names used to designate colors or materials are not intended to imply that products named are required or to exclude products of other manufacturers.

PART 2 - PRODUCTS

MATERIALS

A. General: Provide materials of premier quality grades that comply with requirements of the relevant woodworking standard for each type of woodwork and, where the following products are part of woodwork, with requirements of the referenced product standards that apply to product characteristics indicated:

1. Hardboard.

2. Plastic Laminate Facing: BS 3794, Class 1, 1.5 mm thick.

3. Plywood: BS 1455; WBP bonding; Grade 1 where polished / varnished.

4. Blackboard (Latte): BS 3444; WBP bonding.

5. Face Veneers: Hard, durable and capable being finished to a smooth surface; free from knots, holes splits, stains, filling or any other defects.

6. Adhesives for Face Veneers: BS 1203.

WOOD TYPES

A. General: Provide first quality premier grade wood types where indicated on Drawings and as specified herein.

1. Softwood: Douglas Fir, Longleaf Pine, European Redwood, or other equal approved.

2. Pine: (where shown on Drawings) South American Parana Pine.

3. Hardwoods and Veneers:

a. Generally: Canadian Yellow Birch, Meranti, Zan, or other equal approved.
b. Teak: Burmese teak.
c. Mahogany: Honduran mahogany.

PART 3 - EXECUTION

INSTALLATION GENERALLY

A. Quality Standard: Install woodwork to meet or exceed AWI Section 1700 for same grade specified in Part 2 of this section for type of woodwork involved.

B. Install woodwork plumb, level, true, and straight with no distortions. Shim as required with concealed shims. Install to a tolerance of 6.25 mm in 2400 mm for plumb and level (including tops) and with no variations in flushness of adjoining surfaces.

C. Scribe and cut woodwork to fit adjoining work and refinish cut surfaces or repair damaged finish at cuts.

D. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure to grounds, stripping and blocking with countersunk, concealed fasteners and blind nailing as required for a complete installation. Except where prefinished matching fastener heads are required, use fine finishing nails for exposed nailing, countersunk and filled flush with woodwork and matching final finish where transparent finish is indicated.

E. Casework and Cabinets: Install without distortion so that doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete the installation of hardware and accessory items as indicated and required. Maintain veneer sequence matching (if any) of cabinets with transparent finish.

F. Tops: Anchor securely to base units and other support systems as indicated.

G. Complete the finishing work specified in this section to whatever extent not completed at shop or before installation of woodwork.

ADJUSTMENT AND CLEANING

A. Repair damaged and defective woodwork where possible to eliminate defects functionally and visually; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean woodwork on exposed and semi exposed surfaces. Touch up factory applied finishes restoring damaged or soiled areas.

PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to the Engineer that ensures that woodwork is undamaged at time of Taking-Over.

CHAPTER SEVEN

THERMAL AND MOISTURE PROTECTION

SHEET WATERPROOFING

PART 1 - GENERAL

SUMMARY

A. Extent of each type of sheet waterproofing work is indicated on Drawings.

B. Types of sheet waterproofing specified in this Section include the following:
   1. Polyethylene sheet membrane.
   2. SBS modified bituminous sheet waterproofing membrane.

QUALITY ASSURANCE

A. Installer: Perform sheet waterproofing membrane installations by skilled operations or specialist contractor experienced and regularly engaged in the type of work.

PART 2 – PRODUCTS

MATERIALS

A. General: Provide sheet-waterproofing materials recognized to be generic to the types indicated and complying with required performances. Other similar materials certified in writing to be equal to or better than specified in every significant respect may be used if acceptable to Engineer.

POLYETHYLENE SHEET MEMBRANE

A. Chlorinated polyethylene formed into uniform flexible sheets, minimum 40 mil. thickness. Manufacturers offering products which may be incorporated in the work include but are not limited to:

1. MONYACO International: Lebanon.

B. Applications:

1. Vapor Barrier: Under concrete slabs cast on ground or granular base at sub-grade elevations.

SBS MODIFIED BITUMINOUS SHEET WATERPROOFING MEMBRANE

A. Torch applied, self-adhering, sheet membrane of SBS (Styrene Butadiene Styrene) modified bitumen, reinforced with 160 - 200 g/m2 spun bonded, non-woven, polyester, formed into uniform flexible sheets of thickness appropriate for application intended, but not less than 4 mm thick.

1. Smooth surfaced.

B. Applications:

1. Basement Tanking: Membrane waterproofing to underside / outside surfaces of underground concrete slabs and walls enclosing basement structures.

2. Planter Linings: Membrane waterproofing to inside of concrete planters and the like, as indicated.

3. Unless otherwise specified or indicated provide protective coverings as recommended by the membrane manufacturer for application intended.

C. Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
1. Bitufa (Netherlands): 'Standard Plus', or approved equal.

MISCELLANEOUS MATERIALS

A. Adhesives: Provide types of adhesive compounds, tapes and the like as recommended by sheet manufacturer, for bonding to substrate, for waterproof sealing of seams in membrane, and for waterproof sealing of joints between membrane and flashings, adjoining surfaces and projections through membrane.

B. Primers: Provide type of concrete primer recommended by manufacturer of sheet material for applications required.

C. Coatings: Provide type of coating recommended by sheet manufacturer, for improvement of weathering resistance on exposed areas of membrane, including areas extended as flashing (if any). Provide black coating except as otherwise indicated.

D. Flashing Materials: Except as otherwise indicated, provide types of flexible sheet material for flashing as recommended by sheet manufacturer.

E. Protection Course: Unless otherwise indicated provide type recommended by sheet manufacturer, and acceptable to Engineer.

1. Available Manufacturers: Manufacturers offering products which may be incorporated into the work include but are not limited to:
   a. Cartonal (Lebanon) or approved equal.

PART 3 - EXECUTION

PREPARATION

A. Examine substrates, areas and conditions under which sheet membranes will be installed, for compliance with manufacturer's recommendations and installation requirements.

B. On concrete decks and walls, immediately before placement of waterproofing sheet, grind surface lightly with terrazzo grinder or similar device, to ensure removal of projections, which might penetrate sheet. Clean deck of loose material.

C. Apply primer to concrete (and masonry where applicable) surfaces at rate recommended by manufacturer of primary waterproofing materials. Prime only area, which will be covered by waterproof membrane in same working day; prime areas not covered by membrane within 24 hours.

INSTALLATION

A. Comply with manufacturer's instructions for handling and installation of sheet membrane materials.

B. Coordinate installation of waterproofing materials and associated work to provide complete system complying with combined recommendations of manufacturers and installers involved in work. Schedule installation to minimize period of exposure of sheet materials.

C. Extend sheet and flashings as shown and to provide complete membrane over area indicated to be waterproofed. Seal to projections through membrane and seal seams. Bond to vertical surfaces and also, where shown or recommended by manufacturer, bond to horizontal surfaces.

D. Polyethylene Sheet Vapor Barrier: Lay, lap edges, seal joints with adhesive type, protect and repair vapor barrier sheet membrane according to manufacturer's instructions.

E. SBS Modified Bituminous Sheet Waterproofing: Install sheet waterproofing membrane system according to manufacturer's instructions.

   1. Roll out sheets to minimize wrinkles and bubbles; prime base, fix cants and accessories.

   2. Torch applies to substrate; lap sides and ends and reinforce with multiple thickness at joints and angles; all in accordance with manufacturer's recommendations and instructions.

F. Install protection course of type indicated over completed membrane, complying with manufacturer's recommendations for both waterproofing sheet and protection course materials.

PERFORMANCE REQUIREMENTS

A. It is required that waterproof membranes are watertight and not deteriorate in excess of limitations published by manufacturer.

B. In-place Testing: Before completed membranes on horizontal surfaces are covered by protection course or other work, test for leaks with 50mm depth of water maintained for 24 hours. Repair any leaks revealed by examination of substructure and repeat test until no leakage is observed.

PROTECTION

A. Institute required procedures for protection of completed membrane during installation of work over membrane and throughout remainder of construction period. Do not allow traffic of any type on unprotected membrane.

SBS-MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 - GENERAL

SUMMARY

A. This Section includes the following:
   1. Single-ply, modified bituminous membrane roofing.
   2. Polystyrene board roof insulation.
   3. Precast concrete roof pavers.
   4. Precast terrazzo roof pavers.
   5. Aggregate ballast.

PERFORMANCE REQUIREMENTS

A. General: Install a watertight, modified bituminous membrane roofing and upstand base flashing system with compatible components that will not permit the passage of liquid water and will withstand wind loads, thermally induced movement, and exposure to weather without failure.

SUBMITTALS

A. Product Data: For each type of membrane and roofing product specified. Include data substantiating that materials comply with requirements.

B. Shop Drawings: Include plans, sections, thicknesses and details, including attachments to other work for the following:
   1. Upstand base flashings, cants, and membrane terminations.

C. Samples: For verification and approval of the following products:
   1. 300 x 300mm square of each modified bituminous membrane specified.
   2. 300 x 300mm square of polystyrene board roof insulation.
   3. Full-sized roof paver units, for each type, dimension, color and texture indicated or required.
   4. 2.5kg of aggregate ballast in color and gradation indicated.

D. Installer Certificates: Signed by roofing membrane manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install specified roofing membrane and is eligible to receive the roofing manufacturer's standard warranty.

E. Manufacturer Certificates: Signed by roofing membrane manufacturer certifying that the roofing system complies with requirements specified in the "Performance Requirements" Article. Upon request, submit evidence of complying with requirements.

F. Warranty: Sample copy of roofing manufacturer's standard warranty stating obligations, remedies, limitations, and exclusions of warranty.

DELIVERY, STORAGE, AND HANDLING

A. Store roofing materials in a dry, well-ventilated, weather tight location to ensure no significant moisture pickup and maintain at a temperature exceeding roofing membrane manufacturer's written instructions. Store rolls of sheet materials on end on pallets or other raised surfaces. Do not double-stack rolls.

   1. Handle and store roofing materials and place equipment in a manner to avoid significant or permanent damage to deck or structural supporting members.

B. Do not leave unused sheet materials on the roof overnight or when roofing work is not in progress unless protected from weather and moisture.

C. Deliver and store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing membrane manufacturer.

D. Protect roofing insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

PROJECT CONDITIONS

A. Weather Limitations: Proceed with roofing work only when existing and forecast weather conditions permit roofing to be installed according to manufacturers' written instructions and warranty requirements.

WARRANTY

A. General Warranty: The warranties specified in this Article shall not deprive the Employer of other rights the Employer may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Roofing Manufacturer's Standard Warranty: Submit a written warranty, without monetary limitation, signed by roofing membrane manufacturer agreeing to promptly repair leaks in the roof membrane and up stand base flashings resulting from defects in materials or workmanship for the following warranty period:

   1. Warranty Period: Five (5) years from date of completion of the whole of the Works.

PART 2 - PRODUCTS

MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. SBS-Modified Bituminous Sheet:
   a. Bitufa (Netherlands), 'Standard Plus', or approved equal.

SBS-MODIFIED BITUMINOUS SHEET

A. SBS-Modified Bituminous Sheet: SBS-modified bituminous sheet, smooth surfaced, dusted with fine parting agent on both sides; suitable for installation method specified; manufacturer's recommended thickness and weight for use and application intended, but not less than 4mm thick, and of reinforcing type as follows:

1. Use: Single ply membrane roofing and upstand base flashings.
2. Reinforcing: Woven or nonwoven polyester mat.

B. Physical Properties: Provide SBS-modified bituminous membrane material with a minimum mass of 4.5 kg/m2 and the following properties when tested according to ASTM D 5147:

1. Thickness: 4 mm, minimum.
2. Tensile Strength: 700 N/50mm in each direction.
3. Elongation at Maximum Load: 4.5 percent minimum in each direction.
4. Tear Strength: 100 N minimum.
5. Water Absorption: Less than 0.2 percent mass change.
6. Low-Temperature Flexibility: Pass at minus 20 deg.C.

AUXILIARY MEMBRANE MATERIALS

A. General: Furnish primers, bitumen adhesives, sealants, cants, fasteners, etc., and other auxiliary materials, as recommended by roofing membrane manufacturer for intended use and application, and compatible with SBS-modified bituminous membrane roofing.

PROTECTION SHEET

B. Protection Sheet: Woven or nonwoven polypropylene or polyester fabric mat, water permeable and resistant to UV degradation. Type and weight as recommended by roofing membrane manufacturer for use and application intended.

AGGREGATE BALLAST

C. Aggregate Ballast: Provide aggregate that will withstand weather exposure without significant deterioration and will not contribute to degradation of insulation or membrane, and of the following type and size:

1. Type: Smooth, washed, riverbed gravel or crushed stone acceptable to the Engineer.
2. Size: Ranging from 16 to 25 mm.

ROOF PAVERS

A. Roof Pavers: Factory-cast, square-edged units, specially manufactured for use as roof pavers and acceptable to the Engineer:

1. Precast Concrete:
   a. Size: 300 x 300 mm, unless otherwise indicated.
   b. Thickness: 30 mm, unless otherwise indicated.

2. Precast Terrazzo:
   a. Size: 300 x 300 mm, unless otherwise indicated.
   b. Thickness: 30 mm, unless otherwise indicated.

3. Paver Colors and Textures: To Engineer's approval.
4. Paver Supports: Manufacturer’s standard proprietary high-density neoprene or polyethylene paver support pads.

PART 3 - EXECUTION

EXAMINATION

A. Examine substrates, areas, and conditions under which roofing will be applied, for compliance with requirements.

B. Verify that roof openings and penetrations are in place and set and braced and that roof drains, if any, are properly clamped into position.

C. Verify that wood blocking, curbs, and nailers, if any, are securely anchored to roof deck at roof penetrations and terminations and match the thicknesses of insulation required.

D. Do not proceed with installation until after the minimum concrete curing period recommended by roofing membrane manufacturer.

E. Do not proceed with installation until unsatisfactory conditions have been corrected.

GENERAL INSTALLATION REQUIREMENTS

A. Install modified bituminous membrane roofing system according to roofing membrane manufacturer's written instructions and applicable recommendations.

   1. Clean substrate of dust, debris, and other substances detrimental to membrane roofing installation. Remove sharp projections.

B. Cant Strips: Install 45-degree cant strips at junctions of modified bituminous membrane roofing with vertical surfaces, or angle changes greater than 45 degrees.

C. Coordinate installing roofing system components so roofing membranes and insulation are not exposed to precipitation or left exposed at the end of the workday or when rain is forecast.

ROOF MEMBRANE INSTALLATION

A. General: Install modified bituminous membrane over area to receive roofing, according to manufacturer's written instructions. Extend modified bituminous membrane over and terminate beyond cants.

B. Modified Bituminous Membrane: Install single ply modified bituminous membrane starting at low point of roofing system.

   1. Application: Torch apply to substrate.

C. Laps: Accurately align sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids.

UPSTAND BASE FLASHING INSTALLATION

A. Install modified bituminous membrane upstand base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to roofing membrane manufacturer's written instructions and/or as indicated on Drawings.

1. Upstand base Flashing Application: Torch apply to substrate.

B. Unless otherwise indicated, extend upstand base flashing vertically, a minimum of 200 mm above roof membrane and 100 mm onto field of roof membrane.

C. Securely fasten modified bituminous membrane at top of upstand base flashing, and at terminations and perimeters of roofing.

1. Seal top termination of upstand base flashing as indicated.

PROTECTION SHEET INSTALLATION

A. Install protection sheet over modified bituminous membrane and/or board insulation as indicated, according to manufacturer's written instructions.

AGGREGATE BALLAST INSTALLATION

A. Deposit and spread ballast over protection sheet, and evenly to uniform thickness, taking care to avoid damage to bituminous roof membrane. Install ballast as soon as practicable after installing modified bituminous roof membrane, upstand base flashings and roof accessories.

1. Thickness: Minimum 50 mm layer.

ROOF PAVERS INSTALLATION

A. Install roof pavers over protection sheet, loose laid with well aligned joints, on paver support pads.

PROTECTING AND CLEANING

A. Protect modified bituminous membrane roofing and installed roofing system from damage and wear during remainder of construction period.

B. Correct deficiencies in or remove modified bituminous roofing that does not comply with requirements, repair substrates, reinstall roofing, and repair upstand base flashings to a condition free of damage and deterioration at time of Taking-Over and according to warranty requirements.

TILES ROOFING

Clay (Marseille butterfly type) or approved equal or similar to existing roofing tiles, on and including treated alum. Battens with single layer modified bituminous membrane and clay tile accessories, flashing and counter flashing as indicated or required at roof perimeters and abutments. Shop drawing required for Engineer's approval.

METAL ROOFING

Pitched roofing comprising: Stone enamel galvanized steel sheet, non-combustible, insulated sandwich panel roofing, on and including metal purlins; Single layer modified bituminous membrane with Metal panel roofing accessories, flashing and counter flashing as required at roof perimeters and abutments. Shop drawing required for Engineer's approval.

ROOF DRAINAGE

Aluminum sheet, eaves box gutter as indicated; on and including bedding laid to falls; include ends, joints, sealants and outlets. Shop drawing required for Engineer's approval.

ROOF ACCESSORIES

GENERAL

Proprietary roof accessory units, factory fabricated and assembled; installed complete as detailed and necessarily required; including sub frames and frames, kerbs, upstands and supports; anchorages; fixings and fasteners; flashings, counter-flashings and sealants; hardware, devices, accessories, trim, finishes and finishing; and all other related ancillaries as indicated or required.

SKY DOME

The characteristic of sky dome is according to BS or DTU or any equivalent approved regulations, it must be permanently closed & easy open in case of fire from the lower level by an electronic system or hydraulic or any system approved by the engineer.

FLASHING AND SHEET METAL

PART 1 – GENERAL

SUMMARY

A. The extent of flashing and sheet metal is indicated on Drawings and may include the following:

1. Metal counter flashing and base flashing (if any).
2. Metal wall flashing and expansion joints.
3. Exposed metal trim/fascia units.
4. Miscellaneous sheet metal accessories.
5. Elastic roof/wall expansion joint systems.

B. Roofing accessories installed integral with roofing are specified in "Membrane Roofing".

PROJECT CONDITIONS

A. Coordinate work of this section with interfacing and adjoining work for proper sequencing of each installation. Ensure best possible weather resistance and durability of work and protection of materials and finishes.

PART 2 - PRODUCTS

SHEET METAL FLASHING AND TRIM MATERIALS

A. Sheet Aluminum: Designation NS3, temper grade 0; BS 1470; flashings and cappings 22 SWg.

MISCELLANEOUS MATERIALS

A. Miscellaneous Materials and Accessories:

1. Fasteners: Same metal as flashing/sheet metal or other non- corrosive metal as recommended by sheet manufacturer. Match finish of exposed heads with material being fastened.
2. Bituminous Coating: Solvent-type bituminous mastic, nominally free of sulfur, compounded for 0.4 mm dry film thickness per coat.
3. Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, nondrying, nonmigrating sealant.
4. Elastomeric Sealant: Generic type recommended by manufacturer of metal and fabricator of components being sealed.
5. Epoxy Seam Sealer: 2-part noncorrosive metal seam cementing compound, recommended by metal manufacturer for exterior/interior nonmoving joints including riveted joints.
6. Adhesives: Type recommended by flashing sheet manufacturer for waterproof/weather-resistant seaming and adhesive application of flashing sheet.
7. Paper Slip Sheet: Sized building paper.
8. Polyethylene Underlayment: Carbonated polyethylene film resistant to decay when tested in accordance with ASTM E 154.
9. Reglets: Metal or plastic units of type and profile indicated, compatible with flashing indicated, noncorrosive.
10. Metal Accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of work, matching or compatible with material being installed, noncorrosive, size and gage required for performance.
11. Elastic Flashing Filler: Closed-cell polyethylene or other soft closed cell material recommended by elastic flashing manufacturer as filler under flashing loops to ensure movement with minimum stress on flashing sheet.

PART 3 - EXECUTION

INSTALLATION REQUIREMENTS

A. Underlayment: Where or aluminum is to be installed directly on cementations or wood substrates, install a paper slip sheet of red rosin paper and a course of polyethylene underlayment.

B. Nail flanges of expansion joint units to curb nailers, at maximum spacing of 150mm centers Fabricate seams at joints between units with minimum 75mm overlap, to form a continuous, waterproof system.

CLEANING AND PROTECTION

A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.

B. Protection: Upon completion of flashing and sheet metal work institute appropriate procedures for surveillance and protection of flashings and sheet metal work during construction to ensure that work will be without damage or deterioration other than natural weathering at time of final hand over.

JOINT SEALERS

PART 1 - GENERAL

SUMMARY

A. The extent of joint sealers and fillers is indicated or otherwise implied on Drawings and/or by the provisions of this Section.

SYSTEM PERFORMANCES

A. Provide joint sealers that have by long term production and installation been proved to establish and maintain watertight and airtight continuous seals on a permanent basis.

QUALITY ASSURANCE

A. Single Source Responsibility for Joint Sealer Materials: Obtain joint sealer materials from a single manufacturer for each type of product required.

B. Preconstruction Compatibility and Adhesion Testing: Submit samples of all materials that will contact or affect joint sealers to joint sealer manufacturers for compatibility and adhesion testing, as indicated below:

1. Use test methods standard with manufacturer to determine if priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealers to joint substrates.

    a. Perform tests under normal environmental conditions that will exist during actual installation.

2. Submit not less than 9 pieces of each type of material, including joint substrates, shims, joint sealant backings, secondary seals, and miscellaneous materials.

3. Schedule sufficient time for testing and analysis of results to prevent delay in the progress of the Work.

4. Investigate materials failing compatibility or adhesion tests and obtain joint sealer manufacturer's written recommendations for corrective measures, including use of specially formulated primers.

C. Product Testing: Provide comprehensive test data for each type of joint sealer based on tests conducted by a qualified independent testing laboratory on current product formulations within a 24-month period preceding date of Contractor's submittal of test results to Engineer.

1. Test elastomeric sealants for compliance with requirements specified by reference to ASTM C 920. Include test results for hardness, stain resistance, adhesion and cohesion under cyclic movement (per ASTM C 719), low-temperature flexibility, modulus of elasticity at 100 percent strain, effects of heat aging, and effects of accelerated weathering.

2. For all exterior sealant systems, furnish test results performed on joint sealers after they have cured 1 year.

D. Preconstruction Field Testing: Prior to installation of joint sealants, field-test their adhesion to joint substrates as follows:

1. Locate test joints where indicated or, if not indicated, as directed by Engineer.

2. Conduct field tests for each application indicated below:
   a. Each type of elastomeric sealant and joint substrate indicated.
   b. Each type of non-elastomeric sealant and joint substrate indicated.

3. Arrange for tests to take place in presence of Engineer.

4. Test Method: Test joint sealers by hand pull method described below:

   a. Install joint sealants in 1500mm joint lengths using same materials and methods for joint preparation and joint sealant installation required for completed Work. Allow sealants to cure fully before testing.
   b. Make knife cuts as follows: A horizontal cut from one side of joint to the other followed by 2 vertical cuts approximately 50mm long at side of joint and meeting horizontal cut at top of 50mm cuts. Place a mark 25 mm from top of 50 mm piece.
   c. Use fingers to grasp 50mm piece of sealant just above 25mm mark; pull firmly down at a 90 degree angle or more while holding a ruler alongside of sealant. Pull sealant out of joint to the distance recommended by sealant manufacturer for testing adhesive capability, but not less than that equaling specified maximum movement capability in extension; hold this position for 10 seconds.

5. Report whether or not sealant in joint connected to pull out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate.

6. Evaluation of Field Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants which fail to adhere to joint substrates during testing.

E. Field-Constructed Mock-Ups. Prior to installation of joint sealers, apply elastomeric sealants to the following selected building joints as indicated below for further verification of colors selected from sample submittals and to represent completed work for qualities of appearance, materials, and application:

1. Joints in field-constructed mock-ups of assemblies specified in other sections, which are indicated to receive elastomeric joint sealants specified in this section.

2. Retain mock-ups during construction as standard for judging completed construction.

PART 2 - PRODUCTS

MATERIALS, GENERAL

A. Compatibility: Provide joint sealers, joint fillers and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

B. Colors: Provide color of exposed joint sealers indicated or, if not otherwise indicated, as selected by Engineer from manufacturer's standard colors.

ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealant Standard: Select and provide manufacturer's standard chemically curing, elastomeric sealants of base polymer which complies with ASTM C 920 requirements, including those referenced for Type, Grade, Class, and Uses, and appropriate for purpose, condition and application of use.

MISCELLANEOUS JOINT SEALANTS

A. Acoustical Sealant for Concealed Joints: Manufacturer's standard, nondrying, no hardening, non-skinning, nonstinging, gunnable, synthetic rubber sealant recommended for sealing interior concealed joints to reduce transmission of airborne sound.

COMPRESSION SEALS

A. Preformed Foam Sealant: Manufacturer's standard preformed, pre-compressed, impregnated open-cell foam sealant manufactured from high-density urethane foam impregnated with a nondrying, water repellent agent; factory-produced in pre-compressed sizes and in roll or stick form to fit joint widths indicated and to develop a watertight and airtight seal when compressed to the degree specified by manufacturer; and complying with the following requirements:

1. Properties: Permanently elastic, mildew-resistant, non-migratory, non-staining, compatible with joint substrates and other joint sealers.
2. Impregnating Agent: Manufacturer's standard.
3. Density: manufacturer's standard.
4. Backing: Pressure sensitive adhesive, factory applied to one side, with protective wrapping.
5. Backing: Coated on one face with release agent serving as bond breaker for primary joint sealant.

MISCELLANEOUS MATERIALS

A. Primer: Provide type recommended by joint sealer manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint sealer- substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Provide non-staining, chemical cleaners of type which are acceptable to manufacturers of sealants and sealant backing materials, which are not harmful to substrates and adjacent nonporous materials, and which do not leave oily residues or otherwise have a detrimental effect on sealant adhesion or in-service performance.

C. Masking Tape: Provide non-staining, nonabsorbent type compatible with joint sealants and to surfaces adjacent to joints.

D. Accessory Materials for Fire-Stopping Sealants: Provide forming, joint fillers, packing and other accessory materials required for installation of fire stopping sealants as applicable to installation conditions indicated.

PART 3 - EXECUTION

EXAMINATION

A. Examine joints indicated to receive joint sealers, for compliance with requirements for joint configuration, installation tolerances and other conditions affecting joint sealer performance. Do not proceed with installation of joint sealers until unsatisfactory conditions have been corrected.

PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealers to comply with recommendations of joint sealer manufacturers.

INSTALLATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturers' printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.

B. Elastomeric Sealant Installation Standard: Comply with recommendations of ASTM C 962 for use of joint sealants as applicable to materials, applications and conditions indicated.

C. Installation of Sealant Backings: Install sealant backings to comply with the following requirements:

1. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths which allow optimum sealant movement capability.
   a. Do not leave gaps between ends of joint fillers.
   b. Do not stretch, twist, puncture, or tear joint fillers.
   c. Remove absorbent joint fillers, which have become wet prior to sealant application and replace with dry material.

2. Install bond breaker tape between sealants and joint fillers, compression seals, or back of joints where adhesion of sealant to surfaces at back of joints would result in sealant failure.

3. Install compressible seals serving as sealant backings to comply with requirements indicated above for joint fillers.

D. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths which allow optimum sealant movement capability.

E. Tooling of Non-sag Sealants: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents, which discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

1. Provide concave joint configuration per Figure 6A in ASTM C 962, unless otherwise indicated or required.

2. Provide flush joint configuration per Figure 6B in ASTM C 962, where indicated or required.
   a. Use masking tape to protect adjacent surfaces of recessed tooled Joints.

3. Provide Recessed joint configuration per Figure 6C in ASTM C 962, of recess depth and at locations indicated or required.

F. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials to fill openings around mechanical and electrical services penetrating floors and walls to provide fire-stops with fire resistance ratings indicated for floor or wall assembly in which penetration occurs.

CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

PROTECTION

A. Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of substantial completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work.

BITUMINOUS TACK COAT

SCOPE

This item shall consist of preparing and treating a bituminous or concrete surface with bituminous material, in order to ensure a bond between this surface and the overlying course, in accordance with this specification and to the dimensions as shown on the drawings or as directed by the Engineer.

MATERIAL

The bituminous material shall be either cutback Asphalt or emulsified Asphalt and shall conform to the following requirements:

Type and Grade	Specification	Application Temperature
Emulsified Asphalt		
SS-1, SS-1h	ASTM D 977	25º - 55 °C
CSS-1, CSS-1h	ASTM D 2397	25º - 55 °C
Cutback Asphalt		
RC - 70 (RC-1)	ASTM D 2028	50º - 70 °C

The type, grade, controlling specification, and application temperature of bituminous material to be used shall be specified by the Engineer.

WEATHER LIMITATIONS

The tack coat shall be applied only when the existing surface is dry and the atmospheric temperature is above 15 ºC. The temperature requirements may be waived, but only when so directed by the Engineer.

EQUIPMENT

The equipment used by the Contractor shall include a power broom and/or blower, a distributor and equipment for heating bituminous material. The distributor shall be designed, equipped, maintained, and operated so that bituminous material at even heat may be applied uniformly on variable widths of surface at the specified rate. The allowable variation from the specified rate shall not exceed 10%. Distributor equipment shall include a tachometer, pressure gauges, volume-measuring devices or a calibrated tank, and a thermometer for measuring temperatures of tank contents. The distributor shall be self-powered and shall be equipped with a power unit for the pump and full circulation spray bars adjustable laterally and vertically.

APPLICATION AND QUANTITIES OF BITUMINOUS MATERIAL

A. Immediately before applying the tack coat, the full width of surface to be treated shall be swept with a power broom and/or airblast, supplemented by hand brooms, if necessary to remove all loose dirt and other objectionable material.

B. After removing the dust and all other objectionable material, and prior to the application of the bituminous material, an inspection shall be made of the course to determine its fitness to receive the bituminous material. That portion of the surface of the course proposed for immediate treatment must be dry and in satisfactory condition.

C. Emulsified asphalt shall be diluted by the addition of water when directed by the Engineer and shall be applied a sufficient time in advance of the paver to ensure that all water has evaporated before any of the overlying mixture is placed on the tacked surface.

D. The bituminous material including vehicle or solvent shall be uniformly applied with a bituminous distributor at the rate of 0.15 to 0.65 kg (bitumen residue) per square meter depending on the type of tack coat used and on the condition of the existing surface.

E. In order to determine the necessary exact amount necessary, the Engineer will order trial areas.

F. The type of bituminous material and application rate shall be approved by the Engineer prior to application.

G. Following the application, the tack coat shall be allowed to cure without being disturbed for such period of time as may be necessary until it is in a suitable tacking condition to receive the superimposed bituminous course.

H. This period shall be determined by the Engineer. The surface shall then be maintained by the Contractor until the next course has been placed. Suitable precautions shall be taken by the Contractor to protect the surface against damage during this interval.

I. Blotting shall not be applied to tack coats.

BITUMINOUS MATERIAL CONTRACTOR'S RESPONSIBILITY

A. Samples of the bituminous material that the Contractor proposes to use, together with a statement as to its source and character, must be submitted and approval obtained before use of such material begins. The Contractor shall require the manufacturer or producer of the bituminous material to furnish material subject to this and all other pertinent requirements of the Contract. Only satisfactory materials, so demonstrated by Laboratory and service tests, shall be acceptable.

B. The Contractor shall furnish the vendor's certified test reports for each carload, or equivalent, of bituminous material shipped to the project. The report shall be delivered to the Engineer before permission is granted for use of the material.

C. The furnishing of the vendor's certified test report for the bituminous material shall not be interpreted as a basis for final acceptance. All such test reports shall be subject to verification by testing samples of materials received for use on the project.

D. The Manufacturer's Certificate of Guarantee as required in the General Conditions shall also be submitted.

E. The Engineer may, if he deems necessary, require trial sections to be constructed prior to the commencement of on site tack coat applications. The Contractor shall construct trial sections using varying application rates of bitumen, as selected by the Engineer. Each trial section shall be 2 lanes wide by 50 m long, at approved locations on or close to the Site.

Each trial section shall be constructed using the same materials, mixing and spraying equipment, and construction procedures, proposed for use in the Works.

The objectives of these trials shall be to determine the adequacy of the Contractor's equipment and the most suitable application rates for cutback bitumen tack coats.

The Contractor shall not proceed with any site coat applications until the methods and procedures established in the trials have been approved.

MEASUREMENT AND PAYMENT

A. General

The amount of bituminous tack coat to be paid for shall be the designated net area per square meter tacked at the appropriate rate specified by the Engineer

This rate shall be full compensation for furnishing all materials, for all preparation, delivering and applying the materials and for all labor, equipment, tools and incidentals necessary to complete the item.

B.Pay Items	**Unit of Measurement**
Bituminous Tack Coat	Square meter(m^2)

CHAPTER EIGHT

DOORS AND WINDOWS

METAL DOOR AND FRAMES

PART 1 - GENERAL

DESCRIPTION

A. General

1. Furnish all labor, materials, tools, equipment, and services for metal doors and frame, in accord with provisions of Contract Documents.
2. Completely coordinate with work of other trades.
3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.
4. See Division 1 for General Requirements.

B. Related work specified elsewhere:

1. Finish hardware:
2. Wood doors:
3. Glass and glazing:

Submittals

A. Product Data:

1. Manufacturer's technical information including specifications and catalog cuts for all products specified herein.

B. Shop Drawings:

1. Show details of each frame type and elevations of each door type. Show conditions at openings and details of construction.
2. Show gages, location of reinforcements, anchorage and accessory items.
3. Submit schedule of doors and frames. Use same scheduling system as that shown in the Door Schedule.

PART 2 - PRODUCTS

MATERIALS - GENERAL

A. Steel sheet and strip: Commercial quality carbon steel, ASTM A568.

B. Galvanized steel sheets: ASTM A525, G90 coating, phosphatized.

C. Supports and anchors: Not less than 1.5 mm (16 ga) sheet steel. Galvanize items to be built into exterior walls after fabrication, ASTM A153, Class B.

D. Inserts, bolts and fasteners: Manufacturer's standard units. Galvanize items to be built into exterior walls ASTM A153, Class C or D as applicable.

E. Primer: Suitable for Galvanized metal sheets enamel or paint, air-drying or baked, suitable as base for specified finish paints.

F. Galvanized repair paint: Mil. Spec. DOD-P-21035

G. Lead sheet: ASTM B29, free from imperfection affecting performance, thickness as indicated.

Doors and Frames

A. Doors, Timber or Melamine.

B. Vision panels:
   1. Fixed, integral stops on exterior face, screw less snap-in stops or stops secured with countersunk Phillips head machine screws on interior face.
   2. Glass: Section 8.4.

C. Frames, Timber or Melamine, types as indicated.
   1. Split-type frames are not acceptable.
   2. Conceal all fastenings.
   3. All joints: Tightly butted and fully welded.
   4. All frames should be painted from the back & bottom 15 cm with asphalt.

FABRICATION

A. General:

1. Fabricate rigid, neat in appearance and free from defects.
2. Form to indicated sizes and profiles.
3. Fit and assemble in shop, where practical.
4. Mark work that cannot be fully assembled in shop, to assure proper assembly at site.

B. Prepare for finish hardware, in accord with hardware schedule, templates provided by hardware supplier, and ANSI A115 series "Specifications for Door and Frame Preparation ".

1. Locate finish hardware in accord with SDI 100.
2. Locate patient latches in accord with manufacturer's recommendations.

C. Clean off mill scale and foreign materials, touch-up damaged steel and galvanized surfaces.

D. Shop prime.

PART 3 - EXECUTION

INSPECTION

A. Examine structure, substrates, and conditions under which work in to be installed for conditions detrimental to correct and timely completion.

B. Installation constitutes acceptance of responsibility for performance.

INSTALLATION

A. Place frames prior to construction of enclosing walls and ceilings.

B. Separate structural lintels are to be installed over all doorframes in masonry. Do not use doorframes as lintels to carry masonry.

C. Plumb, align, and brace securely until permanently anchored.

D. After completion of walls, remove temporary braces and spreaders.

E. Install minimum of 3 anchors of type appropriate to wall construction per jamb. Minimum acceptable anchors: 1.5 mm (16 ga), 25 mm (1 IN) wide corrugated steel.

F. Provide removable spreaders at bottom of frame.

G. Coordinate building-in of anchors and frame grouting with other trades.

H. Grout all frames.

I. Leave work complete and in proper operating condition.

G. Remove defective work and provide new acceptable products.

WOOD DOORS

PART 1 - GENERAL

DESCRIPTION OF WORK

A. Extent and location of each type of wood door is shown on Drawings and in schedules.

B. Types of doors required include the following:

1. Flush wood doors with plastic laminate faces.
2. Melamine doors and partitions.

C. Shop finishing of wood doors is included in this section.

D. Factory-preparation for door hardware (pre-machining) for wood doors, melamine doors and partitions is included in this section.

E. The following related work is specified elsewhere:

1. Door hardware installation.
2. Painting.

APPLICABLE CODES AND STANDARDS

ANSI/NWMA	I.S.l Industry standards for wood flush doors.
AWI	Quality Standard; Section 1300Architectural woodwork quality standards
BS 1186	Quality of timber and workmanship
BS 4787: part 1 Dimensions of wood door sets.	
BS 5359	Methods of testing doors

PART 2 - PRODUCTS

MATERIALS AND COMPONENTS - GENERAL

A. General: Provide wood doors, melamine doors and partitions complying with applicable requirements for kinds and types of doors indicated on drawings and as scheduled and specified.

B. Face Panels: Manufacturer's standard 2 or 3-ply face panels, unless otherwise indicated.

C. Exposed Surfaces: Provide decorative picture on of the shown on drawings or scheduled and as further specified and approved by the Engineer. The picture should be fixed by glue on boards on every door to be used printed on vinyl sheets 3 mm thick.

GENERAL FABRICATION REQUIREMENT

A. Transom and Side Panels: Wherever transom panels or side panels of wood are shown in same framing systems as wood doors, provide panels which match quality and appearance of associated wood doors, unless otherwise indicated. Fabricate matching panels with same construction, exposed surfaces and finish as specified for associated doors or by adding a picture on each door.

B. Openings: Cut and trim openings through doors and panels as shown. Comply with applicable requirements for kind(s) of doors required.

1. Openings: Factory cut openings. Trim openings with solid wood edgings and moldings as indicated or required.
2. Factory installs vision panel glass in prepared openings.

FLUSH DOORS: PLASTIC LAMINATE FACED

A. Typical Standard Doors:

1. Facing: Plastic laminate, premium grade complying with BS 3794; 1.5mm thickness.
   a. Color, Texture and Pattern: as indicated or as selected by the Engineer from manufacturer's standard range with picture on.

2. Core: Precision planed softwood blackboard, butt-jointed and glued edge to edge to form a solid laminated construction.

3. Edge: exposed hardwood framed stiles, top and bottom rails; tongued and grooved to core.

4. Vision Panels: 6m thick glass as detailed.

ADHESIVE

A. Adhesive for all interior doors shall be of MR grade.

SHOP FINISH

A. Prefinished wood doors requiring transparent finish at factory or finish shop.

B. Doors requiring paint finish shall be sandpapered smooth, filled and primed at factory, ready for site painting.

C. Comply with recommendations of Applicable Codes and Standards for factory finishing of doors, including final sanding immediately before application of finishing materials.

1. Provide finishes of type indicated or agreed with the Engineer, to match samples held by the Engineer.

PRE-FITTING AND PREPARATION FOR HARDWARE

A. Pre-machine wood doors at factory.

B. Machine doors for hardware requiring cutting of doors.

PART 3 - EXECUTION

INSPECTION

A. Examine door frames and verify that frames are correct size and type and have been installed as required for proper hanging of corresponding doors. Do not proceed with installation until unsatisfactory conditions have been corrected.

INSTALLATION

A. Condition doors to average prevailing humidity in installation area prior to hanging.

B. Hardware: For installation refer to Door Hardware (Ironmongery) section of these specifications.

C. Manufacturer's Instructions: Install wood doors in accordance with manufacturer's instructions and as indicated and required.

D. Shop-Finished Doors: Restore finish on edges of shop finished doors before installation, if fitting or machining is required at the job site.

ADJUST AND CLEAN

A. Final Check:

1. Replace doors damaged during installation or which are warped, bowed or otherwise unacceptable.
2. Rehang or replace doors, which do not swing freely or operate smoothly and satisfactorily.

B. Protection: Provide protection and maintain conditions in a manner acceptable to the Engineer that will ensure doors and door hardware, are undamaged at time of Taking Over.

ALUMINUM DOORS AND WINDOWS

PART 1 - GENERAL

SUMMARY

A. Extent of aluminum doors and windows is indicated on Drawings and schedules.

B. Types required for the project include:
1. Exterior entrance doors and screens.
2. Interior doors and screens.
3. Exterior and interior windows.
4. Louvers.

C. Glass and glazing is specified elsewhere.

D. Lock cylinders are specified in the Door Hardware (Ironmongery) of the specification. Cost is included within the cost of each item.

SYSTEM DESCRIPTION

A. Performance Requirements: Provide aluminum assemblies that have been designed and fabricated to comply with the following specified performance characteristics. Compliance may be demonstrated by testing manufacturer's corresponding stock systems according to methods indicated.

B. Thermal Movement: Provide exterior systems capable of withstanding thermal movements resulting from an ambient temperature range of 5 deg C. to external maximum in direct sunlight of 70 deg. C.

C. Wind Loading: Provide assemblies capable of withstanding a uniform test pressure of 0.96 kPa (20 psf) inward and 0.96 kPa (20psf) outward when tested in accordance with ASTM E 330.

D. Exterior Entrances Transmission Characteristics: Provide entrance doors with jamb and head frames that comply with requirements indicated for transmission characteristics.

1. Air Leakage: Provide doors with an air infiltration rate per linear foot of perimeter crack, of not more than 0.0025 m3/s/m2 (0.50 CFM) for single doors and 0.005 m3/s/m2 (1.0 CFM) for pairs of doors when tested in accordance with ASTM E 283 at pressure differential of 75 Pa (1.567 psf).

E. Exterior Windows (and internal windows where applicable): Except as otherwise indicated, comply with air infiltration tests, water resistance tests, and applicable load tests, specified in ANSI/AAMA 302.9 for type and classification of window units required in each case; or, comply with applicable British Standards, i.e. BS 4873, 4315, Part 1.

F. Applicable Codes and Standards:
ASTM E 330 Structural Performance
ASTM E 331 Water Penetration
BS 1470 Aluminum Plate Sheet and Strip
BS 1474 Aluminum Bars, Extrusions
BS 4315 Methods of Tests for Resistance to Air and Water Penetration

SUBMITTALS

A. Product Data: Submit manufacturer's product specifications, technical data, standard details, and installation recommendations for each type of product required. Include the following information:

1. Fabrication methods.
2. Finishing.
3. Hardware.
4. Accessories.

B. Shop Drawings: submit shop drawings for fabrication and installation of Aluminum doors and windows, including the followings:

1. Elevations.
2. Details section of typical composite members.
3. Hardware, mounting heights.
4. Anchorages and reinforcements.
5. Expansion provisions.
6. Glazing details.

C. Samples: submit pairs of samples of each type and color of Aluminum finish, on 300mm long sections of extrusions or formed shapes and on 150mm square sheets. Where color or texture variations are anticipated, include 2 or more units in each set of samples indicating extreme limits of variations.

D. Certification: Provide certified test results showing that systems have been tested by a testing laboratory or agency acceptable to the Engineer, and comply with specified performance characteristics.

QUALITY ASSURANCE

A. Manufacturer's Qualifications: Unless otherwise acceptable to the Engineer provide doors and windows produced by a single manufacturer with not less than 5 years successful experience in the fabrication of assemblies of the type and quality required.

B. Design Criteria: Drawings indicate sizes, spacing of members, profiles and dimensional requirements of doors and windows. Minor deviations will be accepted in order to utilize manufacturer's standard products when, in the Engineer's sole judgment; such deviations do not materially detract from the design concept or intended performances.

PROJECT CONDITIONS

A. Field Measurements: Check openings by field measurement before fabrication to ensure proper fitting of work; show measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay in the work. Where necessary, proceed with fabrication without field measurements, and coordinate fabrication tolerances to ensure proper fit.

PART 2 - PRODUCTS

MANUFACTURERS

A. Available Manufacturers: subject to compliance with requirements, manufacturers offering products which may be incorporated in the work of a good factory.

MATERIALS

A. Aluminum Members: Provide alloy and temper recommended by the manufacturer for strength, corrosion resistance, and application of required finish; comply with ASTM B 221; BS 1474 for extrusions and ASTM B 209; BS 1470 for sheet or plate.

B. Fasteners: Provide fasteners of Aluminum or non-magnetic stainless steel (316) and fully compatible with Aluminum components, hardware, anchors and other components.

   1. Reinforcement: Where fasteners screw-anchor into Aluminum less than 3mm thick, reinforce the interior with Aluminum or non-magnetic stainless steel to receive screw threads, or provide standard non corrosive pressed-in splined grommet nuts.

   2. Exposed Fasteners: Use of exposed fasteners will not be acceptable unless specifically approved by the Engineer. For the application of hardware and subject to approval by the Engineer, use fasteners that match the finish of member or hardware being fastened.
      a. Provide Phillips flat-head machine screws for exposed fasteners.

C. Brackets and Reinforcements: Where feasible, provide high - strength aluminum brackets and reinforcements; otherwise provide non-magnetic stainless steel or hot-dip galvanized steel complying with ASTM A 386; BS 729.

D. Concrete/Masonry Inserts: Provide concrete and masonry inserts fabricated from cast-iron, malleable iron, or hot-dip galvanized steel complying with ASTM A 386; BS 729.

E. Compression Weather-stripping: Provide the manufacturer's standard replaceable compressible weather-stripping gaskets of molded neoprene complying with ASTM D 2000 or molded PVC complying with ASTM D 2287.

F. Sliding Weather-stripping: Provide the manufacturer's standard replaceable weather-stripping of wool, polypropylene, or nylon woven pile, with nylon fabric or aluminum strip backing, complying with AAMA 701.2.

G. Glass and Glazing Materials: Comply with requirements of Glass and Glazing section of the specifications.

COMPONENTS

A. Aluminum Door, Window and Louver Frames: Fabricate from manufacturer's standard tubular and channel frame assemblies, with welded or mechanical joints in accordance with manufacturer's standards; reinforce as necessary to support required loads. Provide and incorporate all Aluminum components, accessories, and anchorages as indicated and required.

   1. Design: Provide doors and windows of thickness and design indicated.
   2. Glazing: Fabricate doors and windows to facilitate replacement of glass or panels, without disassembly of frames. Provide Snap-On extruded aluminum glazing stops, with exterior stops anchored for non-removal, or heat-resisting PVC glazing sections of a type approved by the Engineer.

B. Glass: Provide manufacturer's standard glass of the type and thickness indicated on drawings, or otherwise approved by the Engineer.

HARDWARE

A. General: Refer to Door Hardware section of the specification for hardware items other than those indicated to be provided by the aluminum entrance manufacturer.

B. Provide manufacturer's heavy-duty hardware units as indicated, scheduled, or required for operation of each door, of sizes, number, and type recommended by manufacturer and approved by the Engineer, for service required, finished to match door.

   1. Keyed Cylinders: Provide mortise type, 5-pin tumbler, outside cylinder units with cast aluminum face;

      a. Co-ordinate and comply with master keying requirements specified in Door Hardware section of the specification.

   2. Exterior Entrance Thresholds: Provide extruded aluminum threshold or size and design indicated in mill finish, complete with anchors and clips, coordinated with pivots and floor-concealed closers.

FABRICATION

A. General: Sizes of door, frame and window units, and profile requirements, are indicated on drawings. Variable dimensions are indicated, with maximum and minimum dimensions required to achieve design requirements and coordination with other work.

B. Prefabrication: Before shipment to the project site, complete fabrication, assembly, finishing, hardware application, and other work to the greatest extent possible. Disassemble components only as necessary for shipment and installation.

   1. Preglaze door, and window units to greatest extent possible.
   2. Do not drill and tap for surface-mounted hardware items until time of installation at project site.
   3. Perform fabrication operations, including cutting, fitting, forming, drilling and grinding of metal work to prevent damage to exposed finish surfaces. For hardware, perform these operations prior to application of finishes.

C. Welding: Grind exposed welds smooth and restore mechanical finish.

D. Reinforcing: Install reinforcing as required for hardware and necessary for performance requirements, sag resistance and rigidity.

E. Dissimilar Metals: Separate dissimilar metals with bituminous paint, or other separator that will prevent corrosion.

F. Continuity: Maintain accurate relation of planes and angles, with hairline fit of contacting members.
   1. Uniformity of Finish: Abutting extruded aluminum members shall not have an integral color or texture variation greater than half the range indicated in the sample pair submittal.

G. Fasteners: Conceal fasteners.

H. Weather-stripping: For exterior doors and windows, provide compression weather-stripping against fixed stops; at other edges, provide sliding weather-stripping retained in adjustable strip mortised into door or window edge.

FINISHES

A. General: Refer to drawings/schedules for type of finish required.

B. Natural Anodized Finish: Provide non-specular as fabricated mechanical finish; chemical etch, medium matte; minimum thickness 0.025 mm clear anodic coating.

   1. Provide natural anodized finish for flush aluminum unless otherwise indicated.

PART 3 - EXECUTION

INSTALLATION

A. Comply with manufacturer's instructions and recommendations for installation.

ADJUSTING

A. Adjust operating hardware to function properly, for smooth operation without binding, and for weather tight closure.

CLEANING

A. Clean the completed system, inside and out, promptly after installation, exercising care to avoid damage to coatings.

B. Clean glass surfaces after installation. Remove excess glazing and sealant compounds, dirt and other substances from aluminum surfaces.

PROTECTION

A. Institute protective measures required throughout the remainder of the construction period to ensure that aluminum doors, screens and windows will be without damage or deterioration, other than normal weathering, at time of Taking-Over.

GLASS & GLAZING

GENERAL

Glass and glazing shall be provided as specified and as shown, including entrances, curtain wall, windows, spandrels, skylights, glazed doors, transoms, sidelights, glazed partitions and mirrors.

DEFINITIONS

Manufacturer as used in this section to refer to a firm that produces primary glass or fabricated glass as defined in the referenced glazing standard.

A) **Deterioration of Insulating Glass:**

Failure of the hermetic seal under normal use due to causes other than glass breakage and improper practices for maintaining, and cleaning insulating glass. Evidence of failure is the obstruction of vision by dust, moisture, or film on the interior surfaces of glass. Improper practices for maintaining and cleaning glass do not comply with the manufacturer's directions.

SYSTEM PERFORMANCE REQUIREMENTS

A) **General**

Glazing systems that are produced, fabricated, and installed shall be provided to withstand normal thermal movement, wind loading, and impact loading (where applicable), without failure including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; and other defects in construction.

B) **Glass Design**

Glass thicknesses indicated on the drawings and herein are the minimum thicknesses required. Contractor shall confirm glass thicknesses by analyzing project loads, and in-service conditions. Provide glass lites for the various size openings in the thicknesses and strengths (annealed or heat-treated or tempered) to meet or exceed the following criteria:

- Minimum glass thicknesses for exterior conditions shall be determined utilizing the structural performance criteria and the test methods of ASTM E997 and E998. Minimum thickness shall be determined using the most stringent of these requirements.
- Minimum glass thicknesses of lites, whether composed of annealed or heat-treated or tempered glass, are selected so the worst- case probability of failure does not exceed the following:

a) 8 lites per 1000 for lites set vertically or not over 15 degrees off vertical and under wind action. Determine minimum thickness of monolithic annealed glass according to ASTM E1300. For other than monolithic annealed glass, determine thickness per glass manufacturer's standard method of analysis including applying adjustment factors to ASTM E 1300 based on type of glass.

b) 1 lite per 1000 for lites set over 15 degree off vertical and under action of wind.

Normal thermal movement results from the following maximum change (range) in ambient and surface temperatures acting on glass-framing members and glazing components. Base engineering calculation on materials' actual surface temperatures due to both solar heat gain and night time sky heat loss.

- Temperature Change (Range): 50o C.

SUBMITTALS

The Contractor shall submit the following:

Product Data: Manufacturer's technical data for each glazing material and fabricated glass product required, including installation and maintenance instructions. Indicate glass thicknesses to be used.

Samples: 300 mm square samples of each type of glass indicated, and 300 mm long samples of each color of gasket and sealant.

Certificates: Certificates from respective manufacturers attesting that glass and glazing materials furnished for project comply with requirements of agencies having jurisdiction.

- Separate certification will not be required for glazing materials bearing manufacturer's permanent labels that represent a quality control program of a certification agency or independent testing laboratory acceptable to authorities having jurisdiction.
- Certification that glass does not exceed the permissible stress by analysis.

Compatibility and Adhesion Test Report:

Statement from sealant manufacturer that glass and glazing materials have been tested for compatibility and adhesion, with interpretations and recommendations for primers and substrate preparation.

QUALITY ASSURANCE

A) **Glazing Standards:**

Comply with recommendations of Flat Glass Marketing Association (FGMA) "Glazing Manual" except where more stringent requirements are indicated. Refer to this publication for definitions of glass and glazing terms not otherwise defined.

B) **Safety Glazing Standard:**

Provide required safety glass which comply with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for Category II materials.

C) **Insulating Glass Certification Program:**

Provide insulating glass units permanently marked with appropriate certification label of Insulating Glass Certification Council (IGCC) for inspecting and testing.

D) **Glazier Qualifications:**

Engage an experienced glazier who has completed glazing similar in material, design, and extent to that indicated for this project with a record of successful in- service performance.

E) **Single Source for Glass:**

To ensure consistent quality of appearance and performance, provide materials produced by a single manufacturer of fabricator for each kind and condition of glass.

DELIVERY, STORAGE AND HANDLING

Glass and glazing materials shall be protected during delivery, storage and handling to comply with manufacturer's directions and to prevent damage to glass and glazing materials from moisture, temperature changes, direct exposure to sun and from other causes.

PROJECT CONDITIONS

Environmental Conditions:

No glazing works shall be carried out when air and substrate temperatures are outside the limits permitted by glazing material manufacturer or when joint substrates are wet or dirty.

WARRANTY

A) **General:**

The Contractor shall submit warranties to repair or replace defective glass and glazing materials or workmanship for a period of 10 years after date of issue of the Provisional Acceptance Certificate, or longer where specified. Defects include, but are not limited to the following:

- Glass breakage due to pressures up to specified values thermal stress, manufacturing defects and damage to glass.
- Spontaneous breakage of heat treated glass.
- Defects in spandrel glass opacifier material.
- Loss of effective glass bite due to shifting of glass.
- Loss of effective glass bearing on setting blocks due to shifting of glass and/or blocks.

B) **Insulating Glass:**

A warranty to replace defective insulating glass for a period of 10 years after date of issue of the Provisional Acceptance Certificate shall be submitted. Defects include, but are not limited to the following:

- Failure of insulating glass edge seal as shown by moisture, dust, corrosion or damage within sealed air space.
- Insulating glass spacer migration.
- Failure to meet specified performance requirements.
- Failure of structural silicone seals.

C) **Mirrors:**

During warranty period, mirrors which develop defects in mirror coating due to normal conditions and not due to practices contrary to manufacturer's instructions shall be replaced at no extra cost to the Client.

Warranty period shall not be less than 5 years after date of issue of the Provisional Acceptance Certificate.

PRIMARY FLOAT GLASS PRODUCTS

Float Glass: ASTM C1036, Type I (Transparent glass, flat Class as indicated below, and Quality q3 (glazing select).

- Class 1 (clear) unless otherwise indicated.
- Class 2 (tinted, heat-absorbing, and light-reducing where indicated).

Refer to coated glass product requirements for tint color and performance characteristics of coated tinted glass for monolithic glazing relative to visible light transmittance, U- values, shading coefficient, and visible reflectance.

Refer to requirements for sealed insulating glass units for performance characteristics of assembled units composed of tinted glass, coated or uncoated, relative to visible light transmittance, U-values, shading, coefficient, and visible reflectance.

INSULATING GLASS PRODUCTS

Sealed Insulation Glass Units: Preassembled units consisting of organically sealed lites of glass separated by dehydrated air spaces complying with ASTM E774 and with other requirements indicated.

- Provide heat-treated, coated float glass of kind indicated or, if not otherwise indicated, Kind HS (Heat Strengthened) where recommended by manufacturer to comply with system performance requirements specified and Kind FT (Fully Tempered) where safety glass is designated or required.

- Performance characteristics designated for coated insulating glass are nominal values based on manufacturer's published test data for units with lites 6.0 mm thick and nominal 12 mm dehydrated space between lites, unless otherwise indicated.

Sealing System: Dual seal; primary sealant (minimum width 3.0 mm): Polyisobutylene; secondary sealant: silicone.

Spacer Material: Manufacturer's standard metal.

Desiccant: Manufacturer's standard; either molecular sieve or silica gel or blend of both.

Corner Construction: Manufacturer's bent and welded construction.

Mirror Glass

Clear float glass conforming to specified standard, quality q1, silvering, 6 mm thick.
Cut glass to sizes indicated and complete edge treatment. Grind, polish and bevel mirror edges not framed. Coat back of glass with chemically deposited silver, covered by film of electrically or chemically deposited copper, and coated with manufacturer's standard 0.05 mm dry film of organic coating.

GLAZING SEALANTS

General: Comply with the following requirements:

Elastomeric Sealant Standard: Provide elastomeric sealant which complies with ASTM C 920 requirements.

Colors: Provide color as selected by Engineer from manufacturer's standard colors.

MISCELLANEOUS GLAZING MATERIALS

Compatibility:

Provide materials with proven record of compatibility with surfaces contacted in installation.

Cleaners, Primers and Sealers:

Type recommended by sealant manufacturer.

Setting Blocks:
Neoprene, EPDM or silicone blocks as required for compatibility with glazing sealants, 80 to 90 Shore A durometer hardness, 100 mm minimum length by width to suit glass thickness.

Shims and Spacers:

Shims and spacers used with setting blocks shall be of the same material, hardness, length and width as the setting blocks.

Edge Blocks:

Same material as setting blocks, of 50 to 60 Shore A durometer, of size to limit lateral movement of glass.

GLASS TYPES

Provide the following glass types subject to compliance with the criteria approved by Engineer and as shown on drawings:

A) **Insulated Glass**

8 mm Tinted tempered glass.
12 mm Air cavity.
6 mm Tinted glass.

B) **Clear Sheet Glass**

Clear sheet glass shall be transparent, flat, relatively thin glass having a glossy, fire-finished, plain and smooth surface. The defects permitted in the central area of the type of glass are a few seeds, an occasional large seed not more than 6mm. long, faint strings or lines, and very light scratches and other surface defects detected only by close security. No pane (separate piece of glass) shall contain all of these defects and those present may not be clustered when in the central area. In general, the central area of light shall be as free from defects as possible and the appearance of the light as a whole shall be such that there is no perceptible interference with sight through the glass.
The clear sheet glass shall not weight less than 10 kg/m2 when 4mm thick and not less than 15 kg/m2 when 6mm thick.

C) **Polished Plate Glass**

Polished plate glass shall have its two surfaces perfectly flat and parallel so that they provide undistorted vision and reflection. Polished plate or float glass shall not weigh less than 10 kg/m2 when 4mm thick and not less than 15 kg/m2 when 6mm thick. The respective weights of the 8, 10, and 12mm thick polished plate glass shall be as manufactured by "PILKINGTON", "SAINT GOBAIN" or approved equivalent.
Mirror glass shall be 6mm thick or as shown on the Drawings or stated in the Bills of Quantities. It shall be of selected quality plate glass silvered on one side, electro- copper-backed followed by a coating of shellac varnish and painted to the satisfaction of the Engineer.
Tinted polished glass shall be "Parsol Bronze" as manufactured by "Saint Gobain" or of an approved equivalent.

D) **Tempered Float Glass**

Tempered float glass shall be "Securit" or approved equal. Tempered glass shall impart mechanical strength and shall be impact resistant. When under terrific impact, it shall disintegrate into innumerable small, blunt edged fragments and not into sharp-like ordinary glass.

E) **Putty**

Putty for glazing to wood other than non-absorbent hardwood shall be tropical grade wood glazing. Putty for glazing to metal and non-absorbent hardwood shall be tropical grade metallic glazing.

WORKMANSHIP

Verify compliance with applicable tolerances; for functioning of weep system; for face and edge clearances; and for effective sealing of joinery. Report conditions detrimental to glazing work. Perform glazing work after unsatisfactory conditions have been corrected.

Clean glazing channels immediately before glazing. Remove coatings which are not firmly bonded to substrates.

GENERAL

Comply with the combined recommendations of glass manufacturers, of manufacturers of sealants and other glazing materials, except where more stringent requirements are indicated by referenced glazing standards.

Glazing channels are intended to provide for necessary bite on glass, minimum edge and face clearances and adequate sealant thickness, with reasonable tolerances. Adjust as required by Project conditions during installation.

Project glass from damage. Remove and dispose of glass units with damage or imperfections of kind that impairs performance or appearance.

Prime joint surfaces as required for adhesion of sealant.

Install setting blocks one quarter of glass width from each corner but with edge nearest corner not closer than 150 mm from corner of 0.125 times glass width, whichever is greater. Install blocks to prevent movement.

Provide spacers of correct size and spacing for clearances, for glass sizes larger than 1200 united millimeters (length plus height), except where gaskets or glazing tapes are used for glazing. Provide 3 mm minimum bit of spacers on glass and use thickness equal to sealant width, or slightly less than final compressed thickness of tape.

Provide edge blocking to comply with referenced glazing standard. Install edge blocks securely, between the mid height and top corner of the glass and anti-walk blocks as required.

Set units of glass in each series with uniformity of appearances.

Provide compressible filler rods as recommended by sealant and glass manufacturers, to prevent sealant from clogging weep systems and from adhering to joints back surface and to control depth of sealant.

Force sealants into glazing channels to eliminate voids and to ensure complete "wetting" or bond of sealant to glass and channel surfaces. Tool exposed surfaces of sealants to provide a "wash" away from glass.

INSULATING GLASS

Insulating glass units shall be 24 mm thick, consisting of two panes of 6 mm glass separated by a desiccant filled metal spacer with bent, welded or fused corners, and welded or fused splices or joints to provide a continuous 12 mm hermetically sealed and dehydrated space. Insulating glass seal shall be dual seal with polyisobutylene and silicone sealants and certified for compliance with seal classification "CBA" by the Insulating Glass Certification Council (IGCC) and shall meet the requirements of ASTM E774 when tested in accordance with the following ASTM test methods. Secondary seal for structural silicone glazed units shall be a silicone edge seal certified for use in structural silicone glazing applications over the temperature range and structural loading as called for by the performance criteria section of this specification.

- E773 Test Method for Seal Durability of Sealed Insulating Glass Units.
- E774 Specification for Sealed Insulating Glass Units.
- E546 Test Method for Frost Point of Sealed Insulating Glass Units.
- E576 Test Method for Frost Point of Sealed Insulating Glass Units in Vertical Position.

The glass shall be fully heat strengthened or tempered as specified to assure adequate glass performance at the design pressures specified under the performance criteria. Glass manufacturer's recommendations are to be accompanied by wind load and thermal stress analysis.

The contractor shall provide certification from the glass producer/fabricator that the glass producer/fabricator has reviewed glass thickness and finds it suitable for the purpose intended in accordance with his published literature and in accordance with these specifications.

MIRRORS

Apply one additional coat of backing paint and allow to dry. Apply mirror mastic to cover not more than 25% of back of mirror. Set mirror on base support, on setting blocks or continuous gasket, and press against substrate to ensure bond of adhesive. Leave open ventilation space, 3 mm or more in thickness between mirror and substrate. Do not seal-off ventilation space at edge of mirror.

TAPE GLAZING

Position tapes on fixed stops so that when compressed by glass their exposed edges are flush with or protrude slightly above sightline of stops.

Install tapes continuously but not in one continuous length. Do not stretch tapes to make them fit opening.

Where framing joints are vertical, cover these joints by applying tapes to heads and sills first and then to jambs. Where framing joints are horizontal, cover these joints by applying tapes to jambs and then to heads and sills.

Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

Do not remove release paper from tape until just before each lite is installed.

Apply heel bead of elastomeric sealant.
Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
Apply cap bead of elastomeric sealant over exposed edge of tape.

GASKET GLAZING (DRY)

Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with stretch allowance during installation.
Secure compression gaskets in place with joints located at corners to compress gaskets producing a weather tight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer. Gaskets shall have moulded corners.
Install gaskets so they protrude past face of glazing stops.

SEALANT GLAZING (WET)

Install continuous spacers between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel weep systems until sealants cure. Secure spacers in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
Tool exposed surfaces of sealants to provide a substantial wash away from glass. Install pressurized gaskets to protrude slightly out of channel to eliminate dirt and moisture pockets.

HEAT SOAKING OF TEMPERED GLASS

All tempered glass shall be subject to heat soaking tested prior to delivery to site.

PROTECTION AND CLEANING

Promptly protect installed glass from breakage with crossed streamers attached to framing and held away from glass. Do not apply markers to surfaces of glass. Remove non-permanent labels and clean surfaces.

Protect glass from contact with contaminating substances. If contaminating substances do come into contact with glass, remove immediately as recommended by glass manufacturer.

Remove and replace glass which is broken, chipped, cracked, abraded or damaged in other ways during construction period, including natural causes, accidents and vandalism.

Wash glass on both faces not more than 4 days prior to date scheduled for inspections to establish date of issue of the Provisional Acceptance Certificate in each area of the Project. Wash glass as recommended by glass manufacturer.

DOOR HARDWARE (IRONMONGERY)

PART 1 - GENERAL

DESCRIPTION OF WORK

Section includes: Hardware for steel & Wooden Doors.

STANDARDS

A: BS EN 1303: 1998	Building Hardware Cylinders for Locks.
B: BS 7352: 1990	Specification for strength and durability performance of metal hinges for side hung applications and dimensional requirements for template drilled hinges.
C: BS 3621: 1980	Defines what constitutes a minimum standard of good security within a lock.
D: BS 5872: 1980	Specifications for locks and latches for doors in buildings.
E: BS EN 1125	Panic exit devices – requirements and test methods.
F: BS 1154: 1997	Controlled door closing devices requirements and test methods.
G: BS 476	Applicable to all fire rated building materials and structures. This test is a must whenever fire rated elements are requested.
H: Fire Rating	All hardware used on fire rated doors should comply to same standards of fire rating as doors and in specific of same fire rating hours.

SUBMITTALS

A. Product Data: Include installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings:

1. Details of electrified door hardware. Include location, sequence of operation, and interface with other building control systems.

2. Indicate type, locations and mounting heights of each type of hardware as scheduled, catalogue cuts, electrical characteristics and connection requirements.

3. Submit manufacturer’s parts, lists and templates.

C. Samples for Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of door hardware indicated.

D. Samples for Approval: For exposed door hardware, representative of each type required, in specified or selected finish, full size. Tag with identification for coordination with the Door Hardware Schedule.

1. Submit samples before submission of the Door Hardware Schedule.

E. Door Hardware Schedule: Prepared by or under the supervision of door hardware supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

   1. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening.

F. Keying Schedule: Prepared by or under the supervision of door hardware supplier, detailing final keying instructions for locks. Include keying diagram and index each key set to unique door designations.

G. Manufacturers Installation Instruction: Submit special procedure, perimeter conditions, requiring special information.

QUALITY ASSURANCE

A. Source Limitations: Obtain all door hardware from a single manufacturer or supplier, unless otherwise indicated.

PART 2 - PRODUCTS

MATERIALS AND FABRICATION - GENERAL

A. Hand of door: The Drawings show the direction of slide, swing or hand of each door leaf. Provide each item of hardware for proper installation and operation of the door swing as shown.

B. Manufacturer's Name Plate: Do not use products which have manufacturer's name or trade name displayed in a visible location.

C. Products: Provide manufacturer's standard catalogue products, conforming to templates, and generally prepared for machine screw installation. Do not provide hardware which has been prepared for self-tapping sheet metal screws.

D. Provide screws for installation with each hardware item. Provide Phillips flathead screws except as otherwise required or approved by the Engineer. Finish exposed (exposed under any condition) screws to match the hardware finish or, if exposed in surfaces of other work, to match the finish of such other work as closely as possible.

E. Concealed Fasteners: Provide concealed fasteners for hardware units which are exposed when the door is closed, except to the extent no standard units of the type specified are available with concealed fasteners. Do not use through bolts for installation where the bolt head or the nut on the opposite face is exposed in other work.

F. Tools for Maintenance: Furnish two complete sets of any specialized tools as needed for Employer's continued adjustment, maintenance, and removal and replacement of hardware.

G. HARDWARE FINISHES

1. General: Exposed surfaces of hardware shall have manufacturer's standard satin anodized or stainless steel finish as indicated by the components listed in the Door Hardware Schedule.

COMPONENTS

A. GENERAL HARDWARE REQUIREMENTS

Where not specifically indicated, comply with applicable BS standards for each type of hardware required. Provide each type of hardware with accessories as required for the applications indicated and for complete, finished operational door.

1. Templates: Furnish templates or physical hardware items to door and frame manufacturers sufficiently to avoid delay in work.
2. Reinforcement Units: Furnished by door and frame manufacturers; coordinated by hardware supplier.
3. Fasteners: Furnished as recommended by hardware manufacturers to comply with application involved (steel, wood…), and as required to secure hardware.
4. Hand of door: The drawing shows the direction of swinging or hand of each door leaf. Furnish each item of ironmongery for proper installation and operation of the door movement as shown.
5. Product finishes: the product finish to be as indicated in schedule as selected from manufacturers wide range of finishes.

B. HINGES, BUTTS AND PIVOTS:

Provide hinges, Butts and pivots as follows:

Number of Hinges: Unless otherwise indicated, supplier should provide number of hinges per leaf to comply with his product fire rating test / certificate. A proof of such test should be presented.
As a general recommendation, three hinges should be provided for net leaf size of 2135mm X 915mm and a fourth hinge for bigger size.

1. **Type of Hinges:**
   a. Provide full mortise 5-knuckle, two ball bearing hinges standard weight, and stainless steel in compliance with BS7352: 1990 class 9.
   b. Provide full mortise rising hinges, standard weight, and stainless steel.

2. **Hinge size**: Unless otherwise indicated, or specified provide door hinge that comply with the requirements of and are sized in compliance with BS7352: 1990, being 4” x 3” x 3mm.

3. **Screws:** Furnish Philips Flat – Head machine screws for installation of units, except furnish Philips flat-head all purpose or wood screws for installation of units into wood. Finish screw heads to match surface of hinges or pivots.

4. **Hinge pins:** Unless otherwise specified, provide hinge pins as follows:
   a. Interior doors: removable stainless steel pin
   b. Exterior doors: non-removable pin

5. **Pivots:** As recommended by manufacturer for size and weight and thickness of door, also check related drawings for further details.

C. LOCKS AND LATCHES:

1. Unless otherwise indicated or specified, provide locks and latches that comply with BS 5872: 1980.
2. Strikes: Provide manufactures standard strikes for each latch or lock bolt: with curved lip executed to protect frame, finish to match ironmongery sets.
3. Rabbeted doors: where rabbeted door stiles are indicated, provide special rabbeted front on lock and latch units and bolts.
4. Provide 76mm Euro profile mortise Sash lock case, 57mm backset 57mm centers, brass follower to suit 8mm spindle, with adjustable tension spring to suit heavy unsprang or sprung lever furniture meeting BS5872 and fire rated to BS476, Stainless steel finish.
5. Provide 76mm Euro profile mortise dead lock case 57mm back set, to meet BS5872 and fire rated to BS 476, stainless steel finish.
6. Provide 76mm mortise bathroom lock, 57mm backset centers with reversible latch bolt, to suit 8mm spindle with adjustable tension spring, and dead bolt follower 5mm, stainless steel.
7. Provide 76mm Euro profile mortise night latch lock case,57mm backset 57mm centers, brass follower to suit 8mm spindle, brass latch bolt automatic locking action without key, when door is closed with latch bolt out, reversible latch bolt, cylinder and lever handle, to suit either hand of door.
8. Equip locks with euro profile double cylinder, 5 pins with length to match with the door thickness and the related installed accessories.
9. Equip locks with Euro-profile single cylinder, 5 pins with length to match with the door thickness and the related installed accessories.
10. Equip locks with Euro-profile single cylinder plus thumb turn, 5 pins with length to match with the door thickness and the related installed accessories.
11. All locks are to differ and are suited to grand master key, with 5 pin cylinders.
12. Provide 3 keys for each lock, finish as manufacturers standard unless otherwise indicated.
13. Provide thumb turn with indicator monitor and emergency release to comply with the provided bathroom lock, stainless steel finish.

D. FLUSH BOLTS AND DUST PROOF STRIKES:

1. **Flush Bolts:**
    a. Lever action manual flush bolt to comply with steel leaf application and fire rating. Manufacturer standard finish unless otherwise indicated.
    b. Automatic flush bolt to comply with steel leaf application and fire rating. Manufacturer standard finish unless otherwise indicated.
    c. Lever action manual flush bolt to comply with wooden leaf application and fire rating. Manufacturer standard finish unless otherwise indicated.
    d. Automatic flush bolt to comply with wooden leaf application and fire rating. Manufacturer standard finish unless otherwise indicated.

Dust proof strike: provides dust proof strikes for foot bolts except where special threshold construction requires specific type. Finish as requested by the Engineer unless otherwise indicated.

E. LEVER HANDLES:

1. Provide one set 19mm diameter 130mm length, 71mm projection lever handle on 50mm diameter rose manufactured from stainless steel.

2. Provide lever handle with half-spindle on one side to comply with the provided night latch lockset and to be 19mm diameter 130mm length 71mm projection on 50mm diameter rose, spring loaded, manufactured from stainless steel.

F. PULL HANDLES / PUSH PLATES/MIDPLATES/KICKPLATES:

1. **Pull Handles:** Provide 19mm diameter 225mm C/C pull handle bolt through. Manufactured from stainless steel sheet rolled. Mounting location as indicated on shop drawings.

2. **Push Plate:** Provide 350mm x150mm, 1.2mm thick, stainless steel satin finish push plate. Round cornered with counter sunk screws. Mounting location as indicated on shop drawings

3. **Mid-plates:** Provide 1.2mm thick, stainless steel satin finish with size to comply with the door width (DWx150mm) mid-plate. Mid-plates to be round cornered with counter sunk screws. Mounting location as indicated on shop drawings.

4. **Kick-plates:** Provide 1.2mm thick, stainless steel satin finish with size to comply with the door width (DWx200mm) kick-plate. Kick-plates to be round cornered with counter sunk screws. Mounting location as indicated on shop drawings.

G. EXIT DEVICES:

1. **General:** Unless otherwise indicated or specified, emergency exit devices shall comply with BS EN 1125 specification requirements for panic bolts and panic latches. And fire rated to BS 476.
    a. Cross bar exit device for single leaf with reversible panic latch and outside trim, silver finish. Location as indicated on hardware schedule.
    b. Cross bar Vertical rod panic bolt to be installed on double leaf doors with outside trim location as indicated on hardware schedule, silver finish.

H. DOOR CLOSER:

1. **General:** Unless otherwise indicated or specified, closers and door control devices shall comply with the applicable requirements of BS EN 1154: 1997 and finish shall be subject to the approval of the engineer.

2. **Specification of Unit:** Door closer with silver cover which features a cast iron body with a hardened steel rack and pinion incorporating needle roller bearing housed beneath a precision zinc die cast cover. And to have the following:
    a. Template and quick-fit back plate
    b. 2-4 adjustable strength size or size to suit door weight and dimensions
    c. Non-handed.
    d. 180 deg. Opening/controlled closing
    e. Separate adjustment of latch action & closing speed.
    f. Temperature compensation –15deg C to +40deg C.
    g. Matching arms.
    h. Quick release arm assembly
    i. Pre-assembled arm assembly
    j. Tripacked for applications
        1. Regular, closer is fitted to the pull (hinge knuckle) face of the door.
        2. Transom mounted, closer is fitted to the transom on push face of the door. Bracket fitted to the door face.
        3. Parallel arm, closer is fitted to the push (opposite to hinge knuckle) face of the door. Bracket is fitted to underside of head frame.

    k. Closer Cover design and finish is to be approved by the engineer in charge.

I. DOOR SELECTOR (DOOR COORDINATOR):

Provide door selector to comply with Application involved and the BS requirements for fire rating and performance. Type and finish to be approved by the Engineer in charge.

J. DOOR STOP

1. General: Unless otherwise indicated or specified door stops shall comply with the latest British standard applicable.

2. Door Stop Units shall include but shall not be limited to door ironmongery as follows:
    a. Dome Stop
    b. Wall Bumpers
    c. Security Door Stop

K. DOUBLE ACTING FLOOR SPRING;

1. **General:** Unless otherwise indicated or specified, double acting floor springs shall comply with the applicable requirements of the European standards for controlled door closing devices **BS EN 1154:1997.** Finish shall be subject to the approval of the engineer in charge.

L. ACCESSORIES:

1. Provide Escutcheon for euro profile cylinder finish to match ironmongery sets.
2. Provide room identification signs to comply with the application involved, shape and finish as approved by the Engineer in charge.
3. Provide Hat and Coat Hook buffered, finish to match ironmongery sets.
4. Provide Rubber door silencer manufacturer standard type.
5. Provide rubber seals for groove type frames manufacturer standard type.

EXAMINATION

A Administrative requirements: coordination and project condition

B Verify doors and frames are ready to receive door hardware and dimensions are as indicated on shop drawings.

PART 3 - EXECUTION

INSTALLATION

A. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be painted or finished in another way coordinate removal, storage and reinstallation or application of surface protection with finishing work specified in other sections. Do not install surface-mounted items until finishes have been completed on the substrate.

B. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

C. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

ACTIVE LEAF OF PAIRS OF DOORS

A. Active leaf of pairs of doors shall be RHRB except that where door leaves are unequal, active leaf shall be larger leaf.

HARDWARE MOUNTING HEIGHTS

A. Mount hardware units at heights generally in accordance with the following, except as otherwise required by the Engineer, or specifically indicated on drawings or required to comply with governing regulations, or avoid interferences

1. Lock Sets and Latches: 950 mm to center of lever or knob from floor.
2. Butt Hinges: 250 mm to bottom of lowest hinge from floor; 125 mm to top of upper hinge from top of door; space other hinges equally between lower and upper hinges.
3. Door Pulls: 1140 mm finish floor to center of pull; center line in 125 mm from edge of flush doors, and centered on stile of narrow stile glass doors.
4. Deadlocks: Center line of cylinder to align with center line of cylinder for lock sets, except where location conflicts with pull handle or push plate, then provide at 1520 mm from finished floor to centerline of cylinder.
5. Cross Bar Exit Devices: 910 mm for standard installations.
6. Push Rail Exit Devices: 1040 mm for standard installations.
7. Push Plate: 1220 mm finish floor to center of plate through mounted to pulls.
8. Flush Bolt Operating Mechanisms: Top bolt 1675 mm to 1830 mm above finished floor, bottom bolt 300 mm above finished floor.

B. Coordinate mounting heights with door and frame manufacturers. Use templates provided by hardware item manufacturer.

C. Install each ironmongery item in compliance with the manufacturers instruction and recommendations whenever cutting and fitting is required to install ironmongery onto or into surfaces which are later to be painted or finished in another way, coordinate removal, storage and reinstallation or application of surface protection. Do not install surface mounted items until finishes have been complete the substrates.

D. Set Units plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation. Separate aluminum and other corrodible metal surfaces from sources of corrosion of electrolytic action at points of contact with other materials. Drill and countersink units which are factory prepared for anchorage fasteners, space fasteners and anchors in accordance with manufacturer’s instructions or as directed.

ADJUST AND CLEAN

A. Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit. Replace units which cannot be adjusted and lubricated to operate freely and smoothly as intended for the application made.

B. Final Adjustment: Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy, and make a final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

C. Instruct Employer's Personnel in proper adjustment and maintenance of hardware and hardware finishes, during the final adjustment of hardware.

Hardware Schedule for Doors

Refer to Wooden Door Schedule, LEGEND & IRONMONGERY.

CHAPTER NINE

FINISHES

LATH AND PLASTER

PART 1 - GENERAL

SUMMARY

A. Extent of lath and plaster is indicated on Drawings and Schedules.

B. Types of work include:

1. Metal lathing.
2. Portland cement plastering.

QUALITY ASSURANCE

A. Field Construction Mock-up: Prior to installation of plaster work, fabricate mock-up panels for each type of finish and application required using materials, including lath accessories and support system (if any) indicated for final work. Build panels 1.2 m x1.2 m x full thickness in location indicated, or if not otherwise indicated, as directed by Engineer. Demonstrate the proposed range of color, texture and workmanship to be expected in completed work. Obtain Engineer acceptance of panel's visual quality before start of work. Retain panel during construction as a standard for judging completed work.

APPLICABLE CODES AND STANDARDS

ASTM C 150 Specification for Portland Cement.
BS 12 Specification for ordinary and rapid hardening Portland cement.
BS 890 Building limes.
BS 1198,
BS 1199,
BS 1200 Building sands from natural sources.
BS 1369 Metal lathing (steel) for plastering.
BS 4049 Glossary of terms applicable to internal plastering, external rendering and floor screeding.
BS 4721 Specification for ready-mixed building mortars.
BS 5262 Code of practice for internal plastering.
BS 6452 Beads for internal plastering and dry lining.

PART 2 - PRODUCTS

LATH

A. Expanded Metal Lath: Fabricate expanded metal lath from galvanized steel sheet to produce lath complying with BS 1369 for type, configuration and other characteristics indicated below, with uncoated steel sheet painted after fabrication into lath.

1. Diamond Mesh Lath: Comply with the following requirements:

   Configuration: Flat.
   Weight: 1.60 kg/m2.

PLASTER ACCESSORIES FOR PORTLAND CEMENT PLASTER

A. General: Comply with material provisions of BS 1369 and BS 5262; coordinate depth of accessories with thicknesses and number of coats required.

B. Metal Corner Reinforcement: Expanded large mesh diamond mesh lath fabricated from tight coat galvanized sheet steel to comply with BS 5262, with weight 2.25 kg/m2 and formed to reinforce external corners of Portland cement plaster on exterior exposures while allowing full plaster encasement.

C. Metal Corner Beads: Small nose corner beads fabricated from tight coat galvanized sheet steel, synthetic coated fitted with PVC strip.

D. Casing Beads: Square-edged style, with expanded flanges and removable protective tape, of the following material:

1. Material: Zinc-coated steel with PVC strip.
2. Two-Piece type: Pair of casing beads with back flanges formed to provide slip joint action, adjustable for joint widths from 3 mm to 15 mm, with PVC edging.

PORTLAND CEMENT PLASTER MATERIALS

A. Base Coat Cements: Type as indicated below:

1. Portland cement, ASTM C 150, Type I or III; BS 12.

B. Finish Coat Cement: Type as indicated below:

1. Portland cement, ASTM C 150, Type I; BS 12.

C. Factory-Prepared Finish Coat: Manufacturer's standard product requiring addition of water only.

1. Product: Subject to compliance with requirements and approval of the Engineer.

D. Lime: Special hydrated lime for finishing purposes, ASTM C 206, Type S; or BS 890 Type.

E. Sand Aggregates: ASTM C 897; BS 1199.

MISCELLANEOUS MATERIALS

A. Water for Mixing and Finishing Plaster: Drinkable, free of substances capable of affecting plaster set or of damaging plaster, lath or accessories.

B. Bonding Agent for Portland cement Plaster: ASTM C 932.

C. Plasticizer: Manufacturer's standard product, subject to compliance with requirements and approval of the Engineer may be used in accordance with manufacturer's recommendations and instructions.

PORTLAND CEMENT PLASTER MIXES AND COMPOSITIONS

A. General: Comply with ASTM C 926 or BS 5262 for Portland cement plaster base and finish coat mixes as applicable to plaster bases, materials and other requirements indicated.

B. Portland Cement Plaster Base Mixes and Compositions: Proportion materials for respective base coats in parts by volume for cementitious materials and in parts by volume per sum of cementitious materials for aggregates to comply with the following requirements for each method of application and plaster base indicated. Adjust mix proportions below within limits specified to attain workability.

1. Three-Coat Work over Metal Lath: Base coats as indicated below:

   Scratch Coat: 1 part Portland cement, ½ part lime, and 4 parts sand.

   Brown Coat: 1 part Portland cement, ½ part lime, and 4 parts sand.

2. Two-Coat Work over Concrete Unit Masonry: Base coats as indicated below.

   Base coats: 1 part Portland cement, ½ part lime, and 4 parts sand.

C. At Contractor's option, provide one of the following:

1. Job-Mixed Portland Cement Plaster Finish Coats: Proportion materials for finish coats in parts by volume for cementitious materials and parts by volume per sum of cementitious materials for aggregates to comply with the following requirements:

   a. 1 part Portland cement, ¾ - 1½ parts lime and 3 parts sand.

2. Factory-Prepared Portland Cement Finish Coats: Add water only; comply with finish coat manufacturer's directions.

D. Mixing: Mechanically mix cementations and aggregate materials for plasters to comply with applicable referenced application standard and with recommendations of plaster manufacturer.

PART 3 - EXECUTION

INSTALLATION OF LATHING AND FURRING, GENERAL

A. Portland Cement Plaster Lathing and Furring Installation Standard: Install lathing and furring materials indicated for Portland cement plaster to comply with ANSI A42.3 or BS 5262.

METAL LATHING

A. Install expanded metal lath for the following applications where plaster base coats are required. Provide appropriate type, Configuration and weight of metal lath selected from materials indicated which comply with referenced lathing installation standards.

   1. At junctions and joints between differing materials and forms of construction, and at all chases and other places where making good occurs.

      a. Install minimum 150 mm wide strip of lath, fixed to substrate on both edges at minimum 600 mm centers.

INSTALLATION OF PLASTERING ACCESSORIES

A. General: Comply with referenced lathing and furring installation standards for provision and location of plaster accessories of type indicated. Miter or cope accessories at corners; install with tight joints and in alignment. Attach accessories securely to plaster bases to hold accessories in place and alignment during plastering.

B. Accessories for Portland Cement Plaster:

   1. Corner Bead: Install at all external corners.
   2. Casing Beads: Install at termination of plasterwork unless otherwise indicated.
   3. Control joints: Install control joints at location indicated, or it not indicated, at locations complying with the following criteria and approved by the Engineer.
      a. Where an expansion or control joint occurs in surface of construction directly behind plaster membrane.
      b. Where distance between control joints in plaster surfaces exceed 5.5 m in either direction.
      c. Where area within Portland cement panels exceed 10 m2.
      d. Where Portland cement plaster panels sizes or dimensions change. Extend joints full width or height of plaster membrane.

PLASTER APPLICATION, GENERAL

A. Prepare monolithic surfaces for bonded base coats and use bonding compound or agent to comply with requirements of referenced plaster application standards for conditioning of monolithic surfaces.

B. Tolerances: Do not deviate more than 3 mm in 1.8 m from true plane in finished plaster surfaces, as measured by a 1.8 m straightedge placed at any location on surface.

C. Grout hollow metal frames, bases and similar work occurring in plastered areas, with base coat plaster material and prior to lathing where necessary. Except where full grouting is indicated or required for fire-resistance rating, grout 150 mm lengths at each anchorage.

D. Sequence plasters application with the installation and protection of other work, so that neither will be damaged by the installation of the other.

E. Apply thicknesses and number of coats of plaster as indicated; or as required by reference standards.

F. Concealed Plaster: Where plaster application will be concealed above suspended ceilings and similar locations, finish-coat may be omitted; where used as a base for adhesive application of tile and similar finishes, omit finish-coat and coordinate thickness with overall dimension as shown, and comply with tolerances specified.

PORTLAND CEMENT PLASTER APPLICATION

A. Portland Cement Plaster Application Standard: Apply Portland cement plaster materials, compositions, and mixes to comply with ASTM C 926 or BS 5262.

B. Number of Coats: Apply Portland cement plaster, of composition indicated, to comply with the following requirements:

1. Use three-coat work over metal lath.
2. Use two-coat work over the following plaster bases:
   a. Concrete unit masonry.
   b. Concrete cast-in-place or precast when surface complies with ASTM C 926 or BS 5262 for plaster bonded direct to solid base.

3. Finish Coat: Floated finish unless otherwise indicated; match Engineer sample.

C. Thickness:

1. Thickness of external plaster (render) shall be 25 mm, 3 coat application over metal lath, having smooth wood float finish.
2. Thickness of internal plaster shall be 15 mm, 2 coat application. Having smooth steel float finish.

D. Moist cure Portland cement plaster base and finish coats to comply with ASTM C 926 or BS 5262, including recommendations for time between coats and curing.

CUTTING AND PATCHING

A. Cut, patch, point-up and repair plaster as necessary to accommodate other work and to restore cracks, dents and imperfections. Repair or replace work to eliminate blisters, buckles, excessive crazing and check cracking, dry-outs, efflorescence, sweat-outs and similar defects, and where bond to the substrate has failed.

B. Sand smooth troweled finishes lightly to remove trowel marks and arises.

CLEANING AND PROTECTION

A. Remove temporary protection and enclosure of other work. Promptly remove plaster from doorframes, windows, and other surfaces, which are not to be plastered. Repair floors, walls and other surfaces, which have been stained, marred or otherwise damaged during the plastering work. When plastering work is completed, remove unused materials, containers and equipment and clean floors of plaster debris.

B. Provide final protection and maintain conditions, in a manner acceptable to the Engineer, which ensures plasterwork being without damage or deterioration at time of Taking-Over.

FLOOR AND WALL CLADDING

SCOPE

These specifications cover floor and wall cladding intended to be used for the Project in accordance with the Drawings, Bills of Quantities and as directed in writing by the Engineer.

GENERAL

The Contractor shall perform all attendance upon other trades and protect all works specified under this Section from damage during subsequent operations, make good any defects clean throughout and leave all works in a perfect condition to the satisfaction of the Engineer.

The Contractor shall be responsible for the design and stability of the scaffolding and for all safety precautions in connection with works specified under this section.

All material and manufactured items that are liable to damage shall be delivered in the original package, containers, etc... bearing the name of the manufacturer and the brand, and shall be carefully loaded, transported, unloaded, stored in an approved manner, protected from damage and exposure to weather or dampness during transit and after delivery to the Site.

Damaged materials and manufactured items shall not be used in the works specified under this Section. Any materials and manufactured items damaged during and after bedding or setting in position shall be removed and replaced by and at the Contractor's expense.

MATERIALS AND MANUFACTURE

A) Cement

Cement shall be ordinary Portland cement and White (non- stain) cement as specified under "BLOCKWORK".

B) Sand (Fine Aggregate)

Sand (Fine Aggregate) for use in plaster, mortar and screed shall be as specified for Mortar under "CONCRETE WORK", except the requirement for gradation shall not apply for screed (maximum size 10 mm) and shall contain no more than 0.06% chlorides.

C) Water

Water shall be demineralized brackish water of maximum of a total dissolved solids of seven hundred ppm. as specified under "CONCRETE WORK".

D) Color Pigments

Color pigments shall conform to B.S. 1014.

E) Precast Cement Tiles

Precast Cement tiles, shall be obtained from an approved manufacturer. Tiles shall be formed with a (1:2 1/2) mix of Ordinary Portland Cement and hardwearing aggregate for the topping (wearing layer) 10mm thick set on a concrete backing of cement and fine aggregate (1:5) mix.

The size and thickness of tiles shall be as shown on the Drawings or stated in the Bills of Quantities and shall be of an approved design and pattern cast in heavy steel moulds under pressure.

F) Precast Terrazzo Tiles, Skirting, Etc..

The precast terrazzo tiles and skirting's shall be formed of white or tinted Portland Cement and granular granite chippings and shall be obtained from an approved manufacturer.
The tiles shall be cast in heavy steel moulds under pressure to the proportions and dimensions shown on the Drawings and approved by the Engineer.
Precast terrazzo skirting's shall be with fair square top edge and produced in the same proportions and mixes for tiles.
Precast terrazzo treads, risers, strings, thresholds, etc... Shall be of the design, dimensions and thicknesses shown on the Drawings and they shall be formed in the same proportions and mixes for tiles.
Grinding shall be done get by means of a No. 80 carborundum stone. Filling shall be with a neat cement grout of the same color as the facing mix and this shall be worked into the surface with a wooden scraper to fill all voids and air holes. After a minimum period of 24 hours polishing shall be carried out wet by means of a No. 140 carborundum stone with the addition of appropriate lead and salt pigments to produce a mirror like glossy finish.

G) Ceramic Floor Tiles

Ceramic floor tiles shall be unglazed heavy duty ceramic tiles manufactured in accordance with to B.S. 6431. Skirting shall be coved type 100 mm high. Acid resistant tiles shall be used where specified. Tiles pattern and color shall be to the Engineer approval.

H) Glazed Wall Tiles

Glazed wall tiles shall conform to the requirements of B.S. 6431 and the size shall be as shown on the Schedules of Finishes or the Drawings and of an approved pattern and color. Single edge and double edge rounded tiles, coves and corner pieces shall be of same quality, color and finish.

I) Cement Screed Floor Finish

The cement screed shall unless otherwise ordered by the Engineer, consist of one part of ordinary Portland cement to three parts of sand by volume. The ingredients shall be proportioned and mixed as specified for concrete work under "CONCRETE WORK".

The screed shall be trowelled smooth with steel trowel and shall be cured for at least 5 days and shall be left perfectly flat with clean and smooth surface finish, free of trowel marks and to the satisfaction of the Engineer.

J) Dressing for Cement Floors

The dressing shall be a granular abrasive in powder form, manufactured for trowel application into the upper surface of the Screed. It shall be manufactured for this purpose and delivered in containers bearing the name of the manufacturers and the instructions for its application.

K) Floor Seal

Floor seal shall be epoxy base sealant material manufactured for application on the finished surface of the screed. It shall be manufactured for this specified application and labelled as such.

It shall be delivered in containers bearing the name of the manufacturer and the instructions for its application.

L) Plasticizer

Plasticizer proposed by the Contractor and approved by the Engineer shall be used in the mortars. Use of lime will in no account be permitted.

WORKMANSHIP

A) Precast Cement and Terrazzo Tiles

The precast cement and terrazzo tiles shall be laid in accordance with BS 5385: Part 5: 1990, BS 8204: Part 4: 1993 and/or BS 8000: Section 11.1: 1989 as applicable and as directed by the Engineer. Precast cement and terrazzo tiles shall be laid on a (1:3) mix of cement and sand mortar and any admixtures approved by the Engineer. Approved PVC separator strips 8 mm thick of color to the approval of the Engineer shall be provided for every $9m^2$ area of the tile works.

All tiles shall be laid with square joints and shall be grouted up on completion, care being taken to fill all joints completely.

The grout shall consist of neat cement of a color to match the tiling. Any surplus grout shall be cleaned off the face of the tiling and surrounding surfaces immediately and all tiling shall be carefully cleaned off.

All terrazzo surfaces shall be polished on completion. Large areas such as floors shall be wet polished by means of approved machines using a No. 140 carborundum wheel. Any narrow surfaces which cannot be polished conveniently by the machine, may be polished by hand using a No.140 carborundum stone and water. Care must be taken during any polishing operation not to damage any angles or arrises. Polishing shall be performed with addition of appropriate lead and salt pigments as approved by the Engineer to produce a mirror-like glossy finish.

Tiles shall be cut with a suitable cutting tool and rough edges shall be rubbed smooth. Cut-tile misfits shall be replaced with properly cut tiles. Straight edges shall be accurately set to the lines established and reset at suitable intervals to keep the joints parallel over the entire area.

Broken tiles or tiles showing the least signs of defects will not be accepted and if laid by the Contractor shall be removed and replaced with sound tiles, at his own expense.

Tiles shall be laid out from the center line of each space outward and adjustment made along walls, partitions, and borders, so as to symmetrize the pattern with a minimum of cut tiles. Tiles of less than half of their full size along one side after cutting should be avoided.

B) Ceramic Floor Tiles

Ceramic floor tiling shall be carried out in compliance with BS 5385:Part 3:1989 and/or BS 8000:Section 11.1 :1989 as applicable and as directed by the Engineer.

The overall thickness of tiles, mortar and screed shall be maximum of 80 mm.

Bedding shall consist of cement: sand mortar 1:3 of a stiff plastic consistency, spread, compacted and leveled to a thickness of 9-10 mm. Water content of mortar must be limited to prevent formation of surface water when mortar is compacted and surface water which does occur must be allowed to dry. Sufficient mortar for 2-3 hours' work maximum shall be laid at any one time.

Tiles shall be dipped in water and surface water allowed to drain off. The back of the tiles shall be buttered with neat cement/water mix (or cement based adhesive), and the tiles laid on bedding and tapped down to form a level surface. All joints shall be as close as possible and shall in no case exceed half (0.5) mm in width on face for areas less than ten (10) square meters and one (1) mm for areas over ten (10) square meters.

Tiles shall be left for at least twelve (12) hours before joints are grouted.

White or tinted cement and water to 1:1 mix of paste consistency shall be worked into the joints until flush with face of tiles.

Acid resistant tiles shall be grouted in a suitable acid-resistant grout to the Engineer's approval.

The surplus grout from the floor surface shall be gently wiped with fine sand. Sawdust shall not be used.

Walking on tiles shall not be allowed for five (5) days after laying.

Perimeter movement joints shall be provided to the full depth of finish, bedding and screed in all tiled floors.

C) Glazed Wall Tiles - Fixing with Adhesive

Wall tiling shall be carried out in compliance with BS 5385:Part 1: 1976 for Internal work and BS 5385: Part 2: 1976 for External work and/or BS 8000: Section 11.1 : 1989, as applicable and as directed by the Engineer.

The background for tiling shall be suitably prepared free from oil, grease, loose or friable materials and shall provide an adequate key for bedding.

The maximum deviation of background shall not exceed 3 mm when measured under a two meter straight edge.

Tiling work shall be carefully set out prior to starting to minimize the amount of tile cutting and to ensure alignment of vertical and horizontal joints.

Tiles shall be dry when fixed, using adhesive, mixed and used strictly in accordance with manufacturer's written instructions and within the stated working time of the adhesive. The manufacturer's recommendations for safe handling and ventilation of working area shall be carefully followed.

Adhesive shall be applied as a floated coat to a thickness of 5 to 6 mm. Tiles shall be firmly pressed into position within the stated working time of the adhesive.

Tiles and fittings shall be set in adhesive to true vertical face with continuous horizontal and vertical joints. Joints shall be straight, level, perpendicular and of even width not exceeding 1.5 mm. The vertical joints shall be maintained plumb for the entire true level and plane by uniformly applied pressure under a straight edge of a rubber faced block. Misfits as well as damaged or defective tiles shall be removed and replaced at the Contractor's own expense.

Special tile fittings shall be located as shown on detail drawings and as directed by the Engineer.

Bedding shall be allowed to set before grouting to avoid disturbance to tiles. Grout shall be applied in matching color according to manufacturer's written instructions and worked in until joints are thoroughly filled flush with the finished face of joint. Surplus grout shall be removed with a damp cloth and joints tooled to a smooth finish. Acid resistant tiles shall be grouted with a suitable acid resistant grout to the Engineer's approval.

Immediately after the grouting has set, tiled surface shall be given a protective coat of non-corrosive soap or other approved method of protection and joints shall be cured for 72 hours.

Wall tiling operations shall not be started until the floor tiling in the same area has been completed.

D) Glazed Wall Tiles - Fixing with Cement: Sand Mortar

Wall tiling shall be carried out in compliance with BS 5385:Part 1:1976 for Internal work and BS 5385:Part 2:1976 for External work and/or BS 8000:Section 11.1 :1989, as applicable and as directed by the Engineer.

Cement and sand mortar (1:4) ten (10) mm. thick shall be laid as base for wall tiling. The surface of the mortar so laid shall be scratched in an approved manner when nearly set, to form key and shall be cured for five (5) days before tiling starts. The surface shall be well wetted before the actual tiling operation is commenced.

Tiles and fittings shall be set in cement and sand mortar (1:4) mix, 6 mm. thick to a true vertical face with continuous horizontal and vertical joints. Joints shall be straight, level, perpendicular and of even width not exceeding 1.5 mm. The vertical joints shall be maintained plumb for the entire true level and plane by uniformly applied pressure under a straight edge of a rubber-faced block. Misfits as well as damaged or defective tiles shall be removed and replaced by and at the Contractor's expense.

The external and internal angles and side edges of glazed wall tiling shall be formed with angle beads whereas top edges of tiles, shall be formed with rounded edge tiles. Joints shall match the general tiling and special fittings shall be used.

Joints in glazed wall tiles and fittings, after the edges of tiles have been thoroughly wet, shall be grouted with a plastic mix of neat white or colored cement immediately after a suitable area of tile has been laid.

The joints shall be tooled slightly concave and the excess mortar shall be cut off and wiped off with a damp cloth from the face of tile, before it sets hard.

Interstices or depressions found in the mortar joints after the grout has been cleaned from the surface shall be roughened at once and filled to the spring line of the cushion edge before the mortar begins to harden.

Immediately after the grout has had its initial set glazed wall tile surfaces shall be given a protective coat of a non-corrosive soap or other approved method of protection and joints cured for 72 hours.

Wall tiles operations in spaces requiring floor tiles shall not be started until the floor tiles installation had been completed.

E) Floor Dressing

The granular abrasive powder shall be trowelled into the finishing surfaces of the screed applied as desired hereinabove. Working out of the dressing shall strictly conform to the method of application recommended by the manufacturer of material.

F) Floor Sealing

The floor seal shall be applied on the surface of screed which have been prepared and applied as described hereinabove. Screed shall be cured for a minimum of five days before application of floor seal.

The priming and the working out of the floor seal shall strictly conform to the method of application recommended by the manufacturer of the material.

AGGLOMERATED TERRAZZO TILES

GENERAL

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY

Section Includes agglomerated (marble aggregate) cement tiles.

SUBMITTALS

Product Data: For each type of product indicated.

Shop Drawings: Include agglomerated cement installation requirements. Include plans, elevations, sections, component details, and attachments to other work. Show layout of the following:

Samples for Initial Selection: Color plates showing the full range of colors and patterns available for each agglomerated cement type indicated.

Samples for Verification: For each type, material, color, and pattern of agglomerated cement and accessory required showing the full range of color, texture, and pattern variations expected. Label each agglomerated cement sample to identify matrix color and marble-chip types, sizes, and proportions. Prepare samples of same thickness and from same material to be used for the Work.

Qualification Data: For qualified Installer.

Material Certificates: For each type of agglomerated cement material or product, from manufacturer.

Maintenance Data: For agglomerated cement to include in maintenance manuals.

QUALITY ASSURANCE

Installer Qualifications: An installer who has proven experience.

Source Limitations for Marble Chips: Obtain each color, grade, type, and variety of granular materials from one source with resources to provide materials of consistent quality in appearance and physical properties.

Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

Reinstallation Conference: Conduct conference at Project site.

DELIVERY, STORAGE, AND HANDLING

Deliver materials to Project site in supplier's original wrappings and containers, labeled with source's or manufacturer's name, material or product brand name, and lot number if any.

Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

PROJECT CONDITIONS

Environmental Limitations: Maintain temperature above (10 deg C) for 48 hours before and during agglomerated cement installation.

Field Measurements: Verify actual dimensions of construction contiguous with precast agglomerated cement by field measurements before fabrication.

Control and collect dust produced by grinding operations. Protect adjacent construction from detrimental effects of grinding operations.

PRODUCTS

A PRECAST AGGLOMERATED CEMENT

Precast Agglomerated Cement tiles.
Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product.

1. Polished Tile size 500 x 500mm.
2. Rough Textured Tile size 500 x 500mm.

Type and Top Edge: As selected by Engineer from manufacturer's full range and matching approved sample and matching approved sample and mockup.

Color, Pattern and Finish: As selected by Engineer from manufacturer full range.

Portland Cement Agglomerated cement Cleaner: Chemically neutral cleaner with pH factor between 7 and 10 that is biodegradable, phosphate free, and recommended by cleaner manufacturer for use on agglomerated cement type indicated.

B MORTAR SETTING-BED MATERIALS

Portland cement: ASTM C 150, Type I or II.

Hydrated Lime: ASTM C 207, Type S.

Aggregate: ASTM C 144.

Latex Additive: Styrene-butadiene-rubber or acrylic-resin water emulsion serving as replacement for part or all of gaging water, of type specifically recommended by manufacturer for use with job-mixed Portland cement and aggregate, and not containing a retarder.

Cleavage Membrane: Asphalt-saturated felt, ASTM D 226, Type I (No. 15); or polyethylene sheeting, ASTM D 4397, 4.0 mils (0.1 mm) thick.

Reinforcing Wire Fabric: Galvanized, welded wire fabric, (50.8 by 50.8 mm) by (1.57-mm) diameter; comply with ASTM A 185 and ASTM A 82, except for minimum wire size.

Thin-Set Materials: For setting floor brick on cured mortar bed, use latex-Portland cement mortar complying with ANSI A118.4, and consisting of the following:

1. Prepackaged Dry-Mortar Mix: Factory-prepared mixture of Portland cement; dry, redispersible, ethylene vinyl acetate additive; and other ingredients to which only water needs to be added at Project site.
2. Mixture of Dry-Mortar Mix and Latex Additive: Mixture of prepackaged dry-mortar mix and styrene-butadiene-rubber or acrylic-resin liquid-latex additive.

C GROUT MATERIALS

1. Portland cement: ASTM C 150, Type I or II.

2. Color: Natural color or white as required to produce joint color indicated.

3. Aggregate: ASTM C 144.

4. White Aggregate: Natural white sand or ground white stone.

5. Colored Aggregate: Ground marble, Stone, or other sound stone; selected to produce required grout color.

6. Colored Mortar Pigments for Grout: Natural and synthetic iron and chromium oxides, compounded for use in mortar and grout mixes. Use only pigments that have proved through testing and experience to be satisfactory for use in Portland cement grout.

7. Polymer-Modified Grout: ANSI A118.7.

8. Packaged, dry grout mix consisting of Portland cement, graded aggregate, and ethylene vinyl acetate in the form of a reemulsifiable powder to which only water is added at Project site.

9. Water: Potable.

D MIXES

1. General: Comply with referenced standards and with manufacturers' **written** instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimum performance characteristics. Discard mortars and grout when they have reached their initial set.

2. Portland Cement-Lime Setting-Bed Mortar: Type S, N complying with ASTM C 270, Proportion Specification.

3. Latex-Modified Portland Cement Setting-Bed Mortar: Proportion and mix Portland cement, aggregate, and liquid latex for setting bed to comply with directions of liquid-latex manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive brick.

4. Mortar-Bed Bond Coat: Mix neat cement and latex additive or water to a creamy consistency.

5. Latex-modified Portland Cement Slurry Bond Coat: Proportion and mix Portland cement, aggregate, and liquid latex for slurry bond coat to comply with directions of liquid-latex manufacturer.

6. Thin-Set Mortar: Proportion and mix thin-set mortar ingredients per directions of liquid-latex manufacturer.

7. Job-Mixed Portland Cement Grout: Proportion and mix job-mixed Portland cement and aggregate grout to match setting-bed mortar, except omit hydrated lime and use enough water to produce a pourable mixture.

8. Job-Mixed Polymer-Modified Portland Cement Grout: Add liquid-latex additive to dry grout mix in proportion and concentration recommended by liquid-latex manufacturer. Proportion cement and aggregate to comply with directions of latex-additive manufacturer.

9. Pigmented Grout: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1 to 10, by weight.

10. Colored-Aggregate Grout: Produce color required by combining colored aggregates with Portland cement of selected color.

11. Packaged, Polymer-Modified Grout Mix: Proportion and mix grout ingredients according to grout manufacturer's written instructions.

EXECUTION

PREPARATION

1. Clean substrates to produce clean, dry, and neutral substrate for agglomerated cement application.

2. Remove substances, including oil, grease, and curing compounds, that might impair bond of agglomerated cement system.

3. Roughen concrete substrates before installing agglomerated cement system.

4. Protect other work from dust generated by grinding operations. Control dust to prevent air pollution and comply with environmental protection regulations.

5. Erect and maintain temporary enclosures and other suitable methods to limit dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

F INSTALLATION, GENERAL

1. Do not use tiles with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

2. Mix tiles from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

3. Cut tiles with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

4. Joint Pattern: As indicated.

5. Hand-Tight Joints: Set tile with hand-tight joints where indicated.

6. Spaced Joint Widths: Provide nominal (10-mm) (13-mm) joint width with variations not exceeding plus or minus (1.6 mm) (3 mm), unless otherwise indicated.

7. Finished-Surface Tolerances: Do not exceed (1-mm) tile-to-tile offset from flush (lippage) nor (3 mm in 3 m) from level, or indicated slope, for finished surface of tile flooring.

8. Finished-Surface Tolerances: Do not exceed (1.6-mm) tile-to-tile offset from flush (lippage) nor (3 mm in 600 mm) and (6 mm in 3 m) from level, or indicated slope, for finished surface of tile flooring.

9. Expansion and Control Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide joint filler as backing for sealant-filled joints where indicated. Install joint filler before setting tile flooring. Sealant materials and installation are specified in Division 5 Section "Joint Sealants."

G PRECAST AGGLOMERATED CEMENT INSTALLATION

1. Install precast agglomerated cement units using method recommended by NTMA and manufacturer unless otherwise indicated.

2. Installation Tolerance: Set units with alignment level and true to dimensions, varying (3.2 mm) maximum in length, height, or width; noncumulative.

3. Do not install units that are chipped, cracked, discolored, or improperly finished.

4. Seal joints between units with cement grout matching precast agglomerated cement matrix.

H THIN-SET MORTARED AGGLOMERATED CEMENT FLOORING

1. Install agglomerated cement flooring on concrete subfloor with thin-set mortar to comply with the following requirements:

2. Wet tile before laying if the initial rate of absorption exceeds (30 g/194 sq. cm) per minute when tested per ASTM C 67. Allow tile to absorb the water so it is damp but not wet at the time of laying.

3. Apply thin-set mortar to substrate with notched trowel complying with admixture manufacturer's specifications for notch depth and configuration and in heavy enough layer to provide a minimum mortar-bed thickness of (2.5 to 3 mm) after bricks are fully embedded. Key the mortar into substrate with flat side of trowel and comb with notched side of trowel in one direction. Apply only as much mortar as can be covered with brick before initial set (15 to 30 minutes).

4. Place tile while mortar is still tacky and before initial set takes place. Immediately before placing tile, apply skim coat of thin-set mortar to back of tile. Place tile by sliding in direction perpendicular to combed ridges and tamp or beat tile with a small beating block to obtain full contact with mortar and to bring finished surfaces within indicated tolerances; do not return to areas already set and disturb tiles for purposes of realigning finished surfaces or adjusting joints.

I CLEANING AND PROTECTION

Precast agglomerated cement cleaning:

1. Remove grinding dust from installation and adjacent areas.

2. Wash surfaces with cleaner immediately after grouting precast agglomerated cement tiles and final cleaning of agglomerated cement flooring.

3. Rinse surfaces with water and allow to dry thoroughly.

4. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that agglomerated cement is without damage or deterioration at time of Substantial Completion.

MARBLE FLOORING AND CLADDING

General

1. **Work Included**

This section covers the furnishing and installation of all marble flooring and related accessories. The contractor shall furnish all labor, materials, tools and equipment required to complete the work.

2. **Applicable codes and Standards**

The following codes and standards are intended to provide an acceptable level of quality for materials and products. The contractor may propose alternative codes and standards provided they give an equivalent degree of quality as the referenced codes and standards are submitted to the Engineer for review and approval in advance of their use.

a. **DIN - Deutsches Institute fur Normung e.v.**

18352 Tile and Slab Laying Works

b. **ASTM - American Society for Testing and Materials**

C150 Portland Cement

C241 Marble abrasive hardness

C33 Fine Aggregates

C206 Types-S Hydrated Lime for masonry purposes

3. **Submittals**

The following shall be submitted to the Engineer for review and approval:

a. Samples

Samples of marble tiles measuring 400 x 400 mm, showing the range of variations.

b. Shop and Installation Drawings

Submit shop and installation drawings for Engineer's approval prior to fabrication or installation, showing pattern and constructural details.

c. Certification

Furnish a certificate from marble producer/supplier and duly attested by the contractor, stating that the marble meets the specified requirements. Certification shall be based on tests made by an independent laboratory.

d. Mock Ups

Before proceeding with the work of this section install at the Engineer Site Office the followings:

One complete panel of patterned marble flooring technique, jointing, finishing.

4. **Product Handling**

a. Do not allow scattering of materials on the job site and use all means necessary to ensure neatness.

b. The rejected materials shall immediately be removed from the site and replaced with the fresh materials.

c. Cementitious materials and aggregates should be stored in such a manner as to prevent deterioration or intrusion of foreign materials.

d. Upon receipt at the job site, the material shall be stacked on timber or platforms at least 100 mm above the ground, and extreme care shall be taken to prevent staining during storage. If the storage is to be for a prolonged period, polyethylene film shall be placed between any wood and finished surface, and shall be used also as an overall protective covering.

5. **Extra Stock**

The contractor shall furnish an extra supply of tile equal to 2% of each type and colour used in the work. This extra supply is over and above the normal allowance for breakage and waste and is to be furnished to the Engineer at the completion of the work. No separate payment will be made for this extra stock. The tiles shall be provided in clean, marked containers.

MATERIALS

1. **Marble Tiles**

Marble tiles shall be obtained from quarries having sufficient quantities to complete the work as indicated on the drawings. Tiles shall be sound with uniform and favorable working qualities. Color and texture shall be within the range of variations represented by samples accepted by the Engineer. Minor natural variations in color and markings which are characteristic of the materials and which do not impair strength or appearance will be permitted. The material shall have the following physical properties:

2. **Cement**

Portland cement conforming to ASTM C150 cement for jointing shall be white Portland.

3. **Sand**

Shall be clean, washed, sharp, and natural or manufactured conforming to ASTM C35. Sand for jointing shall be "white" sand to Engineer's approval.

4. **Water**

Water shall be portable and free from injurious amounts of soils, acids, alkalines, salts, organic materials or other substances that may be deleterious.

5. **Hydrated Lime**

Shall conform to ASTM specification C206 or C207 type-S

6. **Materials and Accepted Manufacturers**

Floor and Skirting shall be in mortar bed tiles as shown on drawings.

Tiles shall be laid in pattern in conformity with architect's special design and as shown on drawings.

Execution

1. **Marble**

a. Tolerances

Maximum variations in dimensions for face dimensions shall be +1mm from the approved shop drawings. Maximum variations in slab thickness shall be +3mm.

Variation from true plane or flat surfaces shall be determined by the use of a 1.2 meter long straightedge applied in any direction on the surface. Such variation shall not exceed 2 mm.

b. Jointing and Bedding

Jointing and bedding shall be carried out in accordance with International common practice.

Paving shall be laid on compacted sand with a minimum 30 mm mortar bedding to falls and levels indicated on the drawings. The mortar bedding shall be continuous such that no voids or pockets remain. Any slabs which sound "Hollow" or which move upon inspection shall be replaced.

2. **Inspection**

a. Inspection

1. Examine surfaces to receive granite tiles, mortar beds, or accessories before granite installation begins.

2. Correct the following conditions before proceeding with Tiling:

   - Defects, or condition adversely affecting quality, execution and permanence of marble installation.

   - Maximum deviation of surfaces to receive tiles veneer:

Vertical surfaces: 6 mm in 2.5 m

b. Condition of surface to receive tiling.

1. Firm, dry, clean and free of oily or waxy films.

2. Anchors, hangers, electrical and mechanical work in or behind marble to be installed prior to proceeding with tiling.

3) Execution

1. **Setting**

a. All setting shall be done by competent tile setters, in accordance with approved shop drawings.

b. Before being set, all marble shall be clean. Unless otherwise shown on approved shop drawings, each piece shall be carefully bedded in a full bed of mortar and tapped home with a rawhide mallet to full and solid bearing. Particular care shall be exercised to equalize bed and joint openings and eliminate the need for redressing of exposed surfaces. Exposed surfaces shall be kept free of mortar at all times.

c. Except for expansion joints and where otherwise specified, all joints and beds shall be completely filled, then raked out to depth specified, and every precaution shall be taken to prevent direct bearing contact between pieces.

d. Surfaces of the tiles shall correspond to the surface of the samples submitted and approved. Slabs disturbing the conformity of floor covering areas (difference in texture, pattern and color) shall be replaced at the contractor's expense.

e. Marble slabs for flooring and stairs shall be selected in such a way that the appearance of the complete finish will be as homogeneous as possible.

2. **Backing**

Backing shall be in accordance with drawings and as directed by the Engineer.

3. **Cleaning and Protection**

a. Cleaning

After being pointed, the Marble slabs shall be carefully cleaned, starting at the top, removing all dirt, excess mortar, stains and other defacements. Stainless steel wire brushes or wool may be used, but the use of other wire brushes or of acid or other solutions which may cause discoloration is expressly prohibited.

b. Protection of finished work

1. After the stonework is installed, it shall be the responsibility of the contractor to see that it is properly and adequately protected from damage. Boxing or other suitable protection shall be provided wherever required, but no lumber which may stain or deface the work shall be used. All nails used shall be galvanized or non-rusting.

2. All work in progress shall be protected at all times during construction by use of a suitable strong, impervious film or fabric securely held in place.

INTERLOCKING CONCRETE BLOCK SURFACING

A) Form of Construction

Concrete block surfacing shall consist of precast concrete blocks on a sand laying course laid on a 100 mm or 150 mm sub-base as shown on the drawings, laid on subgrade. In general blocks should conform to the requirements of the Specification for Precast Concrete Paving Blocks as per B.S.6717.

B) Subgrade

The subgrade shall be prepared in accordance with Roadway Excavation.

C) Base

The base shall be 100 mm or 150 mm thick and shall be laid in accordance with either Aggregate Road Base specification or that for subkha. The material used in any instance shall be as shown on the drawings.

Due allowance shall be made in the final levels of the base for the compaction of the laying course above, which occurs when the paving blocks are being vibrated. The amount of compaction of the laying course shall be determined by site trials prior to commencement of the actual surfacing.

D) Laying course

The laying course shall consist of washed sand with a particle size of 0-5 mm containing not more than 3% silt plus clay by weight. The sand shall be obtained from a single source, allowed to drain before use and shall be covered with suitable sheeting to minimize moisture changes.

Permissible chloride and sulphate contents shall as specified under Section 3 for aggregate.

The laying course shall be laid to a compacted depth of 50 mm. During laying the sand shall be uniform in moisture content and shall be carefully screeded to form a smooth compacted surface to receive the paving blocks.

The profile of the laying course before compaction shall be similar to that of the finished surface. The maximum deviation from the design levels shall be +/- 5 mm.

The edge restraints to the paved area shall be laid in advance of the laying course.

E) Surface Course

The surface course shall consist of precast concrete blocks, 80 mm thick, black color, for roads and 60 mm thick, red color, for sidewalks/footpaths of approved size, shape and pattern and manufactured on an approved machine, unless otherwise specified on the drawings or directed by the Engineer.

F) Admixtures

Block mix 'W' from Cormix additive shall be added at 1% by weight of cement while manufacturing the blocks.
Other admixtures will only be permitted to be used in the concrete with the express permission of the Engineer.

Admixtures used in the manufacture of the blocks shall be strictly controlled at all times to ensure that the correct quantity is administered. The equipment to be used for dispensing and the method of incorporating the admixture in the concrete shall be subject to the approval of the Engineer.

G) Cement, Water and Aggregates Generally

Cement, Water and Aggregates both coarse and fine, shall be as specified under section 3.

H) Concrete Mix

The concrete mix shall be designed to provide the required average compressive strength for the blocks to be not less than 49N/mm^2 plus the appropriate correction factor for the thickness and chamfer condition in a wet condition. No individual blocks shall have a strength of less than 40N/mm^2 plus the correction factor. These values shall be required at the date of testing. However generally they should be considered as 28 day strengths.

Adequate measures shall be taken to ensure that the concrete paving blocks are properly cured in a manner that is to the satisfaction of the Engineer.

I) Sampling Blocks

Two blocks shall be drawn from each group of 1000 blocks for sampling giving 10 blocks for every designated 5000 block section or part thereof in a consignment. All samples shall be clearly marked at the time of sampling in such a way that the designated section or part thereof and the consignment represented by the sample, are clearly defined.

These blocks shall be tested for dimensional accuracy, compressive strength and water absorption.

Should any of the 10 test blocks not comply with the tests detailed under "Test for dimensional accuracy" it shall be left to the discretion of the Engineer whether the whole consignment from which these blocks are selected shall be deemed not to comply with the Specification.

J) Compressive Strength

The average compressive strength of the block on delivery when sampled and tested in the manner described below shall not be less than 49 N/mm^2 in wet condition for 60 mm thick blocks. No individual block strength shall fall below 40 N/mm^2 in wet condition. Thickness and chamfer correction factor for compressive strength expressing the value to the nearest 1 N/mm^2 shall be as shown.

Block thickness	**Correction factors**	
	Plain block	**chamfered**
60 or 65 mm	1.00	1.06
80 mm	1.12	1.18

K) Test for Compressive Strength

The sample specimens shall be tested in a wet condition after being stored for at least 24 hours in water maintained at a temperature of 20°C +/- 5°C. Before the specimens are sub-merged in water, the necessary area shall be determined as follows:-

(i) Where possible, the plan area or the wearing surface area shall be calculated by multiplying the length by the width.

ii) Alternatively the plan area or the wearing area shall be calculated by cutting out shapes of cardboard and weighing it to the nearest 0.05 g.

$$A_S = \frac{20000\, m_S}{m}$$

Where A_S = Area of block (mm^2)

m_S = Mass of cardboard shape matching test block (g) the block shall be placed wearing surface uppermost on the cardboard.

m = Mass of 200 x 100 mm cardboard rectangle (g) cut from the same cardboard.

In case of chamfer or radius, the width of chamfer or radius shall be measured and marked on the cardboard shape. This shape shall then be cut out accurately and weighed for the above calculation of the wearing surface area.

Plywood, nominally 4 mm thick, shall be used as packing between the upper and lower faces of the specimen and the machine platens, and these boards shall be larger than the specimen by a margin of at least 5 mm at all points. Fresh packing shall be used for each specimen tested.

The load shall be applied without shock and increased continuously at a rate of approximately 15 N/mm^2 per minute until no greater load can be sustained. The maximum load applied to the specimen shall be recorded. The strength shall be expressed to the nearest 0.1 N/mm^2.

L) Test for Dimensional Accuracy

Standard rectangular blocks shall be manufactured with a nominal length of 200 mm and a nominal width of 100 mm.

Alternative sizes and shapes shall have a ratio of length to width on plan of not less than 1 1/2 or greater than 2 1/2 the width shall not be less than 80 mm or greater than 115 mm. The minimum

normal thickness for paving blocks of any size shall be 60 mm. The preferred nominal thickness shall be 60, 80 and 100mm.

All arrises shall be clean, plane and of uniform dimension. Wearing surface area shall be not less than 70% of the plan area.

Tolerances: Length +/- 2 mm ; Width +/- 2 mm ; Thickness +/- 2 mm.

M) Water Absorption

Concrete paving blocks shall be tested as the Engineer may direct for water absorption. This test shall be based upon that specified in BS 1881 and the maximum acceptable limits for water absorption shall be:

2% absorbed after 10 mins 5% absorbed after 24 hours

The Engineer may also require tests for Drying Shrinkage and Moisture Movement for which purpose a specimen cut from a typical concrete paving block would be used and the methods of testing would be based upon those specified in BS7263 : Part 1 (Appendix B) and BS 1881 but agreed with Engineer.

Based upon the results of tests specified above, the Engineer may vary the acceptable limits for water absorption to achieve the minimum absorption with the aggregate approved for use in the paving blocks.

N) Color

The colors of the concrete paving blocks shall be as indicated under surface course unless otherwise shown on drawings or instructed by the Engineer and shall be maintained at a uniformity that is acceptable to the Engineer. Pigments shall comply with BS1014.

O) Laying the Blocks

Laying of the paving blocks shall commence at right angles to the main pavement axis starting at one end of the area. The paving blocks shall be laid in a herringbone pattern unless otherwise shown on the drawings or instructed by the Engineer at 45° to the main pavement axis.

The paving blocks shall be laid on the sand laying course in such a manner as not to disturb the blocks already laid. Each block shall be placed firmly against its neighbor so that they fit closely together. The joints between blocks shall not exceed 3 mm.

P) Edge Details

Where blocks do not fit at the edge restraints or other obstructions such as manholes or

Up stands the gaps shall be filled using cut blocks. Blocks shall preferably be cut using a mechanical block splitter but may be cut by hand using a club hammer and bolster chisel after having scored the cutting line on all faces of the block.

Dimensional accuracy, uniformity of joints gaps, alignment and squareness shall be checked after laying the first three rows of blocks and thereafter at regular intervals. If joints begin to open, the blocks shall be knocked together using a hide mallet.

Q) Compaction by Vibration

After each 20 sq.m., or such area that has been agreed with the Engineer, has been laid the blocks shall be compacted to the required levels using a plate vibrator.
The plate vibrator shall have a plate area of 0.2 to 0.3 sq.m and have a compaction force of 9-16 KN.

Two passes of the plate vibrator shall be made in each direction, i.e. at 90° to each other.

R) Filling Joints

Fine dry sand with a particle size of 0-3 mm and which complies with Section 3 of the specifications shall be brushed over the paving, filling the joints. Filling of joints shall be ensured by plate vibrator passes made in each direction.

The plate vibrator shall not pass closer than 1 meter to a temporary unrestrained edge during laying.

No paving shall be left uncompact overnight except for the 1 m strip at the temporarily unrestrained edge.

S) Laying Tolerance

On completion, the finished surface level shall be within 5 mm of the design level and the maximum deviation within the compacted surface, measured by a 3 m straight edge, shall not exceed 5 mm. The level of any two adjacent blocks shall not differ by more than 2 mm. Any areas of paving which do not comply with these tolerances shall be removed, the sand laying course adjusted and the paving blocks re-laid to the correct levels.

SUSPENDED CEILINGS

PART I - GENERAL

SCOPE

These specifications cover suspended ceiling systems intended for use in the Project in accordance with the Drawings, Bills of Quantities and manufacturer's specifications.

MATERIALS

A) **Acoustical False Ceiling**

Acoustical Mineral Fiber tiles 600 x 600mm shall be non- combustible conforming with the requirements of the Americal Federal Specifications SS - A 118b and shall be as described in the current Acoustical Materials Association Bulletin. Sound-Absorption Coefficients of Architectural Acoustical Materials.

Acoustical ceiling tiles or panels shall be as manufactured by "ARMSTRONG CORK COMPANY Ltd" or "Johns - Manville" and/or approved equivalent.

Acoustical ceiling tiles or panels shall be of the size, thickness, whether perforated or non-perforate, design and finishes shown on the drawings and/or stated in the Bills of Quantities.

Samples of acoustical ceiling tiles or panels in suspension system members, with catalog data, shall be submitted to the Engineer for approval at least two weeks prior to order.

B) **Glass Reinforced Gypsum Tile (Concealed) Suspended Ceiling**

Glass reinforced gypsum decorative tile suspended ceiling shall be 600 x 600 x 20 mm thick fully accessible and demountable decorative tiles in a concealed metal suspension system as indicated on drawings.

The tile pattern and colour shall be to the approval of the Engineer.

Gypsum false ceiling shall be composed of moulded decorative panels 600 x 600 x 20 mm thick made of fibrous plaster suitably reinforced with standard backings. The contractor shall produce workshop drawings for the approval of the Engineer before ordering the material. Necessary openings shall be provided for lighting fixtures and A/C grills in coordination with the respective services and the gaps sealed to the satisfaction of the Engineer. The false ceiling shall be finished as recommended by the manufacturer and/or as directed by the Engineer.

Suspended ceilings shall be fixed strictly in accordance with the manufacturer's written instructions using fixing accessories supplied by the chosen manufacturer.

C) **Decorative Gypsum Board Suspended Ceiling**

Gypsum board suspended ceiling system shall be installed as detailed on the drawings to the approval of the Engineer.

Gypsum board suspended ceiling system shall be manufactured and installed as detailed on the drawings by an approved sub-Contractor who has successfully engaged himself in similar works for at least 7 years.

Plaster board ceiling shall comprise of 13 mm thick layer of approved proprietary plaster boards screw fastened to approve support framing at 600 mm centers both ways. Joints shall be sealed with vinyl based cement and perforated paper type and all caulkings shall be with vermiculite plaster (1½ parts exfoliated vermiculite to 1 part plaster). The suspension system shall be designed to suit the layout, spans, and the design loads and all substantiating design calculations and details shall be submitted to the Engineer for his approval. Approval accorded by the Engineer shall not relieve the Contractor of his obligations to provide a safe and aesthetic ceiling.

Plaster boards shall be manufactured with gypsum plaster complying to BS 1191, Class A Plaster of Paris using necessary reinforcements fibers, hardeners and additives.

The suspended ceiling shall be provided with mouldings at all edges, corners, etc., to achieve the desired effect as detailed on the drawings and to the approval of the Engineer.

Fibrous gypsum suspended ceiling mouldings cornices, etc. shall be formed using the approved design mix with all constituent materials being gauged, batched or weighed accurately. Moulds shall be dimensionally and geometrically accurate and release agents/waxes that will allow a clean release of the casting without adversely affecting the component surfaces shall be used. The moulding and castings shall include all necessary fixing holes, brackets, etc. Mouldings and coatings shall be individually inspected for any surface blemishes shall be rectified in an approved manner.

The components shall be true in shape and free from cup and bow. The dimensional accuracy shall be + or - 2 mm per m and the horizontal plane deviation shall not exceed 0.3% of the component length. The squareness of rectangular components shall be such that the difference between the diagonals shall not exceed 0.5% of the shorter diagonal.

The formed components shall be asbestos free, antistatic and shall have a density not exceeding 1500 kg/m3, be unaffected by ultra violet light and not support fungoid attack. Their thermal conductivity (k) value shall not be greater than 0.375 W/m2/deg C and shall have a thermal coefficient of expansion not exceeding 14.94 x 10-6 mm/deg. C. They shall not absorb moisture present in internal locations through excessive humidity.

Components shall have an ultimate tensile strength of not less than 8.27 N/mm2, an impact strength 16812-17232N/mm2 and a Rockwell hardness classification of M 72. Components shall be classed non-combustible when tested to BS 476 Part 4: 1970 (1984).

Component thickness shall be as recommended by the manufacturer or as directed by the Engineer.

The contractor shall form necessary opening for various services including any access panels as required and finish them appropriately to the satisfaction of the Engineer.

The Contractor shall prepare detailed shop drawings after verifying the dimensions at site, of the components and fixings and submit them for the approval of the Engineer prior to casting. The shop drawings shall also detail the various suspension materials and the methods of fixing the casting along with his proposed method of erecting each compact. The Contractor shall prepare for the Engineers approval samples of the various mouldings cornices and decoration works.

The Contractor shall protect all Gypsum works from damage until the completion of the Works. Should any damages be caused it shall be made good to the satisfaction of the Engineer at the Contractors expense. All inlaid materials, mirrors, air conditioning grilles and the like shall be cleaned and left in perfect condition.

D) **Aluminum Ceiling System**

The suspended ceiling system shall consist of Aluminum panel with acoustic infill suspended by proprietary Suspension system with rigid galvanized, suspenders, U channels, cross channels, connecting clips, anchors, matching edge trims, etc.. Fixed and spaced strictly in accordance with the Manufacturer's instructions as detailed on drawings and/or as directed by the Engineer.

The surface treatment shall be polyester powder coating by electro static spraying to not less than 60 microns as per BS 6496:1984 (1991) to a color as shown on the Drawing and/or as directed by the Engineer.

E) **Aluminum Strip Ceilings**

Aluminum ceiling panels shall be similar to " Luxalon Aluminum Panel Ceiling, the product of "Hunter Duglas" or Mirawal - Dampa Aluminum Acoustical Ceiling Systems, the product of "Mirawal Company" and/or approved equivalent.

Aluminum ceiling panels shall be of the size, thickness, whether perforated or non-perforated, design or type and finishes shown on the Drawings and/or stated in the Bills of Quantities.

Samples of Aluminum ceiling panels with carriers shall be submitted to the Engineer for approval prior to order.

F) **Metallic Grid. Hangers and Fixing Accessories**

All suspension members, hangers, wires, strips, clips, clamps, etc. shall be of the sizes and types recommended by the manufacturer of the suspended ceiling systems.

The metal grid for suspended ceilings shall be either concealed or exposed system as indicated on the Drawings and/or stated in the Bills of Quantities.

WORKMANSHIP

The exposed metal grid system for suspended ceilings shall be made of aluminum sections or factory hot dipped galvanized steel sections and the concealed system shall be made of steel sections painted with approved rust inhabitive primer as recommended by the manufacturer of suspended ceilings and approved by the Engineer.

False ceiling materials shall be installed under temperature and humidity conditions similar to those which will exist when the building is occupied. They should not be installed when buildings are damp and cold or dry and hot. Plastering, floor and wall cladding shall be completed and allowed to dry before the installation of acoustical materials commences. All windows and doors shall be in place and glazed. Poured or precast concrete or similar roof decks shall be thoroughly dry.

Buildings shall be examined before beginning work to determine that it is properly enclosed and the structure is in proper conditions to receive acoustical materials and/or suspended system. Areas shall be broom cleaned and uninterrupted for free movement of rolling scaffold.

All products covered by these specifications shall be installed in accordance with the latest edition of the approved manufacturer’s specifications.

All materials and suspension systems shall be installed by skilled labor, thoroughly experienced with this type of installation and in strict conformity with the manufacturer's specifications and to the approval of the Engineer.

Suspended ceiling shall be constructed in accordance with the detail and instructions supplied by the manufacturer and approved by the Engineer. The grid shall be constructed to true level and to produce a perfect alignment of the joints truly parallel to the building lines, and completely free from waviness.

Special access hatches as required shall be provided next to air conditioning and ventilation units and wherever required by the Engineer. Mounting details shall be applied for the surrounding edge of lighting fixtures and air inlets and outlets and edge of ceiling.

After the installation of the panel carriers for the aluminum ceiling panels, the panels shall be clipped on-to the carriers without the use of any tools.

Following installation, the Contractor shall clean soiled or discolored surfaces of units, remove and replace any unit which is damaged or improperly installed to the satisfaction of the Engineer.

NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

SUMMARY

A. Section Includes:
1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
2. Suspension systems for interior gypsum ceilings and soffits.

PART 2 - PRODUCTS

PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: Provide materials and construction identical to those tested according to ASTM E 119.

B. STC-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413.

C. Recycled Content of Steel Products: Provide products with average recycled content of steel products such that postconsumer recycled content plus one-half of pre-consumer recycled content is not less than [**25**] percent.

FRAMING SYSTEMS

A. Steel Studs and Runners: ASTM C 645. [Use either steel studs and runners or dimpled steel studs and runners of equivalent minimum base-metal thickness.]

1. Minimum Base-Metal Thickness: [**As indicated on Drawings**]
2. Depth: [**As indicated on Drawings**].

B. Slip-Type Head Joints: Where indicated, provide[one of] the following in thick-ness not less than indicated for studs and in width to accommodate depth of studs:

1. Single Long-Leg Runner System: ASTM C 645 top runner with (51-mm) deep flanges, installed with studs friction fit into top runner and with continuous bridging located within (305 mm) of the top of studs to provide lateral bracing.
2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch (51-mm) deep flanges and fastened to studs, and outer runner sized to friction fit inside runner.
3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes due to deflection of structure above.
   a. Products: Subject to compliance with requirements, [**available products that may be incorporated into the Work**].

C. Fire stop Tracks: Manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

1. Products: Subject to compliance with requirements, [**available products that may be incorporated into the Work**].

D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Metal Thickness: [**As indicated on Drawings**].

E. Cold-Rolled Channel Bridging: Steel, (1.34-mm) minimum base-metal thick-ness, with minimum (13-mm-) wide flanges.

1. Depth: [**As indicated on Drawings**].
2. Clip Angle: Not less than (38 by 38 mm), (1.72-mm-) thick, galvanized steel.

F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

1. Minimum Base-Metal Thickness: [**As indicated on Drawings**].
2. Depth: [**As indicated on Drawings**].

G. Resilient Furring Channels: (13-mm) deep, steel sheet members designed to reduce sound transmission.

1. Configuration: [**hat shaped**].

H. Cold-Rolled Furring Channels: (1.34-mm) uncoated-steel thickness, with mini-mum (13-mm) wide flanges.

1. Depth: [**As indicated on Drawings**].
2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of (0.8 mm).
3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, (1.59-mm) diameter wire, or double strand of (1.21-mm) diameter wire.

I. Z-Shaped Furring: With slotted or no slotted web, face flange of [(31.8 mm)], wall attachment flange of (22 mm), minimum uncoated-metal thickness of (0.45 mm), and depth required to fit insulation thickness indicated.

SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire.

B. Hanger Attachments to Concrete:

1. Anchors: Capable of sustaining load equal to [5] times that imposed as determined by ASTM E 488.
   a. Type: [**Post installed, expansion anchor**].

2. Powder-Actuated Fasteners: Capable of sustaining, a load equal to [**10**] times that imposed as determined by ASTM E 1190.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.

D. Flat Hangers: Steel sheet, [in size indicated on Drawings].

E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of (1.34 mm) and minimum (13-mm) wide flanges.

1. Depth: [**As indicated on Drawings**].

F. Furring Channels (Furring Members):

1. Cold-Rolled Channels: (1.34-mm) uncoated-steel thickness, with minimum (13-mm) wide flanges, (19 mm) deep.

2. Steel Studs and Runners: ASTM C 645. [**Use either steel studs and runners or dimpled steel studs and runners of equivalent minimum base-metal thickness.**]
   a. Minimum Base-Metal Thickness: [**As indicated on Drawings**]
   b. Depth: [**As indicated on Drawings**].

3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, (22 mm) deep.
   a. Minimum Base-Metal Thickness: [**As indicated on Drawings**].

4. Resilient Furring Channels: (13-mm) deep members designed to reduce sound transmission.
   a. Configuration: [**hat shaped**].

AUXILIARY MATERIALS

A. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide [foam gasket].

PART 3 – EXECUTION

INSTALLATION, GENERAL

A. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

B. Install bracing at terminations in assemblies.

C. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacing's indicated, but not greater than spacing's required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
   a Install two studs at each jamb unless otherwise indicated.
   b. Install cripple studs at head adjacent to each jamb stud, with a minimum (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
   c. Extend jamb studs through suspended ceilings and attach to under-side of overhead structure.
3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
   a. Fire stop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
6. Curved Partitions:
   a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
   b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs (150 mm) o.c.

E. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced (610 mm) o.c.

F. Z-Furring Members:

1. Erect insulation vertically and hold in place with Z-furring members' spaced [**600 mm**] o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced (610 mm) o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than (305 mm) from corner and cut insulation to fit.

G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than (3 mm) from the plane formed by faces of adjacent framing.

INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components according to spacing indicated, but not greater than spacing required by referenced installation standards for assembly types.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
    a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, counters playing, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacing that interfere with locations of hangers, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

3. Do not attach hangers to steel roof deck.

4. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.

5. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.

6. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems [with hangers used for support].

F. Installation Tolerances: Install suspension systems that are level to within [(3 mm in 3.6 m)] measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

GYPSUM BOARD

PART I - GENERAL

SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Tile backing panels.
3. Texture finishes.

ACTION SUBMITTALS

A. Samples:

1. Textured Finishes: [**Manufacturer's standard size**] for each textured finish indicated and on same backing indicated for Work.

PART 2 - PRODUCTS

PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

C. Low Emitting Materials: For ceiling and wall assemblies, provide materials and construction identical to those tested in assembly and complying with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

GYPSUM BOARD, GENERAL

A. Regional Materials: Gypsum panel products shall be manufactured within (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within (800 km) of Project site.

B. Regional Materials: Gypsum panel products shall be manufactured within (800 km) of Project site.

INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements.

B. Gypsum Wallboard: ASTM C 1396/C 1396M

1. Thickness: (12.7 mm)
2. Long Edges: [**Tapered**]

C. Gypsum Ceiling Board: ASTM C 1396/C 1396M:

1. Thickness: (12.7 mm)
2. Long Edges: [**Tapered**]

D. Abuse-Resistant Gypsum Board: ASTM C 1629/C 1629M.

1. Core: [**As indicated on Drawings**] [(12.7 mm), **regular type**].
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D 3273, score of 10.

E. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.

1. Core: [As indicated] [(12.7 mm), regular type] [(15.9 mm), Type X].
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D 3273, score of 10.

EXTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS

A. Exterior Gypsum Soffit Board: ASTM C 1396/C 1396M, with manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements.

2. Core: [**As indicated**] [(12.7 mm)**, regular type**].
   a. Waterproofing
   b. Moisture and mold resistance
   c. Fire resistance
   d. Impact resistance

INTERIOR STONEWORK

PART 1 - GENERAL

SUMMARY

A. Extent of interior stonework is indicated on Drawings and in schedules.

B. Interior stonework includes the following:

1. Marble tile flooring including stair treads and risers.
2. Marble bases and thresholds.
3. Marble cladding facing to walls and columns.
4. Marble partitions at WC cubicles and urinals.

C. Stonework incorporated into joinery and architectural woodwork is specified in Joinery Section.

D. Sealing joints in interior stonework is specified in Joint Sealers section.

QUALITY ASSURANCE

A. Single Source Responsibility for Stone: Obtain each color, grade, finish, type and variety of stone from a single source with adequate resources to provide materials of consistent quality in appearance and physical properties, including the capacity to cut and finish material without delaying the progress of the Work.

B. Single Source Responsibility for Setting Materials: Obtain mortar ingredients of uniform quality and from one manufacturer for each cementations and admixture component and from one source or producer for each aggregate.

C. Standards: Unless otherwise approved by the Engineer, comply with recommendation of:

1. Marble Institute of America (MIA), or the Stone Federation of the UK.

D. Field-Constructed Mock-Up: Prepare mock-ups for the following types of interior stonework. Purpose of mock-ups is further verification of selections made for color and finish under sample submittals and establishing standard of quality for aesthetic effects expected in completed work. Build mock-ups to comply with following requirements:

1. Locate mock-ups on site where indicated or, if not indicated, as directed by Engineer.

2. Build mock-ups for the following types of interior stonework:
   a. Marble flooring including base in form of panel as indicated on drawings.
   b. Marble wall cladding in form of panel as indicated on drawings, incorporating one vertical external corner.

3. Erect mock-ups in presence of Engineer.

4. Retain mock-ups during construction as a standard for judging completed stonework. Do not alter, move or destroy mock-up until work is completed.

PART 2 - PRODUCTS

MATERIALS, GENERAL

A. Comply with referenced standards and other requirements indicated applicable to each type of material required.

B. Provide premier quality matched stones obtained from an approved a single quarry for each type, variety, color and quality of stone required. Extract blocks from a single bed of quarry stratum, unless stones from randomly selected blocks are acceptable to Engineer for aesthetic effect.

C. Provide stones, which are free from vents, cracks, fissures, discoloration or other surface defects, which may adversely affect strength or appearance.

INTERIOR MARBLE

A. Match Engineer's approved sample for each marble type, including variety, group, color, surface finish, and other characteristics relating to aesthetic effects.

1. Marble: white Italian Carrara first choice; polished finish
   a. Tile flooring, and staircase treads and risers.
   b. Bases, thresholds, etc.
   c. Fronts and partitions at WC cubicles and urinals.

2. Marble: Greek Thassous, Crystal; polished finish
   a. Cladding and facing to wall and columns, including copings, returns, reveals, etc.

MORTAR AND GROUT MATERIALS

A. Portland cement: ASTM C 150 Type I; or BS.12. Provide gray or white cement as needed to produce mortar color required.

B. Hydrated Lime: ASTM C 207 Type S; or BS. 890

C. Aggregate: ASTM C 144; or BS. 1198/1200; non-staining and as indicated below:

1. For joints narrower than 6 mm use aggregate graded with 100 percent passing the No. 8 sieve and 95 percent the No. 16 sieve.
2. For pointing mortar use aggregate graded with 100 percent passing the No. 16 sieve.
3. White Aggregates: Natural white sand or ground white stone.

D. Colored Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with record of satisfactory performance in stone mortars.

E. Latex-Portland Cement Grout: ANSI A118.6, of the following composition and requirements:

1. Latex additive (water emulsion) serving as a replacement for part or all of gauging water, added at job site to prepackaged dry grout mix.
2. Manufacturers standard. Prepackaged latex Portland cement dry mix grout specified or supplied by latex manufacturer.
3. Provide grout colors approved by the Engineer to match color of stone.

F. Water: Clean, non-alkaline and potable.

STONE ACCESSORIES

A. Stone Anchors: Stainless steel, type and size shown or, if not shown, as required and approved by the Engineer for securely anchoring and fastening interior stonework in place.

B. Setting Buttons: Lead or resilient plastic buttons, non- staining to stone, sized to suit joint thicknesses and bed depths of stonework involved.

C. Metal Edge Strips: Stainless steel strips, 3 mm wide at top edge, with integral provision for anchorage to mortar bed or substrate, unless otherwise indicated.

D. Cleaner: Provide stone cleaners of proper formulation for kinds of stones, finishes and applications indicated, as recommended by stone producer and, if sealer specified, by sealer manufacturer. Do not use acid-type cleaning agents or other cleaning compounds containing caustic or harsh fillers, except where expressly approved by stone producer for type of condition involved.

E. Sealer for Floors: Colorless, slip and stain resistant sealer which will not affect color or physical properties of stone surface, as recommended by sealer manufacturer and by stone producer for application intended.

MORTAR AND GROUT MIXES

A. General: Do not add admixtures including coloring pigments, air-entraining agents, accelerators, retarders, water repellent agents, anti-freeze compounds, or calcium chloride, unless otherwise indicated.

B. Mixing: Combine and thoroughly mix cementations materials, water and aggregates in a mechanical batch mixer; comply with ASTM, ANSI, BS or other acceptable standard, as applicable, for mixing time and water content.

C. Spotting Plaster: Stiff mix of molding plaster and water.

D. Setting Mortars and Grout for Flooring: Comply with mixing requirements of referenced ANSI or other acceptable standards for materials and installation methods.

E. Pointing Mortar: Provide pointing mortar mixed to match Engineer's approved sample and complying with requirements indicated above for setting mortar including type and the following:

   1. Colored Pigmented Pointing Mortar: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1-to-10, by weight.

PART 3 - EXECUTION

EXAMINATION

A. Examine surfaces to receive stonework and conditions under which stonework will be installed. Do not proceed with installation until surfaces and conditions comply with requirements indicated or for execution of other work which affects stonework.

PREPARATION

A. Advise installers of other work about specific requirements relating to placement of inserts, regrets and similar items which will be used by Stonework Installer for anchoring and supporting stonework. Furnish Installers of other work with drawings or templates showing locations of these items.

B. Prior to setting, clean stone surfaces to remove soil, stains and foreign materials. Clean stones by thoroughly scrubbing stones with fiber brushes followed by a thorough drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh filler or abrasives.

SETTING STONE, GENERAL

A. Execute stonework by skilled tradesmen, and employ skilled stone fitters at the site to perform any necessary field cutting, as stones are set.

   1. Use power saws to cut stones; produce exposed edges, which are cut straight and true.

B. Set stones to comply with requirements indicated on drawings and final shop drawings. Install anchors, supports, fasteners and other attachments indicated or necessary to secure stonework in place. Shim and adjust anchors, supports and accessories to set stones accurately in locations indicated with uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.

C. Construction Tolerances: Set stones to comply with the following tolerances:

   1. Variation from Plumb: For lines and surfaces of columns, walls and arises. Do not exceed 6mm in 3m, 10mm in a story height or 6m maximum, nor 15mm in 12m or more. For external corners, expansion joints and other conspicuous lines, do not exceed 6mm in any story or 6m maximum, nor 15mm in 12m or more.
   2. Variation from Level: For grades indicated, horizontal grooves and other conspicuous lines, do not exceed 15mm in any bay or 6mm maximum, nor 20mm in 12m or more.
   3. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls and partitions, do not exceed 15mm in any bay or 500mm maximum, nor 20mm in 12m or more.
   4. Variation in Surface Plane of flooring: Do not exceed 3mm from level or slope indicated, when tested with 3m straight edge.
   5. Variation in Cross-Sectional Dimensions: For columns and thickness of walls from dimensions indicated, do not exceed minus 6mm nor plus 15mm.

D. Expansion and Control Joints: Provide for expansion and control joints of widths and at locations indicated, or as required.
   1. Sealant for expansion and other joints is specified Joint Sealers section.

INSTALLATION OF STONE FLOORING

A. Extend flooring into recesses and under or behind equipment and fixtures, to form a complete covering without interruptions, except as otherwise shown. Terminate work neatly at obstructions, edges and corners without disrupting pattern or joint alignments.

B. Accurately form intersections and returns. Perform cutting and drilling of stones without marring visible surfaces. Carefully grind cut edges of stones abutting trim, finish or built-in items for straight aligned joints. Fit stones closely to electrical outlets, piping, fixtures and other penetrations so that plates, collars, or covers overlap stones.

C. Metal Edge Strips: Install at locations indicated or where exposed edge of stone flooring meets carpet, wood, or other flooring which finishes flush with top of stones.

D. Jointing Pattern for Tile: Unless otherwise shown, lay tile in grid pattern. Align joints when adjoining tiles on floor, base, walls and trim are same size. Layout tile work and center tile fields in both directions in each space or on each wall area.

E. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise shown.

F. Match tiles for color and other appearance characteristics by using tiles in same sequence as manufactured and packaged.

G. Stone Flooring Set in Portland Cement Mortar Bed:

1. Saturate concrete subfloor with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
2. Apply slurry of cement grout over surface of concrete subfloor about 15 minutes prior to placing setting bed. Limit area to avoid its drying out prior to placing setting bed. Mix slurry to a consistency similar to that of thick cream and consisting of either neat cement and water, or cement, sand and water. Do not exceed 1.5mm thickness for slurry coat.
3. Mix setting bed in proportions of 1:2:6 cement/lime/sand to quantity of water to produce a stiff mixture with a moist surface when setting bed is ready to receive stone flooring.
4. Spread and screed setting bed to uniform thickness indicated to produce subgrade elevations required for accurate shown. Mix and place only the amount, which can be covered with stone prior to initial set. Cut back, bevel edge, remove and discard setting bed material, which has reached initial set prior to placing stone.
5. Butter backs of stone flooring units until firmly bedded to proper finished floor elevation indicated. Set and level each stone unit in single operation, prior to initial set of cement bed; do not return to areas already set and disturb stone for leveling purposes.

H. Grouting Stone Flooring:

1. Mix grout consisting if factory prepared color pigmented grout and liquid latex admixture in proportions recommended by manufacturer.
2. Grout joints in stone flooring units, except at expansion and control joints indicated as required to be filled with sealant. Finish grout flush with finished surface of stone. Fill all gaps and skips to produce a finished joint which is uniform in color, smooth and without voids, pinholes, or low spots.
3. Remove grout spillage from face of stone as work progresses.
4. Cure grout by maintaining in a moist condition for 7 days.
5. Do not permit traffic on stone flooring during setting of units for at least 24 hours after final grouting of joints.

INSTALLATION OF INTERIOR WALL FACING AND TRIM; AND PARTITIONS

A. Erect interior wall facing and trim plumb and true with joints uniform in width and accurately aligned. Provide setting buttons as required to maintain joint width.

B. Erect interior WC cubicle fronts/ partition and urinal partitions plumb, true and accurately aligned as indicated.

   1. Provide all necessary metal supports, brackets, anchors, fixings, fasteners and the like; chromium plated or stainless steel exposed finish.

C. Point joints after setting with pointing mortar of color indicated, mixed in proportions of 1-part Portland cement, 1-part time and 3-parts sand, unless otherwise indicated. Rub joints smooth with plastic tool.

ADJUSTINGS, CLEANING, AND SEALING

A. Remove and replace stonework of the following description.

   1. Broken, chipped, stained or otherwise damaged stones.
   2. Defective joints.
   3. Stones and joints not matching approved samples and field constructed mock-ups.
   4. Stonework not complying with other requirements indicated.

B. Replace in manner which results in stonework matching approved samples and field-constructed mock-ups, complying with other requirements and showing no evidence of replacement.

C. Clean interior stonework after setting, pointing, grouting and curing is complete; use procedures recommended by stone producer for types of application indicated.

D. Apply stone sealer to cleaned interior stone flooring in compliance with sealer manufacturer's instructions.

E. Protect interior stone flooring during construction period with Kraft paper or other heavy covering of type that will not stain or discolor stone.

F. Before inspection for substantial completion, remove protective covering and clean sealed surfaces using procedures and materials recommended by sealer manufacturer.

PAINTING

PART 1- GENERAL

SUMMARY

A. Extent of painting work is indicated and Drawings, schedules and herein, and includes surface preparation, painting, and finishing of exposed interior and exterior items and surfaces.

1. Surface preparation, priming, and finish coats specified in this section are in addition to shop priming and surface treatment specified under other sections.

B. Paint exposed surfaces whether or not colors are designated in "schedules," except where a surface or material is specifically indicated not to be painted or is to remain natural. Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces. If color or finish is not designated, the Engineer will select from standard manufacturer's colors or finishes available.

1. Painting includes field painting exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.

C. Painting is not required on prefinished items, finished metal surfaces, concealed surfaces, operating parts, and labels.

1. Prefinished items not to be painted include all factory-finished components such as:
    a. Prefinished metal fabrications.
    b. Acoustic ceilings.
    c. Joinery and architectural woodwork.
    d. Elevator equipment.
    e. Finished mechanical and electrical equipment.
    f. Light fixtures.
    g. Switchgear.
    h. Distribution cabinets.

2. Finished metal surfaces not to be painted include:
    a. Anodized aluminum.
    b. Stainless steel.
    c. Chromium plate.

3. Operating parts not to be painted include moving parts of operating equipment such as the following:
    a. Valve and damper operators.
    b. Linkages.
    c. Sensing devices.
    d. Motor and fan shafts.

4. Labels: Do not paint over regulation or code-required labels or equipment name, identification, performance rating, or nomenclature plates.

DEFINITIONS

A. “Paint" includes coating systems materials; primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate, or finish coats.

QUALITY ASSURANCE

A. Single-Source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats.

B. Coordination of Work: Review other sections in which primers are provided to ensure compatibility of the total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

PART 2 - PRODUCTS

MATERIALS, GENERAL

A. Material Quality: Provide only best quality grades for the various types of coatings and paint systems required, as regularly manufactured and recommended by acceptable paint manufacturers. Paint material containers not displaying manufacturer's names and product identification will not be acceptable.
   1. Proprietary names used to designate colors or materials are not intended to imply that products of named manufacturers are required or to exclude equivalent products of other manufacturers.

B. Color Pigments: Pure, non-fading, applicable types to suit substrates and services indicated.
   1. Lead contents in pigment, if any, is limited to contain no more than 0.06% lead, as lead metal based on the total non-volatile (dry-film) of paint be weight.

FIELD QUALITY CONTROL

A. The Engineer reserves the right to request the following test procedure at any time and as often as the Engineer deems necessary during the period when paint is being applied:

   1. The Contractor shall engage the services of an independent testing laboratory approved by the Engineer to sample the paint material being used. Samples of material delivered to the project will be taken, identified, sealed, and certified in the presence of the Contractor.

   2. The testing laboratory will perform appropriate tests for all or any of the following characteristics as required by the Engineer:
      a. Quantitative materials analysis.
      b. Abrasion resistance.
      c. Apparent reflectivity.
      d. Flexibility.
      e. Wash ability.
      f. Absorption.
      g. Accelerated weathering.
      h. Dry opacity.
      i. Accelerated yellowness.
      j. Recoating.
      k. Skinning.
      l. Color retention.
      m. Alkali and mildew resistance.

   3. If test results show material being used does not comply with specified requirements, the Contractor may be directed to stop painting, remove noncomplying paint from the site and repaint surfaces coated with rejected paint, and remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two coatings are no compatible.

PART 3 - EXECUTION

EXAMINATION

A. Examine substrates, areas, and conditions under which painting will be performed for compliance with paint application requirements. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.

PREPARATION

A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.

   1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning.

   1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation: Clean/prepare surfaces according to manufacturer's written instructions for each particular substrate condition to be painted.

D. Materials Preparation: Mix/prepare paint materials according to manufacturer's written instructions.

   1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
   2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
   3. Use only thinners approved by paint manufacturer and only within recommended limits.

E. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

APPLICATION

A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.

   1. Surface treatments and paint finishes are indicated in the schedules.
   2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
   3. Provide finish coats that are compatible with primers used.

   4. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
   5. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
   6. Sand lightly between each succeeding enamel and varnish coat.

B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions sand between applications.
2. Omit primer on metal surfaces that have been shop primed and touchup painted.
3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

C. Application Procedures: Apply paints and coatings by brush, roller, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for the type of material applied. Use brush of appropriate size for the surface or item being painted.

2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.

D. Minimum Coating Thickness: Apply paint no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.

E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and in occupied spaces.

F. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.

G. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site.

1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

PROTECTION

A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Engineer.

B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.

1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

PART 4 - PAINT SCHEDULES

EXTERIOR PAINT SCHEDULE

A. General: Provide the following paint systems for the various substrates indicated.

B. Ferrous Metal: Primer is not required on shop-primed items.

1. Full-Gloss Alkyd Enamel: 2 finish coats over primer.
   a. Primer: Synthetic Rust-Inhibiting Primer.
   b. First and Second Coats: Alkyd Gloss Enamel.

2. Lusterless Alkyd Enamel: 2 finish coats over primer.
   a. Primer: Synthetic Rust-Inhibiting Primer.
   b. First and Second Coats: Lusterless Alkyd Enamel.

C. Zinc-Coated Metal:

1. Full-Gloss Alkyd Enamel: 2 finish coats over primer.
   a. Primer: Galvanized Metal Primer.
   b. First and Second Coats: Alkyd Gloss Enamel.

INTERIOR PAINT SCHEDULE

A. General: Provide the following paint systems for the various substrates, as indicated.

B. Concrete and Plasters.

1. Lusterless (Flat) Emulsion Finish: 3 coats.
   a. Primer: Latex-Based Interior Flat Paint.
   b. Under Coat: Latex-Based Interior Flat Paint.
   c. Finish Coat: Latex-Based Interior Flat Paint.

2. Odorless Lusterless (Flat) Latex Finish: 3 coats.
   a. Primer: Latex-Based Interior Flat Paint.
   b. First Coat: Latex-Based Interior Flat Paint.
   c. Second Coat: Interior Flat Odorless Alkyd Paint.

3. Semi-gloss Enamel Finish: 3 coats with total dry film thickness not less than: 0.09 mm, on concrete, 0.06mm on plaster.
   a. Primer: Latex-Based Interior Flat Paint.
   b. Undercoat: Interior Enamel Undercoat.
   c. Finish Coat: Interior Semi-gloss Odorless Alkyd Enamel.

4. Plastic Coating Finish: Multiple coating system including preparation sealer, primer and undercoats; applied in strict accordance with manufacturer recommendations and instructions for substrate and purpose of use.
   a. Purpose: Provision of a heavy duty washable, monolithic and anti-bacterial surface finish to cement plastered walls and ceilings in hospital rooms and areas requiring a high degree of cleanliness and hygiene.
   b. Available Products: subject to compliance with requirements, products which may be incorporated, in the work include, but are not limited to:

C. Concrete Masonry Units:

1. Lusterless (Flat) Emulsion Finish: 2 finish coats over filled surface.
   a. Latex Block Filler.
   b. First and Second Coats: Latex-Based Interior Flat Paint.

2. Semi-gloss Alkyd Enamel Finish: 2 coats over filled surface with total dry film thickness not less than 0.09 mm, excluding filler coat.

a. Latex Block Filler.
b. Undercoat: Interior Enamel Undercoat.
c. Finish Coat: Interior Semi-gloss Odorless Alkyd Enamel.

D. Painted Wood and Hardboard:

1. Semi-gloss Enamel Finish: 3 coats.
   a. Undercoat: Interior Enamel Undercoat.
   b. First and Second Coats: Interior Semi-gloss Odorless Alkyd Enamel.

2. Full-Gloss Enamel Finish: 3 coats.
   a. Undercoat: Interior Enamel Undercoat.
   b. First and Second Coats: Alkyd Gloss Enamel.

E. Ferrous Metal:

1. Lusterless (Flat) Finish: 3 finish coats over primer with total dry film thickness not less than 0.06 mm.
   a. Primer: Synthetic Rust-Inhibiting Primer.
   b. First and Second Coats: Latex-Based Interior Flat Paint.

2. Semi-gloss Enamel Finish: 2 coats over primer with total dry film thickness not less than 0.06 mm.
   a. Primer: Synthetic Rust-Inhibiting Primer.
   b. Undercoat: Interior Enamel Undercoat.
   c. Finish Coat: Interior Semi-gloss Odorless Alkyd Enamel.

F. Zinc-Coated Metal:

1. Lusterless (Flat) Finish: 2 finish coats over primer with total dry film thickness not less than 0.06 mm.
   a. Primer: Galvanized Metal Primer.
   b. First and Second Coats: Latex-Based Interior Flat Paint.

2. Semi-gloss Finish: 2 coats over primer, with total dry film thickness not less than 0.06 mm.
   a. Primer: Galvanized Metal Primer.
   b. Undercoat: Interior Enamel Undercoat.
   c. Finish Coat: Interior Semi-gloss Odorless Alkyd Enamel.

3. Full-Gloss Enamel Finish: 2 Coats over primer with total dry film thickness not less than 0.06mm.
   a. Primer: Galvanized Metal Primer.
   b. Undercoat: Interior Enamel Undercoat.
   c. Finish Coat: Alkyd Gloss Enamel.

CHAPTER TEN
SPECIALTIES

SIGNS AND SIGNALS

Part 1 - GENERAL

SUMMARY

A. Section Includes: Traffic signs as shown on the drawings or inferable there from and/or as specified in accordance with requirements of the Contract Documents, work includes but not limited to the following:
1. Ceiling hung signs including illuminated signs
2. Wall mounted signs including illuminated signs
3. Post mounted signs including illuminated signs.
4. Fabrication of sign and sign post.
5. Graphic/Lettering.
6. Foundation.
7. Installations.

REFERENCES

A. British Standards Institute (BSI):
1. BS 381 : “Specification for Colors for Identification Coding and Special purposes”
2. BS 873 : “Road Traffic Signs and Internally Illuminated Bollards”

B. American Society for Testing and Materials (ASTM):
1. ASTM A 53: “Specification for Pipe, Steel, Black and Hot Dipped Zinc Coated Welded and Seamless.
2. ASTM A 366: “Specification for Steel, Carbon, Cold Rolled Sheet, Commercial Quality”
3. ASTM A 512 : “Specification for Cold Drawn Buttweld Carbon
4. Steel Mechanical Tubing”
5. ASTM A 568 “Specification for General Requirements for Steel Carbon and High Strength Low-Alloy Hot Rolled Sheet and Cold Rolled Sheet”
6. ASTM D 790: “Test Methods for Flexible Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials”
7. ASTM D 1003: “Test Method for Haze and Luminous Transmittance of Transparent Plastics”

C. Comply with the relevant schedules and requirements with local regulations.

D. Unless otherwise stated, the design, materials, construction and erection of signs shall comply with the standards in the General Specification for Hospital signage.

SYSTEM DESCRIPTION

A. Design Requirements:
1. Unless otherwise stated, all road signs shall be of the types used for 85% ile speed of under 45 km/hr. category in the Traffic Signs Manual by Local Municipality.
2. Sign plates or boards employing any method of construction, irrespective of their size and shape, shall be capable of passing the rigidity tests stated in the relevant standards.

SUBMITTALS

A. Manufacturers Data: Submit to the Engineer, in accordance with the requirements of the Contract Documents, copies of manufacturer’s specifications and installation instructions and other data as may be required to show compliance with these Specifications.

B. Shop Drawings: Submit shop drawings for the fabrication and erection of traffic sign work outdoor sign board and indoor sign board. Include details of sections and connections at not less than 1:4 scales. Show anchorage and accessory items and finishes.

C. Samples: Submit to the Engineer, in accordance with the requirements of the Contract Documents, samples as follows:
1. 150 x 150mm Samples of each metal and finish required.
2. 300 x 300mm Samples of each type of acrylic sheet.

QUALITY ASSURANCE

A. Provide traffic sign work (outdoor and indoor) fabricated by a firm specializing in the fabrication of traffic and similar signs and who are capable of producing work of the highest standard of quality in the industry.

B. Locate all signs as required. However, the final arrangement and number of signs shall be subject to the approval of the Owner and the Engineer.

DELIVERY, STORAGE AND HANDLING

A. Deliver all components to project site completely identified. Store in accordance with manufacturer's instructions, protected from the weather, construction activities and other possibility of damage or loss.

Part 2 - PRODUCTS

METALS

A. Materials and Surfaces: For the fabrication of metal work which will be exposed to view, use only materials which are smooth and free of surface blemishes. Do not use materials which have stains and discolorations including welds which do not match the materials.

B. Flatness and Edges: For exposed work provide materials which have been cold-rolled, cold finished, cold-drawn, extruded, stretcher leveled, machine cut and otherwise produced to the highest commercial standard for flatness with edges and corners sharp and true to angle or curvature as required.

C. Welding Electrodes and Filler Metal: Provide the alloy and type required for strength, workability, compatibility and color match after grinding smooth and finishing the fabricated product.

D. Ferrous Metal (Steel): Provide the forms and types shown and specified complying with the following or other equal and approved standards and finish.
   1. Cold-Rolled Sheet Steel: ASTM A 366 and ASTM A 568, commercial quality with type E matt finish.
   2. Steel Pipe: ASTM A53, standard weight (Schedule 40), galvanized, type as required to meet the assigned performance.
   3. Steel Tubing: ASTM A512, sunk drawn, butt welded, cold-finished and stress relieved.
   4. Base Plates, Anchor Bolts, etc.: Non-corrosive, zinc coated of the type and sizes approved and required to withstand the imposed load.

E. Fasteners: Manufactured from the following and as approved by the Engineer:
   1. Brackets: Strip aluminum alloy.
   2. Clips: Aluminum extruded sections.
   3. Screws, bolts, nuts and washers shall be of steel, stainless steel, aluminum alloy or of a high tensile non-corroding metal. Steel screws, bolts, nuts and washers which are in contact with aluminum shall be coated with zinc or cadmium.

F. Sign Plate and Stiffening Frame:
   1. Sign Plate
      a. Steel Construction: Sheet steel not less than 1.25mm thick.
      b. Aluminum Construction: Aluminum sheet not less than 3mm thick.
   2. Stiffening Frame: Manufactured from approved aluminum sections. Provide stiffening frames for plate signs having the following dimensions:
      a. Circular signs size over 600mm diameter.
      b. Triangular signs with base width over 600mm.
      c. All other signs where:
         i) The horizontal or vertical dimension of the sign exceeds 1000mm.
         ii) The maximum dimension is greater than 600mm and the ratio W/D or D/W is equal to or greater than 2.5; where D is the depth and W is the width of the sign.

G. Mounting Posts for Plate Signs
   1. Circular hollow section steel of approved size.
   2. Post Caps: Cast or sheet metal, or a suitable weather resistant type of plastic, as approved.

H. Height Limit Gauge Frame: Fabricated from continuous circular hollow section steel complying with B.S. 873 or other approved standards; size 75mm diameter for frame spanning up to 5.00m and size 100mm diameter for frames spanning over 5.00m.

I. All steel used for the complete work shall be of hot dipped galvanized and all aluminum shall be of anodized finish, as approved.

Part 3 - EXECUTION

INSTALLATION

A. General: Locate sign units. Use mounting methods in compliance with manufacturer's instructions. Install sign units level, plumb and at heights indicated or required, with sign surface free from distortion or other defects or appearance.

B. Metal Signs: Attach metal signs to vertical surfaces of walls, poles, etc., using bolting system, clamping system or other fastening devices recommended by the manufacturer and approved by the Engineer.

C. Acrylic Plastic Signs: Mount the acrylic plastic signs in the light fittings as recommended by the manufacturer and approved by the Engineer.

D. Comply with the relevant requirements for placements and mounting heights for post mounted signs. Mounting height shall be 2100 mm from the kerb level to the lower edge of the sign unless shown or approved otherwise. Provide mounting posts with breakaway joints where required.

E. Treat all sign posts located in areas used by pedestrians with alternate 150mm wide bands of black paint and white reflective tape.

F. Protect aluminum by a bituminous coating where it is in contact with concrete. Protect portions of posts which are buried below ground by coating internally and externally with bitumen.

CLEANING

A. Upon completion of installations, clean soiled sign surfaces in accordance with manufacturer's instructions prior to handing over to the Employer.

PROTECTION

A. Delay the installation of work with exposed painted metal finishes, acrylic and graphics, wherever possible until other work which might damage such finishes has been completed. When such delay of installation is not possible, or would delay the project, protect such exposed work by maintaining suitable temporary coverings to ensure that no damage thereto will result from other work being performed.

TOILET ACCESSORIES

PART 1 - GENERAL

All fixtures shall be fixed with neat workmanship, true to line and as recommended by the manufacturer or shown in the drawings. Care shall be taken to fix all fixtures, brackets and accessories by proper bolts and nuts (expansion bolts).

Care shall be taken in fixing all approved chromium plated (CP) fixtures and accessories so as not to leave any tool marks or damages on the finish. The Plumbing and Sanitary Nominated Contractors shall be responsible for any of the rectification works. All such fixtures shall be tightened with fixed spanners. Use of Stiltson' type pipe wrenches with toothed jaws shall not be allowed.

All fixtures shall be thoroughly tested after connecting the drainage and water supply system. All fixtures shall be thoroughly finished and any leakage in piping valves and waste fittings corrected to the complete satisfaction of the Client/ PMC/ Architects/ Consultants.

Upon completion of the work, all labels, stickers, plaster, etc. shall be removed from the fixtures and all fixtures shall be cleaned with soap and water so as to present a neat and clean toilet.

All the sanitary fixtures and CP fittings are quantified in nos. or set comprising of list of items mentioned with the specifications. The make, colour, range, finish of the fittings shall be as per the detailed BOQ specifications.

EUROPEAN TYPE WATER CLOSET- Wall mounted type.

The closet shall be of white/ color made of vitreous China and shall be of the best quality manufactured by an approved make. Each closet shall be provided with the following accessories: The make and model to be as specified in the BOQ.
European water closet **Wall mounted type.**

Floor mounted type with WC connector, seat cover with buffer flaps.

PVC / Vitreous china flushing Cistern of 3 or 6ltrs capacity with all internal parts of cistern-
Exposed type (dual flush).

Cast-iron chair or cantilever bracket for wall hung type with C.P bolt & nut.

CP wall flanges. Angle valve.

CP / copper / SS connecting pipe to cistern with end nuts.

Flush valve -32 mm Dia / 40 mm Dia, Concealed/ Exposed type as applicable.

Cistern-low level/high level cistern.

WASH BASINS

(Rectangular, oval, round, counter sunk, counter top, corner wash basin free standing
They shall be of white/ color and of vitreous China with best quality manufactured by an approved firm and size as specified. Under cut Oval/circular washbasins shall be supported by a pair of CI brackets of approved design. The make and model to be as specified in the BOQ.
Each wash basin shall be provided with the following.
Single lever mixer/Pillar Cock 15mm CP brass angular stop cock.

CP / copper / SS inlet connecting pipes with end nuts. 32mm CP waste coupling.

CP wall flanges

32mm CP Bottle Trap with extension pipe(casted type) 40mm dia PVC connecting pipe

upto floor trap.

Pedestals- Half / full for rectangular WB (if required).

SINKS

They shall be Stainless steel of best quality and shall be supported on necessary brackets. Each sink shall be provided with 40 mm CP waste coupling, hot and cold single lever sink mixer /wall mounted /table top mounted as specified in the BOQ. The complete set shall comprise of the following.

Single Stainless steel sink with drain board pillar cock with swinging

spout.

Supporting bracket.

40mm CP Waste coupling. CP wall flanges

Angle valves.
CP / copper / SS inlet connecting pipe with end nuts.

TOWEL RAIL

Towel rail shall be of C.P. with reinforced bends and circular flanges. The make and model shall be as specified in the BOQ. The bracket shall be fixed by means of stainless steel counter sunk screws to wooden/plastic cleats firmly embedded in the wall.

TOILET PAPER HOLDER

Toilet paper holder shall be of Stainless Steel. The make and model shall be as specified in the BOQ.

TOWEL RING

These shall be of CP/ sanitary ware. The make and model shall be as specified in the BOQ. These shall be fixed by means of C.P. brass counter sunk screws to wooden / plastic cleats firmly embedded in the wall.

LIQUID SOAP DISPENSER

The Soap dispenser shall be of approved type as specified in the BOQ. It shall be made up of ABS plastic / CP material.

FLOOR TRAPS FRAME AND GRATING

The floor trap frame and grating shall be of approved material as specified in the BOQ. The trap shall be fitted with anti- cockroach grating. A minimum of 70mm depth of water seal shall be provided in the trap.

HEALTH FAUCET

These shall be of CP / sanitary ware. The make and model shall be as specified in the BOQ. These shall be fixed by means of stainless steel counter sunk screws to wooden/ plastic cleats firmly embedded in the wall.

15 mm CP health faucet with 1.0m long flexible tube with end nuts & Hook. 1 No 15mm CP brass

angular stop cock with wall flange
Hook with CP brass counter sunk screws.

MIRROR

The mirror shall be of the best quality India make of superior glass with 6mm thick hard board backing with primer and two coats of enamel painting and fixed to wooden cleats with CP side clips, screws, washers, the size shall be as specified and of approved design.

BRASS BIB COCK AND STOP COCK

A bibcock is a draw off tap with a horizontal inlet and free outlet and stopcock (stop tap) is a valve with a suitable means of connections for insertion in a pipeline for controlling or stopping the flow. They shall be of specified size and shall be screw down type. The closing device should work by means of a disc carrying a renewable non-metallic washer which shuts against water pressure on a seating at right angles to the axis of the threaded spindle which operates. The handle shall be either crutch or butterfly type securely seated pattern. The cocks (taps) shall open in anticlockwise direction. The bib cock and stop cock shall be polished bright (Chrome plated). The minimum finished weights of bib tap (cock) and stop tap (cock) as given in the IS specification are reproduced in the table:

Minimum finished weight

Size	**Bib tap**	**Stop tap**
Mm	kg.	Kg.
8	0.25	0.25
10	0.30	0.35
15	0.40	0.40
20	0.75	0.75

PUSH COCK (NORMAL/ PNEUMATIC TYPE)

These shall be of CP / sanitary ware. The make and model shall be as specified in the BOQ. These shall be fixed by means of stainless steel screws to wooden / plastic cleats firmly embedded in the wall.

STAINLESS STEEL HAND WASH TROUGH

These shall be of SS with a waste coupling for drainage and for insertion of pipeline to the nahani trap. The make and the model shall be as specified in the BOQ.

EPOXY RESIN WORK

PART 1 - GENERAL

Countertops, drinking basin and curbs are molded from a modified epoxy resin that has been especially compounded and cured to provide optimum physical and chemical resistance required for a heavy duty working surface. They are a uniform mixture throughout, and do not depend on a surface coating that can be readily removed by chemical or physical abuse. Tops have a thickness required with a drip groove provided on underside of all sink top exposed edges. All edges shall have a slight radius. Curbs are bonded to the surface on the top to form a square water-tight joint. All joints in tops are bonded with approved epoxy cement and shall be smooth and water-tight. Counters with integral curbs have a junction with a ¾” radius, except around columns and special cutouts, which will have a standard bonded curb.

PART 2 – PRODUCTS

SOLID SURFACE SHEET MATERIAL

A. Composition: Acrylic resins, fire-retardant mineral fillers, and proprietary coloring agents. Through-the-body color for full thickness of sheet material.

B. Material Thickness: 1/2 inch, nominal.

C. Color, Pattern, and Finish Design: Selected from manufacturer's standard offerings.

D. Edge Detail: Selected from manufacturer’s standard offerings.

ACCESSORY MATERIALS

A. Joint Adhesive: Methacrylate-based adhesive for chemically bonding solid surfacing seams. Color complementary to solid surfacing sheet material.

B. Elastomeric Sealant: Mildew-resistant silicone sealant for filling gaps between countertops and terminating substrates in wet environment applications.

C. Siliconized Acrylic Sealant: Siliconized acrylic latex sealant. For general applications to fill gaps between countertops and at terminating substrates.

D. Construction Adhesive: Countertop manufacturer’s recommended silicone-based construction adhesive for backsplashes, end splashes, and other applications according to manufacturer’s published fabrication instructions.

FABRICATION

A. Fabricate components in shop, to greatest extent practicable, in sizes and shapes indicated according to approved shop drawings.

B. Form joint seams between solid surfacing components with specified seam adhesive. Completed joints inconspicuous in appearance and without voids. Provide joint reinforced if required by manufacturer for particular installation conditions.

C. Provide holes and cutouts indicated on approved shop drawings. Rout cutouts and complete by sanding all edges smooth.

PART 3 – EXECUTION

EXAMINATION

A. Examine substrates and conditions that could adversely affect the work of this Section.

B. Substrates must be sound, flat, smooth, and free from dust or other surface contaminants.

C. Commencement of work will constitute acceptance of substrates and conditions to receive the work.

COUNTERTOP WITH SINK, DRINKING BASIN INSTALLATION

A. Install solid surfacing components plumb, level, and true according to approved shop drawings and manufacturer's published installation instructions. Use steel working and specialized fabrication tools acceptable to manufacturer.

B. Form joint seams with specified seam adhesive. Seems to be inconspicuous in completed work. Seams in locations shown on approved shop drawings and acceptable to manufacturer. Promptly remove excess adhesive.

C. Provide minimum 1/2 inch radius for countertop / drinking basin inside corners.

D. Fill gaps between countertop / drinking basin and terminating substrates with specified silicone sealant.

E. Back splashes are manufactured as one piece with countertop / drinking basin as shown on drawings and approved by Engineer.

F. Vanities are manufactured as one piece with counter top as shown on drawings and approved by Engineer.

Anti-Shatter Window Film

SPECIFICATION FOR SECURITY GRADE ANTI-SHATTER FILM FOR WINDOWS

INTRODUCTION

This specification covers materials, workmanship and performance regarding security grade Anti Shatter Film (ASF) for application to glass on public buildings. The specification deals with films of nominal thicknesses from 150 microns to 300 microns.

ASF 1s a strong, flexible and optically clear material of polyester or other plastic compounds which is stuck to glass to mitigate glass fragment hazard arising from blast or impact

The film comprises one or more layers of base film and corresponding layers of adhesive with a removable backing sheet or detackifying layer. The ability of the film to hold shattered glass together depends on the strength and ductility of both the base film and the adhesive. The film to glass adhesive is pressure sensitive and the quality, pressure and method of application is fundamental to the effectiveness of the film under blast conditions. Detackifying layers, where present, have to be thoroughly washed off with plain water. Even where a backing layer is removed it is necessary to mist spray a slip coat of water to aid positioning. This water must be firmly squeegeed out but the traces of moisture remaining have to be allowed to dry out through the film over periods of several weeks before the full adhesive bond strength develops

Ultra violet inhibitors are incorporated to delay age deterioration. Scratch or abrasion resistant coatings are optional solar control, decorative or reflective coatings, layers or additives may also be combined in the film composition.

Scope, Access, Surveys and Installation Schedules

Read this general specification with the contract conditions. All areas measured shall be based on net areas of glass.

Materials and Performance

Base Film Composition

The base film shall be daylight fixed (as per CPNI Guidance Note HOSDB 11A/08 available from www.cpni.gov.uk), optically clear, biaxially orientated, polyester film based upon polyethylene terepthalate (PET) as ICI Melinex 'O' Grade, or other accepted film having proven equivalent or better optical, strength and life properties

Base Film Thickness

Film 1n the following category is to be used:

A1 A film which passes BS6206 Class 'A'. This may equate to a nominal thickness of about 175µm to 200µm thickness but may include high performance films which are thinner or laminated

A2 A film which both passes BS6206 Class 'A' and has a minimum base film thickness of 300µm comprising at least two laminated layers.

Examples of film thickness compositions potentially satisfying the above conditions are

Average thickness of single or combined layers (excluding adhesive etc) not less than:	Minimum thickness (excluding adhesive etc)	Possible composition
Category A1 150µm	140µm	3 x 50µm layers
Category A1 175µm	170µm	Single ply
Category A1 200µm	190µm	2 x 100µm layers
Category A2 300µm	290µm	3 x 100µm layers

Base Film Strength

Film strength and elongation measured at a strain rate not exceeding 50% per minute shall meet the following criteria.

Yield strength in Newtons per 25mm width.

Thickness Category	A1 Class 'A'	A2 300µm
Yield strength	350N	750N

Elongation at yield not less than 3%

Tensile strength to break in Newtons per 25mm width:

Thickness Category	A1 Class 'A'	A2 300µm
Longitudinal	600N	1100N
Transverse	800N	1500N

Elongation at break not less than 90% longitudinal
75% transverse

Depending on country of origin. Strength and elongation tests may be carried out to
ASTM D 882 (straight strip)
ASTM D 638 (dumb bell strip) BS 2782 Method 320A (dumb bell strip)
DIN 53455

Adhesive Composition

The adhesive shall be an optically clear, pressure sensitive, acrylic adhesive containing ultra violet inhibitors, sufficient to protect the product for its required life or other accepted adhesive, having proven equivalent or better optical, strength and life properties.

Adhesive Strength

Supply certificates demonstrating compliance of the film to laboratory peel adhesion tests carried out using 25mm wide strips at constant peel rates to BS 5350 Pt C11 at 20.5T to achieve

A Strength to initiate peeling: not less than 800 grms
not more than 4000 grms

B Mean strength during peeling at a
constant rate of 300mm/minute: not less than 1500 grms

Carry out and record the results of in-situ peel adhesion tests on representative samples of the completed work. The peel strength of the adhesive shall meet the following criteria:

A Strength to initiate peeling: not less than 800 grms

B Time to peel 300mm under a constant pull load of 1500 grms: not less than 1 minute

Impact Strength

The Category A 1 and A2 films shall meet the 'Breaks Safely' requirement for BS6206 Class 'A', when installed on a vertical annealed glass pane 1930 x 865 x either 4mm or 6mm thick (or as separately specified) and subject to an impact from a 45kg bag dropping through an arc at vertical distance of 1200mm.

Fire Resistance

The film shall meet or better the following criteria:

Ignitability: Not Easily Ignitable to BS 476 Part 6
Fire propagation: Zero Performance Index, to BS 476 Part 5

Surface Spread of Flame: Class 1 pass to BS 476 Part 7
Toxicity: No toxic fumes or other health hazards to be caused

Visible Light and Ultra Violet Transmission

Visible light transmission of the film shall not be less than 75% for Category A 1 and A2 films

Ultra violet inhibitors contained in the adhesive shall be sufficient to protect the **film** for its required life and shall limit ultra violet transmission to not more than 5%.

Base Film Finish

Provide a scratch resistant coating where directed in the contract. If provided the coating shall not result in failure to satisfy other specification requirements.

The scratch resistant coating must resist abrasion in accordance with the test method outlined. Resistance to this abrasion test requires that the increase in haze due to the abrasion must be less than 13%.

Roll Width

This film shall preferably be available in a multiple roll widths with at least one width of not less than 1500mm in order to limit necessary joints.

Required Life

The film installation shall have a life of not less than 5 years when installed internally, without deterioration of the specified qualities by more than 10%.

Tests on samples which have been installed for at least 6 months or an equivalent accelerated ageing period may be called for as an indication of long term properties.

Identification

Each roll of film must have a tamper proof label which gives full details of the roll and batch numbers to identify production runs and dates. Each roll is to be uniquely identified. The same information must also be on the outside of the box.

Roll details must be provided at the commencement of the work, or agreed stages, for rolls proposed to be used and at the end of the work for rolls actually used itemized by installation location. Details are to be provided at other times on request.

Sufficient information is to be available on the labels with corresponding records of where batches are installed to enable a full audit trail of the film to be maintained by the contractor. The contractor shall make information available on request, to be lodged with the Client at the end of the contract.

Film type is not to be changed during the life of the contract without prior agreement. Any proposals for change are to be submitted with full information, including full certification, for consideration

Manufacturers of the film shall also maintain adequate records to enable film to be traced.

Compliance Tests and Samples

Certificates

Provide certificates for materials and performance demonstrating compliance with the specified qualities at time of tendering and before installation commences.

Certificates are required for the following:-

		See specification clause
A	Base film thickness	6.1.3.2
B	Base film strength and elongation	6.1.3.3
C	Adhesive peel strength	6.1.3.5
D	Impact strength	6.1.3.6
E	Fire resistance	6.1.3.7
F	Visible light transmission	6.1.3.8
G	Ultra violet transmission	6.1.3.8
H	Scratch Resistance (if required)	6.1.3.9
I	Ageing tests on items	6.1.3.11
J	Spectroscopic analysis	6.1.3.12

If requested, certificates for items A, B, C and J shall be specifically related to the batches to be used on site.

Where required, arrange for separate tests to be carried out by an approved independent test house on samples selected from site to demonstrate compliance with any of the specified qualities.

Prior to work commencement, or on request at any stage, provide a 1m long full roll width sample of the film(s) proposed for use or being installed.

The contractor must also provide an information pack of all certificates described above, plus sample certificate of competence and installation instructions, at time of tendering. Additional information packs to be made available for distribution to actual users at time of ordering, or earlier, if requested.

A certificate of compliance is to be given to the Client at the end of the work.

Sample Panel

Install a sample panel of at least 1m^2 area prior to the commencement of the main work. If the sample panel meets the specification and is accepted visually it will be marked for identification and used as an approved standard for subsequent work. If the sample is unsatisfactory, prepare further sample panels until approved standard is achieved.

It 1s acknowledged that clearing of small trapped air or water bubbles may take some weeks and an early inspection of the sample panel will not reliably identify any problems in this respect. If the installer is confident that air bubbles will clear within the required 28-90 day period (see Annex A) and the sample panel is acceptable in all other respects he may proceed at his own risk with the main work, but must prepare to replace all defective work if the bubbles do not subsequently clear

Site Peel Tests

The contractor shall carry out site peel tests on windows selected to demonstrate the integrity of the installation. Carry out pairs of tests undertaking at least 1 per order plus every 500m^2 thereafter of film installed, or at the frequency specified in the contracts, and at each site where different operatives and/or materials are used.
A report of each test is to be sent to the Client giving full details of the test, including weights, peel times and location by room, floor and building elevation using a format as in Annex A.

The contractor shall replace film, within the contract sum, on the windows where peel tests have been carried out. Local repair is unacceptable.

In the event of a failure on the peel test, a further 5 tests shall be carried out. In the event of further repeated failures the contractor must identify whether the operative has badly applied the film and/or the film is at fault. The contractor must propose a rectification programme - which if the batch of film is at fault - must include all other areas where that batch has been installed. A report will be required to be submitted giving an explanation and the rectification programme. The Client will reserve the right for a complete site, or sites, if appropriate, to be re-applied. On conclusion of the rectification programme further tests will be required and a further report submitted.

Testing and replacement of tested film, plus all rectification work, is to be carried out at no additional cost to the Client.

Workmanship

The contractor shall carry out all preparation and installation using skilled operatives and according to the manufacturer's recommendations and instructions so as to meet the requirements of this specification.
All operatives are to be trained and to have a certificate of competence awarded after satisfactory training.

Film Location

The film shall be fitted to the interior face of the glazing unless written instruction is received to do otherwise.
Where windows are sealed double glazed units, film shall be fitted on the inside face of the inner pane.
Where windows are secondary glazed, film shall be fitted on the inside face of both inner and outer panes.
Where written instruction is received to install the film on the outside face, the film edges shall be sealed with a suitable clear varnish recommended by the manufacturer
The extent of the installation shall be as defined in the contract and on the drawings

Glazing Types

Apply film only to plain, smooth surfaced glass. Any replacement glass supplied must be to the appropriate British Standard. Any putty used must not contain Linseed Oil. Where glass is replaced or reversed, any appropriate redecoration (eg painting) must also be carried out. The cost of any repainting etc must be included in unit rates quoted.

Access and Working Environments

The contractor shall arrange with the Client to ensure that there is proper access for the work. The tenderer shall state his assumptions regarding access and any variations required by the Occupier shall be negotiated and agreed before carrying out work.

The contractor must include in his rates any additional/extra costs which may be incurred in ensuring proper and safe access to do the work (including hiring of special equipment etc). Appropriate hazard warning signs etc will be required when necessary any access equipment and methods of working must satisfy Health and Safety regulations

Cutting and Joins

The film shall be cut to size prior to application or trimmed to size in position according to the manufacturer's recommendations.

Cutting shall be carried out so as to achieve the edge distance of between 1mm and 3mm around the frame and all fittings. Do not over cut around fittings.

Joins will not be acceptable where it is possible to cover the pane with a single sheet Where Joins are unavoidable they shall be located centrally within the pane along the short dimension, minimizing visual impact and the film butt jointed with gaps not greater than 1mm.

Preparation

Remove any existing film that may be on the glass, clean the glass and surrounds to remove all dirt, dust, paint, grit, fluff and any other foreign matter immediately prior to the film installation. Trim and clean off existing irregular putty or painted edges as necessary to avoid allowing film edges to ride over them. Do not use cleaning fluids which may have a harmful effect on the adhesive. Position waterproof sheeting to avoid wetting floors and furniture.

As applicable, completely remove backing sheets from the film and/or completely wash off detackifying layers before attempting to position the film on the glass.

Reject any film which is torn, creased or in any way damaged or contaminated. The appropriate type and grade of film shall be used.

Application

Spray the glass surface and the adhesive face of the film with water or approved fluids. Position film with adhesive side on the glass. Slide into position, squeegee the film surface to expunge water and air bubbles trapped between the film and the glass. Apply sufficient pressure to fully activate the adhesive. Several squeegee passes are normally required. Trim edges. Press down edges and corners with special care.

Never apply film under conditions where ice could form on the glass surface before completion of application.

Visual Appearance

The contractor shall check for visible defects. The completed film installation shall be free from:

- Air or water bubbles (after 28-90 days) and foreign matter trapped between glass and the film;
- Lifting of edges and corners of the film;
- Creases, tears, wrinkles, crazing, patchiness, discolouration;
- Scratches and other imperfections.

Cleaning

Clean down and dry all surfaces taking care not to scratch the film surface. Site to be left clean and tidy.

Testing

Leave for 28-90 days before carrying out peel tests and final visual compliance assessments unless otherwise agreed.

Monitoring

The contractor shall have a system of monitoring to ensure that work is checked and completed prior to final checking by the Client and prior to invoices being submitted.

Maintain a record of all laboratory and on-site tests carried out to demonstrate compliance with this specification. Forward the test results showing values attained to the Client before final payment on the relevant contract.

On Site Peel Adhesion Tests

Peel tests shall be carried out between 28-90 days after installation. The upper limit durations are to cater for thicker films and solar reflective films which take longer to dry out. In warm dry conditions tests may be carried out earlier by mutual agreement at contractor's risk.

As a guide, tests should be carried out at the following interval after installations:

42 days for Category A1 films (175µm)
90 days for Category A2 films (300µm)

Conduct the Peel Adhesion Tests as follows, using accepted test weights and apparatus.

Cut two 25mm wide strips, at lease 400mm, preferably 600mm long or the full window height, if this is less. One of these should be in the center of the window and one on the outer third but not closer than 50mm to the edge.

Mark 1OOmm intervals down the side of the strip

The strip should be carefully peeled back to allow the weight to hang freely and to make the peel angle between 170' and 180' - up to 150mm may be needed.

Attach the 800gm weight to give 1500gm total. Pull the strip gently down to one of the 100mm marks. The stop watch should be zeroed.

Add the 700gm weight to give 1500gm total. Pull the strip gently down to one of the 1OOmm marks. The stop watch should be zeroed.

Start the stop watch at the same time as gently releasing the weights.

Record the time intervals for each of the 100mm drops. The time for each 100mm length should not normally be less than 20 seconds. However, it is normal for the peel rate to start faster and gradually slow down. The total time for the 300mm must be not less than 1 minute.

Record all details of weights, times, film, date of test, temperature and location by window, room and building elevation and pass or fail on an agreed tabular format.

The adhesive is also required to move under a weight of 4000gm to ensure that the adhesive is not too brittle.

NB By agreement a pull spring balance may be used to augment the accepted weights apparatus and increase the rate at which windows are tested, provided failures are not being encountered. This would be to check the load at which the adhesive starts to allow movement. Borderline cases should be retested using the weights.

ANNEX A

Peel adhesion tests on site should be recorded in a format as on the following sheet.

ANTI-SHATTER FILM PEEL ADHESION TESTS

Name of Contact Building:
Address:
ASF Contractor:
Make of Film:

Test No.							
Date of Test							
Date Fitted							
Room							
Elevation of Window							
Spring Balance							
Load to move – gms							
PEEL TEST							
Min. Peel Load gms							
Peel Test Load gms							
Time to Peel (secs)							
100mm							
200mm							
300mm							
Thickness of Film							
Thickness of Glue							
Thick:	Pass		Fail		Pass		Fail	
Comments:							

Test Conducted By:
Witnessed By:

Testing For Abrasion Resistance

- Ten replicate samples of suitable size are to be cut from the film under test.
- For each replicate, the haze is to be measured at four separate points, in accordance with ASTM D 1003, and the average found.
- For each replicate, abrasion is to be performed in accordance with ASTM D 1044 using a Taber Abrader fitted with CS10 wheels, a 100 revolutions test cycle, 500g loading per wheel and 100% vacuum.
- For each replicate, the haze is to be measured at four separate points in accordance with ASTM D 1003, and the average found.
- For each replicate, the increase in haze due to abrasion is to be found from the haze measurements in 6.1.7.2 and 6.1.7.4 above.
- The average increase in haze due to abrasion is found for the film by averaging the values for the ten replicates found in 6.1.7.5 above.
- The test method may be modified for the more rigorous test conditions by increasing the weights used, by increasing the number of revolutions in the test cycle, or by using a higher abrasion wheel. If testing is carried out under more rigorous testing then the results are also more acceptable, provided the increase in haze is less than 13%. More rigorous testing within this limit is regarded as evidence for superior performance and durability of the scratch resistant coating

ACCESS CONTROL

GENERAL

SCOPE

A. Works are to include a complete access control system including the following:
   1. Access Controllers (ACs).
   2. Proximity card Readers.
   3. Proximity Cards.
   4. Door Hardware Accessories (contacts, locks,…etc).
   5. Back-up power by chargers, inverters (if equipment does not operate on DC supply) and batteries.
   6. Full integration & interfacing with the CCTV and Intrusion detection systems by RS-485 communication bus or other communication bus type to be coordinated with the CCTV system and approved by the consultant engineer and interfacing with the fire alarm system by dry contacts.

B. The central panel shall be UL listed for burglar detection and access control. It shall be addressable and shall manage dry contacts from various detectors as well as access control modules and alarm outputs.

C. It shall be software programmable, and allow for the edition of entry reports if ever required.

D. Submit full technical information for approval including manufacturer's catalogues for all system equipment and components, indicating the following:
   1. System operation, equipment specification, software features, listings and certifications.
   2. System expandability
   3. Operating parameters and limitations, ambient conditions, heat dissipation, power requirements etc.
   4. Manufacturer recommended cabling and wiring specifications and characteristics.

E. Equipment is to be tested for quality and operation at factory, and test certificates and reports, certified by an official testing authority, are to be submitted to the Engineer before dispatch to site.

F. Submit drawings for approval including, but not limited to, the following:
   1. Detailed system schematic diagrams
   2. Exact devices & controllers locations, layouts and mounting details
   3. Configuration and construction details of access control cabinet, operating consoles…etc.

G. Approved manufacturers
   1. Northern Computers Inc. (USA)
   2. NAPCO (USA)
   3. Interlogix Security & Life Safety Group/Sentrol(USA)
   4. Eff Eff (Germany)
   5. HID (USA)
   6. Digital Security Controls Ltd. (USA)
   7. Intellex (USA)
   8. Sensormatic (USA)

SPARE PARTS:

A. provide manufacturer's recommended spare parts for replacement and one year's maintenance including, but not limited to, the followings:

   1. Power supply: Quantity equal to 5 percent of amount of each type installed, but not less than one unit of each type.

2. Door Lock: Quantity equal to 5 percent of amount of each type installed but not less than one unit of each type.

3. Door Contact: Quantity equal to 5 percent of amount of each type installed but not less than one unit of each type.

4. Input/output relay interface: Quantity equal to 3 percent of amount of each type installed but not less than one unit of each type.

5. Proximity access control cards (for proximity readers used): Quantity equal to 10 percent of amount used, of each type.

6. One unit of any single point of failure device that could inhibit the usage of the whole system.

WARRANTY

B. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

C. Special Warranty: A written warranty, signed by Contractor and manufacturer, agreeing to replace any component of the access control system that do not meet requirements or that fail within the specified warranty period.

1. Warranty Period: 2 years from date of Substantial Completion for any component of the system.

EQUIPMENT AND PERFORMANCE

2.1 SYSTEM OPERATION AND MATERIAL

A. GENERAL: The purpose of the access control systems is to monitor and control access to the selected areas as indicated on layouts 24 hours a day 7 days a week. The system shall be connected via the local area network (LAN).

B. Access through any such points is controlled through one electronic reader (proximity card). The access control field devices shall be connected to a control panel housing the access control system controllers (security panels or door controllers as indicated on drawings).

C. Access control systems controllers :

1. Modular multi-Point “ON-LINE/OFF-LINE” Controllers that can handle up to 32 readers or input-output cards in an ON-LINE and OFF-LINE mode.

ACCESS CONTROLLER (AC, modular or standard unit)

A. Access Controllers (AC) shall be able to work in both ON-LINE and OFF-LINE mode should:

1. be able to monitor the state of the access point (open or closed) during preset time frames, and detect locally any state of alarm
2. be able to authorize locally the access to card holders with valid codes during their predetermined time zone,
3. to report all abnormal activities at the card reader or at the monitored point via a data link or a dry contact closure,
4. to store in its buffer all recent activities until they are transmitted to the central station,
5. the card holders and the time zones they’ll be authorized to get through,
6. the inputs and the time zones during which they’ll be shunted
7. the outputs and the time zones during which they’ll be disabled

B. Each AC shall have variable capacity features with a minimum of sixteen (16) spare input points and four (4) spare outputs. The AC local memory shall be of the non-volatile type with capability for access authorization data for a minimum of 4,000 individuals. Local memory shall be capable of being expanded to a minimum of 100 percent of its initial capacity. The AC shall be able to accommodate an expansion module that increases the number of outputs to eight (8).

C. ACs shall have an internal lithium battery to prevent loss of information when power is lost for at least 6 months period.

D. Modular chassis shall be mounted in 19” racks (security panels) common to access control and CCTV as indicated on drawings.

E. ACs shall report to all other controllers located behind in case of loop failure to force them to hold to their alarms in their buffers until communication is reestablished.

1. Non-modular ACs are to be housed in lockable steel cabinets, with front access doors only, if wall-mounted. Cabinets are to be totally enclosed, dead front type, protection code IP 42 for indoor installations and IP 55 for outdoor installations, in accordance with IEC 529, and are to be factory designed and assembled.
2. CONSTRUCTION: box, trim and doors, are to be electro-galvanized sheet steel of gauges not less than specified and in accordance with the Standards. Welded joints are to be galvanized after manufacture. Gutter spaces are to conform to the Standards, but are not to be less than 100 mm on all sides. Enclosure is to have predesigned angles or threaded end studs to support and adjust mounting of interior cabinet assembly.
3. TRIMS are to cover and overlap front shield, covering all terminals and bus compartments, to form a dead front panel. Trims are to be fixed to cabinet/box by quarter-turn clamps engaging flange of box (use of screws engaging holes in flange of
4. box is not acceptable). Screws where used are to be oval-head, countersunk and flush. Trims for flush mounted panel boards are to overlap box and front shields by at least 20 mm. Trims for surface mounted panel boards are to be exactly sized to form flush fit to box.
5. DOORS are to have concealed hinges integral with trim, and flush combination cylinder lock and catch. Doors over 1000 mm high are to have vault-type handle and multiple point latch mechanism. Locks are to be keyed alike.
6. FINISH: inner and outer surfaces of cabinet/boxes, trims, doors etc. are to be cleaned, phosphatized, chrome passivated and treated with final thermosetting epoxy powder modified by polyester resins providing high resistance to mechanical injury, heat, acid and alkali solvents, grease, ageing and corrosion and of standard grey color to the approval of the Engineer.
7. DIRECTORIES: under glass, or an approved alternative durable arrangement, are to be provided on inside face of doors, or in metal label holders when trim without doors is specified. Directories are to be typed to identify cabinets and clearly indicate circuit number and description of circuit.
8. OUTDOOR ENCLOSURES are to be heavy duty sheet steel cabinets, minimum 1.5 mm thick, fully weatherproofed (IP 55), without knockouts, but with removable sealed/gasketed bottom gland plates and gasketed doors.

AC's PERFORMANCE

1. Each AC shall serve as the collection point for monitoring and controlling devices in a particular security area. The ACs shall also provide power to devices down line.
2. The ACs shall be connected to all the Security System monitored points and readers (any type) to collect and transmit status information to the CHC for processing. The ACs shall buffer and retain status change information until transfer of data to the CHC is verified. The buffer size should accommodate at lest 500 transactions.
3. ACs shall be capable of being configured from the CHC for operation via readers (any type) only, digital keypad only or readers (any type) and digital keypad in case digital keypad is available.
4. When an ID badge/keycard is presented at a card reader, the encoded information shall be compared with the stored data for authorized access. Access authorization decisions are to be made locally at the card or its associated AC.

CARD READERS

1. Card readers shall consist of a solid-state static sensor head that is compatible with only one (1) type of uniquely encoded ID badge/keycard and an electronic interface box. If required on drawings, card readers shall be equipped with digital keypads.
2. Card readers range shall be 10~14cm minimum unless otherwise mentioned on drawings.
3. Card reader sensor head shall be housed in weatherproof enclosure equipped with a tamper switch. Mounting screws for surface mounting are to be provided inside the enclosure or, if exposed, are to be tamper-proof requiring a special tool for removal.
4. Card readers shall be provided with separate visual indications that an ID badge/keycard has been granted access or denied.
5. Card readers shall be provided in stainless steel body when indicated on drawings.
6. Esthetic design of the card readers shall be subject to the Engineer's approval.

READER TECHNOLOGY

A. Proximity: Where the readers would be equipped with antennas that could pick up a card at different ranges (from centimeters to meters) providing the best of all other technologies except for being the most expensive of all. This technology is best suited for rough environment and is particularly vandal and weather proof. Maintenance shall not be required.

AUTHORIZATION PROCEDURE

A. Authorization decisions include:

   1. Unauthorized access requests and/or the presentation of an inactive, expired, lost, stolen, un-returned or an improperly encoded ID badge /keycard / pin-codes shall be reported to the CHC. Access shall not be granted.

B. At fire emergency exit doors (if required on drawings):
   1. The card reader shall generate a command to temporarily change the status of the associated balanced magnetic switch to "ACCESS" to permit unalarmed entry/exit. The time duration of "ACCESS" shall reset and the "SECURE" status shall begin as soon as the door closes after authorized entry/exit.

C. At operational doors:
   1. The card reader shall generate commands to release the associated electric strike or magnetic lock and temporarily change the status of the associated door status sensor to "ACCESS" to permit unalarmed entry. If the door is equipped with a dual technology sensors, the sensor shall initiate the sequence described above. The time duration for "ACCESS" shall reset entry/exit.

D. At elevator cabs:

   1. The card reader shall enable the elevator call buttons from inside the cabin.

ACTUATION TIME

A. The time periods for activating a local locking device and accessing the associated intrusion detection device(s) shall be independently programmable. In the event two (2) or more individuals utilize the same card reader or exit push-button, each valid request shall reset the time duration for unlocking and "ACCESS" status to allow sufficient time for the unalarmed entry/exit of each subsequent individual.

DOOR HARDWARE ACCESSORIES

A. They are divided into locking Mechanisms (LM) and monitoring devices (MD).

1. The locking Mechanisms (LM) are:
   a. The Electric Door Releases that can handle a limited break force (~150N), and are usually used indoors. There exist a large variety of devices to adapt to all kind of frames (wooden, metallic, aluminum, ...)
   b. The Motorized Door Locks that can handle much greater forces (10 - 15kN) due to the fact that the bolts enter much deeper into the opposite frame, and are usually used outdoors.
   c. The Electro-Magnetic Locks that can handle large forces (~5kN) but can never work in Fail-Secure setups where any loss of power means an immediate release of the door. This type is to be used on doors located on the means of egress.

B. The monitoring devices (MD) are:

1. Balanced Magnetic Door Contacts are similar to Standard Magnetic Door Contacts but besides detecting the absence of the magnetic field, they detect the presence of any other magnetic field. This feature prevents intruders from disabling the contact by applying a strong magnetic field from the outside to simulate the presence of the magnet on the door.

PROXIMITY ACCESS CONTROL READER PERFORMANCE (refer also to 2.11)

A The card reader shall read the encoded data from the access card and/or transponder and transmit the data back to the access control panel (ACs), giving an audible and visual indication of a properly read card.

B The proximity card reader shall provide the following:
1 The card reader shall have a typical read range of 4" to 5.5" (10 - 14 cm).
2 The card reader shall be listed under UL 294 as an access control system unit accessory, and shall have FCC & CE Mark certifications.
3 The card reader shall have separate terminal control points for two LEDs and an audible indicator.
4 The card reader shall have a hold line that will buffer a card read until the panel has asserted that the information can be sent up line.
5 The card reader shall have a card present line that will indicate that card data is ready to send for clock and data applications.
6 The card reader shall have a re-present mode in which the card must be taken from the reader field before being read again; to eliminate multiple reads from a single card presentation.
7 The card reader shall have a built in anti-pass back (multiple read) delay of one second.
8 The card reader shall an operating temperature of -10 to 50 degrees Celsius and an operating humidity of 5-95% noncondensing.
9 The card reader shall communicate in a Wiegand protocol interface, and be compatible with all standard access control systems.

ACCESS CONTROL PROXIMITY CARDS

A The access control proximity cards shall provide the following:

1. The access card shall have a lifetime warranty.
2. The access card shall have up to 84 programmable bits of Wiegand formatted information for universal compatibility with all Wiegand interface reader applications.
3. The access card shall be "Passive" (non-battery operated) proximity technology.
4. The access card shall have a permanent ink jet or laser engraved identification number printed onto it. The card numbering options shall be:
5. Sequential Matching - The internal identification numbers and the external ink jet numbers shall both be sequential and shall match (i.e. internal numbers 1-100, external ink jet numbers 1-100).

6. Sequential Non-Matching - the internal identification numbers and the external ink jet numbers will be sequential but they will not match (i.e. internal numbers 1-100, external ink jet numbers 200-300).
7. Random Non-Matching - the internal identification number shall be random numbers, the external ink jet numbers will be sequential, and the internal and external numbers will not match (i.e. internal numbers 2, 7, 13, 18, etc., external ink jet numbers 1-100).
8. No External Card Numbering - the internal identification numbers are either sequential or random, there are no external ink jet card numbers.
9. The access card shall be slot punched on the short edge of the card for a vertical/ portrait oriented photo, shall be offered with multicolor custom graphics, and be compatible with most self-adhesive photo pouches and PVC labels for use with a direct print printer.
10. The access card shall have an operating temperature of -10 to 70 degrees Celsius and shall have an operating relative humidity of 5-95% noncondensing.
11. The read range of the access card shall be extremely consistent, and not be affected by body shielding or variable environmental conditions.
12. The access card shall be offered with over 137 billion unique codes.

PUSH BUTTONS:

1. Are to have the following features:
2. Vandal Proof.
3. Stainless Steel faceplate. Esthetic design subject to the Engineer's approval.
4. Rating as per access controllers' manufacturer recommendations.
5. Heavy-duty type with gold-plated contacts rated for five million operations, minimum.

BACK-UP BATTERIES AND CHARGERS

A The access control system (provided with back-up batteries and chargers), upon a mains power failure, shall force the gate barriers to open and remain in the open position until the mains power is restored or the emergency generator is on-line. Each access control panel shall have its independent back-up power suitable for powering all connected devices for the indicated back-up time.

B The back-up batteries of the access control system shall have the following specifications:

1. The battery block shall include sealed leak-proof, stand-by, maintenance-free, stationary batteries. Other battery types shall not be accepted.
2. The nominal operating time provided by the battery block shall be 3 hours, for 100% system utilization at the end of the discharge period.
3. The battery block shall be extremely low gassing such that no special precautions are required.
4. The service life of the battery block shall exceed 10 years at 20 °c.
5. The battery block shall have a low self-discharge.
6. The batteries post bushings shall be sealed against electrolyte and atmospheric oxygen.

C The charging devices of the access control system shall have the following specifications:

1. Microprocessor-controlled charging (IU characteristic)
   a. Battery charger: constant voltage, current limited type with electronic solid- state controller. Voltage shall be controlled to within 2% of setting at up to 10% mains supply variations.
   b. Minimum charger efficiency: 85 percent.
   c. Equalizing charge: automatically applied to battery every 90 days.
2. The charger shall be designed for a 90% recharge of a fully discharged battery set within 15 hours.
3. Temperature based with automatic boost charging circuit. The charger voltage shall be automatically adjusted with reference to ambient temperature for optimizing charging & battery life.

CONSTRUCTION REQUIREMENTS

A. Install in accordance with manufacturer's instructions and to the approval of the Engineer. Mount equipment in alignment with other fixtures and fix firmly in place with all supports and fastenings secured.

B. Equipment is to be installed to prevent electro-static or other outside interference impairing system performance.

C. Equipment s to be installed to be readily accessible for operation, maintenance and repair. Minor deviations from the Drawings may be made, but no changes are to be made without prior approval.

D. Make good surfaces of equipment damaged during installation, using touch-up paint provided by equipment manufacturer, to the satisfaction of the Engineer.

E. Routing of bus, loop and signal cables, power and control cables are to be in separate raceways.

F. Where not embedded in the concrete, raceways shall be protected form ingress and vandalism (steel conduits). The use of embedded conduits shall only be authorized where explicitly authorized by the structural engineer. Refer to specification section 26 05 33: Raceways, boxes and fittings.

G. Equipment manufacturer is to provide an Engineer and Technician qualified in the operation of the system and equipment performance and the requirements of the specification, to assist the Engineer to test and verify the system performance.

H. The contractor shall include all necessary items to supply and install a fully working system as required here above.

I. All interconnecting devices such as connecting block and the like shall be installed and supplied by the contractor.

J. The contractor shall provide as-built drawings, user manuals, maintenance manuals, in triplicate and written in English.

K. The contractor shall provide sufficient training to the client's staff such that their ability to properly fully use and exploit the system is demonstrated to the client and the engineer.

L. The contractor shall propose to the engineer and client a procedure testing, commissioning and system start-up. This procedure shall include all the system functionalities for every device used. The commissioning procedure shall be applied only when approved by the engineer and the client. The commissioning shall be done in the presence of the client's representative or engineer; commissioning result shall be signed by both parties (contractor and client's representative or engineer). The commissioning results shall be arranged in typewritten booklet and submitted with the as-built drawings.

CHAPTER ELEVEN

DOMESTIC WATER TEST

LEBANESE STANDARD

مواصفة لبنانية

NORME LIBANAISE

LEBANESE STANDARD

NL

161:2016

Deuxième édition
Second Edition
2016

مياه الشرب

EAU POTABLE

DRINKING WATER

مؤسسة المقاييس والمواصفات اللبنانية
--------LIBNOR--------

Numéro de référence
Reference Number
NL 161 (A)
ICS: 13.060.20

NL 161:2016

مؤسسة المقاييس والمواصفات اللبنانية - ليبنور هي مؤسسة عامة ترتبط بوزارة الصناعة. أنشأت بموجب قانون صادر بتاريخ 23 تموز 1962 تتولى بموجبه "وحدها وضع المقاييس والمواصفات الوطنية ونشرها وتعديلها ومنح حق استعمال شارة المطابقة للمقاييس والمواصفات.

توضع المواصفات والمقاييس وتناقش وتصاغ في لجان فنية اختصاصية تؤلفها المؤسسة لهذا الغرض.

تتناول المقاييس والمواصفات الوطنية – على سبيل المثال لا الحصر – القياسات والمصطلحات والرموز وتحديد النوعية للمنتجات والسلع وطرق الفحص والتحليل والاختبار وأصول العمليات المهنية وقواعد الانشاءات الفنية".

"المقاييس والمواصفات اللبنانية التي تقرها المؤسسة اختيارية مبدئياً، ولكن لاعتبارات تتعلق بالسلامة العامة أو الصحة العامة أو المصلحة الوطنية، يمكن للحكومة أن تعطي لأي من المقاييس والمواصفات اللبنانية صفة الإلزام القانوني بموجب مرسوم يتخذ في مجلس الوزراء".

تشارك ليبنور في أعمال التقييس الدولية من خلال عضويتها وانتسابها إلى المنظمة الدولية للتقييس (**ISO**) واللجنة الأوروبية للتقييس (**CEN**) والمنظمة العربية للتنمية الصناعية والتعدين (**AIDMO**) ولجنة الدستور الغذائي (**CODEX Alimentarius**).

مؤسسة المقاييس والمواصفات اللبنانية
سن الفيل، شارع سيتي راما، بناية ليبنور
ص.ب.: 55120 سن الفيل، لبنان
هاتف: 927 485 1 961 +
فاكس: 929 485 1 961 +
Website: www.libnor.gov.lb
E-mail: info@libnor.org

ليبنور

فهرست

ليبنور

NL 161:2016

تمهيـــد

أعدت هذه المواصفة القياسية "مياه الشرب"، رقم 161:2016، وفقًا لإجراءات ليبنور الداخلية، وكانت لجنة "جودة المياه NL TC 147" في مؤسسة المقاييس والمواصفات اللبنانية هي المسؤولة عن إعدادها.
واعتمدت اللجنة الفنية في إعداد هذه المواصفة بشكل أساسي على الدراسة التي أعدتها منظمة الصحة العالمية والتي إستندت فيها على:

- Guidelines for Drinking-Water Quality – Fourth Edition – World Health Organization 2011.
- National Primary Drinking Water Regulations (NPDWRs) – Table of contaminants – US Environmental Protection Agency (EPA)

تلغي هذه المواصفة القياسية المواصفة القياسية اللبنانية التالية: NL 161:1999
وافقت اللجنة الفنية على هذه المواصفة في اجتماعها بتاريخ 2016/8/2.
أقر مجلس إدارة المؤسسة هذه المواصفة في اجتماعه بتاريخ 2016/10/28.
تجدر الإشارة الى أن الملحقات الإعلامية المرفقة بهذه المواصفة غير ملزمة.

ليبنور

NL 161:2016

اللجنة الفنية

المنسق:	**الجهة:**
سحر الحاج سليمان	مؤسسة المقاييس والمواصفات اللبنانية - ليبنور
الأعضاء:	
مايا أسعد	وزارة الصحة العامة
مايا سرور	وزارة الطاقة والمياه
ميرفت كريدية	وزارة الطاقة والمياه
م. لينا عاصي	وزارة الصناعة
م. منى عساف	وزارة الزراعة
د. سابين بركات	وزارة البيئة
م. تانيا أبي الحسن	وزارة الإقتصاد والتجارة
م. كارول أبي نادر	وزارة الإقتصاد والتجارة - Qualeb
د. بولس سعيد	مؤسسة مياه بيروت وجبل لبنان
سليمان الجمال	مؤسسة مياه البقاع
أمل الشدياق	مؤسسة مياه لبنان الجنوبي
فائزة السنكري	مؤسسة مياه لبنان الشمالي
نوال الذهب	مؤسسة مياه لبنان الشمالي
د. رولى بو خزام	الهيئة اللبنانية للطاقة الذرية – المجلس الوطني للبحوث العلمية
سيلين حجار	مصلحة الأبحاث العلمية الزراعية
م. هوفيك قيومجيان	معهد البحوث الصناعية

ليبنور

NL 161:2016

مختبر البيئة المركزي – الجامعة الأميركية في بيروت	د. كارول السخن
نقابة المهندسين في بيروت	م. علي برو
منظمة الصحة العالمية	نهال الحمصي
شركة ريم للمياه المعدنية الطبيعية	كارين صباغ
Fluid Design sal & Watermaster sal	م. مشلين الصياح

ليبنور

NL 161:2016

مياه الشرب

1. المجال

تختص هذه المواصفة القياسية بمياه الشرب غير المعبأة المعدة للإستهلاك البشري.

2. تعاريف

1.2- مياه الشرب غير المعبأة (مياه الشفة): مياه صالحة للاستهلاك البشري، وتنطبق عليها جميع الخصائص المميزة لها والواردة في هذه المواصفة القياسية.

2.2- المياه السطحية: المياه الجارية في الأنهار والسيول أو مياه البحيرات أو السدود أو البرك أو التجمعات المائية الأخرى.

3.2- المياه الجوفية المحمية: المياه المتواجدة تحت سطح الأرض وغير المعرضة للتلوث والتي تقع ضمن حريم البئر.

4.2- حريم البئر يعني حقوقه من جهاته من كل طرف أربعون ذراعا.

5.2- المياه الجوفية غير المحمية: المياه المتواجدة تحت سطح الأرض والمعرضة للتلوث.

3. المتطلبات والخصائص

يجب أن يتوافر في مياه الشرب ما يلي:

1.3. الخصائص الحسية والفيزيقية

يجب ألا تزيد الخصائص الحسية والفيزيقية لمياه الشرب على الحدود الواردة في الجدول رقم (1) أدناه:

الجدول رقم (1): الحد الاقصى للخصائص الحسية والفيزيقية في مياه الشرب

الخصائص الحسية والفيزيقية	الحد الاقصى المسموح به	وتيرة أخذ العينات لمصادر المياه السطحية، والجوفية المحمية وغير المحمية
الطعم	مقبول لدى المستهلك	يتم تحليل هذه الخصائص عند أخذ أي عينة
الرائحة	مقبول لدى المستهلك	
اللون	أقل من 15 Pt-Co	

ليبنور

الموصلية عند حرارة 20 درجة سْ	200-1500 µS/cm	يتم تحليل هذه الخصائص عند أخذ أي عينة
تركيز شوارد الهدرجين	6.5-8.5	
العكارة	أقل من 5 NTU أو أقل من 5 FTU	
المواد الصلبة الحلولة	100-750 mg/l	
القساوة الإجمالية محتسبة بكربونات الجير (الناتجة عن الكالسيوم والمغنيزيوم)	500 mg/l	يتم أخذ العينات وتحليلها مرة كل ستة أشهر وعند الضرورة
الكلسيوم محتسباً ككربونات الجير ($CaCO_3$)	300 mg/l	
المغنيزيوم محتسبا ككربونات المغنيزيوم ($MgCO_3$)	200 mg/l	

2.3. الخصائص الكيميائية

يجب أن تتوافق الخصائص الكيميائية لمياه الشرب مع المتطلبات الواردة في الجداول رقم (2) و(3) و(4) و(5) و(6) الواردة أدناه:

الجدول رقم (2): المواد الكيميائيّة المتوفّرة طبيعيًّا في الماء

المادة الكيميائية	الحد الأقصى المسموح به	وتيرة أخذ العينات لمصادر المياه السطحية، والجوفية المحمية وغير المحمية
صوديوم Sodium (Na)	200 mg/l	يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة
كلوريد Chloride (Cl^-)	250 mg/l	
فلوريد Fluoride (F^-)	1.5 mg/l (temp 8-18°C) 0.7 mg/l (temp 25-30°C)	
باريوم Barium (Ba)	0.7 mg/l	
الزرنيخ Arsenic	0.01 mg/l	

NL 161:2016

يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة	0.5 mg/l	Iron (Fe) الحديد
	0.1 mg/l	Manganese (Mn) المنغنيز
	2.4 mg/l	Boron (B) بورون
	0.003 mg/l	Cadmium (Cd) كادميوم
	0.05 mg/l	الكروم الاجمالي (الكروم سداسي التكافؤ) Total Chromium (Cr) (Hexavalent Chromium Cr VI)
	0.07 mg/l	Molybdenum (Mo) موليبدينوم
	0.04mg/l	Selenium (Se) سلينيوم
	0.03mg/l	Uranium (U) يورانيوم
	0.35 – 0.5 mg/l	خامس أكسيد الفسفور Phosphate (P_2O_5)

الجدول رقم (3): المواد الكيميائية المتوفّرة في المياه الناتجة من مصادر صناعية والمساكن البشرية

وتيرة أخذ العينات لمصادر المياه السطحية، والجوفية المحمية وغير المحمية	الحد الأقصى المسموح به	المادة الكيميائية
يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة	0.006 mg/l	Mercury (Hg)
	0.05 mg/l	Cyanide (CN)
	0.6 µg/l	Hexachlorobutadiene
	0.009 mg/l	Pentachlorophenol
	0.2 mg/l	Nitrilotriacetic acid
	0.05 mg/l	1,4 Dioxane
	0.008mg/l	Di(2-Ethylhexy) phthalate
	0.02 mg/l	Dichloromethane
	0.03 mg/l	1,2 dichloromethane
	0.05 mg/l	1,2 Dichloroethene
	0.02 mg/l	Trichloroethene
	0.04 mg/l	Tetrachloroethene

ليبنور

يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة	1 mg/l	1,2 Dichlorobenzene
	0.3 mg/l	1,4 Dichlorobenzene
	0.3mg/l	Ethyl benzene
	0.02 mg/l	Trichlorobenzene
	1 µg/l	Hexachlorobenzene
	0.004 mg/l	Carbon tetrachloride
	0.3 mg/l	Methyl tertiarybutyl ether
	0.7 mg/l	Toluene
	0.5 mg/l	Xylene
	0.02 mg/l	Styrene
	0.01 mg/l	Benzene
مرة شهريا وعند الضرورة	< 2 mg/l for TOC	Total organic carbon (TOC) or equivalent tests

الجدول رقم (4): المواد الكيميائية الناتجة عن النشاطات الزراعية

وتيرة أخذ العينات لمصادر المياه السطحية، والجوفية المحمية وغير المحمية	**الحد الأقصى المسموح به**	**المادة الكيميائية**
يتم تحليل هذه الخصائص عند أخذ أي عينة	0.5 mg/l	Ammonia (NH_3)
	45 mg/l	Nitrates (NO_3^-)
	0.05 mg/l	Nitrites (NO_2^-)
يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة	0.01mg/l	Aldicarb
	0.007mg/l	Carbofuran
	0.6 µg/l	Endrin
	0.03 µg/l	Heptachlor and Heptachlorepoxide
	0.002 mg/l	Lindane
	0.02 mg/l	Metoxychlor
	0.2 µg/l	Chlordane

NL 161:2016

يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة	0.03 µg/l	Aldrin+Dieldrin
	0.03 mg/l	2,4 – Dichlorophenoxyacetic acid
	0.009 mg/l	2,4,5 – Trichlorophenoxyacetic acid
	0.02 mg/l	Alachlor
	0.1 mg/l	Atrazine and its metabolites
	300 µg/l	Bentazone
	0.6 µg/l	Cyanazine
	0.009 mg/l	Isoproturon
	0.002 mg/l	MCPA [4 – (2 – Methyl – 4 – chlorophenoxy) acetic acid]
	0.01 mg/l	Mecoprop
	0.006 mg/l	Molinate
	0.02 mg/l	Pendimethalin
	0.3 mg/l	Permethrin
	0.002 mg/l	Simazine
	0.02 mg/l	Trifluralin
	0.01 mg/l	Metolachlor
	0.006 mg/l	Dimethoate
	0.4 µg/l	1,2Dibromoethane
	0.04 mg/l	1,2 Dichloropropane
	0.001 mg/l	1,2 dibromo-3chloropropane
	0.02 mg/l	1,3 Dichloropropene
	10 ng/l	Nitrosamimes

الجدول رقم (5): بقايا المبيدات لأغراض الصحة العامة

وتيرة أخذ العينات لمصادر المياه السطحية، والجوفية المحمية وغير المحمية	الحد الأقصى المسموح به	المادة الكيميائية
يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة	0.001 mg/l	DDT + Metabolites

ليبنور

الجدول رقم (6): المواد الكيميائية المستخدمة في معالجة الماء أو في المواد الملامسة لمياه الشرب

المواد الكيميائية المستخدمة في معالجة الماء أو في المواد الملامسة لمياه الشرب		
منتجات التطهير الثانوية	**الحد الأقصى المسموح به**	**وتيرة أخذ العينات لمصادر المياه السطحية، والجوفية المحمية وغير المحمية**
الكلور الحرّ (Free chlorine)	للتطهير بشكل فعال، يجب أن لا تقلّ نسبة الكلور المتبقي الحر عن 0.5 مغ/لتر بعد 30 دقيقة على الأقلّ من ملامسة المادة للماء في ظلّ رقم هدروجيني يتراوح بين 6.5 و8.5. ويجب أن لا تقل النسبة المتبقية من الكلور الحر في نظام التوزيع كلّه وفي نقطة التسليم (عند المستهلك) عن 0.2 مغ/لتر، كما يجب أن لا تزيد عن 0.5 مغ/لتر.	يتم تحليل هذه الخصائص عند أخذ أي عينة
Monochloramine	0.5 – 1.5 mg/l	يتم تحليل هذه الخصائص عند أخذ أي عينة
Chlorite	0.7 mg/l	يتم أخذ العينات وتحليلها إذا تمت المعالجة بثاني أوكسيد الكلور ClO2
Chlorates	0.7 mg/l	يتم أخذ العينات وتحليلها إذا تمت المعالجة بثاني أوكسيد الكلور ClO2
Bromates	0.01 mg/l	يتم أخذ العينات وتحليلها مرة كل ستة أشهر وعند الضرورة
Chloroform	0.3 mg/l	
Bromoform	0.1 mg/l	
Bromodichloromethane	0.06 mg/l	
Dibromochloromethane	0.1 mg/l	

ليبنور

NL 161:2016

يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة	0.02mg/l 0.07mg/l	**الأسيتونتريلات المهلجنة** Halogenated Acetonitriles Dichloroacetonitrile Dibromoacetonitrile
يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة	0.06 mg/l	Sum of Haloacetic acids
يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة	0.2 mg/l	2,4,6 – Trichlorophenol

وتيرة أخذ العينات لمصادر المياه السطحية، والجوفية المحمية وغير المحمية	**الحد الأقصى المسموح به**	**ملوثات من مواد كيميائية مستخدمة في المعالجة**
يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة	0.5 µg/l	Acrylamide
	0.2 mg/l	Aluminum (Al)
	0.4µg/l	Epichlorohydrin

وتيرة أخذ العينات لنظام التوزيع والشبكات	**الحد الأقصى المسموح به**	**ملوثات من الأنابيب والتوصيلات**
يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة	0.02 mg/l	Antimony (Sb)
يتم أخذ العينات وتحليلها مرة كل ستة أشهر وعند الضرورة	0.7 µg/l	Polynuclear aromatic hydrocarbons (the sum) (benzo[a]pyrene)
يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة	1 mg/l	Copper (Cu)
	0.01 mg/l	Lead (Pb)
	0.07 mg/l	Nickel (Ni)
	µg/l 0.3	Vinyl chloride

ليبنور

3.3الخصائص الشعاعية

يجب أن يكون الحد المرجعي للخصائص الشعاعية كما هو وارد في الجدول رقم (7) أدناه:

الجدول رقم (7): الحد الأقصى للخصائص الشعاعية في مياه الشرب

الخصائص الشعاعية	الحد الأقصى المسموح به	وتيرة أخذ العينات لمصادر المياه السطحية، والجوفية المحمية وغير المحمية
النشاط الإشعاعي ألفا الإجمالي Gross Alpha Activity	0.5 Bq*/l	يتم أخذ العينات وتحليلها مرة في السنة وعند الضرورة
النشاط الإشعاعي بيتا الإجمالي Gross Beta Activity	1 Bq/l	

* 1 بيكريل (becquerel – Bq) = 1 انحلال في الثانية الواحدة

ملاحظة: إنّ قيمتي 0.1 بيكريل/لتر للنشاط الاشعاعي ألفا الإجمالي و1 بيكريل/لتر للنشاط الاشعاعي بيتا الإجمالي ما زال يوصى بهما كمستويين للكشف في مياه الشرب حيث لا حاجة إلى اتخاذ أي إجراء إذا كانت النتائج أدنى منهما. أمّا إذا تمّ تخطّي مستويات الكشف، يجب عندئذ فحص تركيز النويدات المشعّة الفرديّة ومقارنتها بالمستويات المحدّدة الموصى بها. (تمّ ذكرها في الملحق رقم (5)).

4.3لخصائص الحيوية

يجب ان تكون مياه الشرب خلوا من الفيروسات (تم ذكرها في الملحق رقم 4) وخلواً من الحشرات او بويضاتها او يرقاتها او حويصلاتها او اجزائها او الحيوانات الاولية (تم ذكرها في الملحق رقم 4) ومن ضمنها الاميبا، وان تكون خلواً من الطحالب والفطريات.

5.3الخصائص الجرثومية

يجب ألا تزيد الخصائص الجرثومية في مياه الشرب على الحدود الواردة في الجدول رقم (8) أدناه:

الجدول رقم (8): الحد الأقصى للخصائص الجرثومية في مياه الشرب

الخصائص الجرثومية	الحد الأقصى المسموح به	وتيرة أخذ العينات
قولونيات إجمالية Total Coliforms	< 1 CFU in 100 ml	يتم أخذ العينات وفقا للجدول رقم (9)
قولونيات متحملة للحرارة Thermotolerant Coliforms	< 1 CFU in 100 ml	
مكورات معويّة		

ليبنور

	< 1 CFU in 100 ml	Intestinal Enterococci
	< 1 CFU in 100 ml	بسودوموناس ايروجينوزا Pseudomonas Aeruginosa

4.طرق أخذ العينات للفحص الجرثومي

تؤخذ عينات الفحص الجرثومي من مصادر وشبكات توزيع المياه وفقا للجدول رقم (9):

الجدول رقم (9): وتيرة أخذ عينات مياه الشرب للفحص الجرثومي (بالمتر المكعب يوميا")

مصدر مياه الشرب	وتيرة أخذ العينات للفحص الجرثومي
كمية المصادر الجوفية المحمية	عينة / الشهر
كمية المصادر السطحية بالمتر المكعب: تستثمر أقل من 000 5 م3 / اليوم تستثمر من 5000 حتّى 000 100 م3 / اليوم تستثمر أكثر من 000 100 م3 / اليوم	 عينة / الشهر عينتين /الشهر بفارق أسبوعين عينة /الأسبوع
كمية المصادر الجوفية غير المحمية بالمتر المكعب:	عينتين / الشهر
المصادر الرئيسية: تستثمر من 2000 حتّى 4000 م3 / اليوم تستثمر أكثر من 5000 م3 / اليوم	عينة / الأسبوع
المصادر الفرعية: تستثمر أقل من 2000 م3 / اليوم	عينة / الشهر
كمية الشبكة المائية ، نظام التوزيع (محطات الضخ، الخزانات العامة-الشبكات) :	عيّنة من الخزان /الشهر 3 عينات من الشبكة / الشهر
تستثمر أقل من 000 5 م3 / اليوم	
تستثمر من 000 5 حتّى 000 100 م3 /اليوم	عينة من الخزان /الأسبوع 3 عينات من الشبكة / الشهر / 000 5 م3 /اليوم
تستثمر من 000 100 م3 / اليوم حتّى 000 500 م3 / اليوم	2 عينة من الخزان /الأسبوع 3 عينة من الشبكة / الشهر /000 10 م3 /اليوم

ليبنور

5.طرق الاختبار

تعتمد طرق الإختبار المعروفة والمناسبة والمثبتة عالميا والصادرة عن المنظمات العالمية التالية:

- APHA: The American Public Health Association
- AOAC International
- EPA: U.S. Environmental Protection Agency
- FDA: U.S. Food and Drug Administration
- ISO: International Organization for Standardization

6.مراجع البحث

- Guidelines for Drinking-Water Quality – Fourth Edition – World Health Organisation 2011.
- National Primary Drinking Water Regulations (NPDWRs) – Table of contaminants - US Environmental Protection Agency (EPA)

الملحق رقم (1)

(إعلامي)

الملوثات الناتجة عن عوامل حيوية

إنّ الشعيّات والفطريات والزراقم والطحالب تفرز مواد كالجيوسمين،2، ميثيل ايزو بورنيول (Geosmine,2, methyl isoborneol) وغيرها من المواد الكيميائيّة التي تؤثر على طعم مياه الشرب حتى ولو كانت موجودة بكميات ضئيلة جدا (بضعة نانوغرامات في اللتر الواحد من مياه الشرب).

NL 161:2016

الملحق رقم (2)

(إعلامي)

جدول الملوثات الكيميائية التي تؤثر على قبولية مياه الشرب

الحد الأقصى المسموح به	المادة الكيميائية
<0.1 µg/l(taste)----<10 µg/l(odour) <0.3 µg/l(taste)----<40 µg/l(odour) <2 µg/l (taste)----<300 µg/l(odour)	Chlorophenols: 2-chlorophenol 2,4-dichlorophenol 2,4,6-trichlorophenol
72-200 µg/l threshold for taste	Ethylbenzene
0.05-0.1mg/l threshold of taste and odour	Hydrogen sulphide
10---20 µg/l threshold for taste and odour 40---120 µg/l threshold for odour	Monochlorobenzene
250 mg/l threshold of taste	Sulfates as sodium
40---120 µg/l threshold of taste 24-170 µg/l threshold of odour	Toluene
10 µg/l(threshold of taste) 5---30 µg/l(taste),30 µg/l(taste and odour) 50 µg/l (taste)	Trichlorobenzenes: 1,2,3-trichlorobenzene 1,2,4-trichlorobenzene 1,3,5-trichlorobenzene
2-10 µg/l(odour), 1 µg/l(taste) 0.3-30 µg/l (odour), 0.6 µg/l (taste)	Dichlorobenzene: 1,2-dichlorobenzene 1,4-dichlorobenzene
300 µg/l (taste), 20-1800 µg/l (odour)	Xylenes
4 mg/l threshold of taste	Zinc (Zn)
4 – 2600 µg/l	Styrene
0.2 mg/l	Anionic detergents as MBAs

الملحق رقم (3)

(إعلامي)

الإختبارات الجرثومية التي يتمّ إجراؤها عند الضرورة

الخصائص	الحد الأقصى المسموح به
السالمونيلا Salmonella	Absence in 1-5 l
البكتيريا اللاهوائية المختزلة للكبريتيت Sulfite reducing anaerobes	< 1 CFU in 50 ml

الملحق رقم (4)

(إعلامي)

قائمة بالفيروسات والأوالي التي تنتقل بواسطة مياه الشرب

List of Viruses قائمة الفيروسات

Adenoviruses

Astroviruses

Enteroviruses

Hepatitis A virus

Hepatitis E virus

Noroviruses

Rotaviruses

Sapoviruses

List of Protozoa قائمة الأوالي

Acanthamoeba spp.

Cryptosporidium hominis/ parvum

Cyclospora cayetanensis

Entamoeba histolytica

Giardia intestinalis

Naegleria fowleri

الملحق رقم (5)

(إعلامي)

النويدات المشعّة الفرديّة

Individual Radionuclides

المستويات الموصى بها للنويدات المشعّة الشائعة[أ] الطبيعية والاصطناعية لعامة الناس

الفئة	النويدة المشعّة	معامل الجرعة (Sv/Bq)	المستوى الموصى به[ب] (Bq/l)
نظير مشعّ يتشكّل طبيعيًّا ويبدأ سلسلة انحلال اليورانيوم[ج]	Uranium-238	4.5×10^{-8}	10
نظائر مشعّة تتشكّل طبيعيًّا وتنتمي إلى سلاسل انحلال اليورانيوم	Uranium-234 Thorium-230 Radium-226 Lead-210 Polonium-210	4.9×10^{-8} 2.1×10^{-7} 2.8×10^{-7} 6.9×10^{-7} 1.2×10^{-6}	1 1 1 0.1 0.1
نظير مشعّ يتشكّل طبيعيًّا ويبدأ سلسلة انحلال الثوريوم	Thorium-232	2.3×10^{-7}	1
نظائر مشعّة تتشكّل طبيعيًّا وتنتمي إلى سلاسل انحلال الثوريوم	Radium-228 Thorium-228	6.9×10^{-7} 7.2×10^{-8}	0.1 1
نويدات مشعّة اصطناعيّة يمكن إطلاقها في البيئة كجزء من منتجات الانشطار المتوفّرة في انبعاثات المفاعلات النوويّة أو تجارب الأسلحة النوويّة	Caesium-134 [د] Caesium-137 [د] Strontium-90 [د]	1.9×10^{-8} 1.3×10^{-8} 2.8×10^{-8}	10 10 10
نويدة اصطناعية يمكن إطلاقها في البيئة كمنتج انشطار (أنظر أعلاه). ويمكن استخدامها أيضًا في إجراءات الطب النووي وبذلك يمكن إطلاقها في أجسام مائية من خلال مخلفات مياه الصرف الصحّي.	Iodine-131 [د], [ه]	2.2×10^{-8}	10

ليبنور

NL 161:2016

نظير مشع للهدروجين المنتج اصطناعيًا كمنتج انشطار من مفاعلات الطاقة النووية وتجارب الأسلحة النووية. ويمكن أن يتواجد طبيعيًّا في البيئة بكمّية ضئيلة جدًّا. تواجده في مصدر مياه يفيد عن تلوّث صناعيّ محتمل.	Tritium [ه]	1.8×10^{-11}	10 000
نظير مشعّ يتكوّن طبيعيًّا ومتوزّع بشكلٍ واسع في الطبيعة ومتوفّر في المركّبات العضويّة وفي جسم الإنسان	Carbon-14	5.8×10^{-10}	100
نظير اصطناعي يتشكّل في المفاعلات النوويّة ويتوفّر أيضًا بكمّيات قليلة للغاية في خامات اليورانيوم الطبيعيّة	Plutonium-239 [د]	2.5×10^{-7}	1
منتج ثانوي لنظير اصطناعي يتشكّل في المفاعلات النوويّة	Americium-241 [د]	2.0×10^{-7}	1

أ- هذه القائمة ليست شاملة، ويجب التحقيق في نويدات مشعّة أخرى في بعض الظروف.

ب- يتمّ تدوير المستويات الموصى بها إلى الرقم الكامل الأقرب.

ج- تتوفّر مستويات موصى بها منفصلة لنظائر اليورانيوم المشعّة المفردة من حيث نشاطها الإشعاعي (أي ما يعبّر عنه ببيكريل/لتر). إنّ القيمة الإسترشادية المؤقتة للمتحوى الإجمالي لليورانيوم في مياه شرب هي 30 ميكروغرام/لتر بحسب سميّتها الكيميائية التي تعتبر راجحة مقارنة بسميّتها الاشعاعية.

د- إنّ هذه النويدات المشعّة قد تتواجد في مياه الشرب في حالات عاديّة أو قد تتواجد بجرعات شحيحة جدًّا بحيث لا يكون لها أيّ تأثير على الصحّة العامّة. لذلك فهي تعتبر ذات أولويّة منخفضة للتحقيق في حال تخطّت المستويات الموصى بها.

ه- على الرغم من أنّه لن يتمّ كشف اليود والترتيوم بواسطة قياسات النشاطات الإجمالية القياسية وبالرغم من عدم ضرورة التحاليل الروتينية لهذه النويدات المشعة، إلا أنّه وفي حال وجود ما يشير إلى إمكانيّة توفّر هاتين المادتين، يجب استخدام تقنيات قياس وأخذ عيّنات خاصّة بالنويدات المشعّة، ولهذا السبب تمّت إضافتهما إلى هذا الجدول.

الملحق رقم (6)

(إعلامي)

قائمة بأحماض الخل

List of Haloacetic Acids

الحد الأقصى المسموح به	أحماض الخل
	Methyl chloroacetate
	Methyl dichloroacetate
	Methyl trichloroacetate
	Methyl bromoacetate
	Methyl bromochloroacetate
	Methyl dibromoacetate
	2,4-Dichloroanisole
	2,4,6-Trichloroanisole
	Chloroacetic acid
0 mg/l	Dichloroacetic acid
0.3 mg/l	Trichloroacetic acid
	Bromoacetic acid
	Bromochloroacetic acid
	Dibromoacetic acid
	2,4-dichlorophenol
	2,4,6-Trichlorophenol

الملحق رقم (7)

(إعلامي)

قائمة الفتالات

List of Phthalates

التركيبة الجزيئية	الحد الأقصى المسموح به	الفتالات
C20H30O6	0.006 mg/L	Bis (2-n-butoxyethyl) phthalate BBEP
C16H22O6	0.006 mg/L	Bis (2-ethoxyethyl) phthalate BEEP
C24H38O4	0.006 mg/L	Bis (2-ethylexyl) phthalate DEHP
C14H18O6	0.006 mg/L	Bis (2-methoxyethyl) phthalate BMEP
C20H30O4	0.006 mg/L	Bis (4-methyl-2-pentyl) phthalate BMPP
C19H20O4	0.006 mg/L	Butyl Benzyl phthalate BBP
C18H26O4	0.006 mg/L	Diamyl phthalate DAP
C16 H22 O4	0.006 mg/L	Di-n-butyl phthalate DBP
C20H26O4	0.006 mg/L	Dicyclohexyl phthalate DCP
C12H14O4	0.006 mg/L	Diehtyl phthalate DEP
C20H30O4	0.006 mg/L	Dihexyl phthalate DHP
C16H22O4	0.006 mg/L	Diisobutyl phthalate DIBP
C10H10O4	0.006 mg/L	Dimethyl phthalate DMP
C26H42O4	0.006 mg/L	Dinonyl phthalate DNP
C24H38O4	0.006 mg/L	Di-n-octyl phthalate DOP

الملحق رقم (8)

(إعلامي)

قائمة الأمينات النتروزوية

List of Nitrosamines

التركيبة الجزيئية	الحد الأقصى المسموح به	العطريات النتروزية والنترامينات
(C2H5)2NNO	10 ng/L	N-Nitrosodiethylamine (NDEA)[3,4]
C2H6N2O	10 ng/L	N-Nitrosodimethylamine (NDMA)[3,5]
C6H14N2O	10 ng/L	N-Nitrosodi-n-propylamine (NDPA)[3,4]
C8H18N2O	10 ng/L	N-Nitrosodi-n-butylamine (NDBA)[3,4]
C3H8N2O	10 ng/L	N-Nitrosomethylethylamine (NMEA)[3,4]
C4H8N2O2	10 ng/L	N-Nitrosomorpholine[4]
C5H10N2O	10 ng/L	N-Nitrosopiperidine (NPIP)[4]
C4H8N2O	10 ng/L	N-Nitrosopyrrolidine (NYPR)[3,4]

الملحق رقم (9)

(إعلامي)

قائمة المستحضرات الدوائية

List of Pharmaceuticals

أسماء وفئات المستحضرات الدوائية ومنتجات الرعاية الشخصيّة :

الفئة	المركّب
Analgesic	Acetaminophen
Steroid	Albuterol
Antibiotic	Ampicillin
Antibiotic	anhyrochlortetracyline (ACTC)
Antibiotic	anyhydrotetracyline (ATC)
Antibiotic	Azithromycin
CNS stimulant	Caffeine
Antibiotic	Carbadox
analghesic/anticonvulsant	Carbamazepine
Antibiotic	cefotaxime
Antibiotic	chlortetracycline
Antihistamine	cimetidine
Antibiotic	ciprofloxacin
Antibiotic	clarithromycin
Antibiotic	clinathromycin
Antibiotic	cloxacillin
sleep-inducing-analgesic	codein
Alkaloid	cotinine
hypertension drug	dehydronifedipine
Antibiotic	demeclocycline
Steroid	digoxigenin
steroid glycoside	digoxin
calcium channel blocker	diltiazem
CNS stimulant	1,7-dimethylxanthine
Antihistamine	diphenhydramine

NL 161:2016

Antibiotic	doxycycline
Antibiotic	enrofloxacin
Antibiotic	4-epinhydrochlortetracycline
Antibiotic	4-Epinhydrotetracycline (EATC)
Antibiotic	4-Epichlortetracyclin
Antibiotic	4-Epioxytetracycline (EOTC)
Antibiotic	erthromycin
Antibiotic	erythromycin anhydrate
Antibiotic	flumequine
Antidepressant	fluxoetine
Hypolipidemic	gemfibrozil
NSAID	Ibuprofen
Antibiotic	izochlortetracycline
Antibiotic	lincomycin
Antibiotic	lomefloxacin
diabetes drug	metformin
Antifungal	miconazole
Antibiotic	minocycline
Antinflammatory	naproxen
Antibacterial	norfloxacin
acytelated progestin	norgestimate
Antibiotic	ofloxacin
Antibiotic	ormetoprim
Antibiotic	oxacillin
Antibiotic	oxalinic acid
Antibiotic	oxytetracycline
Antibiotic	penicillin V
Antibiotic	penicillin G
Antihistamine	ranitidine
Antibiotic	roxithromycin
Antibiotic	sarafloxacin
Antibacterial	sulfachloropyridazine

Antibacterial	sulfadiazine
Antibiotic	sulfadimethoxine
Antibacterial	sulfamerazine
Antibacterial	sulfamethazine
Antibacterial	sulfamethiazole
Antibiotic	sulfamethaoxale
Antibacterial	sulfanilamide
Antimicrobial	sulfathiazole
Antibiotic	tetracyclin
Antifungal	thiabendazole
Antibacterial	triclocarban
Antibacterial	triclosan
Antibacterial	trimethoprim
Antibiotic	tylosin
Antibiotic	virginiamycin
Anticoagulant	warfarin
Antibiotic	meclocycline
Antibiotic	4-epitetracyclinre

الملحق رقم (10)

(إعلامي)

ملوثات سلفونات البيرفلوروكتاني

Perfluorooctane sulfonate PFOS

الحد الأقصى المسموح به	المادة الكيميائية
200 ng/l	Perfluorooctanesulfonic acid

الملحق رقم (11)

(إعلامي)

المصطلحات التقنية

إنكليزي	عربي
Conductivity	الموصلية
PH value	تركيز شوادر الهدروجين
Organoleptic parameters	خصائص حسية
Turbidity	عكارة
Total dissolved solids	المواد الصلبة الحلولة
Total hardness	قساوة إجمالية
Pesticides	مبيدات
Treatment	معالجة
Disinfectants	المواد المطهرة
Disinfection by – products	منتجات التطهير الثانوية
Halogenated acetonitriles	الأسيتونتريلات المهلجنة
Contaminants	ملوثات
Pipes and fittings	الأنابيب والتوصيلات
Pesticide residues	بقايا المبيدات
Gross alpha activity	النشاط الإشعاعي ألفا الإجمالي
Gross beta activity	النشاط الإشعاعي بيتا الإجمالي
Becquerel	بيكريل
Disintegration	إنحلال
Protozoa	حيوانات أولية - الأوالي
Vesicles	حويصلات
Larvae	يرقات
Amaeba	الأميبا
Algae	طحالب
Fungi	فطريات
Total coliforms	قولونيات إجمالية

ليبنور

NL 161:2016

Thermotolerant coliforms	قولونيات متحملة للحرارة
E. coli	إشريشيا كولاي
Intestinal enterococci	مكورات معوية
Pseudomonas aeruginosa	بسودوموناس أيروجينوزا
Salmonella	سالمونيلا
Sulfate reducing anaerobes	أحياء لاهوائية مختزلة للكبريت
Biologically derived contaminants	ملوثات ناتجة عن عوامل حيوية
Actinomycetes	الشعيات
Cyanobacteria	الزراقم
Geosmine,2,methyl isoborneol	الجيوسمين،2، ايزو بورنيول
Acceptability	قبولية
Individual Radionuclides	النويدات المشعة الفردية
Radionuclide	النويدة المشعة
Dose coefficient	معامل الجرعة
Guidance level	المستوى الموصى به
Radioactive isotope	نظير مشع
Decay series	سلاسل إنحلال
Fission	الإنشطار
Haloacetic Acids	أحماض الخل
Phthalates	الفتالات
Nitrosamines	الأمينات النتروزوية
Nitroaromatics and Nitramines	العطريات النتروزية والنترامينات
Molecular formula	التركيبة الجزيئية
Pharmaceuticals	المستحضرات الدوائية
Personal-care products	منتجات الرعاية الشخصية
Perfluorooctane sulfonate	سلفونات البيرفلوروكتاني
Informative	إعلامي

ليبنور

APPENDIX 1

GENERAL SAFETY, HEALTH AND ENVIRONMENTAL REGULATIONS

Appendix 1

General Safety, Health and Environmental Regulations

1 Introduction

1.1 The prevention of injury and/or illness to site personnel and the public, damage to the Works and to public and private property, protection of the environment, and compliance with applicable laws, are primary objectives of the Employer, and because of the importance the Employer places on meeting these objectives, selected minimum requirements are outlined in these Safety, Health and Environmental Regulations with which Contractors shall comply while working on Government contracts. Given that these Regulations cannot cover every eventuality, the Contractor shall be expected to exercise good judgment in all such matters, even though not mentioned in these Regulations, and shall take any and all additional measures, as required or necessary, to meet his responsibility for safety, health and environmental matters during the period of the Contract.
The Employer and its representatives shall not be held liable for any actions taken by the Contractor that are attributed to following the minimum requirements stated hereinafter.

1.2 The Contractor shall, throughout the execution and completion of the Works and the remedying of any defects therein:

(a) Have full regard for the safety of all persons on the Site and keep the Site and the Works in an orderly state appropriate to the avoidance of danger to any person;

(b) Know and understand all laws governing his activities along with any site requirements and work site hazards. Such information shall be communicated by the Contractor to his personnel and subcontractors;

(c) Take all necessary measures to protect his personnel, the Employer's personnel, other persons, the general public and the environment;

(d) Avoid damage or nuisance to persons or to property of the public or others resulting from pollution, noise or other causes arising as a consequence of carrying out the Works.

2 Compliance with Regulations

2.1 The Contractor shall comply with the requirements of these Safety, Health and Environmental Regulations and all other applicable regulations or requirements under Lebanese laws, laid down by relevant authorities or issued by the Employer or the Engineer concerning safety, health and the environment, in force or introduced or issued from time to time during the period of the Contract.
In so far as these Regulations are applicable, they shall apply to sites and personnel outside the Site associated with the performance of the Contract.

2.2 The Regulations equally apply to subcontractors and all other parties engaged by the Contractor and their personnel. The Contractor shall ensure all such parties are fully aware of and comply with the Regulations.

2.3 The Contractor shall comply with all notifications and written or verbal instruction regarding safety issued pursuant to these Regulations by the Employer, Engineer or relevant authorities within the time specified in the notification or instruction.

Whenever the Contractor is required to obtain the approval, agreement, permission, etc of the Engineer, such approval, agreement, permission, etc shall not relieve the Contractor of his responsibilities and obligations under these Regulations or the Contract.

2.4 The Contractor shall adopt a positive approach, awareness and responsibility towards safety, health and the environment, and take appropriate action, by:

(a) Ensuring the Regulations are enforced and followed by the Contractor's personnel. Any failure by the Contractor's personnel to follow the Regulations shall be regarded as a failure

by the Contractor.

(b) Paying attention to possible injury to unauthorized persons entering the site, particularly children.

2.5 Whenever in these Regulations the Contractor is required to provide test certificates for equipment and personnel or to comply the relevant authorities' requirements and no independent test facilities are available or no relevant authorities exist in Lebanon, the Contractor shall provide:

A) in lieu of independent test certificates:

- For equipment - details of the tests and the date of the tests that have been carried out by the Contractor and a written statement that the Contractor has satisfied himself that the item of equipment is fit and safe for use;

- For personnel - details of the training and experience and a written statement that the Contractor has satisfied himself that the person has the required level of competency;

B) In lieu of relevant authorities' requirements - details of the Contractor's own rules, regulations, requirements and procedures regarding safety, health and the environment.

If the Engineer is dissatisfied with the details provided by the Contractor, the Contractor shall provide further details or carry out further tests or provide further written statements as may be reasonably required by the Engineer.

When the Engineer has satisfied himself regarding the Contractor's own rules, regulations, requirements and procedures provided in accordance with (b) above, such rules, etc. shall be deemed to form part of these Regulations and to which Clause 3 shall equally apply.

3 Failure to Comply with Regulations

3.1 General

3.1.1 Should the Contractor fail to comply with any of the Regulations or requirement:

(a) The Engineer may suspend the Works or part of the Works until the Contractor has taken necessary steps, to the satisfaction of the Engineer, to comply with the regulations or requirements.

(b) The Employer may, following written notice to the Contractor, carry out themselves or arrange for another contractor to carry out such measures as they consider appropriate on behalf of the Contractor. Any such actions by the Employer shall not affect or diminish the Contractor's obligations or responsibilities under the Contract.

(c) The Engineer may, following written notice to the Contractor specifying the breach or breaches of these Regulations by the Contractor, impose the fines stipulated in Sub-Clause 3.2. All deductions for fines by the Engineer will be subject to the approval of the Employer.

(d) The Engineer may, by written notice of suspension to the Contractor, suspend all payments to the Contractor under the Contract if the Contractor fails to rectify any breach of the Regulations within the period specified by the Engineer, provided that such notice of suspension:

(i) Shall specify the nature of the failure or failures; and

(ii) Shall request the contractor to remedy each such failure within a specified period after receipt by the Contractors of such notice of suspension.

Such suspension of payment will remain in force until such time as the Contractor has rectified the breach or breaches to the satisfaction of the Engineer. No interest shall be paid on the suspended payments.

3.1.2 Failure to comply with the Regulations or requirements shall be considered a breach of contract by

the Contractor and may result in termination of the Contract by the Employer.

3.1.3 In the event of the Employer or Engineer taking action based on Sub-Clause 3.1.1(a) or (b) or 3.1.2, the Contractor shall not be entitled to any additional costs or extension to the Contract Completion Date.

3.1.4 All costs incurred by the Employer pursuant to Sub-Clause 3.1.1(b) and the fines imposed on the Contractor by the Engineer under Sub-Clause 3.1.1(c) shall be deducted from amounts otherwise due to the Contractor.

3.2 Fines

3.2.1 Failures by the Contractor to comply with the Regulations or requirements are classified as follows:
F1 - Breaches of Sub-Clause 5.6 (personal protective equipment);
F2 - Breaches of Clause 7 (work in Public Areas);
F3 - Breaches other than F1 and F2.

3.2.2 The basic fine for each classification in Sub-Clause 3.2.1, is as follows:
For F1 - US$100;
For F2 - US$500;
For F3 - US$200.

3.2.3 Fines will be applied as follows:

(a) For the first breach of each regulation or requirement - the basic fine. If the same or similar breaches occur in different situations or locations at the same time, the Engineer may apply fines for each situation or location; this will not apply to breaches related to personal protective equipment.

(b) For a second or subsequent breach of the same Regulation or requirement or failure to rectify a previous failure within the time specified by the Engineer - twice the basic fine.

4 General Requirements

4.1 Preamble

4.1.1 All references to safety shall be deemed to include health and the environment.

4.2 Safety Officer

4.2.1 The Contractor shall appoint a competent Safety Officer who shall be responsible for safety, health and the environment. The Safety Officer shall be given sufficient time by the Contractor to carry out his duties; minimum requirements shall be as follows:
Workforce on Site of over 250 - full time Safety Officer;
Workforce on Site of 100-250 - 50% of Safety Officer's time;
Workforce on Site below 100 - as required for the Works but a minimum of 5 hours per week of Safety Officer's time where more than 20 workers.

4.2.2 The Contractor shall provide the Safety Officer with appropriate identification, including a white hard hat with Red Cross symbol and an identification badge. The appointment of the Safety Officer shall be in writing and copied to the Engineer. The appointment shall include specific instructions to enforce these Regulations and delegated authority to take any action, measure or to issue instructions regarding their enforcement. All persons on Site shall be made aware of the name and authority of the Safety Officer and instructed to comply with any instruction or direction on safety matters, verbal or in writing, issued by the Safety Officer.

4.2.3 The Safety Officer shall be provided with a mobile phone or other similar means of communication. The Safety Officer shall be accessible and available at all times including outside normal working hours.

4.3 Safety Training

4.3.1 The Contractor shall provide safety induction training for all site personnel upon starting on site.

4.3.2 The Contractor shall provide safety refresher/reinforcement training at regular intervals for his staff.

4.4 Safety Meetings

4.4.1 The Contractor shall hold regular safety meetings to provide safety instructions and receive feedback from site personnel on safety, health and environmental matters. A weekly Safety Meeting shall be chaired by the Safety Officer and minutes shall be taken of the meeting. The meeting/minutes shall cover all relevant issues including actions to be taken. A copy of the minutes shall be given to the Engineer. The Safety Officer should attend the Contractor's weekly site meetings and "Safety" should be an item on the agenda.

4.5 Safety Inspections

4.5.1 The Safety Officer shall make regular safety inspections of the work site. The Safety Officer shall prepare a report of each inspection. This report shall include details of all breaches of these Regulations and any other matters or situations relating to safety found during the inspection, instructions issued by the Safety Officer and actions taken by the Contractor. A copy of the Safety Officer's inspection reports shall be given to the Engineer.

4.6 Control of Substances Hazardous to Health

4.6.1 Hazardous materials shall be stored in approved safety containers and handled in a manner specified by the manufactures and/or prescribed by relevant Authorities (see Sub-Clause 2.5).

4.6.2 Only properly trained and equipped personnel shall handle hazardous materials.

4.7 Potential Hazards

4.7.1 The Contractor shall inform employees of potential hazards, take appropriate steps to reduce hazards and be prepared for emergency situations.

4.7.2 The Contractor shall make an assessment of every operation involving hazardous substances. The assessment shall be recorded on a Hazardous and Flammable Substances Assessment Method Statement which shall be submitted to the Engineer prior to the delivery and use of the substance on Site.

4.8 Accident Reporting

4.8.1 The Contractor shall report all accidents and dangerous occurrences to the Engineer. The Contractor shall prepare a report on each accident or dangerous occurrence and a copy of the report, together with witness statements and any other relevant information, shall be submitted to the Engineer. A reportable accident or dangerous occurrence shall include any accident to any person on Site requiring medical attention or resulting in the loss of working hours or any incident that resulted, or could have resulted, in injury, damage or a danger to the Works, persons, property or the environment.

4.8.2 In the event of an accident or dangerous occurrence, the Contractor shall be responsible for completing all statutory notifications and reports. Copies of all statutory notifications and reports shall be passed to the Engineer.

4.8.3 All accidents and dangerous occurrences shall be recorded in a Site Accident Book. The Site Accident Book shall be available at all times for inspection by the Engineer.

4.8.4 The Contractor shall immediately rectify any situation or condition that could result in injury, damage or a danger to the Works, person, property or the environment. If the situation or condition cannot be corrected immediately, the Contractor shall provide temporary barriers and appropriate warning signs and devices and/or take other appropriate action necessary for the protection of persons, property and the environment.

4.9 Notices, Signs, Etc.

4.9.1 All safety, health, environmental and other notices and signs shall be clearly displayed and written in both Arabic and English. All requirements, instructions, procedures, etc issued by the Contractor concerning these Regulations shall be printed in both Arabic and English and displayed and readily available to Contractor's personnel.

4.10 First Aid and Medical Attention

4.10.1 The Contractor shall have comprehensive First Aid Kit(s) on Site at all times. First Aid Kits shall be conveniently located and clearly identifiable.

4.10.2 The Contractor shall have one employee on site trained in first aid for every 25 employees. Such persons shall be provided with appropriate identification, including a red hard hat with a white "red cross" symbol and an identification badge.

4.10.3 The Contractor shall make contingency arrangements for calling a Doctor and transporting injured persons to hospital. The telephone numbers of the emergency services and the name address and telephone number of the Doctor and nearest hospital shall be prominently displayed in the Contractor's site office.

4.11 Employee Qualifications and Conduct

4.11.1 The Contractor shall employ only persons who are fit, qualified and skilled in the work to be performed. All persons shall be above the minimum working age.

4.11.2 Contractor's personnel shall use the toilet facilities provided by the Contractor.

4.11.3 The Contractor shall ensure:

(a) That no firearms, weapons, controlled or illegal substances or alcoholic beverages are brought onto the Site and that no personnel under the influence of alcohol or drugs are permitted on Site.
(b) That all personnel obey warning signs, product or process labels and posted instructions.
(c) That drivers or operators of vehicles, machinery, plant and equipment follow the rules for safe operations. Drivers shall wear seat belts and obey all signs and posted speed limits.

5 Safety Requirements

5.1 Personal Protective Equipment

5.1.1 The Contractor shall provide personal protective equipment, including hard hats, safety glasses, respirators, gloves, safety shoes, and such other equipment as required, and shall take all measures or actions for the protection and safety of Contractor's personnel.

5.1.2 Non-metallic hard hats shall be worn at all times by all personnel at the worksite with the exception of those areas where the Engineer has indicated it is not necessary to do so.

5.1.3 Safety glasses shall meet international standards and be available for use and worn in specified worksite areas. As a minimum, safety glasses shall be worn for the following types of work: hammering, chipping, welding, grinding, use of electrically powered or pneumatic equipment, insulation handling, spray painting, working with solvents, and other jobs where the potential of an eye injury exists. Face shields and/or monogoggles shall be worn where possible exposure to hazardous chemicals, cryogenic fluids, acids, caustics, or dust exists and where safety glasses may not provide adequate protection.

5.1.4 When handling acids, caustics, and chemicals with corrosive or toxic properties, suitable protection, such as acid suits or chemical resistant aprons and gloves, shall be worn to prevent accidental contact with the substance.

5.1.5 Personnel shall not be permitted to work whilst wearing personal clothing or footwear likely to be hazardous to themselves or others.

5.1.6 The wearing of safety shoes with steel reinforced toes is recommended for all Contractor's personnel on site. In all cases, Contractor's personnel shall wear substantial work shoes that are

commensurate with the hazards of the work and the worksite area.

5.1.7 Hearing protection, including muffs, plugs or a combination thereof, shall be provided for all personnel operating in areas where the noise level exceeds 90 decibels. Such protection shall also be provided for operators working with equipment exceeding such a level. This may include equipment such as excavators, shovels, jackhammers, saws, drills, grinders, and the like are being used.

5.1.8 The Contractor shall encourage employees to wear substantial work gloves whenever practical and safe to do so.

5.2 Fire Protection and Prevention

5.2.1 The Contractor shall comply with fire protection instructions given by the Authorities having jurisdiction in regard to fire protection regulations.

5.2.2 The Contractor shall, upon moving on site, provide to the Engineer and the Authorities a fire prevention and evacuation plan. This shall include drawing(s) showing the fire assembly points. The fire prevention and evacuation plan and drawing(s) shall be updated from time to time as the Works progress. The Contractor shall ensure all personnel are fully informed on escape routes and assembly points and any changes thereto.

5.2.3 Fuel storage will not be permitted in construction work areas. Contractors may establish fuel storage tanks in special areas set aside for the purpose and approved by the Engineer. Storage tanks shall be adequately bunded to control spillage. Fire extinguishers shall be provided and installed in a suitable nearby location.

5.2.4 Highly combustible or volatile materials shall be stored separately from other materials and as prescribed by relevant authorities and under no circumstances within buildings or structures forming part of the permanent Works. All such materials shall be protected and not exposed to open flame or other situations which could result in a fire risk.

5.2.5 No combustible site accommodation shall be located inside or within 10 meters of a building or structure forming part of the permanent Works, Where units have to be used in these circumstances, they shall be constructed of non-combustible materials and have a half-hour fire rating inside to outside and outside to inside. Non-combustible furniture shall be used where practical.

5.2.6 All temporary accommodation and stores shall be provided with smoke detectors and fire alarms.

5.2.7 Smoking shall be banned in high risk areas.

5.2.8 Expanded polystyrene with or without flame retarding additive, polythene, cardboard and hardboard shall not be used as protection materials.

5.2.9 Plywood and chipboard shall only be used as protection on floors. Vertical protection shall be non-combustible. Debris netting and weather protection sheeting shall be fire retardant.

5.2.10 When using cutting or welding torches or other equipment with an open flame, the Contractor shall provide a fire extinguisher close by at all times. All flammable material shall be cleared from areas of hot works, or work locations prior to welding or oxy/gas burning operations. All hot works shall cease half an hour before the end of a work shift to allow for thorough checking for fires or smoldering materials. Where appropriate, areas of hot works are to be doused in water before the shift ends.

5.2.11 An adequate number of fire extinguishers of types suited to the fire risk and the materials exposed shall be provided. These shall be placed in accessible, well-marked locations throughout the job site. Contractor's personnel shall be trained in their use. Extinguishers shall be checked monthly for service condition and replaced or recharged, as appropriate after use.

5.2.12 Only approved containers shall be used for the storage, transport and dispensing of flammable substances. Portable containers used for transporting or transferring gasoline or other flammable

liquids shall be approved safety cans.

5.2.13 Fuel burning engines shall be shut off while being refueled.

5.2.14 Adequate ventilation to prevent an accumulation of flammable vapors shall be provided where solvents or volatile cleaning agents are used.

5.2.15 Flammables shall not be stored under overhead pipelines, cable trays, electrical wires, or stairways used for emergency egress.

5.2.16 Paints shall be stored and mixed in a room assigned for the purpose. This room shall be kept under lock and key.

5.2.17 Oily waste, rags and any other such combustible materials shall be stored in proper metal containers with self-closing lids and removed every night to a safe area or off site. Every precaution shall be taken to prevent spontaneous combustion.

5.3 Electrical Safety

5.3.1 All temporary electrical installations, tools and equipment shall comply with current regulations dealing with on-site electrical installations.

5.3.2 The Contractor shall establish a permit-to-work system for work on or in proximity to energized circuits of any voltage. Contractor's personnel shall not commence work on such circuits unless a permit to work has been issued and adequate safety measures have been taken and the work operation has been reviewed and approved by the Engineer.

5.3.3 Only authorized personnel shall be allowed to work or repair electrical installations and equipment.

5.3.4 Portable tools and equipment shall be 110 volt, unless otherwise agreed by the Engineer.

5.3.5 When portable or semi-mobile equipment operates at voltages in excess of 110 volts, the supply shall be protected by a Residual Current Device (RCD) regardless of any such device fitted to the equipment. The RCD must have a tripping characteristic of 30 milliamps at 30 milliseconds maximum.

5.3.6 All static electrically powered equipment, including motors, transformers, generators, welders, and other machinery, shall be properly earthed, insulated, and/or protected by a ground fault interruption device. In addition, the skin of metal buildings and trailers with electric service shall be earthed. Metal steps, when used, shall be securely fixed to the trailer.

5.3.7 Lamp holders on festoon lighting shall be moulded to flexible cable and be of the screw in type. Clip on guards shall be fitted to each lamp unit.

5.3.8 All tungsten-halogen lamps shall be fitted with a glass guard to the element. These lamps must be permanently fixed at high level.

5.3.9 Electrical equipment shall be periodically inspected and repaired as necessary by competent persons.

5.3.10 Any work on electrical equipment and systems shall be made safe through locking, tagging, and/or isolation of the equipment before work commences. Prior to the start of the work, the equipment or systems shall be tested to insure that they have been properly de-energized and isolated.

5.3.11 Electrical repair work on energized systems shall be avoided whenever possible.

5.3.12 Electrical trouble shooting shall be conducted only after getting written approval of the Engineer.

5.3.13 Unauthorized personnel shall not enter enclosures or areas containing high voltage equipment such as switch gear, transformers, or substations.

5.4 Oxygen/Acetylene/Fuel Gases/Cartridge Tools

5.4.1 Compressed oxygen shall never be used in the place of compressed air.

5.4.2 Flash-back (Spark) arrestors shall be fitted to all gas equipment.

5.4.3 Liquid Petroleum Gas (LPG) cylinders shall not be stored or left in areas below ground level overnight. Cylinders must be stored upright.

5.4.4 The quantity of oxygen, acetylene and LPG cylinders at the point of work shall be restricted to a maximum of one day's supply. Cylinders shall be kept in upright vertical rack containers or be safely secured to a vertical support.

5.4.5 Cartridge tools shall be of the low velocity type. Operators must have received adequate training in the safe use and operation of the tool to be used.

5.5 Scaffolding/Temporary Works

5.5.1 No aluminum tube shall be used, except for proprietary mobile towers, unless otherwise agreed with the Engineer.

5.5.2 Drawings and calculations shall be submitted to the Engineer, prior to commencement of work on site, for all Temporary Works, including excavations, false work, tower cranes, hoists, services and scaffolding. Design shall conform to international standards.

5.5.3 The Engineer will not approve Temporary Work designs but the Contractor shall take account of any comments on such designs made by the Engineer.

5.5.4 The Contractor shall inspect and approve all Temporary Works after erection and before access, loading or use is allowed. Completed and approved Temporary Works shall be tagged with a scafftag or similar safety system and the Safe Structure insert displayed. For scaffolding, one tag shall be displayed every 32 m² of face area. A central record system shall be kept on all Temporary Work. Temporary Works shall be inspected weekly and similarly recorded.

5.5.5 All mobile scaffold towers shall be erected in accordance with the manufacturer's instructions and a copy of these shall be submitted to the Engineer prior to any use on site. Additionally, all towers shall be erected complete with access ladder, safety rails and kick boards whatever the height.

5.5.6 The Contractor shall repair or replace, immediately, any scaffold including accessories, damaged or weakened from any cause.

5.5.7 The Contractor shall ensure that any slippery conditions on scaffolds are eliminated as soon as possible after they occur.

5.5.8 All scaffolds used for storing materials, for brick or block laying, for access to formwork or for any other purpose where materials may accidentally fall, shall be provided with wire mesh guards or guards of a substantial material, in addition to kick boards.

5.6 Use of Ladders

5.6.1 Manufactured ladders shall meet the applicable safety codes for wood or metal ladders. Metal ladders shall not be used where there is any likelihood of contact with electric cables and equipment. All metal ladders shall be clearly marked: "Caution - Do not use around electrical equipment".

5.6.2 Job made ladders shall not be permitted.

5.6.3 Extension or straight ladders shall be equipped with non-skid safety feet, and shall be no more than 12 m in height. The maximum height of a step ladder shall be 2 m. Ladders shall not be used as platforms or scaffold planks.

5.6.4 Ladders rungs and steps shall be kept clean and free of grease and oil.

5.6.5 Extension and straight ladders shall be tied off at the top and/or bottom when in use. Only one person shall be allowed on a ladder at a time.

5.6.6 Defective ladders shall be taken out of service and not used. Ladders shall not be painted and shall be inspected for defects prior to use.

5.7 Elevated Work

5.7.1 The Contractor shall provide all personnel, while working at an elevated position, with adequate protection from falls. Details of such protection shall be submitted to and approved by the Engineer.

5.7.2 The Contractor shall carry out daily inspections of all elevated work platforms. Defects shall be corrected prior to use.

5.7.3 Roofing & Sheet Material Laying

(a) A Method Statement detailing the procedures to be adopted shall be submitted to and agreed with the Engineer prior to commencement of work on site.

(b) Mobile elevating work platforms or the equivalent shall be used to install roofing and sheet materials wherever practicable and a suitable base is available.

5.7.4 Erection of Structures

(a) A Method Statement detailing the procedures to be adopted shall be submitted and agreed with the Engineer prior to commencement of work on site.

(b) Safety harnesses and lines shall be provided by the Contractor for use by the erection personnel and worn at all times.

(c) Mobile elevating work platforms or the equivalent shall be used to erect structures wherever practicable and a suitable base is available.

5.7.5 Mobile Elevating Work Platforms
Operators shall be trained in the safe use of such platforms and hold a current Certificate of Competence (see Sub-Clause 2.5).

5.7.6 Hoists

(a) A copy of the current Test Certificate (see Sub-Clause 2.5) shall be submitted to the Engineer before any hoist (personnel or material) is brought into operation on the site. Where the range of travel is increased or reduced a copy of the revised Test Certificate shall be submitted.

(b) Each landing gate shall be fitted with a mechanical or electrical interlock to prevent movement of the hoist when any such gate is in the open position.

(c) Safety harnesses must be worn and used by personnel erecting, altering and dismantling hoists.

5.7.7 Suspended Cradles

(a) Suspended cradles shall be installed, moved and dismantled by a specialist contractor.

(b) Suspended cradles shall comply with local regulations.

(c) All powered suspended cradles shall incorporate independent safety lines to overspeed braking devices and independent suspension lines for personal safety harness attachment.

5.8 Use of Temporary Equipment

5.8.1 The safe design capacity of any piece of equipment shall not be exceeded, nor shall the equipment be modified in any manner that alters the original factor of safety or capacity.

5.8.2 Mobile equipment shall be fitted with suitable alarm and motion sensing devices, including backup alarm, when required.

5.8.3 The Contractor shall ensure that the installation and use of equipment are in accordance with the safety rules and recommendations laid down by the manufacturer, taking into account the other installations already in place or to be installed in the future.

5.8.4 The Contractor shall inspect Equipment prior to its use on the Works and periodically thereafter to ensure that it is in safe working order. Special attention shall be given to such items as cables, hoses, guards, booms, blocks, hooks and safety devices. Equipment found to be defective shall not be used and immediately removed from service, and a warning tag attached.

5.8.5 Natural and synthetic fiber rope made of material such as manila, nylon, polyester, or polypropylene shall not be used as slings unless approved by the Engineer.

5.8.6 Only trained, qualified and authorized personnel shall operate equipment. All drivers and operators

shall hold a current Certificate of Training Achievement for the equipment being used (see Sub-Clause 2.5).

5.8.7 A safety observer shall be assigned to watch movements of heavy mobile equipment where hazards may exist to other personnel from the movement of such equipment, or where equipment could hit overhead lines or structures. The observer shall also ensure that people are kept clear of mobile equipment and suspended loads.

5.8.8 When mobile or heavy equipment is traveling onto a public thoroughfare or roadway, a flagman shall insure that traffic has been stopped prior to such equipment proceeding. While the mobile or heavy equipment is traveling on a public roadway, a trailing escort vehicle with a sign warning of a slow-moving vehicle that is dangerous to pass shall be provided.

5.8.9 Cranes:

(a) The Contractor shall give a minimum of 48 hours' notice to the Engineer prior to bringing a mobile crane on site.

(b) No cranes shall be erected on the site without the prior approval of the Engineer. The Engineer may direct the Contractor as to locations where cranes may not be located. The Contractor shall take such directions into account when submitting his proposals for crane location points, base footings, pick up points and swing radius. Compliance with any such direction shall not entitle the Contractor to any extension of the Period of Completion or to any increase in the Contract Price.

(c) Safety harnesses shall be worn and used at all times by personnel engaged on the erection, alterations and dismantling of tower cranes.

(d) The Contractor shall provide a copy of the current Test Certificate (see Sub-Clause 2.5) to the Engineer before any crane (tower or mobile) is brought into operation on the Site.

(e) All lifting tackle must hold a current Test Certificate (see Sub-Clause 2.5). All lifting tackle must be thoroughly examined every 6 months and an inspection report raised.

(f) All fibrous/Webb slings shall be destroyed and replaced 6 months after first use.

(g) All crane drivers/operators shall hold a Certificate of Training Achievement for the class of crane operated (see Sub-Clause 2.5).

(h) All banksman/slingers shall hold a Training Certificate from a recognized training agency (see Sub-Clause 2.5).

(i) Only certified slingers/banksmans shall sling loads or guide crane/load movement.

(j) The maximum weekly working hours of a crane driver or banksman shall be restricted to 60 hours.

(k) Under no circumstances, shall a crane or load come within 4 m of any energized overhead power line or other critical structure.

5.9 Locking-out, Isolating, and Tagging of Equipment

5.9.1 Equipment that could present a hazard to personnel if accidentally activated during the performance of installation, repair, alteration, cleaning, or inspection work shall be made inoperable and free of stored energy and/or material prior to the start of work. Such equipment shall include circuit breakers, compressors, conveyors, elevators, machine tools, pipelines, pumps, valves, and similar equipment.

5.9.2 Where equipment is subject to unexpected external physical movement such as rotating, turning, dropping, falling, rolling, sliding, etc., mechanical and/or structural constraints shall be applied to prevent such movement.

5.9.3 Equipment which has been locked-out, immobilized, or taken out of service for repair or because of a potentially hazardous condition shall be appropriately tagged indicating the reason it has been isolated and/or taken out of service.

5.9.4 Where safety locks are used for locking out or isolating equipment, the lock shall be specially identified and easily recognized as a safety lock.

5.10 Installation of Temporary or Permanent Equipment

5.10.1 During installation and testing the Contractor's specialist engineer shall be in attendance.

5.10.2 All control mechanism panel and wiring diagrams shall be available and printed in both Arabic and English.

5.11 Laser Survey Instruments

5.11.1 Details of the types and use of laser instruments shall be submitted and agreed with the Engineer.

5.12 Working in Confined Spaces

5.12.1 Confined spaces, including tanks, vessels, containers, pits, bins, vaults, tunnels, shafts, trenches, ventilation ducts, or other enclosures where known or potential hazards may exist, shall not be entered without prior inspection by and authorization from the Site Safety Officer and the issuance of a Hazardous Work Permit.

5.12.2 Prior to entering the confined space, the area shall be completely isolated to prevent the entry of any hazardous substances or materials which could cause an oxygen deficient atmosphere. All equipment that could become energized or mobilized shall be physically restrained and tagged. All lines going into the confined space shall be isolated and/or blanked.

5.12.3 Personnel working in a confined space where emergency escape or rescue could be difficult shall wear a safety harness attached to a lifeline.

5.12.4 A qualified attendant(s), trained and knowledgeable in job-related emergency procedures, shall be present at all times while persons are working within the confined space. The attendant shall be capable of effecting a rescue, have necessary rescue equipment immediately available, and be equipped with at least the same protective equipment as the person making entry.

5.12.5 All equipment to be used in a confined space shall be inspected to determine its acceptability for use. Where a hazard from electricity may exist, equipment utilized shall be of low voltage type.

5.12.6 The atmosphere within the confined space shall be tested to determine it is safe to enter. Acceptable limits are:

- Oxygen: 19.5% lower, 22% higher;
- Flammable gas: not to exceed 10% of lower explosion limit;
- Toxic contaminants: not to exceed the permissible exposure limit.
- Subsequent testing shall be done after each interruption and before re-entering the confined space, as well as at intervals not exceeding 4 hours. Continuous monitoring is preferable and may be necessary in certain situations.

5.12.7 Adequate ventilation shall be provided to ensure the atmosphere is maintained within acceptable limits.

5.13 Demolition

5.13.1 A detailed Method Statement detailing the demolition procedures/techniques to be used shall be submitted to and approved by the Engineer prior to commencement of work on site. The Method Statement must include full details of measures to be taken to ensure that there are no persons remaining in the building/structure and to distance members of the public and Contractor's personnel from the building/structure prior to demolition.

5.14 Use of Explosives

5.14.1 The Contractor shall not use explosives without the written permission from the Engineer and relevant authorities (see Sub-Clause 2.5).

5.14.2 The Contractor shall observe all regulations regarding proper purchasing, transportation, storage, handling and use of explosives.

5.14.3 The Contractor shall ensure that explosives and detonators are stored in separate special buildings. These secured buildings shall be constructed, located and clearly marked in Arabic and English:
"DANGER - EXPLOSIVES"
all as approved by the Engineer and relevant authorities (see Sub-Clause 2.5).

5.14.4 The Contractor shall ensure that all possible precautions are taken against accidental fire or explosion, and ensure that explosives and detonators are kept in a proper and safe condition.

5.14.5 The Contractor shall ensure that explosives and detonators are always transported in separate vehicles and kept apart until the last possible moment and that metallic tools are not used to open boxes of explosives or detonators.

5.14.6 Blasting Procedure: the Contractor shall carry out blasting operations in a manner that will not endanger the safety of persons and property. The Contractor shall, along with other necessary precautions:

(a) Clear all persons from buildings and the area affected by the blasting. All such persons shall be given adequate notice of the actual time and date of blasting,

(b) Ensure that police and other local authorities are kept fully informed, in advance, of the blasting program so that they may be present when blasting takes place if they so require,

(c) Erect warning notices around the area affected that blasting operations are in progress,

(d) Carry out a thorough search of buildings and the area affected prior to blasting,

(e) Ensure that blasting is only carried out by experienced shot firers. Priming, charging, stemming and shot firing shall be carried out with greatest regard for safety and in strict accordance with the rules and regulations of the relevant authorities (see Sub-Clause 2.5).

(f) Ensure that explosive charges are not excessive, charged boreholes are properly protected and proper precautions are taken for the safety of persons and property,

5.14.7 The Contractor shall maintain an up-to-date inventory of all explosives and explosive devices and shall submit a monthly report to the Engineer, detailing the use of all explosives by date and location.

5.15 Excavation and Trenching

5.15.1 The Contractor shall obtain an excavation permit from the relevant local authority before commencing excavation in any public place and he shall observe any restrictions imposed by the authority. He shall produce any such permit for the Engineer's inspection when requested to do so. If he fails to produce the permit, the Engineer shall have the right to order cessation of the relevant work.

5.15.2 The side of all excavations and trenches exceeding 1.3 meters in depth which might expose personnel or facilities to danger resulting from shifting earth shall be protected by adequate temporary supports or sloped to the appropriate angle of repose.

5.15.3 All excavations, slopes and temporary supports shall be inspected daily and after each rain, before allowing personnel to enter the excavation.

5.15.4 Excavations 1.3 meters or more in depth and occupied by personnel shall be provided with ladders as a means for entrance and egress. Ladders shall extend not less than 1 meter above the top of the excavation.

3.15.5 The Contractor shall provide adequate barrier protection to all excavations. Barriers shall be readily visible by day or night.

5.15.6 Excavated or other materials shall not be stored at least 0.65 meters from the side of excavations.

5.16 Concrete Reinforcement Starter Bars

5.16.1 The Contractor shall ensure concrete reinforcement starter bars are not a danger to personnel. Where permitted by the Engineer, starter bars shall be bent down. Alternatively, the starter bars shall be protected using either hooked starters, plastic caps, plywood covers or other methods agreed with the Engineer.

6 Environmental and Health Requirements

6.1 Protection of the Environment

6.1.1 The Contractor shall be knowledgeable of and comply with all environmental laws, rules and regulations for materials, including hazardous substances or wastes under his control. The Contractor shall not dump, release or otherwise discharge or dispose of any such material without the authorization of the Engineer.

6.1.2 Any release of a hazardous substance to the environment, whether air, water or ground, must be reported to the Engineer immediately. When releases resulting from Contractor action occur, the Contractor shall take proper precautionary measures to counter any known environmental or health hazards associated with such release. These would include remedial procedures such as spill control and containment and notification of the proper authorities.

6.2 Air Pollution

6.2.1 The Contractor, depending on the type and quantity of materials being used, may be required to have an emergency episode plan for any releases to the atmosphere. The Contractor shall also be aware of local ordinances affecting air pollution.

6.2.2 The Contractor shall take all necessary measures to limit pollution from dust and any windblown materials during the Works, including damping down with water on a regular basis during dry climatic conditions.

6.2.3 The Contractor shall ensure that all trucks leaving the Site are properly covered to prevent discharge of dust, rocks, sand, etc.

6.3 Water Pollution

6.3.1 The Contractor shall not dispose of waste solvents, petroleum products, toxic chemicals or solutions in the city drainage system or watercourse, and shall not dump or bury garbage on the Site. These types of waste shall be taken to an approved disposal facility regularly, and in accordance with requirements of relevant Authorities. The Contractor shall also be responsible to control all run-offs, erosion, etc.

6.4 Solid Waste

6.4.1 General Housekeeping

(a) The Contractor shall maintain the site and any ancillary areas used and occupied for performance of the Works in a clean, tidy and rubbish-free condition at all times.

(b) Upon the issue of any Taking-Over Certificate, the Contractor shall clear away and remove from the Works and the Site to which the Taking-Over Certificate relates, all Contractor's Equipment, surplus material, rubbish and Temporary Works of every kind, and leave the said Works and Site in a clean condition to the satisfaction of the Engineer. Provided that the Contractor shall be entitled to retain on Site, until the end of the Defects Liability Period, such materials, Contractor's Equipment and Temporary Works as are required by him for the purpose of fulfilling his obligations during the Defects Liability Period.

6.4.2 Rubbish Removal and Disposal

(a) The Contractor shall comply with statutory and municipal regulations and requirements for the disposal of rubbish and waste.

(b) The Contractor shall provide suitable metal containers for the temporary storage of waste.

(c) The Contractor shall remove rubbish containers from site as soon as they are full. Rubbish containers shall not be allowed to overflow.

(d) The Contractor shall provide hard standings for and clear vehicle access to rubbish containers.

(e) The Contractor shall provide enclosed chutes of wood or metal where materials are dropped more than 7 meters. The area onto which the material is dropped shall be provided with suitable enclosed protection barriers and warning signs of the hazard of falling materials. Waste materials shall not be removed from the lower area until handling of materials above has ceased.

(f) Domestic and biodegradable waste from offices, canteens and welfare facilities shall be removed daily from the site.

(g) Toxic and hazardous waste shall be collected separately and be disposed of in accordance with current regulations.

(h) No waste shall be burnt on Site unless approved by the Engineer.

6.4.3 Asbestos Handling and Removal

The Contractor shall comply with all local regulations regarding the handling of asbestos materials. In the absence of local regulations, relevant International Standards shall apply.

6.4.5 Pest Control

The Contractor shall be responsible for rodent and pest control on the Site. If requested, the Contractor shall submit to the Engineer, for approval, a detailed programme of the measures to be taken for the control and eradication of rodents and pests.

6.5 Noise Control

6.5.1 The Contractor shall ensure that the work is conducted in a manner so as to comply with all restrictions of the Authorities having jurisdiction, as they relate to noise.

6.5.2 The Contractor shall, in all cases, adopt the best practicable means of minimizing noise. For any particular job, the quietest available plant/and or machinery shall be used. All equipment shall be maintained in good mechanical order and fitted with the appropriate silencers, mufflers or acoustic covers where applicable. Stationary noise sources shall be sited as far away as possible from noise-sensitive areas, and where necessary acoustic barriers shall be used to shield them. Such barriers may be proprietary types, or may consist of site materials such as bricks or earth mounds as appropriate.

6.5.3 Compressors, percussion tools and vehicles shall be fitted with effective silencers of a type recommended by the manufacturers of the equipment. Pneumatic drills and other noisy appliances shall not be used during days of rest or after normal working hours without the consent of the Engineer.

6.5.4 Areas where noise levels exceed 90 decibels, even on a temporary basis, shall be posted as high noise level areas.

7 Additional Requirements for Work in Public Areas

7.1 General

7.1.1 These additional requirements shall apply to all works carried out in Public Areas.

7.1.2 Public Areas are defined as areas still used by or accessible to the public. These include public roads and pavements, occupied buildings and areas outside the Contractor's boundary fencing.

7.1.3 All work in Public Areas shall be carried out to minimize disturbance and avoid dangers to the public.

7.1.4 Before commencing work, the Contractor shall ensure that all necessary resources, including labor, plant and materials, will be available when required and that the works will proceed without delays and be completed in the shortest possible time. Periods of inactivity and slow progress or delays in meeting the agreed program for the works, resulting from the Contractor's failure to provide necessary resources or other causes within the control of the Contractor, will not be accepted. In the event of such inactivity, slow progress or delays, the Contractor shall take immediate action to rectify the situation, including all possible acceleration measures to complete the works within the agreed program. Details of the actions and acceleration measures shall be submitted to the Engineer. If the Engineer is dissatisfied with the Contractor's proposals, the Contractor shall take such further actions or measures as required by the Engineer. All costs incurred shall be the responsibility of the Contractor.

7.2 Method Statement

7.2.1 The Contractor shall submit to the Engineer a method statement for each separate area of work in Public Areas. The Method Statement shall include:

(a) a general description of the Works and methodology of how it will be carried out.

(b) Details of the measures and temporary works to minimize disturbance and safeguard the public. These shall include temporary diversions, safety barriers, screens, signs, lighting, watchmen and arrangements for control of traffic and pedestrians and advance warning to be given to the public.

(c) Details of temporary reinstatement and maintenance of same prior to final reinstatement.

(d) For works involving long lengths of trenches or works to be completed in sections, the lengths or sections of each activity (eg up to temporary reinstatement, temporary reinstatement, final reinstatement) to be carried out at any one time.

(e) Details of the availability of necessary resources (labor, plant, materials, etc) to complete the work.

(f) A program showing start and completion dates and periods for all activities of each length or section, including temporary works, and the works overall.

(g) Such further information as necessary or required by the Engineer.

7.2.2 The Contractor shall not commence work, including temporary works, until approval of the Contractor's Method Statement by the Engineer.

7.2.3 Method Statements shall be updated based on actual progress or as and when required by the Engineer.

7.3 Closure of Roads, Etc.

7.3.1 The closure or partial closure of roads, pavements and other public areas will only be permitted if approved by the Relevant Authorities and the relevant closure permit has been issued by the Authority. The Contractor shall detail for each closure the extent of area to be closed, the reasons and duration of the closure and, where appropriate, proposed diversions. The Contractor shall produce the Closure Permit for inspection by the Engineer if requested. The Engineer shall have the right to order cessation of the relevant work if the Contractor does not produce the Closure Permit.

7.4 Trench and Other Excavations

7.4.1 The requirements covering trench and other excavations will depend on the location and type of the excavation and the potential risks to the public.

7.4.2 The following guidelines apply particularly to trenches but shall also apply to other types of excavations:

(a) Before commencing work the Contractor shall:

 Notify the Engineer on the location and duration of the work. An excavation permit signed by the Engineer must be issued in accordance with Sub-Clause 5.15.1 before excavation proceeds in any work location.;

 Obtain permission from relevant authorities including the police when required;

 Erect all temporary works such as barriers, warning signs, lighting, etc.

 Have available adequate materials for temporary supports to sides of excavations and necessary labor, plant and materials to complete the work within the shortest possible time;

(b) In carrying out the works the Contractor shall, unless otherwise permitted or required by the Engineer: Not open more than one excavation within a radius of 250 meters;

 Limit the length of trench excavation open at one time to 150 meters;

 Maintain and alter or adapt all temporary works including supports to sides of excavations;

 Remove all surplus excavated material the same day it is excavated;

 Complete the works, including final reinstatement within ten days;

 Where final reinstatement is not achieved within the required time, to carry out temporary reinstatement;

 Ensure that any temporary reinstatement is maintained at the correct level until final reinstatement is achieved.

7.4.3 The above guidelines shall not relieve the Contractor of his obligations and responsibilities.

7.5 Safety Barriers

7.5.1 Safety barriers shall be provided to the perimeter of work areas and to trench and other types of excavations and to existing openings such as manholes, drawpits and the like. When exposed to the public, safety barriers shall be provided to both sides of trenches and around all sides of openings.

7.5.2 The Contractor shall provide details of the type or types of safety barriers for each excavation for the approval of the Engineer prior to commencing work. No work shall commence until the safety barriers are in place.

7.5.3 The type of safety barrier used shall be appropriate to the particular location and the potential risks to the public. Examples of different types of safety barriers are given below:

- Type 1 - excavated material;

- Type 2 - non-rigid barrier of rope or florescent tape strung between metal rods driven into the ground;

- Type 3 - rigid barrier of timber, steel or concrete, such barriers could be in the form of horizontal rail(s) or sheet material secured to posts driven or concreted into the ground.

7.5.4 The following are guidelines on the type of safety barriers that could be used in differing situations. They apply particularly to trenches but also apply to other types of excavations, existing openings and to the perimeter of work areas:

- Areas not subject to vehicular traffic - Types 1 or 2;

- Roadways (low traffic speed) - Types 1 or 2;

- Roadways (high traffic speed) - Types 1 or 3.

7.5.5 The above examples of the types of barriers and the guidelines on situations in which they could be used shall not relieve the Contractor of his obligations and responsibilities.

8 Contractor's Site Check List

8.1 A sample Contractor's Site Check List is included in Annex 1. This is included to assist contractors should they wish to introduce such a system as part of their site management procedures. The list is not exhaustive and further items will need to be added by the Contractor.

8.2 The list is issued for guidance only, and does not, in any way, revise or limit the requirements covered elsewhere in these Regulations.

Annex 1

Sample Contractor's Site Check List

Safe Access:

- ☐ Arrangements for visitors and new workers to the site
- ☐ Safe access to working locations
- ☐ Walkways free from obstructions
- ☐ Edge protection to walkways over 2m above ground
- ☐ Holes fenced or protected with fixed covers
- ☐ Tidy site and safe storage of materials
- ☐ Waste collection and disposal
- ☐ Chutes for waste disposal, where applicable
- ☐ Removal or hammering down of nails in timber
- ☐ Safe lighting for dark or poor light conditions
- ☐ Props or shores in place to secure structures, where applicable

Ladders:

- ☐ To be used only if appropriate
- ☐ Good condition and properly positioned
- ☐ Located on firm, level ground
- ☐ Secure near top. If not possible, to be secured near the bottom, weighted or footed to prevent slipping
- ☐ Top of ladder minimum 1 meter above landing place

Scaffolding:

- ☐ Design calculations submitted
- ☐ Proper access to scaffold platform
- ☐ Properly founded uprights with base plates
- ☐ Secured to the building with strong ties to prevent collapse
- ☐ Braced for stability
- ☐ Loadbearing fittings, where required
- ☐ Uprights, ledgers, braces and struts not to be removed during use
- ☐ Fully boarded working platforms, free from defects and arranged to avoid tipping or tripping
- ☐ Securely fixed boards against strong winds
- ☐ Adequate guard rails and toe boards where scaffold 2m above ground
- ☐ Designed for loading with materials, where appropriate
- ☐ Evenly distributed materials
- ☐ Barriers or warning notices for incomplete scaffold (ie not fully boarded)
- ☐ Weekly inspections and after bad weather by competent person
- ☐ Record of inspections

Excavation:

 Underground services to be located and marked and precautions taken to avoid them
 Adequate and suitable timber, trench sheets, props and other supporting materials available on site before excavation starts
 Safe method for erecting/removal of timber supports
 Sloped or battered sides to prevent collapse
 Daily inspections after use of explosives or after unexpected falls of materials
 Safe access to excavations (eg sufficiently long ladder)
 Barriers to restrict personnel/plant
 Stability of neighboring buildings
 Risk of flooding
 Materials stacked, spoil and vehicles away from top of excavations to avoid collapse
 Secured stop blocks for vehicles tipping into excavations

Roof work:

 Crawling ladders or boards on roofs more than 10 degrees
 If applicable, roof battens to provide a safe handhold and foothold
 Barriers or other edge protection
 Crawling boards for working on fragile roof materials such as asbestos cement sheets or glass. Guard rails and notices to same
 Roof lights properly covered or provided with barriers
 During sheeting operations, precautions to stop people falling from edge of sheet
 Precautions to stop debris falling onto others working under the roof work

Transport and mobile plant:

 In good repair (eg steering, handbrake, footbrake)
 Trained drivers and operators and safe use of plant
 Secured loads on vehicles
 Passengers prohibited from riding in dangerous positions
 Propping raised bodies of tipping Lorries prior to inspections
 Control of on-site movements to avoid danger to pedestrians, etc.
 Control of reversing vehicles by properly trained banksmen, following safe system of work

Machinery and equipment:

 Adequate and secured guards in good repair to dangerous parts, eg exposed gears, chain drives, projecting engine shafts

Cranes and lifting appliances:

 Weekly recorded inspections
 Regular inspections by a competent persons
 Test certificates
 Competent and trained drivers over 18 years of age
 Clearly marked controls
 Checks by driver and banksman on weight of load before lifting
 Efficient automatic safe load indicator, inspected weekly, for jib cranes with a capacity of more than one tonne
 Firm level base for cranes
 Sufficient space for safe operation
 Trained banksman/slinger to give signals and to attach loads correctly, with knowledge of lifting limitations of crane
 For cranes with varying operating radius, clearly marked safe working loads and corresponding radii
 Regularly maintenance
 Lifting gear in good condition and regularly examined

Electricity:

 Measures to protect portable electric tools and equipment from mechanical damage and wet conditions
 Checks for damage to or interference with equipment, wires and cables
 Use of the correct plugs to connect to power points
 Proper connections to plugs; firm cable grips to prevent earth wire from pulling out
 "Permit-to-work" procedures, to ensure safety
 Disconnection of supplies to overhead lines or other precautions where cranes, tipper lorries, scaffolding, etc might touch lines or cause arcing

Cartridge operated tools:

 Maker's instruction being followed
 Properly trained operators, awareness of dangers and ability to deal with misfires
 Safety goggles
 Regular cleaning of gun
 Secure place for gun and cartridges when not in use

False work/formwork:

 Design calculations submitted
 Method statement dealing with preventing falls of workers
 Appointment of false work coordinator
 Checks on design and the supports for shuttering and formwork
 Safe erection from steps or proper platforms
 Adequate bases and ground conditions for loads
 Plump props, on level bases and properly set out
 Correct pins used in the props
 Timberwork in good condition
 Inspection by competent person, against agreed design before pouring concrete

Risks to the Public:

 Identify all risks to members of the public on and off site, eg materials falling from scaffold etc., site plant and transport (access/egress) and implement precautions, eg scaffold fans/nets, banksmen, warning notices etc.
 Barriers to protect/isolate persons and vehicles
 Adequate site perimeter fencing to keep out the public and particularly children. Secure the site during non-working periods
 Make safe specific dangers on site during non-working periods, eg excavations and openings covered

or fenced, materials safely stacked, plant immobilized, ladders removed or boarded

Fire - general:

- Sufficient number and types of fire extinguishers
- Adequate escape routes, kept clear
- Worker awareness of what to do in an emergency

Fire - flammable liquids:

- Proper storage area
- Amount of flammable liquid on site kept to a minimum for the day's work
- Smoking prohibited; other ignition sources kept away from flammable liquids
- Proper safety containers

Fire - compressed gases, eg oxygen, LPG, acetylene:

- Properly stored cylinders
- Valves fully closed on cylinders when not in use
- Adopt "hot work" procedures
- Site cylinders in use outside huts

Fire - other combustible materials:

- Minimum amount kept on site
- Proper waste bins
- Regular removal of waste material

Noise:

- Assessment of noise risks
- Noisy plant and machinery fitted with silencers/muffs
- Ear protection for workers if they work in very noisy surroundings

Health:

- Identify hazardous substances, eg asbestos, lead, solvents etc and assess the risks
- Use of safer substances where possible
- Control exposure by means other than by using protective equipment
- Safety information sheets available from the supplier
- Safety equipment and instructions for use
- Keep other workers who are not protected out of danger areas
- Testing of atmosphere in confined spaces; provision of fresh air supply if necessary. Emergency procedures for rescue from confined spaces

Manual handling:

- Avoid where risk of injury
- If unavoidable, assess and reduce risks

Protective clothing:

- Suitable equipment to protect the head, eyes, hands and feet where appropriate
- Enforce wearing of protective equipment

Welfare:

- Suitable toilets
- Clean wash basin, hot/warm water, soap and towel
- Room or area where clothes can be dried
- Wet weather gear for those working in wet conditions
- Heated site hut where workers can take shelter and have meals with the facility for boiling water
- Suitable first aid facilities

Work in Public Areas

- All risks to the public identified
- Method statement approved
- Road closures approved
- Temporary diversions in place
- Safety barriers erected/maintained
- Safety signs and lighting installed/maintained
- Labor, materials, plant and other resources sufficient to meet program
- Temporary reinstatement completed and properly maintained
- Permanent reinstatement completed at earliest possible date

TECHNICAL SPECIFICATIONS

PART 2
MECHANICAL ENGINEERING SERVICES

TABLE OF CONTENTS

CHAPTER ONE
GENERAL TECHNICAL REQUIREMENTS

1.0 GENERAL TECHNICAL REQUIREMENTS

TABLE OF CONTENTS

CHAPTER ONE
GENERAL TECHNICAL REQUIREMENTS

1. SCOPE, REGULATIONS AND STANDARDS

Specification Scope

This Specification covers the supply, installation and testing of all necessary equipment required for the complete Mechanical and Ventilation Services as described in the attached Contract Documents and incorporates standard descriptions for equipment and the installation to be provided under this Contract. The clauses shall be read in conjunction with the accompanying General Conditions of Contract, Scope of Works document, Schedules and Drawings.

The words 'as indicated', 'where indicated', 'unless otherwise indicated', refer to requirements identified elsewhere in the documents issued in connection with the Contract, e.g. on a drawing, in the specification or in a schedule.

The extent of the work shall comprise the system engineering, the whole labour and materials required to form a complete installation, together with such tests, adjustments and commissioning as prescribed in subsequent clauses and otherwise as may be required in order to provide an effective working installation to the satisfaction of the Engineer.

The words 'complete installation' in the foregoing clause shall mean not only the major items of plant and equipment covered by this Specification, but all the incidental sundry components that are required for the complete execution of the works; also for the proper operation of the installation, together with associated labour charges, whether or not these sundry components are mentioned in detail in the tender documents issued in connection with the Contract.

The Contractor shall comply with the latest applicable Standards of the followings:
1) ASME , American Society of Mechanical Engineers.
2) ASHRAE, American Society of Heating , Refrigerating and Air Conditioning Engineers, Inc.
3) ANSI, American National Standards Institute.
4) CIBSE, Chartered Institute Of Building Services Engineers.
5) ASTM, American Society of Testing Materials.
6) AMCA, Air Moving and Conditioning Association.
7) NEMA, National Electrical Manufacturers Association.
8) NFPA, National Fire Protection Association.
9) BS, British Standards
10) ASPE, American Society of Plumbing Engineers.
11) DIN Deutsches Institut Für Normung
12) FM, Factory Matual.
13) IBR, Institute of Boiler and Radiator Manufacturers
14) ISO, International Standardization Organization.

Compliance with Regulations

The work shall comply with all relevant stringent statutory instruments and regulations, applicable to local codes and regulations, at the date of construction and in particular with the following:-

The requirements of the Local Authority Planning Department, District Surveyor or equivalent.

The requirements of the Local Fire Officer.

The Local Water Authority Regulations.

All installations and materials used for the works shall be carried out and provided in full compliance with the appropriate Specifications or Codes of Practice issued by the above mentioned institutions.

Alternatively the installations and materials may be carried out and provided to other equivalent internationally recognized standards provided the standards are acceptable to the Engineer and the relevant local Authorities.

2. INSTALLATION GENERAL

General

The Contractor shall allow in his Tender for all labor, materials, tools, plant and equipment required to supply, deliver and erect all equipment, pipework, fittings, etc., described in this Specification and indicated on the drawings to form a complete working facility including tests and commissioning. This shall mean not only the main items of plant and equipment but also all incidental sundry components with their labor charges necessary for the complete execution of the works.

The Contractor shall ensure that his work is installed in the correct sequence.

The Contractor shall be responsible for ensuring that all sections of the work and all materials are compatible with one another. The Contractor shall check and ensure that all of the equipment and works offered by him will fit into the space provided in the building(s) including the limited entry through doorways and into ducts.

Operating Conditions

All equipment will be required to operate successfully in the climatic conditions prevailing in the locality. Equipment, even if normally operating in air conditioned spaces, may be required to operate at times when the air conditioning system is not being used. Under such conditions all equipment must operate satisfactorily and still have a working life comparable with that expected from top quality equipment operating in more temperate conditions.

Workmanship and Materials

Materials and workmanship generally shall be of the highest standard and the Specification shall be closely adhered to. Materials shall be brand new bearing stamped ratings as required.

Where materials or equipment are not described in detail they shall be of the best quality available and shall comply with the appropriate Standards. The Contractor shall, if required, submit drawings or samples of such materials or equipment to the Engineer for his approval before use on the Contract works.

Samples of Workmanship

The Contractor shall provide the following samples of workmanship for the approval of the Engineer:-

Samples of pipework.

The samples shall be submitted to the Engineer as soon as possible after the order for the work has been placed so that the subsequent delivery of the associated equipment will not be delayed. No orders shall be placed until the Engineer has approved the samples.

All samples shall be correctly labelled and forwarded to the Engineer's office or to the site as directed by the Engineer. At least 14 days shall be allowed for approval of samples by the Engineer.

Unless otherwise stated, approved samples shall be retained on site by the Engineer, who will reject all such materials, which do not correspond with the approved samples. Rejected materials shall be removed from the site immediately.

Where the Engineer carries out an inspection of materials before they leave the manufacturer's premises prior to being delivered to the site, the Engineer shall be at liberty to reject any such materials after delivery should he consider them to be in any way unsatisfactory notwithstanding the preliminary inspection and tests at the manufacturer's premises.

The Contract shall include for the cost of remedial work or tests and inspections necessary due to unsatisfactory material and/or equipment.

3. NOISE AND VIBRATION CONTROL

Anti-Vibration Mountings

All equipment containing moving parts generating noise and vibration shall be mounted upon specially designed vibration isolators. All service connections to such equipment shall include customised flexible connectors and shall be installed in such a way as to prevent transmission of noise and vibration to the structure, other areas of the building or to other items of equipment.

Where required, mountings shall be provided with a positioning or restraining device, which will prevent the equipment position changing if its load changes, for example, during draining down of the equipment, or other maintenance.

Mounting selection should allow for any eccentric load distribution or torque reaction, so that the design deflection is achieved on all mountings under operating conditions.

4. INSPECTION, TESTING AND COMMISSIONING

General

All the works provided as part of this contract shall be inspected, tested, regulated and commissioned in accordance with all relevant Standards, Specifications and Codes of Practice and the details given in the specification and/or as indicated on the drawings, to the entire satisfaction of the Engineer.

All installations shall be inspected and tested in sections as the work proceeds and on completion as composite systems and it shall be noted that the Engineer may require to inspect or test any equipment during manufacture at the manufacturers works. All necessary arrangements shall be made as part of this contract.

All tests shall be arranged in co-operation with the Engineer and the Engineer and other interested parties shall be given seven (7) days notice in writing of the time, location and nature of the test to be performed. No test shall be considered valid unless the Engineer is present.

All necessary skilled and unskilled labour shall be provided for attendance duties during the test (including pre and post test activities) and the test medium shall be provided and subsequently disposed of except where specifically stated otherwise.

Any defects occurring at any time during the test duration shall be made good and a complete re-test shall be carried out, all at no cost to the contract.
Where failure during a test, inspection or commissioning process results in damage to the building fabric and/or any services or requires subsequent builders work in connection to be carried out, then the remedial work shall be carried out at no cost to the contract.

Where valve and flange boxes and access covers and de-mountable ceilings need to be removed and replaced during the commissioning of the works, these shall be removed, protected from damage and replaced in good order by the Contractor.

The Contractor shall arrange a progressive regulation testing and balancing programme to achieve the Date of Completion of the Contract Works.

During the Commissioning Period the Contractor will hold commissioning meetings, which will be attended by the Engineer. The Senior representative of the Contractor's site and Management staff shall attend the meetings which will be held at fortnightly intervals.

The meetings may continue after issue of the 'Taking Over Certificate' for as long as necessary to deal properly with any outstanding works and defects in the Contract Works.

All representatives present during inspection, testing and commissioning shall be fully conversant with the system concerned and the method of system and instrument operation. Manufacturers or specialist contractors representatives shall attend where specifically indicated elsewhere in the Specification or where necessary to ensure full service and co-operation is available to the Engineer to enable the works to be tested and commissioned in accordance with the requirements of the Specification.

All necessary precautions shall be taken to safeguard against frost damage during inspection, testing or commissioning. Any damage so caused shall be made good at no cost to the contract.

All tests shall last for the minimum time period stated or for a longer period if necessary to ensure all sections have been fully examined as required by the test.

All performance tests shall be carried out initially prior to the Engineer being requested to witness the tests and thereby avoid unnecessary re-tests being required.

Provision of Test Points:

The Bills of Quantities do not separately enumerate test point in pipework and ductwork installations. These are deemed to be included in the pipework or ductwork installation. The Contractor shall allow sufficient points for the correct and complete regulation, testing, and commissioning of the installations. All test points shall be indicated on the Working and Record Drawings.

All test points shall be provided which are necessary to carry out the specified tests and commissioning requirements including facilities for temperature, pressure, pressure drop, volume flow, and other relevant conditions to be measured. Such points shall be fitted with removable plugs, flanges or other approved devices appropriate to the service concerned. Permanent test or reading points shall be provided only where specified elsewhere.

Provision of Regulating Valves and Dampers:

Balancing valves and dampers shall be included on every main, branch and sub circuit to facilitate system commissioning. All such devices shall be identified on the Working drawings and submitted for approval.

Testing of Soil, Waste, Vent and Rainwater Pipework

All works which are to be concealed shall be tested before being finally enclosed, a final test shall be made upon completion for soundness and performance strictly in accordance with the British Standard 5572 for Sanitary Pipework, or equivalent and shall be to the entire satisfaction of the Engineer.

Cleaning and Flushing Out of System

Prior to setting systems to work all systems shall be thoroughly cleaned and pipework systems shall be flushed out.

Water installations shall be flushed out using cold water at maximum mains pressure.

Steam and gas installations shall be thoroughly scavenged with steam or compressed air.

During the cleaning process the flow shall be interrupted occasionally to dislodge debris.

Tanks and vessels shall be similarly cleaned.

Water services for domestic use shall then be chemically cleaned by Chlorine treatment as described elsewhere, tested and set to work to comply fully with the UK Department of Health Code of Practice on the Control of Legionellae, and any other recognized recommendations to prevent the development of legionellae bacteria.

All cleaning and flushing out operations shall be conducted in the presence of the Engineer.

Following the cleaning and flushing out operations a signed certificate shall be provided confirming that the systems have been adequately and satisfactorily flushed through and cleaned. This certificate shall be countersigned by the Engineer and forwarded to the Engineer. No commissioning whatsoever shall take place until the Contractor has received written acknowledgement of receipt of this certificate from the Engineer.

Commissioning of Services

All systems shall be filled with the working fluid, vented as necessary, and brought to operating conditions and the flows then regulated to the design values.

The balancing and testing of systems to verify performance of the engineering systems shall be carried out by a team of experienced specialist Balancing and Testing Engineers who shall be responsible to the Contractor for the complete balancing and testing of all systems and the production of a complete log of all tests including any comments they may wish to make for improving the performance of the installations.

Following regulation and balancing procedures all plant systems shall be put into operation and examined to ensure that the installations are operating correctly.

5. HANDOVER PROCEDURES AND DOCUMENTATION

Operation and Maintenance Instruction Manuals

Three copies of a manual, (or series of manuals if required by the extent of the installations) shall be provided 1 month prior to the anticipated completion date of the contract and shall contain complete operational and maintenance instructions for the various installations.
The purpose of the manuals is to:-

(a) Familiarise maintenance staff with the overall philosophy of the project.

(b) Describe the Mechanical and Public Health Services systems and their inter-relation with other systems.

(c) Act as central point of reference and as such, to contain specific references to Record Drawings and Vendors/ Manufacturers literature to enable the reader to easily locate further information.

(d) Give all the specific information and instructions including safety information, to enable an operator, of technician level, to manually start and run each system at Local Control Station and from any Central Monitoring Control Station included in the Contract. This shall also include procedures for start-up of systems after an emergency shutdown.

(e) To give details of action to be taken by operators in event of fire, plant malfunction or alarm condition occurring.

(f) Provide information and warnings necessary to ensure the health and safety of the general public together with operating and maintenance staff.
The manual(s) shall be agreed in draft form with the Engineer and shall be primarily sub-divided into (a) instructions relevant to items of plant or equipment and (b) instructions relevant to complete systems.
The plant and equipment section shall contain the manufacturers printed maintenance and operator's instructions relevant only to the particular item of equipment concerned. General catalogues will not be acceptable.
The section dealing with complete systems shall be sub-divided into each service with a ready means of reference and detailed index. The function and manner of operation of each system shall be clearly described together with illustration and line diagrams in schematic form showing the location and function of control valves, items of equipment and which spaces or areas are served by these items. The colour coding and identification systems employed shall be explained, and a full lubrication schedule for all lubricated items of plant and equipment shall be included.

Operation and Maintenance charts shall be included for each plantroom area and shall provide essential information and reference data for daily running checks together with weekly, monthly and annual maintenance procedures.
Where more than one system can be shown on a single chart without loss of clarity this will be acceptable. Complex systems must be shown on individual charts.
A special section shall be included in the manual for dealing with fault finding routines and emergency procedures in case of plant or system malfunction.
All equipment shall be scheduled in the document including a complete valve schedule with all items identified in accordance with the plant reference provided on the item of plant or equipment and the as-installed drawings.
A complete itemized list of essential and secondary spares together with the manufacturers ordering reference numbers shall be provided. A list of plant manufacturers names, addresses and telephone numbers shall also be included.
The Operation and Maintenance manual(s) shall include copies of all manufacturers works test certificates for plant items such as heat generating plant, heat exchangers, calorifiers, refrigeration machines, tanks, vessels, motors, fans, pumps, controls, electrical and other like equipment. In the case of fans and pumps copies of the manufacturers characteristic curves for the actual unit fitted shall be supplied.

Labels and Identification

All valves controlling mains and sub-circuits shall be provided with a treffolyte label not less than 75mm x 50mm x 1.6mm thick with a reference number clearly engraved and coloured red. Labels shall be securely fixed to the valve body, handle or spindle in a position where they can be easily read.

The numbers on the valve labels shall refer to those on the "as installed" drawings and valve charts.

All items of plant, motor starters and isolators shall be labelled with their corresponding plant reference engraved on a treffolyte label securely fixed to the item in a prominent position. The plant reference shall correspond to that indicated on the "as installed" drawings and plant schedules in the operation and maintenance manuals.

In addition items of plant such as fans, pumps, calorifiers, etc. shall bear a metal label fixed by the manufacturer giving the makers name, date of manufacture and manufacturer's serial number, test and working pressures, duty, kW, phasing, hertz, speeds, BS number, etc. as appropriate to the item of plant such that its origins and details may be easily traced at a later date.

Schedule of Outstanding Items and Defects

Until the installation is finally taken over as complete, the Contractor shall be responsible for any necessary protection of the installation and electrical safety requirements.

On the completion of the Contract an inspection of the installation will be made by the Engineer. During the inspection a schedule of outstanding items or defects will be provided by the Engineer.

All items included in this Schedule shall be attended to within fourteen days of the date of the inspection.

Certificate of Practical Completion

When the Contractor has demonstrated to the Engineer and to the Engineer's complete satisfaction that the works are operating as intended within the design limits and tolerances of the manufactured items, then the Engineer will issue a Certificate of Practical Completion subject to the clearance of any outstanding items or defects within 14 days of the date of the Certificate and the responsibility for the operation of the plant will pass from the Contractor to the Employer or as otherwise agreed with the Engineer.
This Certificate will not be authorised until all items in this clause have been cleared to the Engineer's satisfaction.

Responsibility During Period of Maintenance

The Contractor shall include for making checks of the Thermal Environment in the building when occupied and in use by the Client and for making normal adjustments to the commissioning and testing settings to tune the installations to the actual building usage.

The Contractor shall include for making checks of the water flow capacities on domestic water services in buildings when occupied and used by the Client and for making normal adjustments to the commissioning settings to tune the installation to the actual building usage.

Testing of Plant Capacity and Efficiency

A heating test shall be carried out under maximum load and design conditions to check the actual plant capacity as supplied and installed. Where possible, thermal efficiency checks shall be made. These tests shall be carried out during the year following practical completion.

Adjustments During Course of Period of Maintenance

The Contractor shall include for making a further visit to the site before the end of the Period of Maintenance to check over and, if necessary, re-adjust the system.

Certificate of Making Good Defects

The Contractor shall carry out a thorough detailed examination of the installations between the eleventh and twelfth month of the defects liability period and shall put right any outstanding works or defects that might have occurred under the Defects Liability Period in the Conditions of Contract.

On completion of such works, and agreement that the requirements of the Conditions of Contract and Specification have been met, the Engineer will recommend to the Architect that a Certificate of Making Good Defects can be issued.

6. RE-MODELLING

Contractor, at Contractor's expense, will be responsible for any items not included in bid, but are shown on plans or specified in the General Specifications or required by local codes and ordinances.

In order to do so the contractor shall inspect all the existing mechanical prior to pricing. All work to conform to all applicable codes. Contractor shall provide all necessary Mechanical works, maintenance, cleaning, relocation or removing, testing & commissioning for the existing Mechanical system to ensure properly working system. Work performed under this section shall result in complete and updated plumbing systems. All material, labor, equipment, and other items to complete the plumbing system as outlined in Bid Document shall be furnished.

All plumbing work, whether existing and to be kept, or new installation performed under this contract SHALL BE INSPECTED, tested, and approved by the Consultant.

Cutting, patching, and cleaning shall be done as necessary by the contractor performing the work; however, special permission shall be obtained from the Consultant before cutting structural members of finished construction.

The plumbing contractor shall clean away all debris caused by his work at the close of each work day, and upon completion of the job.

A salvaged plumbing fixture and upon approval by the Engineer, shall be handed to the Owner representative.
Upon removal of old fixtures, contractor shall inspect all cleats, supports, and floor joists to assure a solid and secure installation. If unforeseen repair or replacement is needed, contractor shall notify the Engineer.

The contractor shall further determine if a change in the location of any plumbing fixture and/or pipes is necessary for proper functional replacement of the unit, and to meet codes.

Repair All Existing Supply lines.

Furnish and install all labor and materials necessary to repair all existing supply lines in and under structure. All work to conform to local plumbing code. Examine all supply lines in and under structure for proper operation. Replace all galvanized.

Repair All Existing Drain lines.

Furnish and install all labor and materials necessary to restore all drain lines in and under structure to good condition (no leaks and fast positive drainage and venting) in accordance with the Code. Care to be taken to not damage any plumbing fixture or other pipes.
Reseat Toilet

Remove toilet and old seating gasket. Clean area and reseat toilet with new wax seal. Make all connections and leave free of any leaks. Installation shall meet all local plumbing codes. If Contractor shall uncover a lead flange once toilet is removed, the Contractor shall notify the Engineer for a decision on whether the flange should be replaced.

Toilet

Replace existing toilet with new first quality vitreous china toilet. Installation shall be complete with new toilet seat and all required plumbing connections. Plumbing equipment and materials and workmanship shall comply with local codes and as per the other sections of this Specification.
Color and style of fixture to be selected as per the specification.

Replace Flush Mechanism

Remove deteriorated flushing unit and install a suitable adaptable unit. All new seals to be installed with new unit. After replacement, unit shall function properly with moderate pressure and completely shut-off when optimum water level is reached.

Repair Faucet

Repair existing defective faucet(s) as set forth in Bid Document. Restore to a watertight condition in accordance with code. Any replacement handles or equipment shall conform to original style as closely as possible. Contractor shall take all necessary precautions to prevent tool scarring or damage to fixture or other accessories. Work shall include replacement of all worn internal components. Final result shall be a faucet that operates easily with no leaks or drips.

Drains, Wastes, Vents, Traps

Furnish and install all required drains, wastes, vents, and traps. Installation shall meet all local plumbing codes. Stack shall extend through roof and be made waterproof. Repair all scarring. When a new plumbing fixture is installed, or an existing fixture is relocated, all work shall conform to local plumbing code. Snake drain lines - where called for in the work write-up a professional contractor shall be used to snake the entire sewer system including all clean outs, roof vents and yard line to the street.

Kitchen Sink

Furnish and install double well, stainless steel sink with sound dampening. Replace all waste to the wall including baskets strainers. Work shall include removal and reinstallation of all items not replaced in the Bid Document.

Vanity/Lavatory/Faucet Top

Remove existing vanity and lavatory. Repair/replace wall surface as needed. Size shall be as specified. Include new supply and waste lines to wall. Unit shall be complete with vented drains, proper traps, cutoffs and washer less faucets.

Replace Existing Drain

Furnish and install all labor and materials to replace existing drain. If existing drain is not vented, provisions shall be made to vent the replacement drain. Size and slope shall conform to the current plumbing code.

Replace Existing Supply Lines

Furnish and install all labor and materials necessary to replace supply lines as indicated in the Bid Document. Piping with all necessary fittings, hangers, supports, and all accessories needed to run piping in a workmanlike manner in conformance with the plumbing code.

Sump Pump

Furnish and install all labor and materials necessary to install sump pump as specified in Bid Document. Pit shall be located at lowest corner of basement. Materials included are sump pump pit, rigid outflow pipe, and electric hook-up. Drainage from sump pump shall not be connected to the sanitary sewer. All work shall conform to local codes in particular if the repair of the existing pumps is required.

Floor Drain Cover

Furnish and install new floor drain cover on existing drain. Cover should fit snugly.

Demolition

Where required, demolition shall be performed without damage to adjacent existing work. All existing fixtures, equipment and piping which have been removed or disconnected by the contractor shall become the property of this contractor and shall be removed from the site at his expense. All remaining lines that are not to be reused shall be deactivated and properly capped and plugged in basement or crawl space areas.

When concrete is removed in a basement floor for access to underground pipes, concrete shall be replaced.

CHAPTER TWO
BELOW GROUND DRAINAGE

2.0 BELOW GROUND DRAINAGE

TABLE OF CONTENTS

CHAPTER TWO
BELOW GROUND DRAINAGE

1. GENERAL PREAMBLE

Description of Works

The belowground drainage shall comprise a separate system of drainage as described herein.

Where drainage is located beneath the building ground floor slab the pipe work shall be suspended from the underside of the concrete slab, where located externally pipe work shall be below ground installed in trenches as described.

Scope of Work

The Contractor shall carry out all works described in these documents strictly in accordance with this Specification, relevant Standards and Codes of Practice and the requirements of the Local Authority.

Connect the foul drainage installation to the Local Authority Foul Sewer, at a point external to the site, as indicated on the site layout plan.

Connect the surface water drainage installation to discharge into the drainage system, if it exists, at a point external to the site, as indicated on the site layout plan.

Co-ordinate the works with the Local Authority in accordance with the building programme and ensure the least inconvenience to the site or surrounding areas.

Strictly adhere to the materials described within this Specification.

Do not commence the drainage works until all materials are delivered to site.

Drainage Termination (Internal)

The underground drainage installation shall in general terminate at Lowest Floor Slab Level.

Where drainage pipe work is indicated as passing through a structural retaining wall connecting to a suspended pipe work installation include the suspended pipe work to form part of the drainage works and terminate at the Floor Slab level immediately above the point of entry through the retaining wall.

Drainage Termination (External)

The drainage installation shall terminate at and include the connections to the Local Authority Sewer.

Drainage By-Laws and Regulations

The Contractor shall state which standards are to be used and submit a copy of the relevant International Standards to the Architect/ Engineer or his appointed representative at the commencement of the contract.

Notification for Inspection

Give a minimum of 24 hours' written notice to the Architect/Engineer or his appointed representative for the purpose of inspection and measurement whenever sections of:-

a) Setting out is completed;
b) Excavations are completed;
c) Concrete and/or granular beds are laid;
d) Drainage installed ready for testing;
e) Compaction/Backfill is to be carried out;
f) Sewer connections are complete;
g) Final testing/commissioning;
h) Simultaneous discharge test.

No further work shall be carried out until each stage of the work has been inspected approved and signed off.

Existing Drain/Sewers/Manholes

Check invert levels of all existing drains, sewers, or manholes before laying new drains, notify the Architect/Engineer or his appointed representative if the declared invert levels are found to be inaccurate.

Where it is necessary to cut into any live drain within the boundary of the site carry out the works causing the minimum disruption to the existing drainage system while the connection is being made.

Check existing drains crossing the area of the site operations, ensure they do not serve other buildings outside the site boundary and either remove and plug off at manholes, or divert clear of the works as directed by the Architect/Engineer or his appointed representative.

Check all drains to be abandoned and record the locations on drawings before filling is carried out.
The Contractor shall indemnify the Employer against all risks connected with any existing pipe mains, drains, sewers and the safety thereof and for all damage caused to them through, or in consequence of, site operations during the construction of the works.

Local Water Authority Sewers

Obtain written consent from the Local Authority before cutting into any Public Sewer.

Confirm to the Local Authority the requirements for the sewer connections, giving size, line, level, and location and establish a programme for the work to be carried out, make necessary arrangements for traffic diversions, road closure order, and any other requirements to comply with the programme.

Drainage, Water, Electric, Telephone Supply Authorities

Give information regarding the line and level of these services and co-operate with the Local Authority, Water, Electricity and Telecommunications Authorities, or any other authorized firms to enable them to provide and lay mains, cables, sewer connections etc., along routes on or adjacent to the site without any undue delays or interruption.

No claim will be allowed for any delay or interference which may be occasioned by this work.

Ensure the various authorities or companies lay their mains in the given positions and/or make provision to enable them to do so at a later date without disturbing the structure of carriageways and/or paved areas, supply drawings showing the runs and positions of such mains to be included as part of the contract.

Ensure supply authorities, companies and/or their agents properly consolidate and reinstate all trenches and other excavations opened by them to ensure the safety of the persons passing adjacent to or within the area of site operations.

On-Site Drainage, Sewers /Water Mains, Electric/Telephone Cables etc.

Take all precautions to avoid damage to water, drains, sewers, culverts, telegraph, telephone or electric cables, ducts or other apparatus that may be met in the course of excavation, together with any walls, buildings or other properties adjacent to the area of operations. Maintain and protect during the progress of the works.

When any water mains, drains, cables etc., are encountered, inform the Architect/Engineer or his appointed representative and obtain information as to the necessary supports or protective measures which may be necessary in accordance with the requirements of the respective Authority or Company, including approval to any permanent works that may have to be put in hand for the purpose of support, protection or deviation.

The cost of providing temporary supports, protection of pipes, drain cables, etc., shall be included and measured as part of the Contract.

If the Architect/Engineer or his appointed representative on inspection of any existing pipes, drains, cables etc., considers that they are in a condition requiring repair, renewal, deviation or other work to maintain their efficiency, and such work not being considered due to any damage caused by site operations, he shall request remedial works be carried out to make good any such damage.

Invert Levels

Invert levels are generally given at all main points of intersection and changes of direction determine all intermediate levels as required by calculating the gradients between given invert levels.

Setting Out

Where the drainage works are to connect directly to a soil, waste or rainwater system the Contractor shall be responsible for:-

(a) Checking all dimensions with his Plumbing Sub-contractor to ensure that all connections relate accurately to his "Sanitary Pipe work Installation Drawings";

(b) Ensuring all dimensions relate correctly to the site setting out and building dimensions shown on the latest Architect/Structural Engineers drawings; and

(c) Relating to the specified sanitary fittings dimensions shown on the Architects Sanitary Fitting Schedule.

Report any uncertainty as to the accuracy of the dimensions or tolerances before the works are carried out, check the drawings and all associated details in sufficient time to enable any adjustments to be made and necessary instructions to be issued. Unless sufficient time is given no claim for delay will be considered.

2. MATERIALS

General

Provide all pipe work, fittings and materials to the entire satisfaction of the Architect/Engineer or his appointed representative in accordance with British Standard Specification or equivalent International Standard.

Standards

EN1401 UPVC Pipes & Fittings for below ground gravity drainage & sewerage.

OR APPROVED EQUAL to European norm i.e. Din, NF, American Standards …Etc.

All materials or article required to comply with a shall incorporate the stamp of the registered certification "kite mark" of the Standard Institution, or alternatively, copies of test certificates shall be furnished by the suppliers or manufacturer indicating compliance with the relevant Standard.

Manhole/Inspection Covers and Frames

Covers and frames shall be either solid or recessed top as described and conform to the following requirements:-

Grade B - Medium Ductile Iron covers and frames shall withstand a test load of 250kN used in areas subject to a wheel load of up to 5.00 tones with non-rocking covers and/or machined faces.

Pre-Cast Concrete Manholes

Shall conform to BS.5911, or equivalent be "Kite Marked" and consist of concrete aggregate chamber rings incorporating "Ogee" joints. Manholes exceeding 1.800m. in depth shall have either a reinforced concrete reducing slab, or a straight back taper with pre-cast concrete shaft rings.

The rings shall have rebate joint for watertight construction.

Provide a pre-cast reinforced concrete cover slab with clear opening to suit the specified manhole cover.

The opening in the concrete cover slab shall be set over galvanized step irons cast into the concrete manhole rings by the manufacturer.

The chamber rings shall be set on an "in situ" concrete base slab incorporating the main drainage channel, and branch drain connections.

Submersible Sewage Pumps

Supply and install submersible sewage pumps where shown on the drawings and of indicated capacities and heads.
The pump and motor housing form a compact integral unit and shall be of the completely submersible type. The motor shall be cooled by the fluid in the sump.

The pump/motor housing shall be complete with:
- Lifting Yoke
- Electrical terminal board, and submersible electric flexible cable between pump motor and control unit.
- Ball bearings good for three years continuous operation
- Stainless steel shaft with precision ground finish.
- Stator, cast iron stator housing and class F stator insulation.
- Rotor.
- Statically and dynamically balanced non-clog impeller with a minimum passage cross-section of 2 ½" (65mm).
- Cast iron pump.
- Base and Stainer.
- Tungesten carbide shaft seals to withstand heavily contaminated liquid.
- Gate valve and check valve at pump discharge.

The wet well housing the pump/motor assembly shall be complete with the following accessories:
- Grouting-in cast iron frame with cast iron cover plate and upper guide rail bracket.
- Cable holder to collect power cables and permit adjustment of height of level regulators.
- Discharge connection with lower guide rail bracket.
- Automatic control unit with level regulatoto start and stop the pumps automatically. The controunit shall also alternate the operaof the pumpsto equialize their operating time. In case of failure of one pump; the control unit shall initiate an alarm and automatically start the other pump.

A high level floats, when reached shall automatically initiate an alarm.
The level regulators (float switches) shall be of polypropylene housing with eccentrically positioned lead weight, mercury switch and 13 meters waterproof cable.

The control unit shall be complete with circuit breakers, starters and indicating lights.

3. WORKMANSHIP

Setting Out

Before laying new drains check existing datum reference points, invert levels, and positions of existing drains, sewers, inspection chambers and manholes with the levels indicated on the Contract Drawings, and relate to building foundations, piles or other features to which the works are related.

The checking of any setting-out, line or level by the Architect/ Engineering of his appointed representative shall not in any way relieve the contractor of his responsibility for the correctness thereof.

Connections to Sewers

Make arrangements to connect new drains to existing sewers to the satisfaction of the Local Authority.

Excavation

Carry out all excavation work arranging to visit site and to judge the extent of works, and site/ground conditions, check information on site reports, trial pits, borehole reports and establish ground conditions and strata.

Main excavation of drain trenches on any section of the works shall not be commenced until a full supply of pipes, fittings and materials is available for completing that section.

Clear the working area of all vegetation, rubbish, debris, contaminated earth, concrete, tarmacadam etc., and include for excavation in whatever type of soil is encountered.

Where top soil is to be replaced over backfilled trenches allow for removal and place clear of the main excavated material. Replace in a single layer at completion of the backfill operation and leave proud to allow for settlement.

Carry out in open cut all excavations to the lines and levels having a minimum size to permit accurate setting out, and installation of the works, including trench sheeting, efficient refilling of voids with approved material, all placed and compacted in accordance with this specification.

Formation of Excavations

Excavate immediately before laying bedding or pipe work.

Remove mud, rock projections, bolders and hard spot. Replace where necessary with approved filling material well consolidated, local soft spots to be stabilized by tamping in bedding material.

Excavations taken out to a greater depth than necessary shall be filled to the required levels with concrete or granular bedding material as directed by the Architect/Engineer or his appointed representative. The cost of additional fill material shall be deemed to be included in the rates of excavation.

The bottoms of all excavations, trenches and headings shall be inspected and approved by the Architect/Engineer or his appointed representative before any concrete or granular bedding is deposited or pipes laid.

Where a true trench formation is required and this cannot be achieved by excavation, a true trench formation shall be achieved using filled bagging or alternatively filled concrete blocks to give a trench profile as described in the Excavation clauses of this specification.

Transport of Spoil

Vehicles and containers used to transport excavated materials from site shall be constructed and loaded to avoid spillage, level all loads before commencement of journey.

Any spillage that occurs outside the boundary of the site shall be cleaned away at the end of each working day.

Laying Drainage Pipe work - General

All pipe materials including concrete, granular material for bedding and surround to be in accordance with the Materials Specification of this document. All pipes, fittings and associated materials to be installed strictly in accordance with the manufacturer's recommendations and technical installation manuals.

Check all pipes and fittings, and test for soundness. Do not use damaged pipe work or fittings in the work.

Cut all pipes square and clean, using approved pipe cutting apparatus or chain cutters.

Road Gully Construction

Construct 150mm thick concrete base and set gully pot truly level, making allowance for finished levels, thickness of grating and frame, and two courses of engineering brick.

Manholes/Inspection Chambers General

Construct all main drainage lines, channels, step irons, benching and branch connections in the specified pipe work and materials with all branch connections discharging in the direction of flow.

Set the concrete cover slab to suit the completion of the surround levels, adjust as necessary, and make allowance for the thickness of the cover and frame and the required courses of engineering bricks for level adjustment.

The depth of the main open channel shall not be less than half the diameter of the main drain line unless otherwise indicated on the Contract Drawings, use vitrified clay channels on pipes up to and including 300mm diameter and joint in sand/cement mortar 1:2.

Where level invert channels and branch connections are required use level invert branch vitrified clay channels or form in situ granolithic concrete 1:1 trowelled to formation and smooth finish.

On branch channel bends up to an included 150mm diameter install three quarter section curved bends in the direction of flow set to discharge over the main channel invert joint in sand/cement mortar 1:2 and form benching.

On branch channel bends over 150mm diameter form in in situ concrete as part of the benching and finish in 25mm thickness granolithic concrete 1:1 trowelled smooth and curved in the direction of flow.

When installing the main drainage line the channels or chambers within the manholes/inspection chambers must be installed at the same time to give continuity of line and to ensure the correct setting of branch connections.

Build galvanized step iron into manhole/inspection chamber walls as work proceeds at 300mm horizontal and 300mm vertical centres directly above the benching as shown on the Contract Drawings, carried up to and within 225mm of the cover and channel benching.

Fix covers and frames in position, bed all frames in sand/cement mortar 1:3 maintaining cover level with surrounding areas, providing an angled fillet to hold frame square to the brick base where covers are located in temporary positions held secure with angled filled and rest to suit final finishes.

Keep all covers in their respective frames at all times to prevent rocking and deformation of frame.
Set light duty frames with covers in position to prevent distortion of the frame.

Fill recessed pattern covers with suitable material to match surrounding areas, the infill material to be well consolidated and tampered, all finished truly level with smooth trowelled finish to paved areas, smooth recessed for filed finish, and tampered finish to rough textured surface.

Pre-Cast Concrete Manhole Construction

Refer to "Manholes/Inspection Chambers General" for description of all associated works.

Construct the pre-cast concrete rings on an "in situ" reinforced concrete base slab to the thickness and profile shown on the Contract Drawings.

Place the rings in position on the base slab set over the main drainage pipeline, channels, branch connections, etc., all set truly level and vertical.

Construct the "in situ" concrete base up to a level of 150mm above the crown of the main drainage line to the profile shown on the Contract Drawings, and form a level base to receive the manhole rings.

Set pre-cast concrete manhole rings on a sand/cement mortar bed 1:2 on the concrete base all set level and firm for placing additional rings.

Ensure all joints are liberally provided with sand/cement mortar 1:2 before lowering sections into position, and neatly strike off joints on the inside of the chamber, filling any voids as work proceeds. Make good any lifting holes.

Make all watertight construction joints in accordance with manufacturer's recommendations and technical installation manuals. Neatly strike off joints on the inside of the chamber, filling any voids as work proceeds, and make good any lifting holes.

When placing pre-cast concrete manhole rings ensure the step irons are aligned vertically and at 300mm horizontal pitch, set over the benching, and in line with any access shafts, pre-cast concrete cover slabs and manhole cover.

Where pre-cast concrete manhole rings are to be supplied without step irons, build in a galvanized mild steel access ladder in the location indicated on the Contract Drawings, complete with all bolt fixings.

When all pre-cast concrete manhole rings, access shafts, cover slabs etc. have been set in position, using sectional fiber glass manhole shuttering, completely surround the manhole rings in 150mm in situ concrete well compacted.

Set pre-cast concrete cover slab in position with the opening in line with the step irons laid on a sand/cement mortar 1:2 bed, all set truly level, filling any voids in the bedding and flush point on the inside of the manhole wall as work proceeds.
Allow concrete work to set hard before back-filling the voids between the concrete surround and side of the excavation.

Concrete Block Manhole Construction

Refer to Manholes/Inspection Chamber General for description of all associated works.

Construct manholes in concrete blocks on an in situ reinforced concrete base with blocks set in bond with no straight joints using sand/cement mortar 1:3, building in galvanized step irons as work proceeds.

Fill hollow blocks with concrete and compact well before construction.

Completely fill all beds and vertical joints with mortar, and cut and flush point as work proceeds.

Backfilling General

Backfilling to trenches shall not be carried out until all interim tests have been successfully concluded.

Backfill adjacent to foundation in accordance with the details shown on the Contract Drawings.

Do not fill void between side of excavation and pre-cast concrete manhole walls until seven days after concrete has been poured and set hard.

Where excavated material is unsuitable for backfilling, suitable material shall be imported to comply with the requirements of this specification and the Engineer's requirements.

4. TESTING

Testing & Inspection

Test all drainage works to obtain the approval of the Local Authority, Architect/Engineer or his appointed representative and generally the following requirements.

Give a minimum of 24 hours' notice to the Architect/Engineer or his appointed representative when interim and final tests are to be carried out to give him/her the opportunity to observe tests.
Keep a record of all tests duly signed, and hand a copy to the Architect/Engineer or his appointed representative for retention.
Any works having previously passed any tests will not relieve the Contractor of his obligations when any further defects are shown during final tests, or appear during the maintenance period. Any defects shall be located and rectified, and the system retested in accordance with this section of the specification and as directed by the Architect/Engineer or his appointed representative.
Ensure all sections of the drainage system are completely clear of obstructions, builder's debris, silt, etc. before interim and final tests are carried out on each section of the installation, all drains to be cored through using apparatus to suit the diameter of the pipe.
Provide all facilities, equipment, clean water, appliances and materials for interim and final testing, and arrange to place in position any branch connections, tubes and plugs when and where required. Seal off and remove all equipment during and after tests.

Testing Underground Manholes/Chambers

Test all chambers for water tightness. Keeping external faces clear of backfill for inspection until approved, temporary seal all pipe connections within the chamber and fill with water up to 1.500m above the crown of the pipe allowing time for absorption. Allow adding water before starting the test, and maintain water level for 30 minutes without adding further water. Any manhole/chamber failing the test shall be re-constructed until a satisfactory test result can be achieved.

Record Drawings

The Contractor shall keep a record of any changes to pipe work location or adjustments to levels during the course of the contract and prepare upon completion Record Drawings/Schedules equal to the Contract Drawings.
The Contractor shall keep a record of any changes to pipe work location or adjustments to levels during the course of the contract, and upon completion hand to the Architect/Engineer to enable him to prepare record drawings.

Handover

Thoroughly clean and flush out the entire drainage installation and clean out silt and debris from drainage gullies etc. before handover.
Give a minimum of 24 hours' notice when tests are to be carried out and provide sufficient personnel to carry out the flushing operation of the various appliances.
Hand to the Architect/Engineer or his appointed representative, copies of the "As Fitted" drainage record drawings.

CHAPTER THREE

SANITARY, WASTE & RAINWATER PIPEWORK INSTALLATION

3.0 SANITARY, WASTE AND RAINWATER PIPEWORK INSTALLATION

TABLE OF CONTENTS

1. GENERAL PREAMBLE

Scope of Work

Soil, Waste, Vent and Rainwater Installations.

Waste Installations.

All Overflows Pipes.

Sanitary Fittings

Shall include the following:-

Order, take delivery, store, and protect during the course of the contract all sanitary ware including fixtures and fittings all in accordance with the sanitary fitting specification and standard.

Allow for fixing and protecting all sanitary ware, fixtures and fittings as indicated, all strictly in accordance with the manufacturers' recommendations.

All pipework and fittings used in the hot and cold water service installations shall be as specified herein.

Allow for all overflows and warning pipes where indicated on the drawings using pipework and fittings specified herein.

2. MATERIALS

General

All pipework, fixtures and fittings shall comply strictly in accordance with the relevant International Standard Specification.

Standards

Where a British Standard and/or Code of Practice is quoted in this Specification, refer to the latest published standard and any subsequent amendments.

British Standard Institution documents referred to in this Specification are:-

BS.4514 Unplasticized PVC soil and ventilating pipe, fittings and accessories or approved equal EN.

BS.5254 Polypropylene waste pipes and fittings (external diameter 34.6 mm, 41.0 mm and 54.1 mm) or approved equal EN.

BS.5255 Plastics waste pipe and fittings or approved equal EN.

BS.3943 Plastics waste traps or approved equal EN.

BS.2494 Materials for elastomeric joint rings for pipework and pipelines or approved equal EN.

British Standard Code of Practice referred to in this Specification are:-

BS.CP.5572 Sanitary Pipework or approved equal EN.

BS.6367 Drainage of Roofs and Paved Areas or approved equal EN.

Building Standards and Regulations

All pipework and fittings shall be installed strictly in accordance with Local Authority Regulations or equivalent.

Termination

The installation shall be deemed to terminate at the buried drain connections.

3. PIPEWORK MATERIALS

Main Soil Waste and Rain Water

Pipe Size	Material
110mm, 160mm 200mm 300mm	- UPVC (EN – 1401)

Main Soil, Waste Rain Water and Vent Pipework shall be deemed to include horizontal pipework underground drainage.

Branch Soil, Waste and Vent Pipes

Pipe Size	Material
- 50mm	- UPVC (DIN. 19531)
- 82mm 110mm 160mm 200mm	- UPVC(BS.4514)+(EN.1329)

Branch Soil, Waste and Vent Pipework shall be deemed to include for all vertical and/or horizontal pipework between the connection to drain or main soil, waste and vent stack, and the terminal connections to the Sanitary appliance or fitting.

All soil and waste pipe work discharging from sump pits shall be cast iron.

Rainwater Pipes

Material	Pipe Size
UPVC (BS.4514) + (EN.1329)	φ 80 - φ 110 - φ 200

General Requirement

There shall be no deviation from the details indicated on the drawings, any alterations to the design intent without prior approval shall be restored to the original design at no extra cost to the contract unless it is proven that the original design cannot be accommodated.

The entire installation shall be carried out to the satisfaction of the Architect/Engineer or his appointed representative.

4. PIPEWORK INSTALLATION

General

All pipework shall be installed truly vertical or if horizontal to the gradient dictated by the design.
All bends and offsets shall be kept to the minimum number and if required be of a wide sweep pattern.

All pipework shall be cut clean and square with the axis of the pipe with all sharp edges and/or burrs removed before installation.

Should any blockage occur within the system caused by general negligence or abuse pipework shall be removed and the system thoroughly cleaned out at no extra cost to the contract.

Pipework Fixtures and Fittings

All pipework fixtures and fittings shall be installed using the correct fixtures and fixing procedures including support brackets to suit the specified materials, and hold pipework secure.

All bracket and support fixings shall be in accordance with the details shown on the coded detail drawings.

UPVC Pipework and Fittings

Shall comply to British Standard 4514 bear the British Standard Kite Mark, or equivalent and shall be installed strictly in accordance with manufacturers recommendations.

All pipework shall be supplied in plain ended lengths.

The pipe and fittings shall be to colour grey, British Standard 5252 with the exception of water closet connections which shall be coloured white where exposed to view.

Method of jointing shall be a combination of solvent welding using the manufacturer's approved solvent cement, with seal ring fittings used where necessary to accommodate thermal movement. The sockets of standard fittings shall be converted to incorporate a rubber seal ring where required.

UPVC Pipework Installation

All pipework shall be installed to accommodate thermal movement, flexible joints shall be incorporated at all fixed points and changes of direction with a secure fixing bracket located in the retention groove moulded on the socket of the fitting.

Waste boss connections when fitted to the pipes shall consist of two parts with inner and outer flanges, solvent welded as a complete unit with inbuilt gradients of 1 1/4o. Where it is not possible to gain access to the bore of the soil pipe self-locking bosses with integral clamping devices shall be used providing the mating surfaces are suitable for and used with solvent weld cement.

Access shall be provided to gain entry into all pipework either by means of an integrally moulded door in an access fitting with external fitted rubber seal and secured with two galvanised bolts and nuts, or alternatively a two piece clamp type door fitted into the pipe run.

Where WC connections are to be fixed in a range a single manifold branch shall be used comprising a single branch with a standard WC connector welded together, up to six WCs may be connected on either side of the soil stack using the available left or right hand fittings as required.
The correct angle and type of fitting to suit the application shall be as described in the manufacturers Product Handbook.

The system shall be installed strictly in accordance with the Product Handbook complying with the recommendations of BS.4940.

UPVC Pipe Supports

UPVC pipe supports shall be made of mild steel with galvanised or PVC protective coating, supplied to suit the specified pipework and fittings and have a two position fixing suitable for either acting as a pipe support allowing thermal movement, or alternatively as a clamp fit on a fitting creating a fixed point. For optimum fit on pipe supports UPVC spacing pieces shall be used.

Maximum intervals between pipe supports shall be:-

Pipe Size	38 mm	42 mm	50 mm	75 mm	100mm
Horizontal	0.5 m	0.5 m	0.6 m	0.9 m	0.9m
Vertical	1.2 m	1.2 m	1.2 m	1.8 m	1.8m

Pipework shall be fixed truly vertical with all horizontal runs laid to gradients in accordance with British Standard 5572 and in any event not less than 18mm/m unless otherwise instructed.

The pipework shall be fixed to the fabric of the building in accordance with BS CP 5572.

5. WASTE INSTALLATION

Access Fittings

All fittings shall give full width access into the bore of the pipe and located as indicated on the drawings.

Access Location (General)

Access points shall be provided to give full access to all sections of installation at the locations indicated on the drawings, to enable section testing and efficient maintenance operations to be carried out and to enable every section of Soil, Waste or Rainwater Pipework to be rodded, tested, inspected and to enable the easy removable of objects or debris from the system.

Roof Vent Fittings

All vent pipes passing through the roof shall be fitted with a connector suitable for a weatherproof seal and to ensure a completely watertight arrangement.

The pipe shall terminate 450mm above finished roof level with a section of spigot end and vent cage, complete with a weathering shroud to enclose the waterproof finish.

WC's Connectors

Pipework connections to WC's shall be flexible self-sealing connectors incorporating multiple plastic and rubber seal gaskets. The connector shall incorporate outward facing rubber seals and plastic fins for insertion into the pipe, and an internal rubber seal with plastic shroud for connection to the WC pan.

The Connectors shall suit the specified pipe materials.

Storage of Pipework and Fixtures and Fittings

All pipework fixtures and fittings including jointing materials shall be stored within a clean dry storage area protected from extreme temperatures and where applicable in accordance with manufacturers recommendations.

UPVC

All pipework fittings, gaskets, and solvents shall be stored to avoid direct exposure to sunlight, and extreme temperature conditions.

Pipework shall be stored on level ground free from stones or sharp objects either on timber bearers 75mm wide and not greater than 1 metre centres and stacked neatly not more than 1 metre high, or alternatively stored in loose racks with side support not greater than 1.5 metres apart.

All fittings, gaskets and solvents shall be stored within a well ventilated cool compartment, and retain in plastic bags and storage containers until ready for installation.

Pipe Sleeves

Where pipes pass through walls, or floors tubular pipe sleeves of non-combustible material shall be provided of sufficient size to permit the free passage of the pipe through the sleeve to ensure the pipe neither touches the sleeve nor the building structure.

All pipe sleeves shall be set in the walls, or floors before plastering or screeding is completed.
All sleeves shall be suitable for the pipe on which they are to be fitted and shall extend the full thickness of the division through which the pipe is to pass, after installation the gap between pipe and sleeve shall be "fire stopped" with suitable non-combustible caulking compound.

Where UPVC pipework passes through walls or floors a fire sleeve shall be provided tested in accordance with BS.476 comprising of a metal clad flanged sleeve with fire resistant filler rings in accordance with the detailed drawings.

Rainwater Roof Outlets (Roof Drain)

All rainwater outlets shall be cleaned to the satisfaction of the Engineer / Architect suitable for the specified pipe material.

Floor Gullies (Floor Drain)

Floor gullies and channel gratings shall be supplied and installed as required within public bathrooms and toilet areas and playgrounds. Where these are of a quality finish they shall be suitably protected until completion of the contract.

Where traps are suspended they shall have weight support lugs cast on with suitable bracket fixing back to the structure.

FCO :	Floor clean out – 20 cm x 20 cm Chrome Plated, Ø 1100mm Bottom outlet
FD-01 :	Floor drain – 20 cm x 20 cm Chrome Plated, Ø 80mm Bottom outlet
FD-02 :	Floor drain – 20 cm x 20 cm Chrome Plated, Ø 80mm Side outlet
CHD-01 :	Channel floor cover – 750 cm x 250 cm Stainless steel medium duty grating cover, Bottom outlet
CHD-02 :	Channel floor drain – 750 cm x 250 cm Nickel bronze medium duty grating cover, Bottom outlet (for excavation of channels, refer to Chapter 2, Below Ground Drainage).

Waste Connections to Mechanical Services Plant

Waste and/or overflow connections from, pump glands, etc, shall discharge into a tundish and connect to drain via a trap connection or alternatively discharge over a trapped floor gully, but on no account connect to a soil pipe.

Overflows/Warning Pipes and Sanitary Fittings

All overflows and/or warning pipes shall be installed strictly in accordance with the Water Authority Bylaws/Regulations including any subsequent amendments, and the detailed drawings.
Depending on the location, the overflows and/or warning pipes shall discharge in the following locations and as indicated on the drawings.

a) External to the building
b) Over a Sanitary Fitting
c) Over the floor

Testing, Flushing Out and Cleaning of Soil, Waste, Vent and Rainwater Pipes

All pipework to be concealed shall be tested before being enclosed, a final test shall be made upon completion for soundness and performance strictly in accordance with the British Standard 5572, and include a simultaneous discharge test.

At completion of the installation all plugs shall be removed and the entire system flushed and rodded through.

6. APPROVED MANUFACTURERS

UPVC
a. Redi
b. Nicoll

or approved equal.

FB & JB
a. Zurn
b. Wade
c. Josam

or approved equal.

CHAPTER FOUR
PIPED SYSTEMS (LIQUIDS)

4.0 PIPED SYSTEMS (LIQUIDS)

TABLE OF CONTENTS

1. GENERAL

This section of the Specification shall apply to the following pipework installations:-

Domestic Hot and Cold Water (including distilled and cold and hot soft water)

And as a supplement to the following sections:-
Soil, Waste and Rainwater

Demarcations

The Domestic Hot and Cold-water service installation shall include final connections between isolation stop-cocks or valves serving sanitary appliances or equipment and the appliances/equipment being served.

2. PIPEWORK INSTALLATION (GENERAL)

Mild Steel

All tubes shall be of uniform thickness within the manufacturing tolerances as stated in the appropriate British Standard and shall have a concentric bore throughout.

All pipework shall be free from rust and without any signs of scaling, pitting or weathering to the satisfaction of the Engineer.

All pipework shall be supplied with varnished finish and each length must have at least one coloured identification band when delivered.

When screwed pipes are required they shall be supplied with at least one socket for each length fitted and threads not fitted with sockets shall be fitted with protectors during transit.

All branches off mains shall be of the easy sweep type, where the size of the branch off the main is outside the range of branch bends available; the branch shall be formed from piping carefully formed to an easy sweep.

Gradients and Erection of Pipework

Pipework shall be graded to ensure adequate draining and venting and wherever possible be self-venting. Draining and venting facilities as detailed in this Specification shall be fitted at all low and high points respectively and wherever else necessary to ensure that all sections and subsidiary sections can be drained and no air locks can form.

The gradients shall be in the direction of flow and shall be appropriate to the service as follows unless otherwise stated on the drawings:-

Service	Gradient
All services	1 in 250

Pipework shall generally be set around all pipes and columns and shall follow the contours of the building whether so indicated or not.

Bare piping shall be erected so that there is 75 mm clear below it to the finished floor level and at least 25 mm to the finished wall face.

Insulated piping shall have sufficient clearance for the proper application of the insulating material. The finished surface of any covering shall be at least 25 mm from walls etc. Clearance between adjacent insulated pipes shall be at least 25 mm.

All pipework valves, fittings and equipment forming the piping installation shall be erected so that it can be dismantled and is accessible for repair and replacement.

Pipe and Services Supports

All pipework shall be supported by means of clips, hangers etc., or in the manner and positions indicated at intervals not exceeding the following:-

Nominal Bore	Steel Interval (Metre)	
	Vert.	Horiz.
15mm	2.4	1.8
20mm	3.0	2.4
25mm	3.0	2.4
32mm	3.0	2.4
40mm	3.7	2.4
50mm	3.7	2.4
65mm	4.6	3.0
80mm	4.6	3.0
100mm	4.6	3.0
125mm	5.5	3.7
150mm	5.5	4.5
and over	6.0	6.0

Care should be taken with the design and installation of supports for A.B.S., pipework, which shall be designed in accordance with the manufacturer's recommendations but shall not be greater spacings than the following table:-

Pipework O/D	UPVC Maximum Horizontal Support Distance m
15	1.0
20	1.0
25	1.0
32	1.1
40	1.1
50	1.2
63	1.4
75	1.6
110	1.9
125	1.9
160	2.1
200	2.5

In the event of two or more pipes being carried by a single support the spacing shall be for the short intervals. No more than two pipes may be supported from a single drop rod support. Double hanging of pipes with unequal expansion movement due to different service temperatures shall not be permitted.

All supports for mild steel pipes and fittings shall be ferrous as indicated and/or specified herein.

Metal pipe clips on plastic pipework shall be free of sharp edges likely to damage the pipe.

Valve supports shall be provided for all large diameter valves in plastic pipework to ensure that distortion of the pipework does not occur.

It shall be the responsibility of the Contractor to ensure that all supports are adequate, firmly and truly fixed, and that they do not transmit vibration.

The Contractor shall provide and install all fixings to the structure or cast in support channels where appropriate to carry the brackets, clips, hangers, etc., for the various services.

The Contractor shall provide all necessary steelwork for the support of the Services in vertical risers at the required intervals, which shall be detailed on drawings and submitted for approval. The drawing shall show full details of all steelwork sizes and fixings and shall show the imposed load from each service.

All pipework shall be supported by substantial brackets, hangers, or clips to the approval of the Engineer. The layout of piping shall take into account expansion and contraction, particularly at ends of runs where changes of direction occur. Main walls or partition walls etc., where pipes pass through sleeves shall not be considered as pipe supports.

Supports for insulated pipes on cold-water service shall be arranged so that there is no penetration by metal of the pipe insulation. In addition precautions must be taken to preserve an unfractured vapour-proof skin at these joints. Two half sections of high density phenolic foam (120 kg/m3) to fit the pipes and of correct thickness to suit the insulation shall be used at all support positions. The joints between the high-density phenolic foam and the insulation shall be chamfered and trowelled in with a mastic compound.

In exposed areas and where metalclad pipework insulation finish is provided the vapour barrier shall be over the band clip to ensure a concealed and straight line finish appearance.

When rested upon fixed supports, freedom of longitudinal movement must be provided.

Pipe Sleeves and Puddle Sleeves

Where pipes pass through walls, floors, footings and waterproof membranes, the Contractor shall include in his price pipe sleeves.

The inside diameter of sleeves shall not be less than 15 mm larger than the outside diameter of the pipe except where pipes pass through bearing walls or footings where sleeves shall be sized to allow for structural movement and 15 mm clearance from the outside diameter of the pipe.

The diameter of the sleeves for cold-water pipework shall be such that adequate clearance between the pipe and the sleeve will enable the insulation to be carried through the sleeve.

Sleeves shall protrude not less than 2 mm and not more than 4 mm proud of the finished surface.

Flushing of Pipework Systems

Prior to the chemical cleaning or treatment of any pipework system the entire system, sectionally or as whole, shall be subjected to a full bore rapid flush to ensure the complete removal of any loose foreign material. This shall also apply to pipework systems where chemical cleaning is not called for.

The Contractor shall also be responsible for providing temporary fill and drain points on each system and for making whatever temporary arrangements that may be necessary to have adequate raw water available at the fill points and for the removal of flushing water from the drain points.

Approved Manufacturers

Galvanized Steel Supports for Pipes
a. Flamco
b. Walraven
c. Mupro
d. Erico

or approved equal.

3. PIPEWORK SERVICE MATERIALS

Polypropylene (PPR) Pipes and Fittings

A. Polypropylene pipe shall conform to the following requirements:

- Polypropylene pipes shall be made of polypropylene, a copolymer RANDOM, Beta PPR with enhanced crystalline structure, Class-2 (S-3.2; SDR-7.4) for embedded domestic cold and hot water pipes applications. Beta PPR with Aluminum layer for exposed and embedded heating pipes, and for exposed cold and hot water pipes application conforming to EN ISO 15874 or approved equal International Standards (DIN, ASTM, ….) for polypropylene pipes.
- Polypropylene pipe: ASTM F 2389, pipe pressure rating shall comply with temperature and pressure ratings per the plumbing code requirement for the applicable service (water distribution, water service).
- Fittings shall have same material and quality as pipes and according to EN ISO 15874.
- Polypropylene Fittings: ASTM F 2389, socket fusion, butt fusion, electrofusion, or fusion outlet fittings shall be used for fusion weld joints between pipe and fittings.
- Mechanical Fittings and transition fittings shall be used where transitions are made to other piping materials or to valves and appurtenances.
- Polypropylene pipe shall not be threaded. Threaded transition fittings per ASTM F 2389 shall be used where a threaded connection is required.

B. Polypropylene – Random Copolymer

- Polypropylene – Random Copolymer (PP-R) used for the manufacture of pipes shall confirm to the requirements of IS 10951 and IS 10910.

- The specified base density shall be between 900 Kg/m3 and 910 Kg/m3 (both inclusive) when determined at 27°C according to procedure prescribed in IS 13360 (Part 3/Sec 1).

- The MFR of the material shall be ≤0.5 g/10min when tested at 230°C with nominal load of 2.16 Kg as determined by method prescribed in IS 13360 (Part 4/Sec1). The MFR of the material shall also be within ± 20percent of the value declared by the manufacturer.

- The resin shall be mixed with sufficient quantity of colour master batches. The colour master batch description shall be uniform throughout the pipe surface.

- Outer Layer (Optional)

  The base resin used for outer layer compounds shall be a base resin certified by the supplier to be compatible to the PPR resin/master batch that is used to produce the pipes.

  Coloured outer layer compound shall be UV stabilized with minimum of 0.2 percent of a hindered amine light stabilizer (HALS).

- Anti-oxidant

  The percentage of anti-oxidant used shall not be more than 0.3 percent by mass of finished resin. The anti-oxidant used shall be physiologically harmless and shall be selected from the list given in IS 10909.

4. VALVES AND COCKS

General

All valves and cocks shall be generally as described and of first class quality.

All castings shall be clean close-grained metal free from rough projections. Unless otherwise specified valves of 50 mm nominal bore and under shall have female ends screwed to BS 21 and valves 65 mm nominal bore and over shall have flanged ends.

Screwed valves shall have heavy hexagon reinforcements at openings, threads of ample length and heavy shoulders to prevent over entry to pipes. Flanged valves shall have the flanges flat faced on valves 50 mm and below and raised face on valves 65 mm and above and of thickness conforming to the appropriate Specifications and drilled.

All valves must have the maker's name or trade mark cast or heavily stamped or rolled on. Valves not bearing these distinguishing marks will be rejected.

Each valve must be made easy to operate before being installed.

Regulating and isolating valves shall be fitted to permit proper isolation and regulation of plant and primary and secondary mains.

All mains shall be provided with isolation valves at the point of entry or exit.

All valves shall be suitable for the fluid carried and the temperatures, test and working pressures of the system in which they are installed.

Where flanged ends are specified, the flanges shall be of the type and nominal pressure rating as specified in the 'Flanged Pipework Jointing' clause in this Section of the Specification.

Isolating Valves to Hot and Cold Water Services

(i) General

Isolating valves shall be installed in the locations shown on the drawings and on connections to single groups of wash-hand basins or wc's, on the draw-off connections to individual sinks and on connections to equipment.

(ii) Mains Water Services

Isolating valves on pipework size 54 mm and below shall be stopcocks of the screw down pattern gunmetal construction in accordance with BS 1010 with pinned jumper and gunmetal or brass spindle with crutch head and union connection.

Alternatively isolating valves where used internally shall be full way lever operated quarter turn spherical ball valves manufactured from dezincification resistant bronze, polished balls and PTFE seats. Ends shall be compression to BS864 Part 2 and the valve shall be suitable for working pressure up to 16 bar.

Servicing valves up to and including 22mm to be the spherical plug type manufactured to BS6675 with compression ends to BS864 and shall be chromium plated.

Valves above 54 mm shall be cast iron, with inside screw, wedge gate valves manufactured in accordance with BS 5163 Class 2, having flanged ends and provided with wheel head assembly unless otherwise noted on the drawings.

Alternatively valves above 54mm shall be butterfly valves to BS5155, lever operation, suitable for pressures up to 16 bar. Valves shall be approved for use on potable water services.

(iii) Cold Water Services

Full way gate pattern valves 54 mm diameter and below shall be bronze or gunmetal construction in accordance with BS 5154 solid wedge disc, non-rising stem, and having either integral solder ring capillary ring union ends, or compression ring joints in accordance with BS 864 Part 2.

Alternatively isolating valves where used internally shall be full way lever operated quarter turn spherical ball valves manufactured from dezincification resistant bronze, polished balls and PTFE seats. Ends shall be compression to BS864 Part 2 and the valve shall be suitable for working pressure up to 16 bar.

(iv) Hot Water Services

Full way gate pattern valves 54 mm diameter and below shall be bronze or gunmetal construction in accordance with BS 5154 solid wedge disc, non-rising stem, and having either integral solder ring capillary ring union ends, or compression ring joints in accordance with BS 864 Part 2.

Alternatively isolating valves where used internally shall be full way lever operated quarter turn spherical ball valves manufactured from dezincification resistant bronze, polished balls and PTFE seats. Ends shall be compression to BS864 Part 2 and the valve shall be suitable for working pressure up to 16 bar.

(v) Fitting Isolation Valves

Isolation valves to individual fittings shall be full port in-line spherical plug ball type of bronze or nickel construction, to BS 6675 with operating lever and compression ring joints in accordance with BS864 Part 2.

Ball Float Valves

Unless otherwise specified ball valves shall be of bronze or gunmetal construction manufactured in accordance with BS 1212, Part 1 and having a bronze or gunmetal seat, lever and plastic float conforming to BS 2456.

Where required ball valves of the delayed action type shall be provided generally as above and complete with hydraulic delay subsidiary tank and bottom float. Galvanised mild steel supports shall be provided to the valve manufacturers recommendations.

The ball valves shall be suitable for the particular pressure requirements at the point of discharge.

Hose Union Bib Taps

Hose Union Bib Taps shall be of the screw down pattern, gunmetal construction manufactured in accordance with BS 1010 and be complete with a bib hose union connection.

The bib taps shall have a polished finish and be complete with a polished brass dust bonnet.

Drain Cocks and Drain Valves

Drain cocks shall be fitted on all low points and on the 'dead' side of all isolating valves and cocks.

Other than on HTHW drain cocks where in exposed positions in rooms shall be of the bronze draining tap type to BS 2879 Type A with screwed end and lockshield dustcap. Elsewhere they shall be of the bronze gland cock type with hose union.

Drain cocks where used on hot, cold and mains water services shall be of the pattern that can be readily rewashered and that are suitable for 1.5 times the system working pressure.

Safety Valves

Safety valves shall be of the enclosed spring loaded type complying with BS 6759 and of size not less than that required for the equipment specified. The safety valve shall be arranged vertically and attached directly to the equipment shell.

The safety valves shall have a padlock and key. Unless otherwise specified safety valve set pressure shall be:-

1.1 x working pressure

The setting shall not exceed the design pressure of the equipment.

Safety valves up to 50 mm n.b. shall have screwed connections, bronze body, cadmium plated steel spring with high tensile brass adjusting screw and locknut suitable for a maximum working pressure of 24 bar.

Approved Manufacturers

a. Crane
b. Nibco
c. Hattarsley
d. Serseg

or approved equal.

5. PIPEWORK ANCILLARIES

Flow Commissioning Sets

Flow Commissioning Sets shall be provided on all main, branch and sub-circuits throughout the heating and chilled water pipework installations to enable satisfactory commissioning of hydraulic circuits. The sets shall comprise a measuring orifice ring with pressure tappings, fitted complete with valve. This valve shall be a double regulating valve in accordance with the appropriate Service Specification, located in the return pipe.

Orifice ring fittings 50 mm and below shall have gunmetal body castings with screwed ends to BS 21 and comply with BS 1400. Orifice ring fittings 65 mm and above shall have cast iron flangeless bodies with notches for pipe alignment fitted with stainless steel orifice plates and gunmetal retaining bushes.

Pressure tappings shall be the brass body mechanical self-sealing type with screwed blanking caps.

For flow rates below 0.04 litres/s low flow or ultra low flow sets shall be provided, appropriate to the low flow rate condition.

Water Strainers

Strainers shall be located at inlets to control valve arrangements and pump sets and generally as detailed on the drawings.

The strainer shall be simplex or duplex as indicated on the drawings.

Each strainer shall be provided complete with a stainless steel strainer screen as follows:-

Application	Perforation Size mm
In pipework 15mm to 50mm nominal bore and on inlets to all control valves.	0.8
In pipework 65mm to 100mm nominal bore.	1.2
In pipework 125mm nominal bore and above.	1.6

Cold Water Applications, HWS and LTHW:

Strainers up to 50 mm shall be "Y" type of bronze or gunmetal construction in accordance with BS 5154 screwed ends to BS 21.

Pressure Gauges

Pressure gauges shall be 100 mm and 150 mm diameter as specified, aluminium alloy cased with chromium bezel Bourdon Type BS 1780, Part 2 and shall be with plain glass front, concentric pointer and

red line at the working pressure scaled in bars.

The range, unless otherwise stated shall be a maximum of one and a half times the working pressure. The tubes shall be of brass construction and removable, and the outlet screwed BSPT.

Temperature Gauges and Wells

Dial type temperature gauges with aluminium alloy cases black painted with chromium bezel shall be fitted in the positions as indicated. Each dial type gauge shall be of mercury in steel type having a nominal dial size of 150 mm.

All gauges shall have a white dial with black numbering and shall be calibrated to cover the operating temperature range plus 30°C on DHWS and cold water.

Water Meters

Water meters shall be provided on the incoming water main and shall be located within an accessible position so as to facilitate easy reading and maintenance.

Meters for use on pipework over 40 mm diameter shall be of the in-line Helical Vane type with graphite iron body to BS 2789 1973 420/12, polypropylene rotor, stainless steel bearings, and shall be provided with flanged connections to BS 4504.

Each meter shall be provided with a suitable pulsed output suitable for connection to a central control and monitoring system.

All counters shall read in cubic meters.

All meters in exposed positions shall be suitable for the prevailing temperature conditions without loss of performance or accuracy.

Air Release LTHW, HWS, Oil

Air vents shall be fitted at all high points. Pipework which requires venting shall be fitted with 6 mm air cocks on air bottles. Air bottles shall be formed from 150 mm length of tube of equal bore to the pipe which is being vented, with 6 mm pipe welded into the top and taken to a low level accessible position unless otherwise specified and fitted with 6 mm lockshield needle valve. The discharge from the needle valve shall be piped to a convenient position for discharge into a container.

In addition, vent points on oil lines shall be provided with a mild steel receptacle hooked onto the piping and arranged to collect oil drips.

Automatic Air Vents

Automatic air vents shall be installed in accessible positions and shall be of aluminium bronze construction with brass spindle nickel alloy valve and seat, brass float and integral lockshield isolating valve. In all cases the air vent shall be preceded by a lockshield pattern stop valve and the discharge from the air vent shall be 10 mm copper pipe. Automatic air vents shall be provided on each service, with the exception of HTHW and MTHW, at the highest point of the service within each plant area and on each vertical distribution riser.

Discharge pipes shall be collected over a covered tundish and the outlet piped to the nearest drain gully. Discharge pipes shall be labelled according to the service.

6. ELECTRICAL WATER HEATER

Supply and install electric water heaters whenever shown on the drawings of capacities as indicated on the drawings.

Each electric water heater shall be of the cylindrical storage type constructed of heavy gauge steel with white enamel finish and glass lining from inside.

Heater shall have polyurethane foam insulation wall between the outer casing and the glass lining all around top and bottom of cylinder. Heater shall be suitable for a working pressure of 100 psi (690 Kpa).

Each electric water heater shall be complete with the following:

- Fast acting surface mounted thermostat for automatic temperature control.

- Factory installed sensitive high limit energy cut-off (for safety to prevent overheating) present at 210 °F (99 °C).

- Electric element of 1500 watt capacity and smaller as indicated on the drawings. Element shall be constructed of highest quality resistant wire sheathed in miniral filling and the whole encased in a copper tube and subjected to a high voltage test.

The water Supply System shall consist of piping, valves, automatic controls, tanks, electric water heaters, and all equiment as hereinafter specified and shown of the Drawings.

Approved Manufacturers

a. Rheem
b. Buderus
c. Aristan

or approved equal.

7. WATER STORAGE TANKS

Polyethylene Water Tank (s)

Polyethylene water tank(s) shall be of the size and shapes as indicated on the drawings.
All elements of the tank(s) and their appurtenances shall be designed to withstand all conditions of the intended service without undue stress or deflection. The design shall take into account the stressed caused by the contents of the tank. The minimum allowable thickness of any portion of the tank(s) and their appurtenances shall be 7 mm, which shall be increased as necessary to provide adequate strength and shall be fully insulated to minimize heat gain.

The tank(s) shall be provided with reinforced threaded openings for all pipe connections and float switches indicated on the Drawings.

The top of tank(s) shall be equipped with a removable cover. The cover shall have a whole cur for the fill.

Interior and exterior surfaces shall have a relatively smooth texture.

Stainless Steel Water Tank (s)

Stainless steel tank shall be made of stainless steel sheet and as per the described size. It shall be construction free from any wrap or deform under direct sunlight. No temperature rise shall be incurred of stored water by sunlight due to mirror finish material. It shall be tested for leaks and shall be protected against insects from entering & contaminating the water. The material of construction is the most preferred material for use of potable water.

It shall have no rust, solvents or painting requirements and shall remain ductile at all temperature ranges with its properties been not impacted by exposure to UV light.

Inlet and outlet pipes shall be connected firmly with gate, float valves and small vent pipe with screen and elbow shall be provided on the upper level.

A drain pipe shall be provided with valve to allow hygiene flushing.

TESTING AND DISINFECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Specified

1. Testing and disinfection of all pressure piping for leakage as specified.
   a. The CONTRACTOR shall furnish all labor, equipment, test connections, vents, water and materials necessary for carrying out the pressure and leakage tests as specified and required.
   b. The work specified shall include all labor, material, equipment, services and incidentals necessary to fill, clean, chlorinate, flush, and test all pipelines which will carry or hold potable water.

B. Related Work Specified Elsewhere

1. Section 02080 - Fire Hydrants
2. Section 15051 - Buried Piping Installation
3. Section 15106 - Ductile Iron Pipe and Fittings
4. Section 15108 - Thermoplastic Pipe
5. Section 15109 - Prestressed Concrete Cylinder Pipe
6. Section 15110 - Valves and Appurtenances
7. Section 15120 - Piping Specialties and Accessories

C. Description

1. Permission shall be obtained from the OWNER of the water system before the use of water from any existing system. The CONTRACTOR shall:
   a. Conform to the requirements of the OWNER.
   b. Pay all costs connected with the taking or use of water for any retesting.
   c. The CONTRACTOR shall provide written notice to the Authority and ENGINEER at least three working days in advance of testing and disinfection.
2. All work under this section shall be performed in the presence of the ENGINEER. A representative of the public health authority having jurisdiction must also be present, as required.
3. Chlorination shall be scheduled such that sampling and flushing will be performed during normal business hours.

1.2 QUALITY ASSURANCE

A. Reference Standards

1. AWWA B300, Standard for Hypochlorite
2. AWWA B301, Standard for Liquid Chlorine
3. AWWA C104, Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water
4. AWWA C301, Prestressed Concrete Pressure Pipe, Steel-Cylinder Type for Water and Other Liquids
5. AWWA C502, Standard for Dry-Barrel Fire Hydrants
6. AWWA C504, Standard for Rubber Seated Butterfly Valves
7. AWWA C600, Standard for Installation of Ductile Iron Watermains and Their Construction
8. AWWA C651-14, Standard for Disinfecting Water Mains
9. AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe, 4-inch Through 12-inch for Water Distribution
10. NSF/ANSI Standard 60 and 61 (as applicable)
11. Standard Methods for the Examination of Water and Wastewater, latest edition
12. 1996 Safe Drinking Water Act

1.3 SUBMITTALS

A. The CONTRACTOR shall submit proposed materials, methods, and operations regarding testing and disinfection to the ENGINEER for review prior to the start of testing.

B. CONTRACTOR must provide a sketch to the ENGINEER of the sampling locations identifying at minimum the following:

1. Street names,
2. North arrow,
3. Sampling locations,
4. House numbers of nearest buildings to sampling locations.
5. Other distinguishable landmarks,
6. Any other information as requested by ENGINEER, OWNER, AUTHORITY, or County Health Department.

C. The CONTRACTOR shall submit certification that all backflow preventers (Reduced Pressure Zone attachments) and pressure gauges have been tested and certified within the last year.

D. Qualifications of laboratory analyzing biological samples shall be New York State ELAP certified.

E. Chain-of-Custody forms are to be furnished for all biological samples taken.

F. For flushing operations, ENGINEER shall supply calculations identifying that a minimum 3.0 ft/sec scour velocity has been achieved in the new waterline and that three pipe volumes have passed through it.

G. ENGINEER shall provide pressure testing and leakage test results.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All products must be suitable for use in a potable water system and NSF-60 certified. All piping, valves, etc. shall be NSF-61 certified.

B. Chlorination shall be by the use of a solution of sodium hypochlorite contained in the pipe or structure as specified. The use of calcium hypochlorite in powdered, granular, or tablet form, shall not be allowed.

C. If the chlorination procedure was found to be harmful to the network, other chemicals, such as bromine or any other equivalent chemical, can be used

PART 3 - EXECUTION

3.1 TESTS ON PRESSURE PIPING FOR POTABLE WATER

A. General

1. Flush, test and disinfect prior to connection to existing water mains as specified below, except as otherwise authorized by the ENGINEER.
2. The length of piping and sections included in the tests shall meet the approval of the ENGINEER; however, the length shall not exceed 2,000 feet in any case. Pressure test of pipe section shall be from valve to valve regardless of water main size.
3. Notify the ENGINEER 72 hours in advance of testing.
4. Equipment in or attached to the pipes being tested shall be protected. Any damage to such equipment during the test shall be repaired by the CONTRACTOR at his expense.
5. Conduct all tests per AWWA C-600 and C-651, latest editions in the presence of the ENGINEER. Repeat tests in the presence of local authorities having jurisdiction if required by them.
6. CONTRACTOR shall have sufficient personnel at the site for the entire duration of all tests.
7. When piping is to be insulated or concealed in a structure, tests shall be made before the pipe is covered.
8. Provide outlets to flush line, expel air and perform specified tests.
9. Where connections to existing lines are called for only one such connection will be allowed.
10. All fittings, hydrants and appurtenances must be properly braced and harnessed before the pressure is applied. Thrust restraining devices which will become a part of the system must also be tested at the test pressure.

11. When testing absorbent pipe materials such as cement or concrete, the pipeline shall be filled with water at least 24 hours before the test is made.
12. The CONTRACTOR must supply all materials and manpower to perform the tests as specified herein.
13. Testing and disinfection shall be acceptable and approved by the agency of jurisdiction before another connection is made.

B. Initial Flushing

1. CONTRACTOR shall fill and flush new main to remove dirt and miscellaneous debris from the inside of the watermain.
2. CONTRACTOR is responsible for removing all entrapped air during flushing.
3. Flushing must have sufficient flowrate to achieve a fluid velocity of 3.0 feet per second inside the waterline.
4. A minimum 2" tap is required for proper flushing of all watermains having a diameter of 8 inches or less, however, multiple taps or larger taps may be required. ENGINEER shall be responsible for determining necessary connections and providing calculations verifying flushing conditions are met.
5. Refer to AWWA C651, for number of taps required to obtain the minimum 3.0 feet per second flow velocity in all pipes.
6. CONTRACTOR is responsible for providing a water source for flushing. With the permission of the OWNER, an existing watermain may be used as a water source, however, the following restrictions apply:
   a. The CONTRACTOR is not allowed to operate any valves or hydrants or operate any components which belong to the OWNER.
   b. If water is drawn from the existing system, an appropriate backwater preventer such as a Reduced-Pressure Zone (RPZ) device must be used. The RPZ must be tested within one (1) year and approved prior to usage.
   c. Water from flushing procedures must be disposed of properly. Water may be piped or gravity-fed to an existing storm sewer with the ENGINEER'S and the OWNER'S permission if proper erosion control methods to minimize sediment build-up are used. Discharge of water into a roadway or into a parking lot area is strictly prohibited. Water discharging operations shall not cause damage to any public or private property.
7. CONTRACTOR shall partially open and close valves and hydrants several times under expected line pressure to flush foreign material out of the valves and hydrants.
8. Flushing shall continue until three pipe volumes have passed through the new waterline and the water appears sediment-free.

C. Pressure Test

1. Pressure test apparatus must be installed as shown on the Drawings
2. Test pressure shall be as specified in Section 15051, Buried Piping Installation, at the lowest point in the line.
3. Test pressure shall be held on the piping for a period of at least 2 hours, unless a longer period is requested by the ENGINEER, OWNER, or AUTHORITY. Pressure should not fluctuate by more than 5 psi during testing.
4. Pressure gauge must be in good working condition and must be demonstrated to be accurate to the ENGINEER prior to any testing.
5. Gauge must have proper labeling to allow ENGINEER to accurately distinguish the maximum allowable 5 psi change in pressure. Gauge must have markings at no greater than 2 psi increments to allow accurate readings.
6. ENGINEER is responsible for reading the gauge and recording the test results he/she witnesses. Results obtained by the ENGINEER are considered final, and not subject to discussion by the CONTRACTOR.
7. ENGINEER may tap pressure gauge at each reading to ensure needle is measuring pressure accurately.
8. The AUTHORITY reserves the right to read the pressure gauge and record the test results for those lines considered suspect or for potentially inaccurate result recording.
9. ENGINEER shall record pressure at 15 or 30 minute intervals to help determine if the pressure loss is stabilizing.
10. The CONTRACTOR will inform the ENGINEER when to begin the test.
11. If the pressure drop is greater than 5 psi in 2 hours, or if the ENGINEER believes the line is suspect, the CONTRACTOR shall explore for the cause of the excessive leakage and after repairs have been made, the line shall be retested. This procedure shall be repeated until the pressure loss is less than the maximum allowable and the ENGINEER is satisfied.
12. If the pressure drop is 3 psi or greater but less than 5 psi in 2 hours, the CONTRACTOR shall continue the test for another 2 hours. If the pressure drop over the 4 hour period is 5 psi or greater, the test failed and must be repeated after the cause of the leakage is explored and the necessary repairs have been made
13. The ENGINEER shall make a preliminary determination if the test passes or fails based on the pressure and volume losses recorded during testing.
14. After each test, the CONTRACTOR must demonstrate that the test apparatus, including the pressure gauge, is fully functional and accurate. Inaccurate gauges or non-satisfactory equipment will be grounds for test failure, regardless of test results. CONTRACTOR will resupply proper equipment and retest, at his expense.
15. The pressure loss recorded over the 2 or 4-hour test must be acceptable to the County Health Department and AUTHORITY for final hydrostatic testing approval to be given.
16. At the end of the test, the pressure shall be increased to the starting pressure, so that the leakage test data is acquired. See Section D Leakage Test below, for additional information.

D. Leakage Test

1. The leakage test shall be conducted concurrently with the pressure test.
2. The rate of leakage shall be determined at 15-minute intervals by means of volumetric measurement of the makeup water added to maintain the test pressure. The test shall proceed until the rate of leakage has stabilized or is decreasing below an allowable value, for three consecutive 15-minute intervals. After this, the test pressure shall be maintained for at least another 15 minutes.
   a. At the completion of the test the pressure shall be released at the furthermost point from the point of application.
3. All exposed piping shall be examined during the test and all leaks, defective material or joints shall be repaired or replaced before repeating the tests.
4. The leakage for pressure pipelines shall not exceed the following allowable rates in gallons per hour per 1000 feet of pipe at the test pressure specified in Section 15051, Buried Piping Installation:

Pipe Diameter	Pipe Material	ECWA Allowable Leakage*

4"	PVC, DIP	0.26
6"	PVC, DIP	0.40
8"	PVC, DIP	0.53
10"	PVC, DIP	0.66
12"	PVC, DIP	0.79
16"	DIP, PCCP	1.06
20"	DIP, PCCP	1.32
24"	DIP, PCCP	1.59
30"	DIP, PCCP	1.98
36"	DIP, PCCP	2.38
42"	DIP, PCCP	2.78
48"	DIP, PCCP	3.17

* 75% of allowable leakage per AWWA C600-17.

5. Regardless of the above allowables, any visible leaks shall be permanently stopped.
6. The CONTRACTOR shall provide a meter certified within the last year or a source-water tank/barrel of small enough cross section so that measurable changes in water depth can be accurately recorded. A two hour test is permitted for circular tanks/barrels of 15 inches in diameter or less. A four hour test is required for circular tanks/barrels greater than 15 inches in diameter. If a tank of non-circular cross section or irregular shape is used, and the change in water depth cannot be properly measured, the ENGINEER or AUTHORITY may require the test to be run more than 2 hours until an accurate depth change can be recorded and the ENGINEER is satisfied with the results.
7. The leakage volume recorded over the 2 or 4-hour test must be acceptable to the County Health Department and AUTHORITY for final waterline approval to be given.

3.2 BUTTERFLY VALVE TESTING

A. Each butterfly valve shall have a field leakage test performed with the pressure differential as identified in Section 15051, Buried Piping Installation, applied in both directions. This requirement does not waive the requirements stipulated in AWWA C504.

B. The duration of each field test in each direction shall be a minimum of two (2) hours.

1. The CONTRACTOR shall demonstrate to the ENGINEER'S satisfaction that all system components operate correctly, both individually and as a system. All testing equipment and materials required to perform all tests shall be provided by the CONTRACTOR and demonstrated as functional and accurate to the ENGINEER. Non-functional or inaccurate equipment, regardless of test results, will be grounds for test failure. CONTRACTOR shall resupply proper equipment and retest.

3.3 RESILIENT SEAT GATE VALVE TESTING

A. Each gate valve shall have a field leakage test performed with the pressure differential as identified in Section 15051, Buried Piping Installation, applied in both directions. This requirement does not waive the requirements stipulated in AWWA C509.

B. The duration of each field test in each direction shall be a minimum of two (2) hours unless specifically defined by the ENGINEER.

C. The CONTRACTOR shall demonstrate to the ENGINEER'S satisfaction that all system components operate correctly, both individually and as a system. All testing equipment and materials required to perform all tests shall be provided by the CONTRACTOR and demonstrated as functional and accurate to the ENGINEER. Non-functional or inaccurate equipment, regardless of test results, will be grounds for test failure. CONTRACTOR will resupply proper equipment and retest.

3.4 TAPPING SLEEVE AND VALVE TESTING

A. Prior to making the tap, gate valves shall have a field leakage test performed with a hydrostatic pressure as identified in Section 15051, Buried Piping Installation, on the open end.

B. Once the system is complete, the valves shall be tested in accordance with the Butterfly and Resilient Seat Gate Valve Testing criteria stated above.

C. The duration of each field test shall be a minimum of two (2) hours unless specifically defined by the ENGINEER.

D. After installation of the tapping sleeve or saddle and prior to tapping the main, the sleeve or saddle shall be air tested in accordance with manufacturers' recommendations. If the results of the air test do not meet manufacturers' specifications, the sleeve or saddle will be replaced and retested until the results are satisfactory.

E. The CONTRACTOR shall demonstrate to the ENGINEER'S satisfaction that all system components operate correctly, both individually and as a system. All testing equipment and materials required to perform all tests shall be provided by the CONTRACTOR and demonstrated as functional and accurate to the ENGINEER. Non-functional or inaccurate equipment, regardless of test results, will be grounds for test failure. CONTRACTOR will resupply proper equipment and retest.

3.5 DISINFECTION

A. Before disinfection, the line shall be cleaned and flushed with clean water as defined in the Initial Flushing section. CONTRACTOR shall provide outlets as required.

B. The chlorine solution shall be admitted to pipelines through corporation stops placed in the horizontal axis of the pipe, to structures by means of tubing extending directly into the structure or other approved methods.

C. CONTRACTOR shall install 2-inch saddles on existing and proposed mains and run 2-inch Type K copper tubing with backflow prevention device to allow for addition of chlorinated water. The rate of chlorine solution flow shall be in such proportion to the rate of water entering the pipe or structure that the resulting free chlorine residual shall be between 50 and 100 milligrams per liter (mg/l). Concentrations over 100 mg/l shall not be allowed to enter the piping system.

D. The placement of chlorine powder or tablets inside the pipe during installation as a means of disinfection will not be allowed.

E. The proposed piping shall be tested in all respects, prior to connecting the second end of the pipe to the existing system and prior to installing the annular fill at casing pipes.

F. All valves to existing mains must be closed during the chlorination process. CONTRACTOR must flush the proposed main through a backflow preventer such as a Reduced Pressure Zone (RPZ) and 2-inch copper until chlorine residual at the opposite end reaches 50 mg/l. All valves to the existing water network are to remain closed until this level is reached. While the chlorinated water is being added, all appurtenances on the main shall be operated so as to completely disinfect the new work. The operation shall be repeated as necessary to provide complete disinfection.

G. Chlorinated water from hydrants and taps must be properly collected and disposed of by the CONTRACTOR. Discharge of chlorinated water into the existing storm sewer or a natural water body shall not be allowed.

H. The chlorine treated water shall be retained in the pipe or structure at least 24 hours, unless otherwise directed. During the retention period all valves and hydrants within the treated sections shall be operated.

I. The chlorine residual shall be not less than 25 mg/l at any point in the pipe or structure at the end of the retention period. CONTRACTOR shall immediately perform final flushing to reduce the retention time high levels of chlorinated water.

J. When making repairs to or when specified, structures and portions of pipelines shall be chlorinated by a concentrated chlorine solution containing between 200 mg/l and 300 mg/l of free chlorine. The solution shall be applied with a brush or sprayed on the entire inner surface of the empty pipes or structures. The surfaces disinfected shall remain in contact with the strong chlorine solution for at least 30 minutes.

K. The CONTRACTOR must use an approved test method, as defined in AWWA C651 and *Standard Methods for the Examination of Water and Wastewater*, to determine chlorine levels. Test strips and test kits will be allowed for testing chlorine levels if the kit is less than six months old, in the original bottle, is not past the expiration date, and has a color coded scale on the side with legible concentrations defined. ENGINEER and AUTHORITY reserve the right to reject test results if the test strip or kit is suspect. Sending samples to an approved laboratory is also acceptable.

3.6 FINAL FLUSHING

A. Upon completion of each disinfecting operation, the CONTRACTOR will be required to empty the contents of the pipe into a tank truck. Dumping into a sewer will only be allowed with approval from the local governing body. In no instance will chlorinated testing or flushing water be emptied onto the roadways, in ditches, culverts, streams, wetlands, or any other natural water body.

B. Final flushing will continue until such time as the chlorine residual is between 0.5 and 1.2 mg/l.

C. Prior to discharging into storm or sanitary sewer systems, and with the written approval of the municipality, the CONTRACTOR shall use a reducing agent (such as sodium thiosulfate) to neutralize any chlorine residual. CONTRACTOR shall prove to the ENGINEER, AUTHORITY and municipality that the water has been properly neutralized prior to discharge using an appropriate testing method.

3.7 BACTERIOLOGICAL TESTING

A. After disinfection and final flushing, a representative of the laboratory hired by the CONTRACTOR shall, in the presence of the ENGINEER, take two bacteriological samples from sampling points at maximum 1,000-foot intervals along the waterline, at every branch off the main line, and at each end of the test section (one immediately after final flushing and a second one after 24 hours) for testing by an ELAP certified laboratory in accordance with the latest Health Department requirements.

B. Should acceptable results not occur after these two consecutive tests, the CONTRACTOR shall, at his expense, repeat the disinfection procedure until safe results are obtained.

C. All precautions shall be taken to maintain dry and sanitary conditions and to prevent contamination of any piping, at the CONTRACTOR'S expense.

D. If, in the opinion of the ENGINEER or AUTHORITY, contamination has occurred, the CONTRACTOR shall repeat the disinfection and bacteriological testing at his cost and expense.

E. Test results from the laboratory shall be sent directly to the ENGINEER. Test results sent through the CONTRACTOR shall not be considered.

F. Bacteriological test results shall expire 30 calendar days after the samples are taken. After 30 calendar days, the CONTRACTOR shall be required to repeat the process, taking two sets of samples and submitting results for review.

G. As per AWWA C651-14 standards, the limit for pipe installed without bacteriological samples being taken is 20 linear feet.

3.8 APPROVAL

A. The ENGINEER shall submit the Waterline Installation Complete Works Approval Report(s) to the Erie County Water Authority for review and processing.

B. Once approval is given, after reconnecting the proposed piping to the existing piping, the CONTRACTOR shall slowly refill the water main with water and allow it to pressurize so that the ENGINEER may inspect the connections and/or other piping.

C. The CONTRACTOR shall, at his expense, correct any observed defects to the satisfaction of the ENGINEER and OWNER.

END OF SECTION

CHAPTER SIX
GENERAL BOILER PLANT

5.0 GENERAL BOILER PLANT

TABLE OF CONTENTS

1. GENERAL

Related Work

- Pipe and pipe fittings.
- Valves.
- Pumps.
- Control & Instrumentation.
- Testing and Commissioning.

System Description

A. General

1. Provide and install where indicated on the drawings sealed expansion unit for each separate heating system.

2. This section of the Specification covers the supply, installation, testing and commissioning of boiler plant and all associated ancillaries necessary to generate the required heat at a central source for onward distribution to terminal equipment.

References

Refer to individual materials for specified standards.

Submittals

A. Product Data

Descriptive literature for each of the actual proposed equipment to be used including:

a. Capacity
b. Operating Pressure Ranges
c. Pressure Losses

d. Fluid Flows
e. Test Reports
f. Certificates of Approval
g. Operation and Maintenance Data
h. Any other Technical Data

B. Shop Drawings

Shop Drawings for each of the actual proposed equipment shall include the following:

a. Working or Manufacturing Drawings.
b. Calculations.
c. Installation Details.
d. Connections by other services.
e. Wiring and Control Diagrams.
f. Accessories Available indicating those included.
g. System Diagrams.

2. PRODUCTS

Materials

The pipe work shall be as specified in Chapter 4. Seamless black steel, schedule 40, ASTM A53 Grade B.

Valves shall be as specified in Chapter 4.

Insulation shall be as specified in Chapter 11.

Heating Pumps

Supply and install whenever shown on the drawings hot water circulators of the centrifugal in line type directly coupled to an electric motor suitable for handling hot water at 200° F (93° C).

Circulators shall be horizontal or vertical all bronze with stainless steel and watertight mechanical seals. Motor shall be sleeve type bearing drip proof with built in automatic over load protection.

Circulators shall be complete with switch pilot light and electric wiring adjustable immersion type thermostat shall be furnished and installed for each pump to start and stop the pump motor and maintain its thermostat setting.

Aluminum Radiator

- The contractor shall supply and install aluminum radiators of capacity as indicated on the drawings.
- Each radiator shall be of sectional type
- Each radiator shall be complete with the following:
  Supply valve
  Manual air vent
  Manual flow adjusting bronze elbow
  Wall brackets
- Each radiator shall have two coats of finishing paint over the base paint.

Boilers

A. Cast Iron Hot Water Heating Boiler

Type : cast iron, sectional type, design for firing by forced draught burner, with pressurized combustion chamber. It is to be factory assembled, sealed and hydrostatically tested to 10 bars for a operating pressure of 6 bars at 100° C.

Combustion Chamber : to be water cooled by being completely surrounded with water. It is not to require firebrick or refractory except at limited locations such as on rear wall and at bottom if front of burner to evaporate oil drippings from burner nozzle.

Boiler Section : high grade cast iron ribbed to provide continuous path for combustion gases for best efficiency of heat transfer. Boiler to have integrally cast supporting legs to permit it to rest directly on concrete support with uniform distribution of load throughout length. Boiler to be assembled with steel tie rods and nuts and externally sealed with special high temperature mastic for complete gas tightness.

Access doors : cast iron cleanout doors to be provide on front section to permit easy access to internal combustion gas passages hinged cast iron burner mounting door to be provided for full access to combustion chamber. Doors to be sealed gas-tight with asbestos rope gaskets, stud bolts and brass nuts.

Burner Mounting door to be fitted with thick; steel front plate for securing burner, supplied undrilled and provided with internal frame to support factory supplied refractory. Hole for burner nozzle to be formed in refractory. Door to have pyrex observation port with cover for inspecting flame condition.

Boiler shall be supplied with motorized air damper installed on boiler chimney and interlocked with the boiler.

Accessories : boiler to have cast iron real smoke hood with horizontal smoke outlet fitted to boiler with asbestos rope gasket to ensure permanent gas-tight seal. Necessary threaded connections to be integrally cast with boiler sections for boiler fill, boiler drain, altitude gauge, thermometer and two thermostats. Connections to be plugged at factory.

Accessories : the following are to be packed separately for field installation : all-around fiber glass insulated heavy gauge sheet steel jacket, sectionalized for fitting to boiler without removal of door fittings or pipe connections, cast iron flanged outlet and return headers with steel counter flanges, gaskets, bolts and nuts, brass separable socket wells for insertion of thermometer and thermostat bulbs into boilers and decorative control panel designed for fitting on boiler.

Maintenance equipment : boiler to be provided complete with set of cleaning brushes with handle, special tools required for maintenance and installation, gun for application of sealing mastic and recommended quantity of sealing mastic in sealed containers required for field sealing of joints.

B. Oil Fired Boiler (Cast Iron)

Boiler Construction

Boiler shall be of the steel type rated for 88.5 psi (610 kpa). each boiler shall be complete with the following :

- Automatic, high pressure, gun-type burner suitable for light oil No. 2 atomization.

- Fuel oil solenoid valve.

- Burner Plate.

- Insulated and enameled steel jacket and fire bricks.

- 4mm. thick steel breaching with 2" (50mm) insulation, connecting the boiler with the chimney.

- Draft control damper.

- Thermometer.

- Pressure gauge.

- Aquastat.

- Pyrostat or photocell.

- Safety relief valve.

- Electric control panel complete with switches and pilot lights and all electrical wiring.

The Aquastat shall control burner operation to maintain water leaving the boiler at 180*F (82 *C) and the Pyrostat or the photocell shall monitor burner operation and stop it in the event of flame failure or if combustion does not take place.

Burner

Burner shall be of the fully automatic mechanical pressure atomizing type; factory assembled and fire tested.

Burner shall be suitable for burning diesel fuel No. 2. It shall be complete with the following components

and accessories.

- Oil burning nozzles.
- Ignition transformer and ignition electrodes.
- Fuel oil pump of the rotary type, directly connected to the blower motor.
- Blower.
- Blower and oil pump motor auto-starter.

Controls

Burner shall be automatically controlled by an aquast at actuated by the outgoing boiler water temperature.

In addition to the aquastat, the burner shall be controlled by the following safety devices.

High limit thermostat, for protection against high water temperature.

Pyrostat to provide for a shutdown of the burner in the event that combustion does not take place.

Audible alarm shall be provided in case of malfunctioning of the boiler.

Boiler Stacks and Insulation

Boiler stacks must be carefully sized for the total simultaneous capacity of the plant and other fuel fired devices in order to maintain reasonable flue gas velocities for the fuel being burned, the firing equipment and the available draft.

Field fabricated stacks are to be of 2.5 mm. (No. 12 U.S. gauge) black iron welded construction, insulated with 50 m. (2 in.) of hydrous calcium silicate (asbestos free), all joints cemented. Exposed sections are to be covered with an aluminum jacket. The stack must be self-supporting, with an air space between it and the enclosing shaft wall.

Insulation shall be of Rockwool (120kg/m3) 100 mm thick with aluminum sheet metal jacket 0.8 mm thick as described for heating water pipes in Mechanical Rooms

C. Boiler Control Panel & Electricals

A fully factory prewired, tested and mounted boiler electrical panel shall be installed at the front end or side of boiler.

The control panel shall be fully enclosed, hinged, dust-proof. The control panel shall be of the PLC type fully programmable. The cascade operation of the two boilers shall be fully automatic, with the first boiler with the main controller being the master and the second boiler being the salve with a PCB. The connection between the two boilers shall be using a bus cable.

All sensors shall be connected to the main control panel. The system shall include the following sensors:
 Outside temperature sensor.
 Indoor temperature sensor with automatic mode, night mode or off mode.
 Aquastat sensors.
 Supply water temperature sensor.

The control panel shall include:
 A step-down control transformer.
 Control and power fuses.
 All relays and transformers.
 A blower motor starter with overloads and auxiliary contracts.
 A oil pump motor starter with overloads and auxiliary contracts.
 The fame safeguard and programming relay complete: Base.
 Chassis and modules as outlined elsewhere.
 Terminal strips, numbered for easy tracing of wiring, complete with all hardware.

All wires running out of the panel shall be installed within metallic conduits and terminated at the punched holes to the panel sides, with the required hardware as per IEC code.

Refer to division 16, section for wiring recommendations shall stay on until the failure condition has been corrected.

The control panel shall be able to be programmed for a full week. It shall take also night or day mode in addition to weekend mode.

The reading of the outside temperature sensor shall regulate the supply water temperature to meet the required load and comfort.

D. Boiler & Burner Manufacturers:

Obtain unit from one of the following:
De Dietrich (France)
Buderus (Germany)

Chemical Feeder Pot

The unit shall be of a quality construction with dished ends for safe operation at pressure and shall be supplied complete with all valves and funnels all factory assembled. The feeder unit shall be supplied with a stand and shall be pressure tested with a certificate from the factory.

Chemical feeder pot shall be similar to Houseman dosage pots or approved equal.

Expansion Tank

Provide compression tank (expansion tank) as shown on the drawings, constructed for 930 Kpa working pressure, stamped with “U” symbol and supplied with National Board from U-1 denoting compliance with ASME boiler and pressure vessel code or any equivalent European standards. Provide fittings and connections to related equipment in accordance with tanks manufacturer’s recommendations. Tank shall be insulated externally. Insulation shall be same type used for exposed ductwork, specified hereinbefore. Tank diaphragm shall withstand 10 deg. C up to 120° suitable for heating water systems.

Refer to drawings for tank support.

Heating Water Treatment

Contractor shall assign a chemical specialist to execute all chemical treatment works subject to the approval of the Engineer.

The scope of work for the chemical treatment specialist is as follows :

1. Chemical Supply
2. Supervision of treatment program applied
3. Water analysis and recommendations.

The mechanical contractor shall make sure that the following are completed and handed over to the engineer prior to commencement of water treatment works:

1. System is electromechanical operating.
2. System is tested and pressurized for leaks.
3. System to be cleaned should be final and arty new loops to be connected should be separately.
4. Drain points should be provided and sufficient for quick system draining.
5. Make-up water supply should match with system volume.

3. EXECUTION

General Installation

A. Piping

The piping shall be installed generally as described and as shown on the drawings for heating water.

Install thermometers in piping system adjacent to the heat exchanger inlet and outlet secondary connections.

Install strainers in water piping a head of all pumps, automatic modulating valves, and heating coils.

Provide balancing valves and pressure gage cocks in all returns from three way valve bypass loops to balance the system.

Balancing valves shall be required on the return of each branch main to balance the system.

Provide flexible connections at the inlet and outlet to all major equipment which require vibration isolation.

B. General : Except as otherwise indicated, install heating plant work, including components and controls required for boiler operation, in accordance with boiler manufacturer's instructions, and. with recognized industry practices, to ensure that boiler equipment complies With requirements and serves intended purposes.

C. Locate boilers in general position indicated in relation to other work. Position boilers with sufficient clearance for normal service and maintenance, including clearance for cleaning and replacement of tubes and clearance for component replacement.

D. Paint damaged and abraded factory finish with touch-up paint matching factory finish.

Examination of Related Work

Observe installation. of other work (related and connected to boiler work) and after completion check for inadequacies and protect operation and performance of boiler work to suit boiler manufacturer's requirements and to the Royal Commission's satisfaction and approval, do not start boiler work until inadequacies have been corrected in a manner acceptable to the Engineer.

Field Quality Control

Manufacturer’s Supervision: Boiler manufacturer shall supervise field assembly (if any) and installation of boiler work, with a factory-trained technical service representative, for a minimum of 2 working days, plus one additional day for each boiler unit in excess of one. Prepare manufacturer’s written report of installation.

Boiler Start-Up

General: Except as otherwise indicated, start-up boiler in accordance with boiler manufacturer's instructions.

Sustained Operation: Do not place boiler in sustained operation prior to initial balancing of mechanical systems affected by boiler operation. Refer to requirements of Division 15 sections for testing, adjusting, and balancing.

Cooperate with other trades of other work during the testing, adjusting, balancing and start-up of mechanical systems

Testing

General: Except as otherwise indicated, test boiler as directed by the Engineer.

4. FUEL OIL SYSTEM

GENERAL

System Description

A. This Section covers:

1. The daily services tanks constructed of steel

2. Underground main fuel tanks.

3. The oil feed pumps and piping circuits.

Quality Assurance

A. Manufacturers Qualifications

1. The manufacturer must be experienced in the manufacture of the type and size of tank using the materials specified and shall be approved.

References

A. Refer to individual materials for specified standards.

B. American Petroleum Institute (API)

1. API - 650 Fabrication of Oil Tanks.

Submittals

A. Product Data

1. Descriptive literature for each of the actual proposed equipment to be used including :
   a. Capacity.
   b. Test Reports.
   c. Certificates of Approval .
   d. Operating and Maintenance Data .
   e. Any other Technical Data.

B. Shop Drawings

1. Shop drawings for each of the actual proposed equipment shall include the following :
a. Working or Manufacturing Drawings.
b. Calculations.
c. Installation Details.
d. Connections by Other Services.
e. Wiring Diagrams.
f. Accessories Available Indicating Those Included.
g. System Diagrams.

PRODUCTS

Pipes And Tubes

A. Refer to Part 3 Article " Piping Applications" for identification of system where pipe and tube materials specified below are used.

B. Steel pipe : ASTM A53, Schedule 40, Seamless type, Grade B, black, with beveled ends.

Pipes And Tubes Fittings

A. Refer to Part 3 Article " Piping Applications" for identification of system where pipe and tube fitting materials specified below are used.

B. Malleable-iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threads according to ASME B1.20.1.

C. Steel Fittings: ASTM A 234/A 234M, welded, for welded joints.

Oil Safety Valves :

UL-listed for flammable or volatile liquids, 1725 kPa maximum working pressure, 288 deg C maximum operation temperature. Include ASTM B 61 bronze body, bronze bases and discs, and field adjustable cadmium- plated carbon steel springs, factory set at 20 percent above operating pressure. End connections have inside threads according to ASME B1.20.1.

Oil Tanks

A. General

1. Fuel oil storage tanks shall be provided where located on the drawings with capacities as scheduled.

B. Storage Tank (Horizontal Mounting)

- Tank shall be constructed of 4 mm. thick welded black steel sheet metal to the capacities indicated on the Drawings.

- Tank shall be tested for leaks before installation and shall be painted with two coats of red lead oxide or approved equal, and two coats black bituminous paint.

- Tank shall be mounted on a concrete pad and shall be equipped with the following:

* Manhole and manhole cover, air tight.
* Protected oil level indicator fixed to the tank.
* Fill and vent pipes.
* Gate valves as shown on drawings.
* Overflow, drain and supply lines.

C. Fuel Oil Strainers

Y-pattern, full size of connecting piping. Include Type 304 stainless steel screens with 1.2 mm perforations.

1. Pressure Rating: 860 kPa (125 psig) minimum steam working pressure.

2. Size 65 mm and Smaller: Bronze body, with female threaded ends.

3. Sizes 80 mm and Larger: Cast-iron body, with flanged ends.

4. Screwed screen retainer with centered blow-down and pipe plug.

D. Level Switches in Fuel Tank

Level switches installed in daily fuel oil tank all on one stem to operate solenoid valve shall be of the type suitable for fuel oil with four level switches as indicated on drawings. Mounting and stem material shall be of brass, float shall be of polysulfone or polypropylene. Switches shall give signal for:

- Low level alarm
- Low level open valve.
- High level close valve.
- High level alarm.

Grip rings shall be of copper and collar of brass Stem size shall be 5/16 inches diameters of the adjustable type with length suitable for day tank height.

Level switch shall be UL listed, Thomas products LTD level and flow switches mode 4000 or approved equal.

Low level switch and high level switch in underground fuel tank shall be as described above but shall give low level signal BMS and high level signal to give alarm that tank is over filled with fuel oil by tanker and a signal to BMS.

Flame Arrestor

Flame arrestor shall be installed at end of fuel oil vent pipes and shall consist of a series of sturdy round discs mounted on a durable collar casing.

Flame arrestor shall be constructed of light weight cast aluminum collar, weather hood and flame arrestor plates. Flame arrestors shall be UL listed with quality assurance from factory before shipment.

Flame arrestor shall be Protectoseal Model No 6670 or approved equal.

Pressurization and Expansion Units

HWS Expansion Vessels

Expansion vessels shall be constructed of mild steel generally in accordance with BS 4814 and BS 5169 and as per ASME section VII Div. 1.

Each vessel shall be provided with a removable, heavy duty Butyl rubber bladder, removes easily for inspection and maintenance.

Each vessel shall be suitable for the working pressure of the system and shall be provided with a charging valve connections and feed connection to the system.
The vessels shall be suitable for the total water content of the various systems.

EXECUTION

Piping Applications

A. Aboveground Piping, Sizes 50 mm and smaller : Steel pipe, malleable-iron fittings, and threaded joints.

Pipe Installations

A. Install strainers on the supply side of each control valve, pressure regulating valve, oil burner connection, and elsewhere as indicated. Install 20 mm pipe nipple and ball valve in blow-down connection of strainers 50 mm and larger. Use same size nipple and valve as blow-off connection of strainer.

Hanger And Support Installation

A. Refer to Division 15 Section " Hangers & Supports " for hanger and support devices.

B. Install hangers for horizontal piping with following maximum spacing and minimum rod sizes :

Nominal Pipe Size (Millimeters)	Steel Pipe Span (Meters)	Max. Min. Rod Diameter (Millimeters)
15 & smaller	2.1	2.1
20	2.1	2.1
25	2.1	2.1

- Support vertical steel pipe at each floor and at spacing not greater than 4.6m.

Valve Installations

A. Install valves in accessible locations, protected from physical damage. Tag valves with a metal tag attached with a metal chain indicating the piping systems supplied.

B. Install gate valves at each branch connection to supply mains and elsewhere as indicated.

C. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.

Terminal Equipment Connections

A. Sediment raps : Install a “T” fitting with the bottom outlet plugged or capped as close to the inlet of the oil burning appliance as practical. Drip leg shall be a minimum of 3 pipe diameter in length.

Field Quality Control

A. Test fuel oil piping according to NFPA 31 . Remark leaking joints and connections using new materials.

B. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

Demonstration

A. Train Owner’s maintenance personal on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventive maintenance.

B. Review data in Operating and Maintenance Manuals. Refer to Division 1 Section “ Project Closeout”.

C. Schedule training with Owner with at least 7 days advance notice

Commissioning

A. Before activating system perform these steps:

1- Open valves to full open position and close bypass valves.
2- Remove and clean strainer screens.
3- Check pump for proper direction of rotation.
4- Fill oil storage tank with proper fuel type.
5- Check operating controls of fuel burner units.
6- Check operation at automatic bypass valves.
7- Check and set operating temperature controls on oil heaters.

CHAPTER SEVEN
VENTILATION

7.0 VENTILATION

TABLE OF CONTENTS

1. DUCTWORK

1.1 General

All site measurements for manufacture and installation co-ordination of ductwork shall be taken by the Contractor.

Ducts shall be anchored securely to the structure in an approved manner and shall be installed so as to be completely free from vibration under all conditions of operation.

1.2 Construction of Sheet Metal Ductwork

Supply and install all ductwork as shown on the drawings and specified therein.

Ducts shall be constructed of galvanized steel sheets conforming to ASTMA 526-71, galvanized by the hot-dip process coating designation G90 or approved equivalent standard. Minimum weight of zinc coating (total on both sides) 275 g/m2.

Ductwork shall be installed in accordance with ASHRAE or SMACNA requirements for low pressure ducts.

Ductwork galvanized after manufacture shall be of adequate thickness to avoid undue distortion during the galvanizing process. All ductwork shall be to the approval of the Engineer.

The ductwork shall be manufactured without longitudinal joints at the bottom and suitable gaskets shall be provided at flanges to prevent leakage of condensation. The ductwork shall be installed with a fall back to the dishwasher or grease filters as applicable. Access doors shall be provided for inspection and cleaning at 3 meters intervals and at each change in direction. Where restricted space dictates that these access panels must be mounted on the bottom face of the duct an internal lip shall be incorporated to minimize the risk of spillage. The access panels shall be provided with suitable gaskets.

Sheet metal ducts shall be properly braced and reinforced with steel angles or other structural members approved by the Engineer all in accordance with ASHRAE & SMAGMA requirements. Unless otherwise required, the internal ends of all slip joints shall be installed in the direction of flow.

2. DUCTWORK ANCILLARIES

2.1 Flexible Connectors

2.1.1 General

Flexible connectors shall be included in the price on ductwork crossing building movement joints on all fan and air handling plant ducting connections including fan coil units and grille/diffuser plenum boxes to provide isolation. Metal ducts shall be arranged so that there is a clear gap of not less than 100 mm or greater than 200mm where necessary between the ends of the ducts and the fan spigots, and the ducts shall be supported either side of the connector to ensure the alignment of the duct and/or fan spigots.

Flexible connectors shall be hemmed and seamed as appropriate and formed to a section to suit the dimensions of the duct or fan connection.

The flexible connections shall be made from non-inflammable and rot resistant approved material with a surface spread of flame of Class '0' as defined in BS 476 Part 7 in ceiling voids and Class '1' to BS 476 Part 7 in plantrooms. The material shall be of adequate thickness to give a minimum of noise reduction of 12 dB at 125 Hz.

2.1.2 Sheet Metal Ducting

Angle iron welded flange frames shall be secured to the ends of the flexibles by riveting through the inside flange of the angle iron and using a flat mild steel backing strap on the outside of the flexible. Mating flanges shall be provided unless otherwise specified on the adjacent ductwork or fan connection.

In rectangular ductwork other than fan connections with the longest side less than 450 mm the flexible may be riveted direct to the ductwork using a flat mild steel backing strap or when approved a four piece bolted band clip provided that angle iron stiffeners are fitted to the ductwork.

In circular ductwork other than on fan connections and ductwork over 900 mm diameter mating flanges may be omitted and flexibles secured with a worm driven draw up band clip provided that angle iron stiffening rings are fitted to the ductwork.

3. DAMPERS AND TERMINAL UNITS

3.1 Fire Dampers

Sheet Metal Ductwork

Fire dampers and duct access panels shall be provided wherever ductwork penetrates a fire barrier.

Fire dampers shall be stainless steel curtain dampers comprising a continuous series of folded interlocked blades contained within, and arranged to close the opening of a surrounding frame.

The damper blades when set shall fold up out of the airstream.

The damper blades shall be of not less than 0.7 mm stainless steel strip type 430 to BS 1449. All blades shall be shaped on both edges to form a continuous interlocking hinge extending the full length of the blade to ensure correctness of action, each blade incorporating two Vee formed ribs along each blade length for maximum strength.

The blade assembly shall be fixed to the damper framework by the first blade being secured flat to the inside face of one side of the outer frame.

The damper casing shall be of rolled section so shaped as to provide two 25.4 mm internal flanges spaced at not more than 78 mm apart. This frame shall be airtight and of not less than 1.59 mm strip mill cold reduced sheet continuously hot dipped galvanized to BS 2989, Group 2, Class B.

All welded edges and joints shall be protected with zinc chromate primer or zinc rich paint.

Spring tempered 0.25 mm stainless steel type 301S21 to BS 1449 side gasketting shall be inserted between the blade end and damper casing to provide an increased blade edge seal to reduce the passage of smoke and combustible gases.

The blades shall be held open by a purpose made straight bar type fusible link, locking into two stainless steel cam latch assemblies or similar.

This link assembly, combined with a ramp blade release toggle fitted to the leading blade of each fire damper assembly, shall allow the fire damper to be tested and reset from either side of the damper when installed. The fusible link shall be rated 72°C unless otherwise specified.

The unit shall include indication that the damper is closed.

The dampers shall be clearly marked "bottom of unit" to assist correct installation.

All dampers shall be closed by two constant tension coil band springs exerting a pull of not less than 35N, and shall be capable of completely closing against the normal in duct air flow total pressure. These springs shall be stainless steel 17/7PH or type 304S31 to BS 1449 and not less than 19 mm wide by 0.3 mm thick.

The coiled end of the spring shall be retained around a stainless steel pivot fixed to a catch plate in such a way that it will not become dislodged from the pivot by side movement.

3.2 Constant Volume Dampers

The Contractor shall supply and install as indicated in the Scope of Works constant volume controllers designed to maintain a constant downstream duct pressure regardless of fluctuating upstream pressures.

The controller shall be system operated with mechanical constant volume action factory preset to the required air volume.

The volume tolerance shall be + 5% with a pressure variation of 700 Pa.

The constant volume control damper shall be manufactured from galvanized steel in circular construction with damping by air bellows and a stainless steel control spring. The blade spindle shall be mounted in ball bearings. The control damper shall be suitable for connection to circular ductwork. It shall be possible to site adjust the volume setting.

Each supply unit shall be provided complete with a downstream LTHW reheater battery and with outlet attenuation to achieve the relevant required room noise level, all as a composite proprietary constant volume terminal unit.

3.3 Hand Operated Volume Control Dampers

3.3.1 Sheet Metal Ductwork

Galvanized steel aerofoil opposed blade control dampers shall be installed on systems without constant volume dampers to ensure the ventilation systems can be properly balanced. The use of opposed blade dampers behind diffusers to balance ductwork branches will not be permitted. A separate branch ductwork damper shall be provided and the diffuser damper used only for fine-tuning of the flow to the room. Blades shall be of a low profile and aspect ratio for lowest possible turbulences, air resistance and noise. The blade size shall be such as will permit site withdrawal of the complete damper regardless of damper blade position.

Volume control dampers shall be provided on every main duct, branch duct and sub-branch in accordance with the C.I.B.S.E. COMMISSIONING CODE.

Damper control shall be via finely toothed precision moulded nylon gears and bearings, which shall be completely out of the air stream. The gearing shall have a 4:1 ratio to give minimum torque during operation.
All moving parts shall be enclosed in a galvanized sheet steel dustproof control box and be complete with visual blade position indicator, operating and locking assembly.

The damper casing shall be of slimline airtight dustproof double skin construction of high rigidity and maximum strength. The outer frame shall be manufactured from roll formed 1.6 mm galvanized steel and the inner frame from 1.0 mm. The outer frame shall have continuously welded corners and integral peripheral flanges pre-punched with elongated holes for ease of duct attachment and height adjustment. The external damper casing surface area shall have only one penetration of drive shaft to simplify insulation where required.

In large ducts where a multiple assembly is required the dampers shall be arranged so that control shall be from one central control.

In circular low velocity (not exceeding 7.5 m/s) ductwork dampers shall be as specified above and fitted with rectangular to circular masking plates. The air leakage past the damper shall not exceed 5% when in the fully closed position at a static pressure equal to the maximum static pressure in the system.

All volume control dampers shall be supplied with duct access panels as specified.

3.4 Back Pressure Dampers

Backpressure dampers shall be of the automatic self-operating type and constructed in a galvanized mild steel frame with flanged connections drilled for installation in the ductwork system. The blades shall be coupled together and shall be constructed from aluminium on stainless steel shafts with bronze bearings and neoprene seals.

4. INLET AND OUTLET TERMINALS

4.1 Grilles

The Contractor shall select and locate the grilles and diffusers and coordinate them into the architectural reflected ceiling plans where applicable.

During construction the Contractor shall co-ordinate the location and fixing of the grilles and diffusers with the ceiling installations. The Contractor shall site measure and agree with the Engineer the final dimensions of all grilles and diffusers before manufacture.

4.2 Louvers

Intake and discharge louvers in the face of the building will be provided as part of the Mechanical Contract and are therefore included in the Scope of the Mechanical Services. All louvers shall be of aluminum construction, weather proof and complete with bird screens.

Acoustic louvers, silencers etc. shall be installed as indicated on the drawings. All louvers will be painted to match the buildings facia.

Approved Manufacturers

a. KBE
b. Trox
c. Titus

or approved equal.

5. FANS

5.1 General

The Contractor shall supply and install in accordance with this Specification, fan and motor assemblies as detailed in the Schedules of Equipment and as indicated on the drawings.

Fan unit performance curves derived in accordance with BS 848 shall be supplied showing volume, static pressure, maximum absorbed kW and static efficiency with the unit operating condition clearly marked. These details shall be issued to the Engineer for approval prior to the fans being installed.

A sound spectrum for each fan and motor assembly derived in accordance with BS 848 shall be supplied to the Engineer before manufacture, but under no circumstances shall the sound power level exceed that given in the Schedule of Equipment.

Additional attenuation is specified in the Schedules to meet specific noise criteria for fan systems. Where fans are supplied having different sound spectrum or ductwork is modified, the attenuator insertion losses shall be adjusted to ensure design noise criteria are maintained.

The fan motors shall comply with the relevant clauses on Electric Motors set down elsewhere in this Specification.

Unless otherwise specified or detailed each fan assembly shall be installed on a 150 mm concrete base and shall be isolated from the structure by anti-vibration mountings in accordance with the relevant clauses of this Specification.

The complete fan assembly shall be primed and painted in a colour to be agreed with the Engineer and in accordance with the relevant section of this Specification relating to painting.

Each fan shall be isolated from the ductwork installation by flexible connections complying with the relevant clauses set down elsewhere in this Specification.

5.2 Axial Flow Fans

Axial flow fan impellers shall be of the multi-blade type dynamically balanced with blades of 'aerofoil section' constructed from aluminum alloy.

The casings shall be of the long type of heavy gauge mild steel having flanges at both ends and hot dipped galvanized to BS 729 after manufacture.

The casings shall be provided with bolted inspection doors and an external weatherproof terminal box.

The impellers shall be direct driven by motors of totally enclosed continuously rated 3-phase type with ball bearings and extended grease point. The impellers shall be capable of giving fan total efficiency of not less than 75%.

Purpose made feet shall be provided on the fan casing for supporting the fans.

The fan speed shall not exceed 24 rps (1440 rpm).

Each axial flow fan shall be supported by means of a strong rolled steel angle or channel frame from the steelwork, wall or floors as necessary.

5.3 Approved Manufacturers

a. Penn
b. Woods
c. Ventaxia
d. Kanaflakt
e. Greenheck
f. Acme

or approved equal.

CHAPTER EIGHT
FIRE PROTECTION

8.0 FIRE PROTECTION

TABLE OF CONTENTS

PART 1.0 – GENERAL

1.1 DESCRIPTION

This section of the specifications includes the furnishing and installation of fire extinguisher.

PART 2.0 - PRODUCTS

2.1 PORTABLE FIRE EXTINGUISHERS

Portable fire extinguishers shall be provided to the types specified, and at locations as shown on the drawings. Standard portable fire extinguishers are 10 pound (4.54 kilogram) ABC dry chemical units with a UL rating of 4A-60BC. A 20 pound (9.07 kilogram) BC dry chemical unit shall be located adjacent to each cooking line. Carbon dioxide extinguishers shall be provided for all electrical equipment areas.

Portable extinguishers shall be located within combined hose rack cabinets where shown, or attached to walls with purpose made brackets. Extinguishers with a gross weight of forty (40) pounds (18.14 kilograms) or less, may be installed in a position where the top of the extinguisher is no more than 5 feet (1.53 metres) above the floor. Extinguishers with a gross weight in excess of forty (40) pounds (18.14 kilograms) shall be installed such that the top of the extinguisher is no more than 42" (1070mm) above the floor.

2.3 APPROVED MANUFACTURERS

a. Kiddi
b. ABC
c. Fridhom

or approved equal.

CHAPTER NINE
WATER TREATMENT

8.0 WATER TREATMENT

PRODUCT: COMMERCIAL REVERSE OSMOSIS SYSTEM

1.0 GENERAL

Furnish a commercial reverse osmosis system (RO) as specified here in this section and as called for in the equipment schedule for the reduction of total dissolved solids. The RO shall be supplied complete, and assembled entirely by one manufacturer. System to include all components required for proper operation of the system. These components include system control package, flow meters, high pressure pump, membranes, pre-filter, adjustment valves, pressure gauges, automatic inlet valve, and frame. RO shall be from a known manufacturer with a proven record.

3.0 COMPONENTS

3.1 System Support Frame

All components of the reverse osmosis (RO) system will be mounted on a single support frame. The support frame shall be constructed of a one piece broke 304 stainless steel panel measuring .10” in thickness. The support frame shall be suitable for wall mounting.

3.2 Pre Filter

The pre-filter housing shall be a single element type constructed of FDA grade reinforced polypropylene and certified to NSF/ANSI standard 42. The housing will have a 100 PSI maximum working pressure and a maximum temperature rating of 100 deg. F (37 deg. C). The housing will have 1” NPT inlet and outlet and accept a 4 ½” X 10” single replaceable filter cartridge element... The housing will be sized to flow 15 GPM at a pressure drop of 3 PSI using a five micron pleated cartridge. The replaceable filter element shall be a pleated type five micron nominally rated cartridge with plastisol end caps. The pleated filter fabric shall be composed of 100% polyester to resist the growth of microbiologic films.

3.3 High Pressure Pump

A high pressure pump will be provided, mounted on the RO frame, to boost the membrane feed water pressure to a maximum of 250 psi. The pump shall be a multi-stage type with 304 stainless steel pump housing, motor adaptor base, pump shaft, and discharge. Impellers shall be constructed of acetal. All motors must be 230 volt 1 phase with ODP motor housings. 1.25 and 2.5 gpm production systems will use a 1 horsepower motor and 3.75 gpm production systems will use a 1.5 horsepower motor to ensure adequate membrane feed water volume and pressure.

3.4 Membrane and Membrane Housings

The membrane housings shall be constructed of fiberglass reinforced plastic for superior corrosion resistance, with glass reinforced polypropylene end caps. The maximum operating pressure of the housings shall be 300 psi. The housing’s maximum operating temperature will be 100 deg. F (37 deg. C). Membranes shall be of a known brand. Membranes must have a minimum average salt rejection of 95% under the standard test conditions of 225 psi feed pressure, and 77 deg. F (25 deg. C), with a 2000 ppm NaCl feed solution at a pH of 7.0.

3.5 System Controls

The system will include electronic and hydraulic controls for automatic operation and manual adjustment. The electronic controller shall be a micro processor based controller with inputs and outputs for automation of the RO components. Input signals shall be: low feed water pressure, tank level full, and pretreatment interlock. Output signals shall be: open/close automatic inlet valve and start/stop high-pressure pump. The controller shall have an adjustable 10 minute through 80 minute delayed automatic restart after a low feed water pressure shut down to prevent on off cycling of the system during a low feed water pressure condition. The controller will have a rocker switch for manual on off control of the system and indicator lights for tank full/ pretreatment interlock, low pressure shut down, and supply power. The electronic controls will be housed in an ABS electrical enclosure with a NEMA 3 rated gasket sealed access door. The automatic inlet valve will be a normally closed nylon globe valve rated for 150 PSI maximum working pressure, 176 deg. F (80 deg. C) maximum temperature, with a 24V coil. Manual hydraulic control valves will be provided on the RO system to regulate reject recycle and reject water

volume. The reject water and recycle water adjustment valves shall be globe valves, constructed of 316 stainless steel, and rated for 300 psi maximum working pressure.

3.6 Flow indicators and Gauges
The RO system will be supplied with pressure gauges to indicate the pressure of the pre-filter inlet, pre-filter outlet, and pump discharge water. All pressure gauges shall have an acrylic window. The pump discharge pressure gauge will be glycerine filled. Flow meters will be provided to give an indication of product and reject water flow rates. Flow meter flow rate scales are to be calibrated to gallons per minute and liters per minute within 3 percent accuracy. Flow meters shall be variable area inline type with disconnects at each end to ease internal cleaning of the meter body. Meter bodies are to be constructed of polysulfone or acrylic, with 316 stainless steel float and float rod, and viton orings. Prefilter inlet/outlet and pump discharge pressure gauges and all flow meters are to be mounted next to the electronic controller so that all are in plain view of the operator while the system is running.

3.7 System Piping
Pump suction, pump discharge, reject and reject recycle piping will be high pressure UPVC pipes. Membrane interconnecting piping will be UPVC pressure pipes.

3.8 Test Kit
Provide a Myron L model 6 P hand held water quality meter along with pH 4 and pH 10 calibration solutions and conductivity KCl- 7000 (7 mS), 442-3000 TDS calibration solutions. Each calibration solution shall be provided in a one quart quantity. Also provide a silt density index test kit, Watts model number T3031, for testing RO feed water SDI.

4.0 SERVICES

4.1 Warranty
Provide a 1 year parts and labor warranty for the system to protect against manufacturers defects. System shall not be subjected to water temperatures above 100 deg. F (37 deg. C), below 35 deg. F (2 deg. C), iron, hardness, or chlorine.
4.2 Start Up
The Contractor providing the equipment shall provide startup of the RO system, a complete set of operating, maintenance, and installation instructions, one complete set of spare pre-filter cartridges for the pre-filter housing, and operator training.

Approved Manufacturers

a. Culligun
b. Metito
c. Emco
d. Alama

or approved equal.

CHAPTER TEN
SANITARY FIXTURES

9.0 SANITARY, FIXTURES

TABLE OF CONTENTS

1. GENERAL

The Sanitary Fixtures Work shall consist of installing, testing and putting in operation all Sanitary Fixtures, accessoires, pipe fittings and equipment as here inafter specified and as show on the drawings.

2. GENERAL REQUIREMENTS

- All fixtures and trimmings, in sofar as practicable, shall be of one manufacture.
- Ample application of petroleum jelly shall be made to all surfaces of exposed chrome plated piping, valves and fittings immediately after installation
- All fixtures shall be set straight and true.
- Concealed brackets, hangers and plates shall have a shop coat of paint.
- All exposed piping and trim shall be chrome plated and fully protected during installation.
- Strap or padded wrenches shall be used on chrome plated pipefittings and valves.

3. SANITARY FIXTURES

- Sanitary fixtures shall be complete with all required trimming, including mixers, waste plugs or flow waste, traps, supplies, stop valves, escutcheons, casings and all necessary hangers, plates, brackets, anchors and supports.
- Vitreous china fixtures shall be of first quality with smooth glazed surfaces, free from warp, cracks, checks, discolorations or other imperfections.
- Enamelled cast iron fixtures shall be of acid - resisting type.
- The selection & approval of sanitary fixtures and their accessories & manufacturers is decided by the Client and or/his Representative

4. EXPOSED PIPING AND TRIM IN TOILET AREAS

All piping, valves and fittings exposed to view shall be screwed, polished, chrome plated brass. Plating shall be accomplished after threading.

5. FIXTURE SETTING

Fixtures shall be set in a neat, finished and uniform manner making the connections to all fixtures at right angles to the wall, unless otherwise directed by the Engineer. Roughing for this work must be accurately laid out so as to conform to finished wall material. Fixtures are not to be set until so directed by the Engineer.

The location and disposition of all items shall be as indicated on the relevant drawings.

All fixtures and fittings shall be as detailed in the schedule of fixtures, indicated on the drawings.

6. WATER CLOSET - Type EWC

White vitreous china, dual flush, water closet with wall outlet, syphonic action. EWC shall be complete with the following fittings:

WC pan with side outlet, cistern of 6 litres capacity for bottom supply and overflow with plastics syphon fitting, flush valve and mechanism, HP/LP bottom supply ballvalve with refill unit, ¾ in bottom overflow, servicing valve and close coupling fitment (cistern fittings are not reversible), and chrome plated side lever, seat and cover, screws (pair), Plastic outlet connector for connection to 102 bore soil pipe. System shall be completed with flushing hose.

EWC-1 Kids WC
EWC-2 Teacher / Student WC
EWC-3 Ditto as ECW-2 but for handicapped
EWC-4 Floor mounted – Kids
EWC-5 Floor mounted – Teacher / Student

7a. LAVATORY - Type LAV

White vitreous china lavatory shall be mounted basin into granite or marble vanity top and complete with the following fittings: 1 taphole ,mixer, 1 ¼ in bead waste, 1 ¼ in chrome bottle trap with 75mm seal concealed bracket with fixing clamps in aluminium alloy & servicing valve.

LAV-1 Kids LAV. (without mixers: Mixers specification, refer to Item 7b).
LAV-2 Teacher / Student LAV.
LAV-3 Ditto as LAV-2 but for handicapped

7b. LAVATORY FITTINGS

1 tap self close mixer, 1in bead waste, 1in chrome bottle trap fitted on LAV-1 & LAV-4 (Resin LAV-4: Refer to Architectural BOQ & Specifications)

7c. TAPS FOR BASINS

Faucet shall be self-closing wall-mounted, push button and adjustable fitted on the pan as provided by others.

It shall include an integrated aerator, chrome finish complete with flow regulator, vandal proof and wall plate.

1¼“ drain shall be provided with chrome plated trap and connected to the drain UPVC pipe.

The number of faucets shall be as shown on the drawings.

8. SINKS - Type KS

Sinks shall be made of satin finish 18/10 non-ferrous stainless steel, lay on with back slash. Sinks shall be provided with the following: Mounting flange, Combination sink tap centre-set with swing spout & Stainless steel waste with over flow tube.

Kitchen sinks shall be provided with drain boards. Underside of compartment must contain sound absorbing asphaltic plate.

The mixer shall be provided with a gooseneck swing spout and aerator mounted on common deck base with loop for chain. Sinks shall be provided with vitreous china semi recessed soap and sponge holder.

KS-01 (60 – 120 cm width)
KS-02 (140 cm width)

9. BATHROOMS ACCESSORIES

Refer to Architecture BOQ and Specifications.

10. EXECUTION

Fixture Joints

Joints shall be standard fittings furnished with the fixtures. Where space conditions will not permit standard fittings, special short-radius fittings shall be provided.

The fixture joints on soil pipes shall be made absolutely gastight and watertight.

Strainers and Fixture Outlets

Lavatory basins shall have waste outlets not less 30mm in diameter. Wastes may have open strainers or may be provided with stoppers.

Shower-receptaclewaste outlets shall be not less than 50mm in diameter and have removable strainers.

Sinks shall be provided with waste outlets not less than 40mm in diameter. Waste outlets shall have open strainers or shall be provided with stoppers.

Fixture Supports

Wall hung plumbing fixtures not supported on chair carries shall be supported on wall hangers on screw bolts furnished with the fixtures.

Where appearance of the bolts is not objectionable, the fixture shall be fastened to the wall by through-joint bolts. Bolt heads or nuts shall be hexagonal and painted or chromium-plated, and washers shall be painted or chromium-plated to match bolt heads or nuts.

Where appearance of bolt heads or nuts is objectionable, fixture shall be fastened to walls by machine-bolt expansion shields or stud-type expansion bolts.

Fixture Traps

Sanitary fixtures, excepting those having integral traps, shall be separately trapped by a water-seal trap, placed as close to the fixture outlet as possible.

The trap shall be of the same diameter as the fixture drain to which it is connected.

The fixture trap shall have a uniform interior and smooth waterway.

Each fixture trap shall have a water seal of not less than 60mm.

Fixture trap, except those integral or in combination with fixtures in which the trap seal is readily accessible or except when a portion of the trap is readily removable for cleaning purposes, shall have accessible brass trap-screw of ample size.

Cleanouts on the seal of a trap shall be made tight with threaded element plug and approved washer.

No fixture shall be double trapped.

CHAPTER ELEVEN

THERMAL INSULATION

10.0 THERMAL INSULATION

TABLE OF CONTENTS

1. PIPEWORK THERMAL INSULATION (Type A)

A. Material

1. Thermal insulating material shall be made from long, fine fiber glass, Rockwool, free from short or coarse fibers, bonded with a temperature resistant binder and formed into a cylindrical or semi-cylindrical rigid pipe sections with aluminum foil facing as described in duct insulation of thickness as specified below with a thermal conductivity of not greater than 0.05W/m•C. Insulation exposed on roof tank and in Mechanical Rooms shall have a density of 96kg/m3. Insulation in false ceiling voids and shafts shall have a density of 64 kg/m3.

2. Thickness of Insulation

DOMESTIC HOT WATER SUPPLY AND HEATING WATER PIPES

NOM-BORE MM	THICKNESS MM
15-32	25
40-100	30
125	40
150 & above	50

3. The insulation shall have an alkalinity of between PH6.0 and PH10.0. Then insulation shall not include substances which will promote corrosive attack on the services with which it is to be in contact. The insulation shall also be free from objectionable odour at the temperature at which it is to be used, unable to encourage pests or support the growth of fungi, or suffer deterioration under the specific conditions of use or as a

DOMESTIC HOT WATER SUPPLY AND HEATING WATER PIPES

result of contact with moisture due to thickness, uniformity of thickness and internal diameter from manufacturer's standards dimension are as follows:

Thickness : + 3 mm

Uniformity of thickness The local thickness at any point shall not differ from the average thickness by more than 3 mm.

Internal Diameter : -0+1.5 or 1% , whichever is the greater

Pipe Fittings Insulation

- Where hangers are installed on the pipe covered with insulation, the entire hanger up to the rod shall be insulated.
- Where insulated piping is subject to movement and supported on rollers and chairs, or sliding plate brackets, steel protection saddles shall be provided.
- All insulated pipework not supported as described in Section 15060 but subject to movement, shall be provided with protection shields at all hanger locations. Shields shall be No. 10 gauge galvanized iron extending on each side of the hanger for a distance equal to the diameter of the insulation and shall be provided with cork pad support.
- Insulate valves, strainers, fittings and flanges with identical material, density, thickness and finish as the pipe insulation. Use premoulded material where available, otherwise use shaped block segments wired on with all edges filled with insulating cement or filler.
- Insulate strainers to permit removal of the basket without disturbing the insulation of the strainer body.

2. PIPEWORK THERMAL INSULATION (TYPE B)

This type of insulation shall apply to domestic hot water system under tiles or in walls.

Pipes shall be insulated with rubber type insulation Armaflex 19 mm thick. Insulation shall be closed sell tubing with finished skin, chemical and oil resistant with minimum water absorption. Insulation shall stand extremes temperatures ranging from 40ºC to 120ºC. Inner tubing insulation diameter shall be equal to outer utility pipe diameter. Rubber insulation shall be wrapped with 2 layers of PVC tape.

Insulation density shall be 0.111 Gms/m3 with thermal conductivity K value at 40ºC mean temperature 0.041 W/M-K insulation shall be self extinguishing.

Insulation shall be ASTM approved similar to Gulf – O – Flex or approved equal.

3. APPROVED MANUFACTURERS

Johns – Manville	(USA)
Armstrong	(France)
Fiberglass Limited	(UK)
Isotoprack	(Turkey)
ST. Goban	(France)
Al Fujairah Rockwool Factory	(U.A.E.)
Knauf Insulation	(USA)

TECHNICAL SPECIFICATIONS

PART 3
ELECTRICAL ENGINEERING SERVICES

TABLE OF CONTENTS

CHAPTER 1

BASIC ELECTRICAL REQUIREMENTS

1 - GENERAL

1.1. RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other chapters of part 3.

1.2. SCOPE OF WORK

1.2.1 The scope of electrical work for the Project will include but is not necessarily limited to:

A. Power Supply and Distribution consisting of:
- Sub-distribution and final branch circuit panel boards,
- Cables, wires and related accessories,
- Conduits, wire ways, supporting systems and related accessories,
- Earthing system. `

B. Lighting and Power Installations including:
- Functional indoor and outdoor lighting installations,
- Wiring devices including all lighting switches, isolating switches, socket - outlets, plates,

1.2.2. Unless otherwise specified, includes the supply, installation, testing and commissioning of the complete electrical systems, equipment and materials shown on the Drawings and/or described in the Specification together with all associated ancillary work, support work and builder's work in connection.

1.2.3. Incoming power supply and connection will be provided by the Local Power Authority at 220/380 V to the location shown on the Drawings.

1.3. GENERAL REQUIREMENTS

1.3.1. INSTALLATIONS GENERALLY:

A. Carry out electrical work in accordance with the Drawings, Specification and Regulations, ensuring compliance with design and performance requirements, to provide safe and protected systems with equipment readily accessible for operation, maintenance and repair

B. Installations are to be complete, ready for operation and fully integrated and coordinated with all other work

C. Installations are to be carried out by qualified personnel

D. Provide accessories necessary to complete the installations, of the types specified or recommended for the purpose by the manufacturer of the equipment or accessories.

1.4. DESIGN CONDITIONS

1.4.1. Nominal characteristics of power supply and distribution are as follows:

A. low voltage : 380 V, 3 phase, 4 wire, solidly earthed neutral
B. frequency : 50 Hz.

1.4.2. DISTRIBUTION SYSTEMS are to be supplied or derived from the voltage system previously described, as shown on the Drawings, or as otherwise specified.

1.4.3. EQUIPMENT is to be designed for the system voltage and frequency previously described, unless otherwise specified. Special provisions are to be made for equipment sensitive to power supply frequency and voltage variations and for equipment operated at other voltages/frequencies or by direct current sources.

1.4.4. CLIMATIC CONDITIONS: equipment, including transformers, switchgear, cables, relays, lighting fixtures, motors etc., is to be designed and derated for continuous and trouble free service under the following climatic conditions:

A. altitude : at sea level

B. maximum ambient temperature: 40 deg. C (in the shade)

C. minimum ambient temperature: 4 deg. C

D. maximum relative humidity: 90 %

E. atmospheric conditions: 1 bar

Where design and operating conditions, different from the above are required for particular equipment, they are described in the specification of the equipment concerned.

1.4.5 REGULATIONS: carry out electrical work in accordance with the current issue of the local codes of practice, local power authority regulations and IEC Regulations for Electrical Installations, where not in contradiction with the local codes of practice and regulations, herein referred to collectively as 'the Regulations'.

1.4.6 STANDARDS: unless otherwise specified, equipment and materials are to be manufactured and installed in compliance with the relevant recommendations of the following:

IEC :	The International Electro-technical Commission
ISO :	The International Standardization Organization
EN :	European Norm
NF-USE :	The French Regulation
BS :	British Standards

or other equal and approved standards, herein referred to as 'the Standards'. Local standards, where enforced and relevant, are to have precedence over the Standards.

1.5. EQUIPMENT AND MATERIALS

1.5.1. AVAILABILITY: confirm availability of equipment and materials proposed for use in the work prior to submission for approval. If, after approval, equipment or materials cease to be available, submit alternative items of equal quality and type for approval.

1.5.2. ACCEPTANCE BY AUTHORITY: confirm that proposed equipment and material characteristics where required are compatible with the requirements of the Local Power Authority or other authorities having jurisdiction and are acceptable to them. Inform the Engineer of any modifications necessary to comply with the Local Power Authority's requirements.

1.5.3. MANUFACTURERS' STANDARDS: equipment is to be the latest standard product of the manufacturer. Component parts are to be the product of a single manufacturer, unless otherwise approved and provided that components made by other manufacturers are of a standard design and are interchangeable.

1.5.4. APPROVED MANUFACTURERS: listing of approved manufacturers in the Specification does not necessarily constitute approval of their standard products as equal to those specified. As certain that listed manufacturers are able to supply equipment and material in conformity with the Specification.

1.5.5. LABEL AND IDENTIFY all equipment, instruments, control and electrical devices etc. to indicate duty, service or function, to the satisfaction of the Engineer. Labels are to be laminated plastic or anodized aluminum discs with black surface and white core with incised lettering in English or Arabic to the satisfaction of the Engineer. Alternative methods of labelling may be submitted for approval. Fix labels with non-corrodible screws to equipment, or to adjacent permanent surfaces or as approved by the Engineer.

1.5.6. EQUIPMENT NAMEPLATES are to be non-corroding, robust metal, inscribed in English, and firmly fixed to equipment at factory. Nameplates are to indicate name and address of manufacturer, model, serial number,

ic characteristics and ratings of equipment and are to include elementary diagrams etc., all in accordance with the Standards.

1.6. SUBMISSIONS

1.6.1. GENERALLY: submit for approval, manufacturers' technical literature, shop and construction drawings and other information required by the Specification, before ordering equipment or materials and before executing any related work on site.

1.6.2. TECHNICAL LITERATURE is to include detailed manufacturers' specifications and original catalogues or catalogue cuts, characteristics, model number, application and operating criteria of all equipment and materials, together with other information necessary to satisfy the Engineer that proposed equipment and systems are suitable and adequate.

1.6.3. SHOP AND CONSTRUCTION DRAWINGS are to demonstrate to the Engineer that the design requirements are understood by indicating all equipment and material proposed to be supplied and installed and by detailing fabrication and installation methods proposed to be used. Shop and construction drawings are to clearly state the name and location of the work, the names of the Engineer and Contractor, submission date, cross-references to the Drawings and Specification and the specific reference number, location, service and function of each item.

1.6.4. LIST OF PROPOSED MANUFACTURERS of all equipment and materials, including all items for which choice of manufacturer is at the discretion of the Contractor, is to be submitted for approval.

1.6.5. TEST CERTIFICATES AND REPORTS: where required by the Specification, submit manufacturer's type and routine test certificates and reports for equipment and devices. Complete test results are to be submitted in clearly identified and organized booklets, indicating item of equipment, make, model, type, date of tests, type of tests, descriptions and procedures.

1.6.6. LABORATORY TESTS: if manufacturer's test certificates are considered unsatisfactory, then independent laboratory tests are to be carried out on equipment in accordance with the Specification and the Standards, as required by the Engineer.

1.6.7. SPARE PARTS SCHEDULES: submit with the Tender itemised schedules of spare parts to be provided, as required by the Specification, and state against each item the manufacturer's unit price including packaging and delivery to site.

1.6.8. TOOLS AND INSTRUMENTS SCHEDULES: submit with the Tender itemized schedules of tools and instruments to be provided, as required by the Specification, and state against each item the manufacturer's unit price including packaging and delivery to site.

1.6.9. LABELLING SCHEDULE: submit for approval, prior to installation, a schedule of all equipment and devices to be labeled and the suggested details, lettering, position and fixing methods of each label indicating its application.

1.6.10 SAMPLES: submit samples of all equipment and materials for approval. Major items of equipment for which samples cannot be submitted are to be demonstrated in existing installations or by manufacturer's information, test certificates and reports.

2 - TESTS ON SITE, RECORDS, TRAINING AND MAINTENANCE

2.1. TESTS ON SITE

2.1.1. GENERALLY: carry out inspection and acceptance tests on site on each complete system, before final placement into service, in accordance with the Regulations and Standards, as described in the Specification and required by the Engineer.

2.2. RECORDS

2.2.1. GENERALLY: not later than the date of substantial completion, provide the Engineer with four copies of all approved as-installed drawings, test records, manufacturers' guarantees and warranties, operating and maintenance manuals and other records required by the Specification.

2.2.2. OPERATING AND MAINTENANCE MANUALS are to contain the following:

A. Technical description of each system and item of equipment installed, written to ensure that the Employer's staff fully understand the scope and facilities provided.

B. Schedules (system by system) of equipment installed giving manufacturer, catalogue list numbers, model, rating, capacity and operating characteristics; each item is to have a unique code and number, cross- referenced to the diagrammatic drawings and layout drawings.

C. Manufacturers' lists of recommended spare parts for items subject to wear and deterioration, giving expected running period and indicating specifically those items which may involve extended deliveries.

2.3. MAINTENANCE

2.3.1. MAINTENANCE CONTRACTS: where required by the Specification, submit supplementary proposals for annual maintenance contracts. The proposals are to:

A. include for maintaining the installations in efficient working order including routine and emergency service checks, adjustments, lubrication and the supply and replacement of damaged parts etc.

B. Set out the terms of the offer, the work to be carried out, the guarantees of performance and the price of the work or part thereof for the first twelve months after substantial completion.

The proposals will not be considered as part of the Tender.

CHAPTER 2

DISTRIBUTION, SUBDISTRIBUTION AND FINAL BRANCH CIRCUIT PANELBOARDS

1. GENERAL

A. ELECTRICAL WORK GENERALLY is to be in accordance with the requirements of the chapter1 of the Specification.

B. DESCRIPTION OF WORK: panel boards for distribution and sub distribution of electric power and for protection of circuits, including fixing and supporting materials and materials for termination of feeders, sub-circuits and branch circuits.

C. STANDARDS: panel boards generally are to comply with the requirements of IEC EN 60439-1, Factory-Built Assemblies of Low Voltage Switchgear and Control Gear. Exceptionally, they may not be factory-built nor type tested.

D. DESIGNATIONS: panel boards are designated on the Drawings and in the Schedules as follow:

1. Final branch circuit panel boards, power panel boards and sub distribution panel boards respectively, for secondary lighting and power distribution with either miniature circuit breaker (MCB) or moulded case circuit breaker (MCCB) protection on sub feeder or branch circuits, as shown on the Drawings.

E. EQUIPMENT DATA: submit data for approval including, but not limited to, the following:

1. Manufacturers' catalogues indicating specific equipment selected.

2. Types of panel boards and circuit breaker characteristics including duties and ratings compensation at and above 40 deg. C ambient conditions and corresponding temperatures within the enclosures.

3. Dimensions of panels and specific contents of each panelboard.

4. Integrated equipment tabulations for coordinated short- circuit series combinations of circuit breakers (cascading and discrimination).

F. TESTS AND CERTIFICATES: submit complete certified manufacturer's type test and routine test records in accordance with the Standards.

G. APPROVED MANUFACTURERS: obtain panelboards from one of the following:

1. Merlin Gerin, Telemecanique (Schneider) (France)
2. Klockner Moeller (Germany)
3. ABB (Germany)
4. Siemens – ITE (Germany)
5. Legrand (France)

2. PRODUCTS AND SYSTEMS

2.1 DISTRIBUTION, SUBDISTRIBUTION PANELBOARDS

2.1.1. GENERAL REQUIREMENTS

A. RATED INSULATION VOLTAGE is to be in accordance with the respective Standards.

B. PANELBOARDS are to be totally enclosed, dead front type, protection code IP 42 for indoor installations and IP 55 for outdoor installations, in accordance with IEC 529, and are to be factory designed and assembled.

C. EARTHING BAR is to be provided in every panel board.

D. PROTECTION is to be fully rated throughout the systems.

E. CIRCUIT BREAKERS are to be non-fused type.

2.1.2. PANELBOARD ENCLOSURES

A. TYPE: general purpose type, suitable for relevant ambient conditions, flush or surface mounted as shown on the Drawings, comprising box, trim, or trim and door to approved manufacturer's standards and sizes.

2.1.3 BUSBARS

A. TYPE: one piece, 98% pure electrolytic copper, based on maximum total temperature rise of 20 deg. C over an ambient of 40 deg. C at full continuous rating. Bolted contact surfaces are to have maximum current density not exceeding requirements of the approved standards. Aluminum is not to be used for busbars or panel board parts.

B. DESIGN: busbars are to be shrouded/insulated and rigidly designed so that branch circuit devices can be removed without disturbing adjacent units or changed without additional machining, drilling or tapping. Busbars are to be full size without reduction. Busbar System and blank plates are to allow installation of future circuit devices, where indicated on the Drawings.

C. NEUTRAL BAR is to be solid and fully insulated from cabinet or box. One solder-less box type set-screw connector is to be provided for neutral wire of each branch circuit and one bolted clamp-type connector or anti-turn lug with set-screw for main incoming neutral wire. Neutral is to be fully sized and rated as for phase busbars.

D. EARTHING BAR is to be copper, brazed to panelboard cabinet, with bolted pressure connector for main conductor and one set-screw-type tunnel terminal

E. for each outgoing conductor, to provide secure and reliable contact with all metal parts and enclosure.

2.1.4 MOULDED CASE CIRCUIT BREAKERS (MCCBs)

A. TYPE: tested to approved standards, totally enclosed, moulded case, constructed from high quality, high temperature resistant, tropicalized, moulded insulating materials, for normal operation at maximum temperature within enclosures at point of application, and provided with front operated single toggle type handle mechanism for manual operation of main contacts in addition to automatic operation under overcurrent and short circuits conditions. Multi-pole breakers are to have common integral trip bar for simultaneous operation of all

poles. Ampere rating is to be clearly visible. All terminals are to be box lug or clamp type with set screws, suitable for copper or aluminum.

B. MCCBs FOR SDB: To comply with IEC947-2 test sequences I, II, III, utilization category A, and are to have rated service short circuit breaking capacities to meet the electrical requirements at the panelboard location.

C. FRAME SIZE is defined as maximum continuous current rating of circuit breaker which corresponds with its maximum trip range and which is to be related to minimum acceptable short-circuit interrupting ratings, based on fully rated interrupting duties: normal duty (N), high break (H), or current limiting (L), as specified.

D. RESIDUAL CURRENT OPERATED EARTH LEAKAGE TRIP DEVICES (RCDs) are provided as add-on or built-in earth leakage accessories, where required and as shown on the Drawings. Protection against earth fault current, in addition to overcurrent and short-circuit protection, is to be in accordance with the Regulations. Trip current sensitivity on breakers for branch circuits is to be 30 mA, and for main breakers ratings are to be as shown on the Drawings. Circuit breakers are to include current transformer with tripping coil assembly, test button and trip free mechanism to ensure circuit breaker cannot be held closed against earth faults.

2.1.5 MINIATURE CIRCUIT BREAKERS (MCBs)

A. TYPE: thermal magnetic non-adjustable type, tested in accordance with IEC 947.2 & IEC 898. Breaker type and short circuit interrupting ratings are mentioned on design drawings.

B. MINIMUM SHORT-CIRCUIT BREAKING CAPACITIES are to be as shown on drawings. Contractor to check and confirm those levels (according to final equipment location: Transformers, MDBs, Panel Boards,….)

C. CONSTRUCTION: MCBs are to be tropicalized for operation at ambient temperatures up to 70 deg. C within panelboard enclosure and humidity up to 95%, and are to be constructed from high quality, high temperature, moulded insulating materials. Guaranteed duties and characteristics are to be submitted for temperatures above 40 deg. C. MCBs and combinational devices are to be modular, of unified profile and mounted to a standard DIN rail.

D. OPERATION: under overload conditions, thermal tripping is to provide close protection of insulated conductors. Under short-circuit conditions, magnetic trip is to operate at 5-10 times normal rated current (curve C characteristic). Magnetic operation is to be in the current limiting region and opening time is not to exceed 5 milli-seconds.

E. RATINGS: preferred rated currents are to be 6, 10, 16, 20, 25, 30, 40, 50, 60, 80 and 100 A, calibrated at 40 deg.C, available as 1+N, 2, 3 and 4-pole circuit breakers. Derating above 40 deg. C is not to exceed 1% per deg.C, and loading is not to exceed 70% of circuit breaker rating.

F. RESIDUAL CURRENT DEVICES for earth leakage protective circuit breakers are to be add-on devices, or built-in and integral with the standard circuit breaker. Non-adjustable sensitivities of 30 mA, 100 mA and 300 mA are to be available for all ratings of 1+N, 2-pole and 4-pole circuit breakers.

2.2 PANELBOARDS

A. ARRANGEMENT: to comprise set of homogeneous branch circuit breakers with unified profile and base, and one main circuit breaker or switch (as shown on drawings). Circuit breakers or other devices are to occupy modular spaces. Accommodation of contactors and split-bus arrangement or other devices is not to change regularity of standard box width.

2.2.1. FINAL BRANCH CIRCUIT PANELBOARDS SDB- TYPE MCB

INTERNAL ASSEMBLY: to comprise removable back plate or back pan of rigid construction, attached to enclosure by four captive screws through keyhole fixings, and provided with DIN rails in horizontal arrangement for single and three phase panels. Assembly is to be complete with earthing bar and one piece insulated bolt-on/comb-type phase busbar. Busbars are to be single-phase and neutral or 3-phase and neutral with spade connectors for fixing by tightening a single screw on circuit breaker. Insulation is to be high thermal rating, capable of carrying maximum short-circuit current for one second without overheating beyond acceptable limits required by the Standards. Panelboards are to comply with NFC and IEC standards. If the busbars rating exceeds 100 Amp (where the frame size of the main breaker is larger than 100 Amps), comb busbars shall not be used but still clause 2.1.3. of this specification shall apply.

A. SINGLE PHASE TYPE PANELBOARDS are to be suitable for 240 V maximum service voltage, single-phase and neutral, with MCBs on branch circuits and main incoming.

B. SINGLE PHASE TYPE PANEL BOARD MAIN CIRCUIT BREAKER OR SWITCH DISCONNECTOR is to be double-pole, with or without earth leakage device (RCD), as shown on the Schedules.

C. SINGLE-POLE + NEUTRAL (1 + N) AND DOUBLE-POLE (2P) MCBs for 240 V service, are to have trip ratings between 6 A and 50 A, with ICU (n)/ICS as required in the Schedules.

D. THREE PHASE TYPE PANELBOARDS are to be suitable for up to 415 V a.c. maximum service voltage, 3 phase and neutral, with MCBs on branch circuits and 4 pole switch disconnect or circuit breaker, main incoming, as shown in the Schedules or on the Drawings.

E. FOUR-POLE BRANCH CIRCUIT BREAKERS are to have trip ratings between 6A and 100A, with ICU/ICS as required in the Schedules.

G. THREE PHASE TYPE PANELBOARD MAIN SWITCH DISCONNECTOR OR CIRCUIT BREAKER is to be four-pole, with or without earth leakage device (RCD), as shown on the schedules.

H. SHORT-CIRCUIT RATING: THREE PHASE panel boards may only have an integrated equipment (series) short-circuit rating in accordance with calculations.

3. FIELD AND INSTALLATION WORK

3.1 INSTALLATION

A.FIXING GENERALLY:

- Align, level and securely fasten panelboards to structure
- Fix surface mounted outdoor panelboards at least 25mm from wall ensuring supporting members do not prevent flow of air.
- Do not use connecting conduits to support panelboards
- Close unused openings in panelboard cabinets.

B. PANELBOARD INTERIORS: do not install in cabinets until all conduit connections to cabinet have been completed.

C. WIRING INSIDE PANELBOARDS: to be neatly arranged, accessible and strapped to prevent tension on circuit breaker terminals. Tap-off connections are to be split and bolted type, fully insulated. Wiring shall be arranged on terminals and connection blocks with marking as indicated in section 16120 of the specifications.

D. TRIM: fix plumb and square prior to painting. Fix trim for flush mounted cabinets flush with wall surface finish.

E. PROTECTION: treat concealed surfaces of recessed cabinets with heavy field application of water-proof compound prior to installation.

3.2. INSPECTION AND TESTS ON SITE

A. GENERALLY: carry out sample tests, as required by the Engineer, on panel boards after installation, to verify short-circuit capability of circuit breakers and busbars. Inspect conditions within panel boards and verify insulation conditions by use of a megger.

B. CIRCUIT BREAKERS: tests are to include operation of every circuit breaker manually. Check automatic operation of selected circuit breakers, as required by the Engineer, by applying necessary short-circuit, overload and earth leakage current for tripping circuit breaker as applicable and compare with manufacturer's data/characteristic curves. Measure and report ambient temperature inside enclosure.

C. INSULATION CHECK TESTS: carry out insulation tests on all busbars, between phases and between phases and earth/cabinet, and between neutral and earth. Record all readings, using 500 V megger for equipment on 240 V systems, and 1000 V megger for equipment on systems up to 600 V, for 1-minute, with circuit breakers in open position.

D. ROUTINE TESTS ON SITE are to be carried out, in accordance with the Standards, on all panel boards assembled from standardized components of the manufacturer outside the works of the manufacturer.

CHAPTER 3

CONDUITS, WIREWAYS, SUPPORTING SYSTEMS AND RELATED ACCESSORIES

1. GENERAL

1.1. ELECTRICAL WORK GENERALLY:

is to be in accordance with the requirements of the chapter 1 of the Specification.

1.2. DESCRIPTION OF WORK:

raceways including conduits, wireways, cable trays and related installations and accessories necessary to support and protect cables, feeders, branch circuit wiring and wiring of low current systems, communications and signal cables.

1.3. REGULATIONS AND STANDARDS:

conduits, wireways, cables trays and fittings are to be designed, constructed and installed to give safe installation and reliable mechanical protection for wires and cables in accordance with the Regulations. Standards of products are to be as specified. Local production is prohibited if not tested and approved by a legal authority.

1.4. TECHNICAL DATA:

Submit data for approval including, but not limited to, the following:

A. Manufacturer's catalogues with specifications of raceways including conduits, trunking etc. and related accessories.

B. Samples of each type of raceway and accessory.

1.5. SHOP AND CONSTRUCTION DRAWINGS:

submit drawings for approval including, but not limited to, the followings:

A. Exact routing of conduits, trunking etc. With indication of boxes, accessories and expansion joints, size of conduits and boxes

B. Typical assembly details of installation of trunking, trays etc.

C. Construction details of pull boxes.

D. Typical installation details including connection of conduits to metal enclosure. Connections of flexible conduits, vapour- tight installations in cold rooms, liquid tight flexible metallic outdoors etc. and earthing connections.

1.6. APPROVED MANUFACTURERS:

obtain conduit, wireways and related accessories from one of the following or other equal and approved:

A A.UNIVOLT (Austria)
B EGA Tubes (England)
C DIELECTRIX (England)
D Siemens (Germany)
E Simplex (England)
duct (UAE)

2. PRODUCTS AND SYSTEMS

2.1. CONDUITS AND ACCESSORIES

2.1.1. RIGID & FLEXIBLE METAL CONDUIT

A. MATERIAL: steel, cold rolled and annealed, non-threaded type, formed from continuous length of helically wound and interlocked strip steel, with fused zinc coating on inside and outside.
Black enameled or hot dipped galvanized, L= 3m, screwed on both ends to NF-C-68-100. Locally manufactured conduits shall not be accepted.

B. LIQUID- TIGHT FLEXIBLE METALLIC CONDUIT: is to have PVC jacket extruded over core.

C. FITTINGS GENERALLY: thread less, hinged clamp type, hot dipped galvanized or cadmium plated malleable cast iron. Fittings used in corrosive atmospheres are to be specially treated.

D. STRAIGHT CONNECTORS: one piece body, female type, hot dipped galvanized or cadmium plated malleable cast iron. Fittings used in corrosive atmospheres are to be specially treated.

E. ANGLE CONNECTORS: of 45 or 90 degree and terminal connectors are to be as specified for straight connectors, except that body is to be two-piece with removable upper section.

2.1.2. RIGID MEDIUM GAUGE PVC CONDUIT.

A. MATERIAL: rigid un-plasticized, could form a bend with PVC accessories, polyvinyl chloride with high impact and high temperature resistance, flame retardant, non hygroscopic and non-porous, compressive strength 750 N, to CEE 26, BS 4607 and BS 6099, DIN 49026, NFC 68-107 or other equal and approved standards conforming to IEC 423.

B. FITTINGS GENERALLY: unbreakable, non-inflammable, self-extinguishing, moulded plastic.

C. ASSEMBLY: conduits, boxes and accessories are to be assembled by cementing, using manufacturer’s recommended products and appropriate connectors or spouts are available use smooth bore male PVC bushes and sockets.

2.1.3. FLEXIBLE MEDIUM GAUGE PVC CONDUIT

A. MATERIAL: flame retardant, heat resistant, non-hygroscopic PVC, high resistance to impact, ribbed on circumference for flexibility.

3. FIELD AND INSTALLATION WORK

3.1. CONDUIT AND WIREWAYS GENERALLY

A. USE: unless otherwise specifically indicated all light and power circuits, communications, signal and low current systems wiring are to be drawn inside conduits or wireways up to the various electric power consuming equipment as shown on the Drawings. Separate conduit and wireways installations are to be used for LV cables/wires normal light and power circuits, emergency light and power circuits and communication, signal and other low current systems wiring.

B. BOXES: junction, pull and splice boxes of ample capacity are to be provided as indicated or required. Boxes are to remain permanently accessible.

C. TOOLS AND ACCESSORIES: for forming and installing conduit and wireway systems are to be purpose made for the particular application and used in accordance with manufacturer's instructions.

D. FIXING: conduits and wireway installations are to be concealed as much as possible.

E. SIZES: Unless otherwise specified conduits and wireways sizes, not shown on the Drawings, are to be selected in accordance with the tables on design drawings and in relation to the number and size of conductors. Minimum size of conduit for all applications is to be 20 mm diameter, unless otherwise shown on the Drawings.

F. MECHANICAL CONTINUITY: conduits and wireways are to be effectively joined together and connected to electrical boxes, fittings and cabinets to provide firm mechanical assembly. Earthing jumpers are to be installed on steel conduits where required to ensure effective electrical continuity irrespective of whether a protective earth conductor is required or not.

3.2. PVC CONDUITS

A. COUPLING OF CONDUIT and/ or termination into spouted fittings are to be made watertight and permanent using special cement.

B. TERMINATION: connect conduits terminating in switchgear, fuseboards, trunking, adaptable boxes or non-spouted enclosures etc, with smooth bore male PVC bushes and sockets.

C. ENDS OF CONDUIT end conduit fittings are to be cleaned and jointed using

D. PVC cement recommended by manufacturer.

E. SEMI-PERMANENT ADHESIVE: use in joints requiring expansion couplers.

3.3. EMBEDDED CONDUITS

A. CONDUITS IN CONCRETE SLABS: place conduits parallel to main reinforcing steel.

B. CONDUITS IN PARTITIONS OR SIDE WALLS: horizontal or cross runs are to be avoided.

C. PULL-BOXES are not to be used. If unavoidable, pull-boxes may be approved if located inconspicuously.

D. CONDUITS IN FLOOR OF BEDS ON GRADE: encase in concrete, minimum thickness 50 mm or to thickness allowed by architectural detail.

E. PVC CONDUITS IN REINFORCED CONCRETE STRUCTURES are generally to be installed after placing reinforcement and before concreting, if protected against damage, or are to be placed in grooves in formed in the concrete, if approved.

3.4. EXPOSED CONDUITS

A. CONDUITS ON WALLS: run neatly, horizontally or vertically.

B. SUPPORTS: use approved clamps, hangers or clips fastened by machine screws to expansion sleeves in inserts or to lead anchors.

C. SPACING OF CLAMPS OR CLIPS for supporting steel conduits is not to be greater than:

Conduit Size mm (inches)	Maximum Spacing of Supports meters
20 (3/4)	1.5 m
25 (1)	1.5 m
32-38 (1-1/4-1-1/2)	2 m

D. SPACING OF CLAMPS OR CLIPS for supporting PVC conduits is not to be greater than.

Conduit Size mm (inches)	Maximum Spacing of Supports meters
20 (3/4)	0.60
25-50 (1-2)	0.75
63-75 (2-1/2-3)	0.90

E. BENDS AND FITTINGS: firmly fasten conduit at each side of bends and within 900 mm of each outlet box, junction box, cabinet or fitting.

F. OUTLETS: do not run more than one conduit to any surface wall outlet. Install junction box on home run near to ceiling level and tap-off vertical conduit to outlet box below.

CHAPTER 4

WIRING DEVICES AND DISCONNECTS

1. GENERAL

1.1. GENERAL WORK GENERALLY
is to be in accordance with the requirements of the chapter 1 of the Specification.

1.2. DESCRIPTION OF WORK:
wiring devices, lighting switches, socket outlets, cord outlets, automatic and manual lighting control equipment, dimmers, outlet boxes and plates, disconnect switches etc.

1.3. STANDARDS:
components are to be standard manufactured items, uniform and modular, complying with one set of approved Standards.

1.4. EQUIPMENT DATA:
submit data for approval, including catalogues, detailed literature, manufacturer's name, catalogue number, rating, specification, overall dimensions and special features, as applicable for each item.

1.5. SHOP AND CONSTRUCTION DRAWINGS:
submit drawings for approval including, but not limited to, the following:

A. Exact indication of position of each item and outlet box and fitting on layout drawings, with box and equipment types and sizes.

1.6. SAMPLES:
submit samples of each type of device for approval, unless otherwise agreed in writing by the Engineer.

2. PRODUCT AND SYSTEMS

2.1. FITTINGS

2.1.1. OUTLET BOXES AND PLATES GENERALLY

A. SURFACE OR RECESSED BOXES are to be suitable for type of related conduit or cable system. Shapes and sizes of boxes are to be compatible standards as switches, socket outlets and lighting fixtures selected and of various types and mounting methods required.

B. UNUSED OPENINGS in outlet boxes are to be closed with knock-out closers manufactured for the purpose.

C. BLANK PLATES: blank plates are to be installed on outlet boxes on which no apparatus is installed or where apparatus installed does not have suitable cover for box. Blanks plates for wall outlets are to be attached by a bridge with slots for horizontal and vertical adjustment.

2.1.2. MOULDED PLASTIC OUTLET BOXES

A. TYPE: boxes and covers used with PVC conduit systems are to be heavy gauge pressure moulded plastic, minimum 2 mm thick, self extinguishing, with softening point not less than 85 deg. C. Boxes are to have provision for securely terminating conduits and are to be manufacturer's standard for required application.

B. FITTINGS: boxes are to have brass inset threads to receive cover screws and for mounting devices or accessories, push- fit brass earth terminals, and steel insert clips to provide additional support for pendants or for heat conduction. Neoprene gaskets are to be provided for weatherproof installations.

C. MANUFACTURERS: obtain moulded plastic outlet boxes from:
1. Egatube (England)
2. M.K. (England)
3. Legrand (France)
4. B Tichino (Italy)
Or other equal and approved.

2.1.3. SWITCHES

A. GENERALLY: quick- make, quick- break type with silver alloy contacts in arc resisting moulded base, with toggle, rocker or push- button as specified, for inductive or resistive loads up to full rated capacity, and arranged for side and/or back connection.

B. TYPES: single, two- way or intermediate, single pole or double pole, as shown on the Drawings.

C. GENERAL LIGHTING SWITCH: 10 A 220 V a.c., rocker operated, grid- switch with plastic plate, for indoor installations in general, unless otherwise indicated.
1. Man: Legrand or other equal and approved.
Ref: unless otherwise mentioned on drawings:
One way one gang 74010
One way greater or equal to two gang 74000

D. PUSH BUTTON SWITCH, Ref unless otherwise mentioned on drawings:
One gang 74040
Two or larger than 74030.

E. MANUAL SWITCH: 2 pole, for fractional single and three phase motors and appliances, to interrupt motor and induction loads, rated 20 A at 415 V a.c., toggle operated, with positive indication of on/off position of contacts.

1. Man: Merlin Gerin or other equal and approved.
2. Ref: [(15006 + 13392) when installed as one gang] for single phase, (15007 + 13392) for three phase (without Neutral) and (15008 + 13392) for
three phase (with Neutral).

2.1.4. SOCKET OUTLETS

A. GENERALLY: to have injection moulded plastic base with self- adjusting, non-expanding contacts to prevent permanent distortion, arranged for side and/or back connection and with screw terminals accepting at least three parallel branch- circuit wires.

B. TYPES: general-purpose socket outlets are to conform with standard German practice concerning layout & rating).

C. DUPLEX SOCKETS are to be mounted in parallel under one common plate with break- off feature for two-circuit connection

D. WEATHERPROOF SOCKET OUTLETS are to be any of the types indicated, enclosed in surface mounted cast metal box and with cover comprising spring- retained gasketted hinged flap. Enclosure is to be pre- designed box and cover for type of socket outlet specified.

E. GERMAN STANDARD SOCKET: single phase, three wire for plug with 3 mm round pins at 19 mm centers, with grounding in accordance with standard German practice and rated 10/16 A, 250 V a.c.
   1. Man: Legrand or other equal and approved.
   2. Ref: 74130 (and 74132 for UPS).

2.1.5. PLUGS

A. TYPE: compatible with type of socket outlet specified, break resistant, of impact resistant moulded insulating material (separable construction), with solid brass pins and cord grip and of shape providing easy hand- grip for removal.

B. QUANTITY: supply number equal to 20% of total number of each type of socket outlet supplied.

2.1.6. SWITCH DISCONNECTOR (DISCONNECTING SWITCH)

A. RATING: 690 V, 2,3 or 4 pole, load break, short- circuit make, in accordance with IEC 947-3, utilization category 22 for heating and lighting loads, category 23 for motor circuits, and with ampere rating shown on the Drawings.

B. DESIGN: non- fusible, air- break switch disconnect, single throw, safety type, housed in separate metallic enclosure with arc quenching devices on each pole.

C. OPERATING MECHANISM: quick- make, quick- break, independent of operator, with external operating handle mechanically interlocked to prevent opening door unless switch is in open position. Switch disconnect is to have provision for by- passing interlock. Position of handle is to be positive and clearly indicated on cover.

D. ENCLOSURE: General purpose sheet steel for indoor use IP 42 and weather- proof type cast- metal or sheet steel for outdoor installations IP 65 IK 08, unless otherwise required or shown on the Drawings. Locking of operating handle is to be possible in open and closed positions.

E. MANUFACTURERS: obtain switch disconnect from one of the following of the following or other equal and approved:
   1. Merlin Gerin (France)
   2. Klockner Moeller (Germany)

3. ABB (Germany)
4. Siemens (Germany)
5. Socomec (France)
6. Legrand (France)

3. FIELD AND INSTALLATION WORK

3.1. INSTALLATION

A. LOCATIONS: the Drawings generally show approximate locations of outlets and equipment. Exact locations are to be determined from interior finishing and detail drawings. Any condition that would place an outlet in an unsuitable location is to be referred to the Engineer. Locate switches at strike sides of doors, whether shown on the Drawings or not. In locating outlets allow for overhead pipes, ducts, variations in arrangement, thickness of finishing, window trim, paneling and other architectural features.

B. MOUNTING HEIGHTS for outlet boxes and similar equipment are to be uniform within the same or similar areas. Mounting is to be as shown on the Drawings or as approved by the Engineer. Unless otherwise shown or instructed, mount lighting switches and socket outlets generally at 1200 mm and 300 mm from finished floor level respectively. Mount switches with long dimension vertical and operating handle, if of the toggle type, up when in the on position.

C. SINGLE POLE SWITCHES are to switch the phase wire. Do not run neutral wire through switches having neutral shunt or bridge.

D. ADDITIONAL OUTLETS to those shown on the Drawings are to be provided as required by equipment manufacturers for control or other wiring.

E. EXPOSED OUTLET BOXES: securely fasten to wall with machine screws to permanent inserts or lead anchors.

F. RECESSED OUTLET BOXES: make neat openings, to the satisfaction of the Engineer, allowing for thickness of finishing and use extension rings if required. Repair damaged finishing to original condition before installation of fittings or plates.

G. APPEARANCE: install exposed boxes and plates plumb, square and parallel to finished wall surface. Exposed plates covering recessed boxes are to rest neatly on wall surface without gaps, and fully covering the box.

H. GROUPED OUTLETS: arrange neatly so that use of fittings is convenient and clear.

I. WATERPROOF AND EXPLOSION- PROOF FITTINGS: follow manufacturer's instructions for installation and connection to conduit system to fully achieve required degree of protection.

J. DAMAGED FITTINGS: reject damaged fittings or plates with damaged finish. Protect fittings and plates against damage after installation and handed over.

K. CONNECTION OF APPLIANCE:
   1. Where appliance is designed to adapt directly to outlet box, extend electrical wiring to incoming terminals inside appliance.
   2. Where appliance is not designed to adapt to outlet box, install connecting wiring in flexible conduit firmly fixed to outlet box cover plate and to terminal box on appliance.

3.2. INSPECTION AND TEST ON SITE

A. VISUAL INSPECTION: fittings and equipment are to be inspected for fixing and workmanship.

B. MEGGER TESTS are to include switch and socket outlet tests together with insulation resistance of wiring installations.

C. OPERATION: devices are to be tested for operation and are to perform as intended at full load without any signs of heating.

EQUIPMENT is to be insulation tested and observed, under full- load for not less than 3 days operation, with respect to undue heating and performance in general.

CHAPTER 5

GENERAL LIGHTING INSTALLATION

1. GENERAL

1.1. ELECTRICAL WORK GENERALLY is to be in accordance with the requirements of the chapter 1 of the Specification.

1.2. DESCRIPTION OF WORK: complete indoor and outdoor lighting installations including fixtures, control gear, mounting provisions, accessories and connection to circuit wiring and to corresponding lighting control equipment.

1.3. FIXTURE DESIGN AND STANDARDS: the Specification and the Drawings are a guide to the selection of lighting characteristics and lighting fixtures, giving general features of construction, materials, method of installation and conditions of operation. Unless otherwise specified, fixtures are to be manufacturer's standard series, designed and manufactured for the purpose and application required, generally in accordance with the Schedule of Lighting Fixtures and complying with IEC 598 and CISPR 15.

1.4. DESIGN LAYOUT: fixture layout has been determined from photometric data of specified fixtures to achieve desired level and uniformity of illumination. Reflected ceiling plans are to be checked to ensure exact positions of fixtures with respect to structural members, ducts pipes, other installations and ceiling panels/tiles, where required.

1.5. EQUIPMENT DATA: submit data for approval including, but not limited to, the followings:

A. Detailed literature on each fixture, lamp and control gear including manufacturer's name, catalogue number, rating, material specification, overall dimensions, operating characteristics and principals.

B. Details of changes to standard fixtures for adaptation to condition of installation and to the Specification.

C. Photometric data for lighting calculations including polar light distribution curves, coefficient of utilization, glare classification, efficiency, depreciation factors etc.

1.6. SAMPLES: submit fully equipped sample of each fixture type, modified if required, together with color and texture samples of each fixture.

2. PRODUCTS AND SYSTEMS

2.1. COMPONENTS AND ACCESSORIES

2.1.1. LIGHTING FIXTURE CONSTRUCTION-GENERAL

A. GENERALLY: construction and wiring of fixtures are to comply with the Regulations and Standards. Fixtures are to be fabricated, assembled and wired entirely at factory. Manufacturer's name, factory inspection stamp and official quality label are to be fixed to each fixture supplied.

B. LIGHTING FIXTURES (LUMINAIRES): to be manufacturer's standard, as given in Lighting Fixture Schedules shown on the Drawings, or equal.

C. SHEET STEEL HOUSINGS: to be not less than 0.6 mm thick, and thicker when required by the Specification or the Standards.

D. SHEET STEEL REFLECTORS: to be not less than 0.5 mm thick.

E. ALUMINUM REFLECTORS: to be not less than 0.7 mm thick, unless otherwise approved.

F. FABRICATION: metalwork is to be mitred, welded and ground smooth without tool marks or burrs. Flat metal parts are to be stiffened by forming grooves and edges during fabrication. Metal parts are to have finish free from irregularities.

G. RUST-PROOF FERROUS BASE: ferrous metal parts are to be bonderized (treated with corrosion resistant phosphate solution) and given an approved rust-inhibiting prime coat before application of final finish.

H. FINISH FOR NON-REFLECTING METAL SURFACES: approved baked enamel paint. Paint color on fixture frames and trims is to be as specified or as selected by the Engineer.

I. FINISH FOR LIGHT REFLECTING SURFACES: white baked enamel paint having reflection factor not less than 85%. Mirror reflectors, where specified, are to be highly polished, anodized aluminum with reflection factors not less than 97%.

2.1.2. FLUORESCENT FIXTURES

A. LAMP HOLDERS GENERALLY: to IEC 400, heavy duty, moulded white plastic with non-corroding spring contacts.

B. LAMP HOLDERS FOR INDUSTRIAL FITTINGS: spring loaded turret type, heavy duty, dust protected.

C. BALLASTS GENERALLY: to IEC 82. Only single (36 W) or two-lamp (18 W) ballasts are to be used in any one fixture. Two-lamp ballasts are to be lead-lag, series type. Equipment is to be enclosed in sheet steel casing with corrosion resistant finish.

D. BALLAST THERMOSETTING COMPOUND is not to soften, liquify or support combustion under any operating condition or upon ballast failure, and is to fill ballast enclosure and dampen vibrations. Temperature rise, under normal operating conditions, is not to exceed 55 deg. C above maximum ambient temperature of 40 deg. C.

E. BALLAST PROTECTION: each ballast is to have one-time external fuse and fuse holder rated in accordance with manufacturer's instructions.

F. BALLAST TYPE: electronic or electronic high frequency dimmable type, as stated in fixture description and as shown on the drawings, power factor corrected to above 0.9, having manufacturer's lowest case temperature. Sound rating is not to exceed level given in the Standards. Harmonics to IEC EN 60929, radio interference suppression to IEC EN 55015 and immunity to IEC EN 61547. The ballast shall operate at a frequency not less than 30kHz.

G. BALLAST RATING: ballast is to be manufactured and certified for the specific lamp it controls and for operation from nominal power supply, with voltage and frequency equal to nominal voltage and frequency of distribution network.

H. CAPACITORS: to IEC 566, having snap-type connectors and fastening, bolt type M8, for fixing to fixture.

I. STARTERS, if required, are to comply with IEC 155, and are to be selected in conjunction with respective ballast and lamp.

3. FIELD AND INSTALLATION WORK

3.1. INSTALLATION

A. GENERALLY: install fixture level, aligned and parallel or square to building lines and at uniform heights as shown on the Drawings or as approved by the Engineer. Make final height adjustment after installations.

B. FIXTURE SUPPORT: provide fixture and/or fixture outlet boxes with hangers, brackets and flanged bolted fittings, as necessary, to support weight of fixture. Submit details of hangers etc. and method of fastening for approval. Rigidly secure fixture mounted on outlet boxes to fixture studs. Install hooks or extension pieces, when required, for proper installation. Provide one point of support in addition to the outlet box fixture stud for individually mounted fixtures longer than 600 mm.

C. SUSPENDED CEILINGS: if ceiling construction is unable to support weight of fixtures without strain or deformation, suspend fixtures directly from building structure.

D. SOLD CEILINGS: coordinate dimensions of recesses in ceilings with exact fixture dimensions and structural elements.

E. CONTINUOUS ROWS: arrange fixture so that individual fixtures can be removed without dismantling remaining fixtures. Provide minimum spacing between fixtures.

F. COVER PLATES: install cover plates over fixture outlet box or opening in ceiling or structure when left unused.

G. FLUSH RECESSED FIXTURES: install to completely eliminate light leakage within fixture and between fixture and adjacent finished surface.

H. VENTILATION: keep ventilation channels free after fixture is installed, if required by the design of the fixture.

I. EARTH metal frames of fixtures as described in Section 219 of the Specification.

J. TIGHTNESS: ensure that enclosed fixtures are reasonably insect/ dust tight when installed, and completely weather-proof for installations subject to weather conditions.

K. LAMPS FOR PERMANENT INSTALLATION: place new lamps in fixtures immediately prior to hand-over and when instructed by the Engineer. Lamps used for temporary service are not to be used for final lamping of fixtures.

3.2. INSPECTION AND TESTS ON SITE

A. VISUAL INSPECTION: check neatness of installation, uniformity of equipment and nameplates etc.

B. ILLUMINATION MEASUREMENTS: to be taken at selected locations, to determine level and uniformity.

C. OPERATION: check lighting installations for operation including control and regulation equipment.

D. ELECTRICAL DATA: measure power factor, current and voltage at start for installations with discharge lamps.

CHAPTER 06

EARTHING SYSTEM

1. GENERAL

1.1. ELECTRICAL WORK GENERALLY is to be in accordance with the requirements of the chapter 1 of the Specification.

1.2. DESCRIPTION OF WORK: complete installations to earth every source of energy and to provide protective earthing and equipotential bonding, based on the TN-S system arrangement, including:

A. Main earthing system.

B. Main earthing terminals or bars.

C. Electrical room earthing terminal.

D. Exposed conductive parts of electrical equipment.

E. Extraneous conductive parts.

F. Standby generators earthing terminal.

1.3. REGULATIONS AND STANDARDS: carry out work in accordance with the following:

A. IEC publications 364-3 and 364-41 Electrical installations in Buildings.

B. Latest edition of NFC 15-100 Regulations.

1.4. DEFINITIONS OF TERMS used on the Drawings and in the Specification are as follows:

A. EARTH: conductive mass of the Earth whose electric potential at any point is conventionally taken as zero.

B. EARTH ELECTRODE: conductor or group of conductors in initial contact with, and providing electrical connection to, Earth.

C. EXPOSED CONDUCTIVE PART: any part which can be readily touched and which is not a live part, but which may become live under fault conditions.

D. MAIN EARTHING TERMINAL OR BAR: the terminal or bar provided for the connection of protective conductors, including equipotential bonding and functional earthing conductors if any to the means of earthing.

1.5. EQUIPMENT DATA: prior to ordering materials, submit data for approval including, but not limited to, manufacturer's catalogues for earth rods, connecting clamps, earthing conductors, protective conductors, bonding conductors, connectors and other accessories, exothermic welding kits and tools etc., and samples of samples conductors as requested.

1.6. SHOP AND CONSTRUCTION DRAWINGS: submit drawings for approval including, but not limited to, the following:

1. Exact location of earth pits, rods and details of installation and connection.

2. Exact routing of buried earthing conductors with indication of cross-section, depth of laying and covering.

3. Cross sectional area of all earthing, protective and bonding conductors

4. Layout and details of earthing provisions at substations, generator rooms, switchgear, distribution panelboards etc., indicating fittings used, insulation, plates and marking, passage and routing of earthing conductors, conduit, sleeves, grooves, niches etc., giving sizes and dimensions of component parts.

1.7. APPROVED MANUFACTURERS: obtain materials from one of the following:

A. BICC (England)

B. Copperweld (U.S.A.)

C. Furse (England)

D. G.E.C. (England) or other equal and approved.

2. PRODUCTS AND SYSTEMS EARTHING SYSTEM (TYPE TN-S)

2.1. GENERAL REQUIREMENTS

A. COMPONENT PARTS of earthing system are to include the following:

1. Earth electrode (rods, tapes etc.)

2. main earthing terminals or bars

3. Earthing conductors

4. protective conductors

5. Equipotential bonding conductors

6. electrically independent earth electrodes for special systems with transient earth clamp (similar to ERICO TEC 100C) for connection to standard earthing electrodes (Following the recommendation of the NFC 15-100 with this respect.)

7. Accessories and termination fittings, bonding, welding kits and other materials.

B. EARTH ELECTRODE is to consist of one or more earth rods, interconnected by buried earthing tape or cable, which is to have a total combined resistance value, during any season of the year and before interconnection to other earthed systems or earthing means, not exceeding 3 ohm other wise use additional earth rods. Distance between two rods is not to be less than twice the length of one rod driven depth.

C. FUNCTIONAL EARTH ELECTRODE is to be provided separately from, but interconnected to general bus collecting all the earth at the building and to other earth electrode (s) through suitably rated (470 V) spark gap. Functional earth electrodes are to be used for earthing electronic equipment (communication equipment, digital processors, computers etc.) as required by the particular Section of the Specification and recommendation of manufacturer.

D. ALTERNATIVE EARTH ELECTRODE: other types of earth electrode may be used, after approval, including:

1. Cast iron pipes with special surround material

2. Copper plate (s)

3. Tape mats (strips)

4. MAIN EARTHING BAR is to be provided at point of service entrance or main distribution room, and as described in the Specification or shown on the Drawings, to which all earthing conductors, protective conductors and bonding conductors are to be connected. Two insulated main earthing conductors are to be provided, one at each end of the bar, connected via testing joints to the earth electrode at two separate earth pits. conductor is to be sized to carry maximum earth fault current of system at point of application with final conductor temperature not exceeding 160 deg. C for at least 5 seconds. Main earthing conductors are to be minimum 95 mm2 bare copper conductor or as otherwise required by the particular Section of the B.O.Q.

5. TESTING JOINTS (TEST LINKS) are to be provided, in an accessible position, on each main earthing conductor, between earthing terminal or bar earth electrode. A bus system shall allow the disconnection of the lightning earth cable from the other earth cable in order to provide a separate test for each earth.

6. PROTECTIVE CONDUCTORS are to be separate for each circuit. Where protective conductor is common to several circuits, cross-sectional area of protective conductor is to be the largest of the conductor sizes. Unless otherwise mentioned the selection of sizes is to be in accordance with Table 54F of IEE Regulations.

7. PROTECTIVE CONDUCTORS are not to be formed by conduit, trunking, ducting or the like. Where armored cable is specified and armour is steel, it may be used as a protective conductor, if approved and if not otherwise shown on the Drawings.

8. CONTINUITY OF PROTECTIVE CONDUCTORS: series connection of protective conductor from one piece of equipment to another is not permitted. Extraneous and exposed conductive parts of equipment are not to be used as protective conductors, but are to be connected by bolted clamp type connectors and/ or brazing to continuous protective conductors which are to be insulated by moulded materials.

9. MAIN EQUIPOTENTIAL BONDING: main incoming and outgoing water pipes and any other metallic service pipes are to be connected by main equipotential bonding conductors to main earth terminal or bar. Bonding connections are to be as short as practicable between point of entry/exit of services and main earthing bar. Where meters are installed, bonding is to be made on the premises side of the meter. Cross-sections of conductors are not to be less than half of the earthing conductors connected thereto, and minimum 6 mm2.

10. IDENTIFICATION: connection of every earthing conductor to earthing electrode and every bonding conductor to extraneous conducting parts is to be labelled in accordance with the Regulations, as follows:

11. SAFETY ELECTRICAL CONNECTION- DO NOT REMOVE.

12. IDENTIFICATION: protective and earthing conductors are to be identified by combination of green- and - yellow colours of insulation or by painting bar conductors with these colours, as approved.

13. IDENTIFICATION: source earthing conductor is to be identified along its entire length by continuous green/yellow insulation labelled ‘earthing’.

2.2. EARTHING OF MAIN DISTRIBUTION BOARDS, PANELBOARDS, LIGHTING INSTALLATIONS AND WIRING ACCESSORIES

A. MAIN EARTHING BAR is to be provided in location mentioned on drawings and connected to earth network by insulated conductor (size as mentioned on drawings) via testing joints.

B. DISTRIBUTION, LIGHTING AND POWER PANELBOARDS are to be connected by protective conductors run together with incoming feeder cable, connecting earth terminals in panelboards with respective main building earthing bar.

C. SOCKET OUTLETS are to be earthed by protective conductor looped around with the branch circuit and connected to earth terminal within socket outlet box and to which socket outlet terminal is to be connected.

D. LIGHTING FIXTURES AND OTHER EXPOSED CONDUCTIVE PARTS of electrical installations, such as switches, heaters, air conditioning units etc. are to be connected by protective earth conductors to earthing terminals of respective panelboards.

2.3. MATERIALS AND PRODUCTS

A. EARTH ROD: copper clad steel, 20 mm diameter, 1.2 m length, extendible as necessary (minimum 2) to obtain required earth resistance. Earth rod is to be complete with couplings, head and bolted connector of sufficient size, and number of bolted clamps to connect all cables terminated thereto.

B. BURIED EARTH CONDUCTORS: annealed copper conductors 95 mm2 cross-section.

C. TAPS MATS: where earth rods are not likely to be used, earth electrode is to consist of parallel and perpendicular copper strip, 2.4 m apart, welded together by exothermic welds to form a grid. Tape is to be 25x25 mm strip conductor.

D. EARTH PIT: pre-cast, square or circular section concrete hand-hole (minimum 450 mm internal diameter), with concrete cover, and extending to about 150 mm below top of earth rod. Earth pit is to be provided for each earth rod where connected to an earthing conductor. Cover is to have inset brass plate with inscription ‘Earth pit-Do Not Remove.

E. EARTHING CONDUCTORS: insulated (green/yellow) or bare copper conductor as described in the Specification for the particular application.

F. TESTING JOINTS (TEST LINKS): copper or copper alloy, with bolted end connections, disconnectable by use of a tool, and suitably sized for earthing conductors or earth bar connection. Links are to be fixed to porcelain or other approved insulating supports. Contact surfaces are to be tinned.

G. PROTECTIVE CONDUCTORS: single core stranded annealed copper, PVC insulated cables, having rated insulation grade compatible with circuit protected, or to be a conductor forming parts of a multi-core cable, color coded.

H. MAIN EARTHING BAR: hard drawn copper, 40x4 mm where formed into a closed loop, and 50x6 mm where open ended. Earth bar is to be labelled Main Earth Bar and is to be drilled, for connection of conductors, at a spacing not less than 75 mm, and is to be supplied with copper alloy bolts, nuts and washers and wall mounting insulators.

I. PROTECTIVE BONDING CONDUCTORS: bare copper strip conductor, annealed stranded copper cable or flexible strap (flexible braid) of cross- sectional area as described in sub-section 1 hereof.

J. EARTHING ACCESSORIES: copper or copper alloy, purpose made, of approved design, compatible with points of connection, and of adequate cross- section and current carrying capacity. Connectors and clamps are to be bolted type. Bolts, nuts and washers are to be high quality phosphor bronze or copper silicon alloys.

3. FIELD AND INSTALLATION WORK

3.1 INSTALLATION

A. CONTINUITY: ensure that complete earthing system is electrically continuous and mechanically secure.

B. EARTH RODS: while siting earth rods, ensure that resistance areas associated with individual rods do not overlap. Earth rods are to be located at a distance greater than 600 mm from foundations of buildings. Where rocks are encountered, a hole of sufficient size is to be drilled before lowering the rod. Conductive filler such as Marconite or Bentonite or equal filler that will not corrode, is to be provided around the rod.

C. BURIED EARTHING CONDUCTORS are to be laid at a depth not less than 0.8 m from ground surface.

D. EARTHING CONDUCTORS are to be following shortest path between earth rods and main earthing terminals or bars, and are to run in PVC conduit (duct) fastened to building structure by approved supports and extending 0.2 m above level, and are to be protected against mechanical damage and corrosion.

E. PROTECTIVE CONDUCTORS: separate protective conductors, which are not part of a cable, are to be fixed on same support or drawn into same conduit as circuit conductors.

F. PROTECTIVE BONDING: remove any non-conductive paint, enamel or similar coating at threads, contact points and surfaces and ensure that bonding is made by fittings designed to make secure bonds.

G. PROTECTION AGAINST CORROSION: protect bolted connections against corrosion either by filling with Vaseline or coating with a special anti-corrosion compound and proper capping.

H. CONNECTIONS: earth connections are to be readily accessible. If inaccessible earth connection is permitted, approved exothermic welding or brazing technique is to be employed.

I. CONNECTIONS: where earth connections between dissimilar metals must be made, use bimetallic fittings and protect by coating with moisture resisting bituminous paint or compound, or by wrapping with protective tape to exclude moisture.

CHAPTER 07
LIGHTNING PROTECTIVE SYSTEM

1. GENERAL

1.1. ELECTRICAL WORK GENERALLY is to be in accordance with the requirements.

1.2. DESCRIPTION OF WORK: air termination network, down conductors, earth termination network, bonding to prevent side flashing and accessories.

1.3. STANDARDS: work is to comply with NFC17-102.

1.4. TECHNICAL DATA: submit data for approval including manufacturer's illustrated catalogues with description and specification of component parts for Protective terminations, conductors, fasteners, testing joints (test links), earth rods, connectors, wall inserts and bolts and any accessories forming part of the lightning protective system.

1.5. SHOP AND CONSTRUCTION DRAWINGS: submit drawings for approval including but not limited to, the followings:

A. Exact location and routing of roof and down conductors with indication of sleeves and types of fixings.

B. Exact location of earth pits and routing of interconnecting ring

C. Typical details of jointing and bonding.

1.6. AS- BUILT DRAWINGS: provide as- built drawings and indicate nature of soil, special earthing arrangements, date and particulars of salting if used, test conditions and results obtained.

1.7. MANUFACTURERS: obtain equipment, manufactured specifically for lightning protection, from one of the following:

A. Helita (France)
B. Franklin (France).

2. PRODUCTS AND SYSTEMS

COMPONENTS AND ACCESSORIES

2.1. TECHNICAL REQUIREMENTS

A. LIGHTNING WITH PROTECTIVE ROD. Lightning protection based on the following principles:
The lightning Protective Rods works when the lighting approaches the ground, a brush discharge is initiated at the lightning conductor, the Protective Rod will urge the brush discharge to propagates in the direction of the direction of the descending leader after a long transition phase. The Protective Rod initiation advance permits to reduce the required time for the formation and continuous propagation of the ascending discharge and brings thus a higher efficiency for the lightning capture.

B. DOWN CONDUCTORS every down conductor has to have test link above ground for testing earth termination network, has to be protected against corrosion for 0.3 m above and below ground level, has to terminate in an earth electrode and has to be insulated with PVC or polyethylene (5 mm thick) from test link to electrode connection point.

C. EARTH TERMINATION NETWORK: earth electrodes are to be interconnected and buried with the top at least 1 m below ground surface and minimum 0.6 m from the foundations. All electrodes are to have resistance to earth (in ohms) not exceeding, tested with test link removed and before bonding to other services or other earth electrodes. Combined resistance to earth of whole network is not to exceed 5 ohms.

D. COMMON EARTHING: earth termination electrodes are to be interconnected in a ring around the structure and bonded to earth electrode of protective earthing system, forming a common earth ring of total resistance value to earth below the lower value of any of the two systems.

The protective rod shall have a 3 meters stainless steel nast to which additional nast units could be attached. The height of the tip of the protective rod shall be minimum 3 meters higher than any other object of the project.

The radius of protection Rp shall cover the whole project with the specified safety margin.

2.2. MATERIALS AND COMPONENTS

A. ROOF CONDUCTORS: bare, high conductivity, annealed copper strip, 25 x 3.0 mm.

B. OPERATION OF THE PROTECTIVE ROD
The Protective Rod tip plays a triple role:
- Collect the energy necessary to power the electrical device contained in the cylinder,
- Emit the brush discharges created by the high-voltage pulses,
- Capture the lightning current to convey it to the ground.

The metal disc is the upper part of the external air gap designed to convey the lightning current from the tip to the ground. The metal cylinder contains the electric device of the Protective Rod system that generates the brush discharges. The pole serves to fix the Protective Rod for installation. The connecting clamp must be fixed to it, together with the down conductor.

C. Rod solid copper with roll formed threads at base, bronze nut, cast gun metal terminal base of appropriate thickness and low resistance, and any other accessories for rigidly mounting to surface.

D. EARTH ROD: unless otherwise indicated on the drawings to be 20 mm diameter, 2.4 meter long, high strength, low carbon steel core of high tensile strength (600 N/mm2), grade 43 A of BS 4360, with 99.99% pure electrolytic copper moleculary bonded into steel core, 0.25 mm minimum thickness. Driving head is to be high strength steel. Couplings are to be long length silicon bronze, grade CS101 of BS 2874, internally threaded. Threads are to be rolled onto rod to ensure uniform layers of copper and strength.

E. INSPECTION (EARTH) PIT: precast concrete construction, of dimensions shown on the Drawings, with heavy duty cover and brass plate engraved ‘Earth Pit Below’ inset in cover. One pit is to be provided for each earth rod.

F. TEST LINKS: two- bolt split- coupling, copper alloy, made to join two ends of down conductor specified. Plate indicating position and number of electrodes is to be fitted above each test link.

G. BONDING CONDUCTORS: high conductivity, bare annealed copper tape, 20x3.0 mm minimum dimensions, or 70 mm2 soft drawn stranded copper cable.

H. ACCESSORIES including supports, joints, fasteners, clamps, bonds, test links etc. are to be copper or copper alloy and specially manufactured for the purpose. Clamps and connectors are to be specifically designed and sized for clamping and connecting to the various shapes and surfaces of bonded metalwork. Bimetallic connectors are to be used between different materials. Galvanized or plated steel nails, screws and bolts will not be accepted on copper installations.

I. FLEXIBLE BONDING STRAPS: flexible annealed copper braid, 25x3.5 mm, suitable for bonding flat surfaces, cut to length required and with drilled flat terminals for bolted connections. Special bimetallic alloy terminals are to be provided for joining to aluminum conductive parts.

3. FIELD AND INSTALLATION WORK

3.1. INSTALLATION

A. SUPPORT ROOF AND DOWN CONDUCTORS using fasteners spaced at not more than 400 mm centers horizontally and vertically, and fixed by anchor bolts or lead inserts with machined screws.

B. BENDS IN CONDUCTORS are not to be less than 200 mm radius and are not to exceed 90 degree turn.

C. DOWN CONDUCTORS are to follow most direct path between air terminals and earth pit. Re-entrant loops are not permissible. Tight angle bends may be allowed where absolutely necessary at edge of roof, whereby length of loop in relation to distance between its start and end is kept

below eight times. Direct path is to be through an air space in a non- combustible, non- metallic duct with net cross- section 15 times area of conductor.

D. MECHANICAL PROTECTION OF DOWN CONDUCTORS: provide asbestos cement or PVC pipes underground, starting 0.3 m below ground and to a height of 1.2 m above ground. Test link is to be positioned 1.3 m above ground.

E. BOND EXPOSED METAL PARTS OF STRUCTURE to lightning protective system if clearance between any element of lightning system and metal part is less 1800 mm or the distance allowed by the Standard, whichever is smaller.

F. INSPECTION (EARTH) PIT is to extend 150 mm below top of earth rod. Cover earth rod connector with suitable protective compound which can be easily removed for inspection. Connector is not to be covered with backfill material and is to remain clean.

3.2. TESTS ON SITE AND RECORDS

A. RESISTANCE TO EARTH of each termination electrode and the network and of the complete bonded installation is to be measured during the dry season and checked against specified resistance.

B. ELECTRICAL CONTINUITY of conductors, bonds etc. is to be checked.

C. RECORDS: submit the following:
1. Actual layout and specification of components of the system
2. Nature of soil and characteristics and any special earthing arrangement
3. Test conditions and results.

CHAPTER 08
SOLAR SYSTEM

1. GENERAL

1.1. ELECTRICAL WORK GENERALLY is to be in accordance with the requirements.

1.2. DESCRIPTION OF WORK: PV Photovoltaic panels, grid inverter, solar batteries, hybrid inverter and accessories.

1.3. STANDARDS: work is to comply with international standards.

1.4. TECHNICAL DATA: submit data for approval including manufacturer's illustrated catalogues with description and specification of component parts.

1.5. SHOP AND CONSTRUCTION DRAWINGS: submit drawings for approval including but not limited to, the followings:

A. Exact location and routing of Photovoltaic PV panels, cables and wires with indication of sleeves and types of fixings.

B. Exact location of solar batteries, inverters and all accessories.

C. Typical details of panel boards.

1.6. AS- BUILT DRAWINGS: provide as- built drawings for the system.

1.7. MANUFACTURERS: obtain equipment, manufactured specifically for electrical solar system from one of the European firms.

2. PRODUCTS AND SYSTEMS

COMPONENTS AND ACCESSORIES

2.1. TECHNICAL REQUIREMENTS

A. PV PHOTOVOLTAIC PANELS:
- The panels should be placed at the roof and its exact location shall be determined on site as per the environmental conditions (tilted angle).
- The panels are fabricated from multi crystalline (156 x 156mm), maximum weight of 18.6 kg, white back sheet with silver anodized aluminum alloy and a J box with IP 65 rated.

B. PV MOUNTINGS:
PV mountings should be:
- Corrosion resistant; made of 100% aluminum
- Quick, simple, virtually tool-free installation.
- System design based on the latest wind dynamics research.
- Reduced number of components for shorter mounting type.

C. SOLAR BATTERIES:
- Solar batteries should be located inside a room or cabinet and its exact number shall to be determined on site according to the solar system requirements.

D. INVERTERS:
- Three phase output voltage 380/220V or single phase output voltage 220V/50 Hz.
- Fixed load steady state: +/- 0.5% from no full load to full load.
- Dynamic output regulations: +10% - 8% with a load variation of 50%.
- Recovery time of the steady state value:

< 20 ms for ^ U +/- 1%
< 40 ms for ^ U +/- 0.5%
- Output frequency: 50 Hz
- Harmonic content: < 4%