7.7 CIVIL AND ARCHITECTURE GENERAL PROVISION

7.7.1 REFERENCES

7.7.1.1 General

The design and construction under this Section shall conform to the latest edition of the codes and standards listed below. The Bangladesh National Building Code (BNBC) 2020 shall be the governing code for this Project. Where BNBC 2020 is silent on a matter, the following order of precedence shall apply: (1) ACI 318-19 and associated ACI standards; (2) AISC 360-16; (3) ASTM International standards; (4) IEC/IEEE standards, where referenced; (5) BS/BS EN standards. Any proposed substitution of a listed standard by an equivalent international standard shall be subject to the Engineer's approval on a demonstration of equivalence.

7.7.1.2 Design and Construction Standards

- Structural / Loading: BNBC 2020 (governing structural design code, including seismic zoning, wind loading, and load combinations); ACI 318-19; ACI 201.2R (Durable Concrete); ACI 216.1 (Fire Resistance of Concrete); AISC 360-16; AWS D1.1 (Structural Welding — Steel)
- Geotechnical: BNBC 2020; BS 1377 (index/classification tests); ASTM D1586 (SPT); ASTM D2166/D2850 (Unconfined Compression); ASTM D2435 (Consolidation); ASTM D4318 (Atterberg Limits); ASTM D422 (Particle Size); ASTM D1143 (Static Pile Load Test); ASTM D4945 (Dynamic Pile Testing); ASTM D5882 (Pile Integrity Testing)
- Concrete and Reinforcement Materials: BDS EN 197-1 / ASTM C150 (Cement); BDS 612 (Sulphate-Resisting Cement); ASTM C33 / BDS 243 (Aggregates); BDS ISO 6935-2 / ASTM A615M / A706M (Reinforcement, Grade 420); BDS 208 / BS EN 771-1 (Clay Bricks); ASTM C270 (Masonry Mortar); ASTM A123 / A153 (Galvanized Coatings)
- Masonry: BNBC 2020; ACI 530 / TMS 402
- Fire Protection: BNBC 2020; UL 1479 / BS EN 1366-3 (Fire-Stop Systems)
- Accessibility: BNBC 2020
- Waterproofing / Roofing: BS 8102; ASTM D6135 / D5147 or BS EN 13707; ASTM D6164 / D6222 (Modified Bitumen Membranes)
- Lightning Protection: IEC 62305, Parts 1–4
- Grounding / Electrical Interface: IEEE Std 80; IEEE Std 81; IEC 61936-1; IEC 60364
- HVAC / Ventilation: ASHRAE 62.1; IEC 62485-2 / IEEE 484 (Battery Room Ventilation)
- Drainage / Sanitary: BS EN 124; ASME A112 series / ISO 3822; Bangladesh Environment Conservation Rules (Drinking Water Quality); DPHE Guidelines
- Vertical Transportation (where provided): BNBC 2020; ASME A17.1
- Door/Window Hardware: ANSI/BHMA A156 series; BS EN 1935, BS EN 12209, BS EN 1154
- Glazing: ASTM C1036; ASTM C1048; ASTM C1044; ASTM E1300; ANSI Z97.1; CPSC 16 CFR
- Interior Finishes: ASTM F1066 (Vinyl Composition Tile); ASTM C1186 (Fiber-Cement Board, non-asbestos); ASTM C1396 (Gypsum Board)
- Safety Signage: ISO 7010 / ANSI Z535
- Also applicable: BS EN 124, BS 5395, BS 5572, BS 6465, BS 6700, BS 8005, BS 8100, BS 8215, BS 8290, BS 8301.

7.7.2 DESIGN

7.7.2.1 General

Architectural and Structural design shall be submitted by the Contractor to the Employer for approval, together with the governing seismic/wind design basis calculations. As this is an Occupancy Category IV (essential facility) structure, an independent structural design review by a qualified third party shall be carried out prior to construction.

7.7.2.2 Architectural and Structural Requirements of Buildings

Detailed Architectural, Structural, HVAC, and Green Building design shall be submitted by the Contractor for Employer approval. The Green Building concept shall be demonstrated against a defined checklist, comprising as a minimum: wall/roof U-value limits, low-VOC interior paints, water-efficient fixtures, and daylighting provision.

All new buildings shall be architecturally pleasing to the satisfaction of the Employer, suited to withstand the tropical climate with minimal maintenance, and shall comply with BNBC 2020 as the primary code, supplemented by ACI 318-19 and the standards at Cl. 7.7.1. The minimum covered area of each floor shall be 300 sqm (3,229 sft).

Modern architectural elevations of all building faces shall be agreed before detailed plans proceed.

All buildings shall be RCC-framed structures, designed for the Seismic Design Category and Zone applicable to the confirmed Project site, in accordance with BNBC 2020, using the Equivalent Static or Response Spectrum method as applicable, with LRFD load combinations per BNBC 2020.

The structural frame, cladding, roof and all projecting elements (sunshades, canopies) shall additionally be designed for the Basic Wind Speed applicable to the Project site per BNBC 2020 (3-second gust), including cyclone risk considerations.

The Building shall comprise: 03-storey foundation (no basement), G+2; Ground Floor height 12 ft (Transformer Room, housing two Station/Auxiliary Transformers); 1st Floor height 14.5 ft (33 kV GIS Equipment Hall on a raised access floor per Cl. 7.7.2.1(c), and Battery Room per Cl. 7.7.2.1(d)). Only Ground Floor and 1st Floor (G+1) shall be constructed under the present Contract, on the three-storey foundation, with ground-storey and first-storey columns extended above the 1st Floor roof level with starter bars for a future 2nd storey. Column reinforcement continuity at the future construction joint shall be by mechanical couplers or a lap-splice length per Cl. 7.7.18, as shown on the drawings; exposed starter bars shall be protected for the interim period by an epoxy coating or a removable, non-shrink grout cap, and each exposed column top shall receive a waterproof capping detail (membrane or grout topping, sloped to shed water) maintained until the future storey is constructed. Since the 2nd Floor is not constructed under the present Contract, the 1st Floor roof slab shall function as the building's roof for the interim period and shall be fully waterproofed per Cl. 7.7.31, in addition to the column-top capping detail above; the waterproofing system shall be protected during future-storey construction and made good at any location disturbed by that work. Before the future storey is built, the construction-joint surface shall be prepared per Cl. 7.7.13. The Contractor shall furnish the Employer, as part of the O&M/handover documentation, an as-built column schedule recording final reinforcement, size, and design axial/moment capacity reserve for future-storey loading. An external concrete stair shall be provided from Ground Floor to the roof, with handrails at 900–1000 mm height with an intermediate rail, per BNBC 2020. The stairhouse roof shall be an RCC slab, waterproofed per Cl. 7.7.31 consistent with the main roof.

Floor and roof live loads shall be as scheduled in Table 7.7.2-1 below, rather than a single uniform value across all floors.

Area	Minimum Design Live Load
Control / Relay / Battery rooms, GIS Equipment Hall, cable galleries	7.5 kN/m² UDL; design shall additionally check concentrated (point) loads from GIS bay/switchgear/battery rack feet transferred to the structural slab at raised-floor cut-outs, per equipment supplier data (Cl. 7.7.2.1(c))
Raised access floor system (self-weight + cable fill), GIS Hall — superimposed dead load	Minimum 1.5 kN/m² allowance (verify against raised-floor manufacturer's system self-weight and actual cable fill)
Corridors / Stairs	4.8 kN/m²
Roof (1st Floor roof slab, interim roof condition)	per BNBC 2020, min. 1.5 kN/m²

The main entrance to all buildings shall be shaded by a roof projection or a separate lower-level roof, lime-terraced and drained by rainwater pipes with cast-iron hoppers and grilles. Window openings shall be fitted with protruding concrete sunshades, designed for the wind pressures established above.

All external walls shall be 250 mm first-class brickwork, using units conforming to BDS 208 or BS EN 771-1 (minimum compressive strength 15 MPa, water absorption ≤ 20%), faced as directed by the Architect. Internal walls shall generally be 125 mm first-class brickwork, rendered and finished with low-VOC plastic emulsion paint. Mortar shall be Type S (1:4 cement:sand, min. 12.5 MPa) per ASTM C270 for load-bearing partitions and Type N (1:6) for non-load-bearing infill. The extent of clay brick masonry versus concrete block masonry (Cl. 7.7.27) across the building shall be as shown on the Architectural drawings.

Brickwork shall be tied to the RCC frame using minimum 6 mm diameter galvanized (Class 3, 610 g/m^2 zinc coating per ASTM A153) dowel/mesh ties at maximum 400 mm vertical spacing, embedded minimum 150 mm into brickwork, with seismic detailing per BNBC 2020.

Externally, rendered walls shall receive a primer plus two finishing coats of low-VOC acrylic exterior-quality paint or similar approved.

Control-room clear height shall provide approximately 1 metre clearance over cabinet tops to the underside of the false ceiling; switchgear-room clearance shall be approximately 1 metre over switchgear to the roof-slab soffit, or greater where required for equipment removal. All rooms on a given floor shall be of one uniform height. The roof shall be treated with waterproofing agent with protective Ferro cement layer to control the dampness of the roof.

Where a below-grade cable basement is provided for a control building (as shown on the drawings for other buildings at this site, if any), it shall be waterproofed per BS 8102. For this Building, cable routing at 1st Floor is provided via the raised access floor system specified at Cl. 7.7.2.1(c), not a cable basement.

7.7.2.2.1 Fire Protection

The transformer room, battery room, cable basement/gallery, and relay/control rooms shall be enclosed by walls, floors, and doors achieving a minimum 2-hour fire-resistance rating per BNBC 2020, with reinforcement cover in these areas determined per ACI 216.1. All cable/duct penetrations through fire-rated walls or floors shall be sealed with a fire-stop system tested to UL 1479 or BS EN 1366-3. Means-of-egress travel distance and exit width shall comply with BNBC 2020.

7.7.2.2.2 Accessibility

At least one accessible entrance, an accessible-width door (minimum 1200 mm clear) at the main entrance, and accessible sanitary facilities shall be provided in accordance with BNBC 2020.

7.7.2.2.3 GIS Equipment Hall and Raised Access Floor

The 1st Floor GIS Equipment Hall shall be provided with a raised access floor system minimum 600 mm (or as per the requirement) deep for cable routing, conforming to EN 12825 (or an equivalent recognised access-floor performance standard), with a point-load and uniformly-distributed-load class selected for GIS-hall maintenance and rolling-equipment loads, subject to Engineer approval; office/computer-room duty classes shall not be used. GIS bay and switchgear equipment bases shall bear directly on the structural slab through cut-outs in the raised floor system, coordinated with the GIS equipment supplier's foundation/anchor-bolt drawings, and shall not be supported by the raised-floor pedestal grid. The metallic pedestal grid shall be bonded/earthed to the building earthing system per Cl. 7.7.49.7. Fire-stopping shall be provided at every point the raised-floor void crosses a fire-rated wall, per Cl. 7.7.2.1(a). The void perimeter shall be sealed against dust and moisture ingress, and access panels shall be removable for maintenance, rated for the same load class as the general floor system. GIS Hall floor flatness beneath the raised floor shall meet the FF/FL tolerance at Cl. 7.7.26. A design indoor condition of 25°C DB / 60% RH maximum shall apply; the Contractor shall submit HVAC dehumidification design confirming non-condensing conditions are maintained per the GIS equipment manufacturer's requirement. Forced ventilation for the GIS Hall shall include low-level extraction and an SF_6/oxygen-deficiency monitoring and alarm interface, coordinated with the electrical/HVAC design, per IEC 61936-1. An installation method statement covering pedestal layout/fixing, cable installation sequence, floor cut-out coordination with the GIS supplier, and panel load-testing shall be submitted before installation begins.

7.7.2.2.4 Transformer Room

The Ground Floor Transformer Room shall be provided with an oil containment pit or soak-away sized for the total oil volume of the largest Station/Auxiliary Transformer plus fire-fighting water allowance, per IEC 61936-1, draining via an oil-water separator/interceptor before discharge to the site drainage system at Cl. 7.7.2.3; oil-contaminated water shall not be discharged directly to the site drainage system. Transformer roll-in/roll-out

provision (rail track, pull-in pit, or equivalent) or lifting-beam anchor points rated for the transformer weight shall be provided, as shown on the drawings. Ventilation shall be sized from the transformer heat-load (losses) data, independent of the general habitable-space ventilation basis at Cl. 7.7.47. Cable entries into the Transformer Room shall be sealed per Cl. 7.7.2.1(a) and shall additionally be rodent/pest-proofed.

7.7.2.3 Ground Conditions, Foundations and Site Investigation

7.7.2.3.1 Fill Sites

On fill sites where fill depth exceeds 3 metres, piled foundations shall be installed below buildings, designed per BNBC 2020. If piled foundations are found unnecessary in the final site investigation report, a corresponding reduction in Contract value shall be agreed on the basis of schedule rates.

Piles shall be concrete (cast-in-situ or precast); where timber piles are used, strip footings adequate to support the building after eventual timber deterioration shall be provided.

On every fill site, the Contractor shall demonstrate that switchyard foundations will not settle more than 20 mm, by static plate load testing per ASTM D1194 / BNBC 2020, to twice the design bearing pressure, held until the rate of settlement is ≤ 0.02 mm/hr (or a minimum of 20 days where governed by consolidation of cohesive strata). Differential settlement between adjacent foundations shall not exceed 1:500.

Outdoor equipment shall be provided with spread footings. The Employer will provide a pre-fill soil-level survey; the Contractor shall check for uneven fill depth below any foundation and restrict differential settlement to a 1-in-400 slope where uneven depth exists.

Where a fill site has not experienced one wet season before foundation work starts, the Contractor shall flood the site to 50 mm depth for 10 days (not required on hydraulic fill sites). Rainwater shall be piped away, ponding in open foundations prevented, and foundations backfilled promptly. Fill settlement shall be monitored (concrete posts, 50×50×750 mm, on a 10 m grid) at 30-day intervals from the date of site access, and the Contractor shall maintain the fill, including batter slopes, until handover.

7.7.2.3.2 Unfilled Sites

Original delta levels are generally 4 m below road level. Fill settlement may be considered complete where fill exceeds 3 years old.

7.7.2.3.3 Site Investigation

Boreholes shall be on a 25 m grid, with at least three additional boreholes beside each building, located to ±0.5 m accuracy, to a minimum depth of 20 m or twice the building footing width, whichever is greater, backfilled with compacted sand after completion.

In each borehole: Standard Penetration Tests at 1.5 m intervals per ASTM D1586; undisturbed samples at approximately 1.5 m and 3 m depth tested by unconfined compression per ASTM D2166/D2850; one-dimensional consolidation tests at 1.5, 3, and 4.5 m depth per ASTM D2435 (reporting Mv and Cv); particle-size analysis per ASTM D422 and Atterberg limits per ASTM D4318; groundwater level determination by dipping until level stabilizes over two days; vane shear tests per BS 1377: Part 9 at three depths in cohesive soils; and soil/groundwater aggressivity testing for sulfate-resisting cement selection per ACI 201.2R.

Liquefaction susceptibility of saturated cohesionless strata shall be evaluated for the design seismic event per BNBC 2020, reporting a Factor of Safety against liquefaction for each borehole; where FS < 1.2, ground improvement or a deep foundation solution shall be adopted.

7.7.2.3.4 Site Investigation Report

The report shall be submitted in two copies by the key programme date, prepared and countersigned by the Contractor's own foundation engineers even where fieldwork is performed by a sub-consultant.

7.7.2.3.5 Foundations

Minimum foundation depths: transformer bases 0.9 m; other switchyard foundations 1.1 m; control building foundations, including all internal walls, 1.5 m; boundary wall foundations 1.1 m.

Formations shall be compacted before placing a minimum 70 mm Class B concrete blinding within 24 hours of bottoming excavation, projecting at least 300 mm beyond footings, inspected by the Engineer.

Between column footings, all walls shall be provided with a reinforced concrete strip footing (minimum 800 mm wide × 250 mm deep) at column-footing level, structurally linked to them. Column footings shall additionally be tied at foundation and floor level by beams to every adjacent column in both directions, designed to resist 1-in-200 differential settlement without distress and to resist the seismic load established at Cl. 7.7.2.1 for the confirmed Project site.

Exposed concrete and outer cable trench/tunnel surfaces shall receive two coats of bitumastic paint before backfilling.

Foundation settlement shall be monitored monthly and reported to the Engineer until settlement reduces to less than 1.5 mm in 3 months. Foundation tops shall terminate 1000 mm above average finished site level, with 20×20 mm chamfers on exposed edges.

Excavation shall proceed only when groundwater is at least 1000 mm below foundation level, kept dry by sumps/pumps, with rainy-season shelters over open excavations. Over-excavation shall be filled with Class B concrete. Backfill shall be compacted to 95% maximum dry density per BS 1377 (2.5 kg rammer method).

Foundations shall be designed for uplift/buoyancy assuming the design groundwater table (highest recorded site-investigation level, or ground level if unavailable), with a minimum Factor of Safety of 1.2 against flotation, per BNBC 2020; the 15° frustum method may be used where this FS is demonstrated.

On fill sites where fill exceeds 3 m depth, the Contractor shall provide piled foundations per BNBC 2020. Pile testing shall comprise: static load test to 200% of design load per ASTM D1143 on minimum 1% of production piles (minimum 1 pile; minimum 2 where more than 50 piles installed); dynamic load testing (PDA) per ASTM D4945 on minimum 2% of piles; and low-strain integrity testing (PIT) per ASTM D5882 on 100% of cast-in-situ piles.

7.7.2.4 Drainage

Drainage shall be designed for a minimum rainfall intensity of 60 mm/hour, with pipe and manhole standards as shown on the drawings. All discharge to the site drainage system with an air gap/trap to prevent condensate drains from air-conditioning equipment shall odour ingress. Drainage from the Transformer Room and any area that could carry transformer oil shall pass through an oil-water separator/interceptor per Cl. 7.7.2.1(d) before discharge to the site drainage system. Cable trench/tunnel drainage shall be checked for compatibility with the fire-stopping requirements of Cl. 7.7.2.1(a) at wall/floor crossings.

7.7.3 EARTH WORK

7.7.3.1 Scope

This clause covers excavation for foundations and equipment shown on the drawings, and other necessary excavation/banking, including removal, use, or disposal of excavated materials. Excavation and backfill compaction shall be verified per BNBC 2020, and the standards below.

7.7.3.2 Clearing

Clearing shall include removal of trees, shrubs, stumps, and objectionable matter from the construction area, disposed of as approved by the Engineer, subject to applicable Department of Environment (DoE) clearance requirements where tree removal triggers such requirements. The Contractor shall not fell trees outside the site boundary without permission of the parties concerned.

7.7.3.3 Excavation

Excavation shall consist of removal, hauling, dumping, and satisfactory disposal of excavated material; excavated slopes shall be protected against erosion, with the Contractor repairing any slope damage at its own expense; excavation methods shall not loosen ground outside the excavation line, with temporary sheeting provided where necessary; excavation shall avoid damage to adjacent structures and buried services.

All excavations exceeding 1.5 m depth shall be shored, braced, or sloped/benched to a stable angle appropriate to the soil classification, per a recognized excavation-safety standard (e.g. OSHA 29 CFR 1926 Subpart P, or equivalent). A competent person shall inspect excavations daily and after any rainfall event before workers re-enter. Dewatering shall be maintained continuously during occupied excavation work.

Excess or over-excavation shall be made good at the Contractor's expense using approved fill, compacted per Cl. 7.7.3.6. The Contractor may request a revised excavation line based on observed soil conditions, subject to Engineer approval. All objectionable material shall be removed from the foundation surface before proceeding.

7.7.3.4 Sheeting

Sheeting shall be suited to foundation and groundwater conditions and shall be a safe structure. Where sheet piles are driven near buried structures, their location shall be confirmed before piling, with care taken to avoid damage when sheeting is subsequently withdrawn.

7.7.3.5 Banking

Harmful material shall be removed from banking areas; groundwater inflow treated; excavation stepped on unfavourable slopes; 3% settlement allowance graded within ±5 cm; fertile soil, swelling materials, and impermeable clay excluded against structures susceptible to earth pressure; lift thickness ≤ 50 cm per layer; appropriate compactor selection; optimum moisture content maintained; rock spread evenly without voids; and Engineer approval obtained before burying any temporary facility in banking.

Compaction shall be verified per ASTM D698 (Standard Proctor) or ASTM D1557 (Modified Proctor), achieving a minimum 95% of Maximum Dry Density, confirmed by field density testing per ASTM D1556 or ASTM D6938 at a minimum frequency of one test per 500 m^2 per compacted lift. Banking on rainy days shall proceed only with written Engineer approval.

7.7.3.6 Back-Filling

Compaction shall be verified using the criterion at Cl. 7.7.3.5 (95% MDD per ASTM D698/D1557, verified by ASTM D1556/D6938).

7.7.3.7 Disposal of Excavated Materials

Spoil shall be piled, graded, or disposed of at Employer/Engineer-specified locations, subject to Engineer inspection, and in accordance with applicable DoE requirements for construction-waste disposal.

7.7.3.8 Gravel Layer

Gravel and rubble for sub-base/bedding layers shall conform to the gradation limits of ASTM C33 or AASHTO M43, compacted by mechanical compactor to the finished level shown on the drawings.

7.7.4 PILING

7.7.4.1 Pile Driving

Piles shall be driven by equipment suited to pile type/size and site conditions, without causing public nuisance. Jointing method shall be approved before use; driving records shall be kept and submitted. Piles shall be driven vertically at the exact location shown, continuously, to avoid pile-head deviation.

Pile verticality shall not deviate more than 1:75 from plumb, and pile-head positional tolerance shall not exceed the lesser of 75 mm or D/4 (D = pile diameter), per BNBC 2020.

Caps or cushions shall protect pile heads during driving; penetration shall be measured toward the end of driving as directed; where a pile cannot be driven to specified depth, the Contractor shall proceed per Engineer's instruction; driving method/equipment requires prior approval; pile groups shall be driven from centre outward. Final set/driving criteria shall be established using a recognized dynamic pile-driving formula or wave-equation analysis (WEAP), verified by dynamic load testing (PDA) per ASTM D4945.

Where eccentricity exceeds the tolerance above, or a pile is damaged/cracked during driving, this shall be reported to the Engineer and the pile replaced or supplemented as directed. Void inside hollow piles shall be backfilled with excavated material or concrete as required.

7.7.4.2 Field Joining of Piles

Field joints shall be made by arc welding. Welders shall have minimum 6 months' continuous piling-welding experience, qualified under JIS Z-3801, AWS D1.1, or ASME Section IX. Electrodes shall conform to AWS A5.1 or an IEC-listed equivalent, kept dry before use. Welding surfaces shall be cleaned of slag, moisture, dust, rust, oil, paint, or other foreign matter; root face of steel pipe piles shall be 2 mm; current and speed shall ensure complete penetration and avoid cracking. Welding shall not proceed on wet parent metal or during strong winds unless the

joint is adequately protected and approved. Defective welds shall be chipped out, re-welded, and re-inspected. Weld inspection shall include 100% visual inspection and ultrasonic testing (UT) per AWS D1.1 of a minimum 10% of field welds.

7.7.4.3 Treatment of Pile Head

Pile heads shall be cut to the designated level and embedded into the footing; steel pipe piles shall be anchored per the drawings.

7.7.4.4 Transportation and Handling

Piles shall be transported and handled to prevent damage; any damaged or deformed pile shall be repaired before driving and re-approved by the Engineer.

7.7.4.5 Cast-in-Situ Bored Piles

Where used, boring, temporary casing or bentonite/polymer slurry support, reinforcement cage placement, and tremie concreting shall follow ACI 336.3R and ACI 304R. Concrete shall be tremie-placed with the pipe embedded a minimum of 2 m below the rising concrete surface at all times; slurry properties shall be tested per ASTM D5731. Pile-base cleanliness shall be verified immediately before concreting; concrete shall be placed continuously.

7.7.5 REINFORCED CONCRETE WORK

7.7.5.1 General

This clause covers all reinforced and plain concrete work for permanent structures. The Contractor shall furnish all materials and equipment for concrete work. Reinforced and plain concrete work shall comply with BNBC 2020, and ACI 318-19.

Reinforcement cover shall be at least one bar diameter. For footings and important members cast directly against ground, cover shall be at least 75 mm; for members buried or facing ground/severe weather, cover shall be at least 50 mm (bars >16 mm) or 40 mm (bars ≤16 mm); slab soffits may use 25 mm minimum cover even under severe exposure, provided the durability requirements at Cl. 7.7.5.2 are also satisfied. Cover for fire-resistance-rated structural members shall be determined from BNBC 2020 and ACI 216.1, based on the required rating (minimum 2-hour for members supporting or enclosing the transformer room, battery room, cable basement/gallery, and control/relay rooms).

7.7.5.2 Quality of Concrete

Concrete shall be of uniform quality, with the required strength, durability, and water tightness, based on 28-day compressive strength tested per ASTM C39 / BNBC 2020. Minimum grade, maximum water-cement ratio, and minimum cementitious content shall be as follows, per BNBC 2020 and ACI 318-19 Chapter 19:

Exposure Condition	Min. Grade	Max. w/c Ratio	Min. Cementitious Content
Structural elements — general	C25 (25 MPa)	0.50	320 kg/m^3
Below-grade / cast against ground / exposed to weather	C25 (25 MPa)	0.45	350 kg/m^3
In contact with saline groundwater or sulfate-bearing soil	C30 (30 MPa)	0.40	380 kg/m^3, using Sulphate-Resisting Cement
Plain concrete / blinding / leveling	C15 (15 MPa)	—	—

7.7.5.3 Materials

Materials shall conform to the standards at Cl. 7.7.1.2. Cement shall be Ordinary Portland Cement per BDS EN 197-1 (CEM I 42.5N) or ASTM C150 Type I/II, or Portland Composite Cement per BDS EN 197-1 (CEM II), subject to Engineer approval of strength-development data; Sulphate-Resisting Cement (Type V) shall be used where

soil/groundwater sulfate content exceeds the threshold at Cl. 7.7.5.2. Mixing water shall be free of injurious substances, tested per ASTM C1602 where potability is in doubt; sea water shall not be used. Fine and coarse aggregate shall be clean, hard, durable, and suitably graded, with sieve analysis per ASTM C136. Reinforcement shall conform to BDS ISO 6935-2 (Grade 500W) or ASTM A615M/A706M (Grade 420/60); specialty bars (cold-drawn, epoxy-coated, galvanized) shall conform to the relevant ASTM standard. Crushed stone shall conform to BDS 243 or ASTM C33. Admixtures require prior Engineer approval; chloride-containing admixtures shall not be used with embedded aluminum or in sulfate-exposed concrete; air-entraining admixtures shall conform to ASTM C260, water-reducing/retarding/accelerating admixtures to ASTM C494/C1017, pozzolans to ASTM C618, GGBFS to ASTM C989, pigments to ASTM C979.

7.7.6 STORAGE OF MATERIALS

Cement shall be stored by type in silos or damp-proof warehouses, sacked cement stacked at least 30 cm above floor level in stacks of at most 13 sacks; cement shall not be used beyond 60 days from manufacture unless re-tested and re-approved. Aggregate shall be stored separately by type/grading, well-drained, and shaded in hot weather. Reinforcement shall not be placed directly on the ground and shall be stored covered, with bar bundles tagged by heat/lot number for mill-certificate traceability. Admixtures shall be stored per manufacturer's data sheet, first-in-first-out, re-tested if quality is in doubt.

7.7.7 TESTING OF MATERIALS

All materials shall be approved by the Engineer following submission of test results. Test methods shall comply with ASTM, ACI, and BNBC 2020. All testing shall be carried out by a laboratory accredited to ISO/IEC 17025 by BAB or an equivalent accreditation body; reports from non-accredited laboratories shall not be accepted for material-approval or payment purposes.

7.7.8 MIX PROPORTIONS

Mix proportions shall minimize unit water content while securing required strength, durability, water tightness, and workability, submitted for Engineer approval prior to use, following ACI 211.1. Design concrete strengths shall be as follows:

Application	Design Grade
Architecture and Switchyard structural elements	C25 (25 MPa) minimum
Transmission-related structures/foundations	C20–C25, per exposure class at Cl. 7.7.5.2
Leveling / blinding concrete	C15 (15 MPa)

Mix design shall follow the ACI 211.1 trial-batch procedure to verify the strength/water-cement relationship for the actual Project materials.

7.7.9 BATCHING AND MIXING

Materials shall be batched per the approved mix design; batching method and equipment require prior Engineer approval. Surface-water and effective-absorption tests shall be per ASTM C70/C566. Materials shall be batched by weight except water/admixture solution, which may be by volume. Allowable batching error shall conform to ASTM C94, Table 2 (cement/water ±1%, aggregates ±2%, admixtures ±3%).

Ready-mixed concrete shall be produced/delivered per ASTM C94 or ASTM C685; job-mixed concrete shall be mixed for a minimum of 90 seconds (tilting mixer) or 60 seconds (forced mixer), not continued beyond three times the specified mixing time; concrete that has begun to set shall not be re-tempered and used. All concrete placement shall comply with ACI 305R (Hot Weather Concreting); concrete temperature at discharge shall not exceed 32°C, using chilled mixing water or shaded stockpiles as needed during hot-weather placement (ambient ≥ 35°C), with temperatures recorded per batch. Complete batching/mixing records shall be kept identifying batch quantity, proportions, approximate final location, and time/date.

7.7.10 CONVEYING AND PLACING

A conveying-and-placing plan shall be submitted for Engineer approval before construction begins. Concrete shall be conveyed to minimize segregation, placed immediately; where delayed, the time from mixing to completion of placing shall not exceed 45 minutes (30 minutes during hot-weather concreting, ambient ≥ 35°C, per ACI 305R). Concrete awaiting placement shall be protected from sun, wind, and rain; no concrete that has begun to set shall be used.

Conveying equipment shall permit deposition without segregation (belt conveyors with baffle plates and elephant trunk; buggies on a level path; chutes uniformly inclined with discharge height ≤ 1.5 m, fitted with elephant trunk). Placement preparation shall confirm reinforcement/formwork arrangement, equipment cleanliness, and dewatering of pits/sumps.

Concrete temperature at placing shall not exceed 32°C per ACI 305R. Conveying equipment shall protect concrete from drying/heating; placement shall be protected on completion/interruption; reinforcement shall not be disturbed; concrete shall be worked with abundant mortar around embedments; each section shall be placed continuously; lift height shall not exceed 40 cm; successive layers shall be placed while the layer below remains plastic; tall pours shall use placing openings/chutes to prevent segregation.

7.7.11 COMPACTION

Internal vibrators shall be the principal compaction method, with prior Engineer approval; concrete shall be thoroughly compacted immediately after placement, worked into corners and around reinforcement. Vibrator frequency shall be 8,000–12,000 vpm, insertion spacing not exceeding 450–750 mm, insertion duration 5–15 seconds per point until air bubbles cease and mortar rises around the vibrator head, per ACI 309R.

7.7.12 ADDITIONAL PLACING AND CURING

Additional concrete placed on a partially hardened layer shall be worked to achieve a monolithic connection, per the joint provisions at Cl. 7.7.13. Concrete shall be protected from injurious low-temperature, drying, or sudden temperature change, and from vibration/impact/load while hardening; the curing method requires Engineer approval.

Freshly placed concrete shall be protected from sun/wind/showers, covered with wet mats/canvas/sand or continually watered for a minimum of 7 days (OPC/PCC) or until 70% of 28-day strength is verified, whichever governs, per ACI 308R. An ASTM C309-compliant liquid curing compound may be used as an alternative, subject to approval, particularly for large exposed flatwork.

7.7.13 JOINTS

Joint location and detailing shall follow the drawings; joints not shown shall be positioned to avoid impairing strength/appearance, subject to Engineer approval. Construction joints shall be located where shear is minimized; joints at high-shear zones shall be reinforced with keys/grooves or embedded steel. Horizontal and vertical construction joints shall have old-concrete surfaces cleared of laitance, roughened/cleaned, wetted, with bonding paste/mortar applied before fresh concrete placement.

Construction and movement joints located below the design groundwater level or in water-retaining/excluding structures shall incorporate a PVC or rubber waterstop per ASTM D5199 / BS EN 681-2. Movement joints shall additionally be provided in long exterior walls, roof slabs, and paved areas at intervals per ACI 224.3R or the structural drawings, sealed with a flexible UV-resistant sealant per ASTM C920.

7.7.14 REINFORCEMENT WORKS

Reinforcement shall be processed to the shape/dimension shown without impairing material quality; unavoidable heating requires Engineer approval. Reinforcement shall be cleaned of loose rust before fabrication, placed and secured to prevent displacement, with important crossings tied using annealed wire ≥ 0.9 mm diameter per ASTM A1064; clearance from formwork maintained by spacers; fabrication inspected before concrete placement.

Reinforcement shall be bent per a Contractor-prepared Bar Bending Schedule, with bend diameters and hook details per BNBC 2020 / ACI 318-19 Chapter 25, and fabrication/placement tolerances per ACI 117. Lap joints shall use the required lap length (Cl. 7.7.26.1), tied at several points with ≥0.9 mm annealed wire; projecting reinforcement left for future jointing shall be protected from damage and corrosion.

7.7.15 FORMS AND STEEL SHUTTERING

All formwork/shuttering in contact with concrete shall be fabricated from steel — modular steel form panels (minimum 3 mm mild-steel face plate on a welded steel frame conforming to ASTM A36) with steel walers, studs, and clamping/bolting systems. Timber formwork is not permitted, except that the Engineer may, at his sole discretion and by prior written approval, permit a limited timber infill piece for a genuinely irregular, non-repetitive geometry where a standard or custom steel panel is not practicable.

Forms shall be modular steel panels, readily assembled and struck; panel-to-panel joints shall incorporate a foam or rubber gasket to prevent grout leakage; corners shall use factory-made steel corner/fillet pieces for uniform chamfers; temporary openings shall be provided for cleaning, inspection, and placing.

The staging/shoring system supporting the steel formwork shall likewise be steel — adjustable steel props, steel scaffold tube-and-coupler systems, or proprietary steel shoring towers — of a type suitable to the loads involved. For important structures, staging design drawings and load-capacity certificates shall be submitted for approval; anticipated settlement under placed-concrete weight shall be estimated, with camber introduced where necessary.

A form-release agent compatible with steel and non-staining to concrete shall be applied before each use. Steel form panels shall be maintained free of dents, rust pitting, and residual concrete build-up; damaged or corroded panels shall be repaired or replaced before re-use.

Forms and staging shall be inspected by the Engineer before placement, checked against ACI 117 tolerances. Formwork/staging shall not be removed until concrete reaches a strength sufficient to carry its own weight and construction loads: minimum 70% of specified 28-day strength or 24 hours (whichever governs) for vertical formwork (columns, walls); for slabs/beams, minimum 70% of specified strength at the location, or the striking times of ACI 347R (adjusted for ambient temperature), whichever is more conservative, verified by matching-cured test cylinders. Timing/sequence of removal and any loading immediately following removal shall be subject to Engineer approval.

7.7.16 FINISHING

Where uniform appearance is required, special attention shall be given to placing concrete for the predetermined section continuously, without changing materials, proportions, or method.

Compacted surfaces not facing shuttering shall not be finished until bleed water ceases or is removed; cracks forming before hardening shall be removed by tamping/re-finishing. Floor and slab surfaces shall meet flatness/levelness tolerances per ACI 302.1R, appropriate to the intended finish.

Exposed concrete facing steel shuttering shall present a uniform, mortar-rich, off-form finish; the required finish class (Class A/Rubbed or Class B/Smooth-Formed per ACI 347) shall be as shown on the drawings for each exposed element. Surface projections/lines shall be removed for flatness; honeycombing and chipped areas shall be cut out, moistened, and patched flush; cracks appearing after form removal shall be repaired as directed.

7.7.17 QUALITY CONTROL AND INSPECTION

Materials, reinforcement, equipment, and workmanship shall be controlled to economically produce reinforced concrete of the required quality, in accordance with a Contractor-prepared Inspection & Test Plan (ITP), submitted to and approved by the Engineer prior to commencement of concrete work, carried out by an ISO/IEC 17025-accredited laboratory.

During construction, the following tests shall be performed: slump test per ASTM C143 for every batch/truck at discharge; air content test per ASTM C231 where air-entrained concrete is specified; compression test per ASTM C39, at a sampling frequency of not less than one set of test cylinders for each day's pour, nor less than one set for each 115 m^3 of concrete, nor less than one set for each 465 m^2 of surface area for slabs/walls, whichever yields the greater number of tests, per ACI 318-19, §26.12.2 / BNBC 2020. Of each set: 3 specimens tested at 7 or 14 days for early-strength indication, and 3 specimens at 28 days for acceptance. Testing costs shall remain included in the Contractor's unit rates.

Reinforcement shall be verified against mill test certificates per heat/lot, with independent testing at a BUET/KUET/RUET/CUET or other ISO/IEC 17025-accredited laboratory at a minimum rate of 1 sample per 50 tonnes or per truckload, whichever is more frequent. Test methods shall conform to ASTM/ACI/BNBC 2020. Test

results shall be reported within 24 hours of completing an early-age test and within 48 hours of completing a 28-day or final acceptance test.

Concrete strength shall be considered satisfactory if the average of any three consecutive strength tests equals or exceeds specified f'c, and no single test falls more than 3.5 MPa below f'c, per ACI 318-19, §26.12.3. Where these criteria are not met, the Engineer shall direct an investigation per ACI 318-19, §26.12.5 (which may include core testing, non-destructive testing, or load testing) before accepting, remediating, or rejecting the affected concrete. Concrete construction tolerances shall be per ACI 117.

Where concrete quality is found unsuitable, remedial measures shall be taken and the placed concrete checked for its ability to perform its designated structural function, with further measures directed by the Engineer.

7.7.18 STEEL REINFORCEMENT — LAPS, ANCHORAGE, COVER

Lap-splice length and anchorage (development) length shall be calculated per BNBC 2020 / ACI 318-19, Chapter 25, as a function of bar size, concrete grade, casting position, clear spacing/cover, and reinforcement yield strength (Grade 420 per Cl. 7.7.5.3). Splices at points of high stress shall be avoided wherever possible and shall not be concentrated at a single location. Dowels at construction joints shall be installed at right angles, aligned parallel to the finished surface, rigidly held during placement. Concrete cover for durability and fire resistance shall be per Cl. 7.7.5.1/7.7.5.2, applied uniformly throughout the Works.

7.7.19 INSPECTION OF STRUCTURES

Structures shall be inspected on completion and at defined hold points during construction, per the Contractor's approved ITP, comprising: dimensional/tolerance inspection against ACI 117; visual inspection of finish/cracking/cover per Cl. 7.7.16; documentary inspection confirming all material test records are complete and within acceptance criteria before a structural stage is signed off; and, where the Engineer has reasonable grounds to doubt in-place quality, non-destructive testing (rebound hammer per ASTM C805, or core testing per ASTM C42) with acceptance per ACI 318-19, §26.12.5. No structural element shall be covered until it has passed the applicable hold-point inspection.

Prior to commencing masonry work, the surface of masonry units shall be thoroughly cleaned and sufficiently moistened to ensure smooth adherence of mortar, per Cl. 7.7.27.0.

7.7.20 ROAD WORK

Road construction shall be per the Drawings. Demolition and restoration of public/private roads shall follow the specifications of the responsible road authority, notwithstanding this Specification and the Drawings. Road pavement design and construction shall additionally conform to the Roads and Highways Department (RHD) Standard Specification for Road and Bridge Works (latest edition), supplemented by AASHTO standards where RHD is silent.

7.7.20.1 Road Work Inside the Premises

Sub-grade excavation and banking shall follow Cl. 7.7.3; fill placed in compacted lifts ≤ 20 cm finished thickness; sub-grade finished by proof-rolling with an 8-tonne (or heavier) loaded vehicle, reworking defective areas. Sub-grade shall be compacted to minimum 95% of Modified Proctor MDD per ASTM D1557, achieving a minimum California Bearing Ratio (CBR) of 8% (or the design CBR shown on the drawings), verified per ASTM D1883. Finished sub-grade shall be within ±5 cm of design elevation.

Sub-base materials shall be per the Drawings — typically Aggregate Base Course or Water Bound Macadam conforming to the RHD Standard Specification, with a materials-quality/sampling report submitted for approval. Finished sub-base surface shall be within −10 mm/+5 mm of design elevation.

Asphalt mixture shall be designed by the Marshall Method (ASTM D6927) or Superpave (AASHTO M323), achieving minimum 95% of laboratory (Marshall) density per ASTM D2726. The finished surface shall be checked with a 3 m straight-edge parallel to the road centreline; depressions shall not exceed 5 mm. No subsequent layer shall be placed until the Engineer has inspected and approved the preceding layer.

7.7.20.2 Public Road (Including Private Road)

Demolition of pavement shall avoid hazarding surrounding pavement/concrete. Temporary road-keeping construction shall suit prevailing site conditions without endangering traffic, per drawings approved by the

Engineer, with the Contractor patrolling and maintaining such roads until restoration and hand-back. A Traffic Management Plan, including signage, barricading, and flagman arrangements consistent with the local road authority's requirements, shall be prepared and submitted before commencing any work on or adjacent to a trafficked road.

7.7.21 DRAINAGE WORK

Drainage work shall be per the Drawings, Cl. 7.7.3, and Cl. 7.7.5. Water/plumbing facilities for drainage shall be constructed so as not to cause trouble to surrounding areas or structures, with design and execution schedules submitted for approval, consistent with the rainfall-intensity criterion at Cl. 7.7.2.3, BS 8301, and BNBC 2020.

7.7.22 PAINTING WORK

7.7.22.1 General

This clause covers painting applied to plaster, wood, and metal surfaces per the drawings. No painting shall be applied to stainless steel, copper, bronze, brass, or reinforcement embedded in concrete. Painting shall be performed by skilled workers, with colour selection determined by the Engineer unless otherwise specified.

7.7.23 MATERIALS AND PAINTING COAT

7.7.23.1 Materials

Water-based paints (emulsion) shall conform to BDS 1097 or ASTM D2834/D6578; interior emulsion paints shall meet a low-VOC limit (≤50 g/L). Ready-mixed paints and enamels shall conform to BDS 402, BDS 616/617, or ASTM D1535/SSPC-Paint standards. Thinners/solvents shall conform to ASTM D3925 or the current BSTI-adopted equivalent. Varnishes/lacquers shall conform to BDS 1064–1066 or ASTM D1544. All paints and coatings shall be certified lead-free (lead content ≤90 ppm per ASTM D3335) and shall meet the low-VOC limits above; manufacturer's MSDS and third-party test certificate shall be submitted with the paint sample for approval.

7.7.23.2 Painting Coat

Number of coats (primer/secondary/finishing) for each substrate shall be per the Coat Schedule shown on the drawings. Minimum total Dry Film Thickness (DFT) shall be as recommended by the paint manufacturer, verified by DFT gauge per ASTM D1186 (ferrous) or ASTM D1005 (non-ferrous), at a minimum frequency of one reading per 10 m^2.

7.7.23.3 Workmanship

Smooth-finished, soft-coloured plastic paint shall be used on interior wall/ceiling plaster; smooth-finished, Architecturally approved weather-coat on exterior wall plaster. Painting shall be by spraying, brushing, or rolling on smooth, dry, clean surfaces free of rust/grease/loose scale; paint samples/catalogues shall be submitted for approval.

7.7.23.4 Protection

Drop cloths shall protect all work during execution; droppings shall be fully removed, damaged surfaces repaired. Work showing laps, stains, or surface imperfections shall not be accepted. Rubbish/waste shall be regularly removed; adjacent surfaces/hardware/glass shall be protected, with any damage made good at the Contractor's expense. Paint waste, containers, and solvent residue shall be disposed of per applicable DoE hazardous-waste requirements, and shall not be discharged to the site drainage system.

7.7.24 TEMPORARY WORK, EARTH WORK AND PILING WORK

Temporary Work, Earth Work, and Piling Work shall be as specified in Section 1 "General Provisions," unless otherwise specified in this Section 7.7. Where any requirement in Section 1 conflicts with Cl. 7.7.3 (Earth Work) or Cl. 7.7.4 (Piling) of this Section, the more stringent requirement shall govern.

The pile to be used for the Control Building shall be steel pipe pile, 406.4 mm OD × 6.4 mm wall thickness, conforming to ASTM A252 Grade 2 or 3. Given the aggressive/saline soil and groundwater conditions at Cl. 7.7.2.2(c), steel pipe piles shall be provided with a corrosion allowance (additional sacrificial wall thickness, minimum 1.5 mm, determined from the site-specific corrosion investigation) or an approved external protective coating/cathodic protection system, per BNBC 2020 and API RP 2A durability guidance.

7.7.25 CONCRETE WORK (BUILDING-SPECIFIC)

Concrete work shall be per Cl. 7.7.5–7.7.18 of this Section 7.7, which shall govern over any conflicting provision in Section 1 "General Provisions."

Structural concrete classification and reinforcement grade shall be per Cl. 7.7.5.2/7.7.5.3 and Cl. 7.7.8. Fabricated bar mats (ASTM A184M), deformed wire ≥ size D4 (ASTM A496), and welded wire fabric (ASTM A497, welded intersections ≤ 400 mm apart in the direction of calculated stress, except stirrup fabric) are acceptable, consistent with the Grade 420 reinforcement standard.

All formwork addressed in this clause is steel formwork/shuttering, per Cl. 7.7.15; timber formwork is not permitted except by the narrow Engineer-approved exception stated there. Form (release) oil shall be light-coloured paraffin oil or other approved non-staining material, applied per Cl. 7.7.15. Form ties shall be steel snap-ties, she-bolts, or taper-ties with plastic or steel cone spacers, of a type and working-load capacity approved by the Engineer; after form removal, tie-rod ends/cone recesses shall be patched flush with non-shrink mortar matching the adjacent concrete finish.

STEEL REINFORCEMENT — SURFACE AND FINISH REQUIREMENTS

Interior concrete floors intended for vinyl tile bedding or exposed steel-trowel finish shall receive a steel-trowel finish, forming a true plane surface with deviation not exceeding 3.0 mm under a 300 mm straightedge, pitched to drains where shown. Power-finishing machines may be used provided the surface is free of machine marks. For the GIS Equipment Hall raised-floor support slab and any area with stringent flatness requirements, the FF/FL flatness/levelness measurement of ACI 302.1R shall govern.

Concrete surfaces to be exposed shall be produced from steel formwork achieving a finish quality per Class A (Rubbed) or Class B (Smooth-Formed) of ACI 347, as designated on the drawings. Smaller steel form panels shall be used only where required by openings or joint details, with each area less than 120 cm wide formed using a single, accurately cut steel panel. Cut panel edges shall be smooth and treated with form-release coating; panel joints shall be smooth and free of offset. Form panels with defects impairing finish texture/appearance shall not be used. Column forms shall be fabricated with the minimum practicable number of panel joints.

7.7.26 MASONRY WORK

7.7.26.1 Clay Brick Masonry

Prior to commencing clay brick masonry work (per Cl. 7.7.2.1), the surface of each brick shall be thoroughly cleaned and sufficiently moistened to ensure smooth adherence of mortar. Brick units and mortar shall conform to Cl. 7.7.2.1 (BDS 208/BS EN 771-1 units; ASTM C270 Type S/N mortar), with ties to the RCC frame per the seismic-detailing requirement at Cl. 7.7.2.1 (BNBC 2020).

7.7.26.2 Concrete Block Masonry

This clause covers walls, partitions, and lintels constructed with precast concrete hollow blocks, reinforced with steel bars. Cement and aggregate shall be as specified at Cl. 7.7.5, with coarse aggregate not exceeding one-fifth of the narrowest block-section width; blocks shall conform to ASTM C90, minimum net-area compressive strength 13 MPa. Reinforcing bars shall be Grade 420 per Cl. 7.7.5.3. Mortar mix proportion shall be Type S (1:4 cement:sand, min. 12.5 MPa) per ASTM C270, unless a different proportion is shown on the drawings.

Block-laying working drawings, including reinforcement arrangement and anchor-bolt locations, shall be submitted for approval. Unless otherwise specified, reinforcement shall be D10 bars at 3-block horizontal and 2-block vertical intervals, wire-tied at intersections; D13 bars around opening perimeters; read together with the Bond Beam requirement at Cl. 7.7.29 and seismic infill-tie detailing at Cl. 7.7.2.1.

Concrete surfaces receiving blocks shall be cleaned and wetted before laying; units shall be clean, laid in cement mortar, with 10 mm uniform joints, exposed joints raked 10 mm deep and tooled smooth; reinforced/jointed cells compactly filled with mortar; laying height shall not exceed 1.2 m per day; embedded pipes/conduits placed without damage to blocks.

7.7.27 LINTEL

Lintels over openings shall be of reinforced concrete and shall extend a minimum bearing length of 200 mm into the adjoining walls on each side. All block cells directly below the lintel bearing shall be filled solid with mortar.

7.7.28 BOND BEAM

Where the height of a concrete block wall exceeds 30 times the wall thickness, a reinforced (precast or cast-in-place) concrete bond beam shall be provided at each height increment of 30 times the wall thickness, per BNBC 2020.

7.7.29 PRECAST CONCRETE BLOCK

Cement, aggregate, and reinforcement shall be per Cl. 7.7.5. Maximum coarse-aggregate size and specific gravity shall be confirmed against the block-machine manufacturer's data and ASTM C33 grading, subject to Engineer approval. Specific gravity of coarse aggregate shall be 2.7 or greater; mix proportion (cement:sand:coarse aggregate) shall be 1:2:4, achieving minimum compressive strength per ASTM C90. Coarse aggregate for lightweight blocks shall have specific gravity 1.7–1.9, conforming to ASTM C331.

7.7.30 WATER PROOFING WORK

This clause covers waterproofing, built-up roofing, and mortar waterproofing. Asphalt primer, compound, and roofing felt shall conform to JIS K 5400/A 6006 or equivalent ASTM standards (ASTM D41, D312, D226). As a more durable alternative for tropical/UV exposure, an SBS- or APP-modified bitumen membrane system conforming to ASTM D6164 or D6222 may be proposed, subject to Engineer approval.

Class A waterproofing shall be applied to the roof, Class B to lavatories, with base-concrete inclination of at least 1:100 (or steeper, e.g. 1:60, where required by the selected membrane manufacturer or site drainage history, given the 60 mm/hour design rainfall intensity at Cl. 7.7.2.3). Asphalt primer shall be sprayed over the base concrete/insulation board; compound then poured/spread, not heated above 230°C. Felt/roofing shall be laid flat with minimum 9 cm overlap, fully watertight joints, with care taken around anchor bolts, parapets, and roof drains. Hot bituminous roofing work shall be carried out under a Contractor hot-works permit system, with fire watch, extinguishers, and coordination with the Employer given the proximity to GIS switchyard/oil-filled equipment.

All waterproofing systems shall carry a minimum 10-year material and workmanship warranty, jointly issued by the membrane manufacturer and the Contractor/specialist applicator.

7.7.31 MORTAR WATERPROOFING

Waterproofing agent shall be used in roof/balcony mortar waterproofing; cement and sand per Cl. 7.7.37; catalogue and mix proportion submitted for approval; application per Cl. 7.7.37. Integral waterproofing admixtures shall conform to ASTM C1107 or BS EN 934-2.

Caulking compound shall conform to JIS A 5751 (oil-based) or JIS A 5754 (Thiokol/polysulfide), or an equivalent silicone (ASTM C920 Type S) or polyurethane (ASTM C920 Type M) sealant; Thiokol or equivalent modern sealant shall be used at all exterior door/window/concrete-panel joints. Joint surfaces shall be sound, clean, dry, fully cured, primed with a compatible primer, mixed/applied per manufacturer's recommendation, by skilled workers.

7.7.32 CONTROL JOINT FOR ROOF

Control joints shall be provided between the mortar finish and lightweight concrete block at approximately 4.0 metre intervals in the lightweight-block roof area, consisting of an elastic sealant and asphalt mortar, consistent with Cl. 7.7.13.

7.7.33 TILE WORK

This clause covers mosaic tile, ceramic tile, and other finishes on floors and walls. Ground/underground floor finish under transformer bases shall use dry gravel bedding, with Rustic Tiles for walkways/common spaces. Interior bathroom wall tile shall be European-standard ceramic tile, high quality/grade. Exterior wall ceramic tile shall be 60 × 227 mm, colored/glazed, colour as designated by the Engineer. All tile shall additionally conform to ISO 13006 or ANSI A137.1; floor tile in walkways, entrances, and wet areas shall achieve minimum slip resistance R10 per DIN 51130 or wet Coefficient of Friction ≥0.5 per ASTM C1028.

Cement/sand for mortar bed shall be per Cl. 7.7.5; bedding mortar shall be 1 part Portland Cement to 3 parts sand, or polymer-modified thin-set adhesive per ANSI A118.4/ISO 13007 where approved. Mosaic and ceramic tile setting (bed floating, tamping, expansion/control joints at 6 m centres per Cl. 7.7.13(6), grouting, protection, cleaning) shall follow standard workmanship practice, with tile soaked one hour prior to setting for ceramic tile.

Gun-sprayed tile shall conform to JIS A 6910-C or equivalent, over a sealer coat, using white Portland cement, dolomite plaster, and colouring agent as designated.

7.7.34 METAL WORKS

This clause covers all metal works for flooring, siding, walling, flashing, railings, roofing, risers, plumbing, and related fixtures; fabrication and installation drawings shall be submitted for approval. JIS steel/stainless/aluminum references throughout this clause shall be read as "or the ASTM equivalent, or other equivalent international standard, subject to Engineer approval" (e.g., JIS G 3452 ≈ ASTM A53; JIS G 3101-SS41 ≈ ASTM A36; JIS G 4305-SUS304 ≈ ASTM A240 Type 304; JIS G 3131/G 3141 ≈ ASTM A1011/A1008; JIS H 4100/H4000 ≈ ASTM B221; JIS A 5511 ≈ ASTM A48).

Staircase railings shall use stainless steel pipe, square box, or decorative post per the drawings; embedded pipe inserts shall be galvanized unless otherwise specified. Handrails and their connections/embedments shall be designed for a minimum horizontal design load of 0.75 kN/m applied at the top rail per BNBC 2020, provided at 900–1000 mm height per Cl. 7.7.2.1. Mitered/welded joints shall be made by fitting post to rail, mitering corners, groove welding, and grinding smooth; bends shall be made in suitable jigs without crushing the pipe. Rails shall be installed via steel sleeve inserts anchored in concrete or welded to the stringer/beam/toe plate, level and aligned; the space between pipe posts and sleeve inserts shall be filled solid with non-shrink cementitious or epoxy grout, or welded — molten lead filling shall not be used.

Steel ladders shall be fabricated of L-65×6 steel angle stringers with 19 mm diameter steel bar rungs at 350 mm spacing, welded to the stringers, all painted; where ladder height exceeds 6 m, a safety cage or fall-arrest system shall be provided per Cl. 7.7.2.1.

Corner guards, stair safety nosing (extruded bronze or stainless steel), divider strips, roof drains, corner beads, blind boxes, doorsills, flashing plates, embedded plates/hooks/sleeves, joiners, and downspouts shall be provided as scheduled on the drawings, per the material equivalence table above.

7.7.35 PLASTER WORK

Concrete surfaces too smooth to receive plastering shall be roughened beforehand with chisels; distorted or uneven surfaces shall be repaired with mortar. Bed, scratch coat, and treated surfaces shall be cleaned and wetted before the following coat; unbonded areas shall be repaired immediately. Door/window work shall be completed before plastering begins, with sheet covering and water sprinkling used to prevent soiling and premature drying; neighbouring surfaces shall be protected.

7.7.36 MORTAR PLASTERING

Cement shall conform to BDS EN 197-1 or ASTM C150, per Cl. 7.7.5.3, aged not more than 90 days from manufacture per Cl. 7.7.6. Sand shall be clean, graded per the standard gradation table (100% passing 5 mm sieve, ≤10% passing 0.15 mm sieve for first/second coat; 100% passing 2.5 mm sieve, ≤10% passing 0.15 mm sieve for finish coat), verified against ASTM C144. Water shall be per Cl. 7.7.5.3.

Mix proportions and coat thicknesses shall be per the standard tables shown on the drawings. First coat/dubbing out shall be roughened and left standing at least 10 days (first coat) / 5 days (dubbing) to allow full crack development before the next coat; second coat shall use a ruler at corners/edges for an even finish; finish coat shall be steel-troweled, wood-troweled, or brushed as directed, exterior walls wood-troweled then steel-troweled then brushed, minimizing water use. Floor mortaring shall use stiff, low-water mortar, tamped and screeded, with crack-control joints at approximately 3.0 m intervals per Cl. 7.7.13(6).

7.7.37 PLASTERING (GYPSUM)

Gypsum plaster shall conform to JIS A 6904 or ASTM C28/C842; cement used shall not exceed the 90-day shelf-life limit at Cl. 7.7.6/7.7.37. The receiving surface shall be levelled with a 1:2 cement:sand mortar coat, scratched for adhesion, cleaned and dampened before gypsum plaster application.

7.7.38 DOORS, WINDOWS AND LOUVERS

7.7.38.1 Wooden Doors and Frames

This clause covers wooden doors/frames and finish hardware. Doors shall be flush type, locally produced where practicable; standard flush doors shall be double-panel 6 mm plywood with stiffening ribs at 15 cm centres,

bonded per JIS K 6801/6803 or ASTM D5751; lavatory doors shall use 6 mm, 5-ply waterproof plywood, phenolic-resin bonded, passing boiling and wet/dry cycling tests; all wooden doors/frames shall be painted per Cl. 7.7.22–7.7.23.

Frames shall be accurately set, plumb, level, and securely fixed to embedded wooden blocks. Where solid-wood (e.g. Teak) frames/shutters are specified at the Employer's direction, the timber shall be sourced from a legally verified, sustainably managed supply chain, with documentation demonstrating compliance with applicable CITES provisions and Bangladesh timber-import regulations; FSC or equivalent chain-of-custody certification is recommended.

Doors shall be accurately cut, trimmed, and fitted with allowance for paint finish and swelling/shrinkage; top clearance shall not exceed 6 mm.

Builders' hardware shall conform to ANSI/BHMA A156 series, or BS EN 1935 (Hinges), BS EN 12209 (Locks and Latches), BS EN 1154 (Door Closers), with BDS 113:1986 and the applicable Bangladesh/national standards retained as acceptable alternatives.

7.7.39 STEEL FITTINGS

This clause covers steel doors, frames, and finish hardware. Steel sheet shall conform to JIS G 3131/G 3141 or ASTM A1011/A1008; plate thickness shall be: Door Frame 1.6 mm; Architrave 1.2 mm; Threshold 2.3 mm; Door Leaf frame/flush plate 1.6 mm; Stiffener/anchor plate 2.3 mm. Machine screws/rivets shall conform to JIS B 1101–1205 or ASTM/ANSI B18 series.

Steel doors shall be single/double hollow-core, swing, or sliding type per the drawings, complete with frames, hardware, and accessories; shop-fabricated frames without threshold shall be temporarily spread for shape retention; metal surfaces shall be cleaned and given two coats of rust-inhibitive paint after shop zinc plating, with field finish per Cl. 7.7.22–7.7.23. Steel louvers shall be 45° slit, 100 mm thick louver/frame assembly per the drawings. Shop drawings shall be submitted for approval; frames shall be erected plumb/square/true, installed by an authorized manufacturer representative before plastering is completed.

7.7.40 ALUMINUM FITTING

This clause covers aluminum doors, windows, and related hardware. Extruded aluminum shapes/sheet shall conform to JIS H 4100/H 4000 or ASTM B221. Reinforcing strips/struts/anchors shall be zinc-plated steel plate conforming to JIS G 3101-SS41 or ASTM A36. Small screws shall be stainless steel per ASTM A276 Type 304 or high-strength aluminum alloy per JIS H 4040 or equivalent.

Shop drawings shall be submitted for approval. Aluminum windows shall be installed by the manufacturer or authorized representative, set plumb/square/level, securely anchored. Aluminum in contact with masonry shall receive one heavy brush coat of bituminous paint before installation.

7.7.41 GLASS AND GLAZING

The Contractor shall furnish and install glass per the drawings, in accordance with ASTM C1036, ASTM C1048, ANSI Z97.1, and CPSC 16 CFR. Glass types (sheet, polished plate, figured, wired, laminated, tempered, insulated) shall conform to the equivalent ASTM/ANSI standards (e.g. tempered glass to ASTM C1048). Putty shall conform to JIS A 5752/5753, Class 1 (steel fittings) or Class 2 (aluminum fittings), or an equivalent silicone/polysulfide sealant per ASTM C920.

Glass thickness for each pane shall be determined by structural glazing design per ASTM E1300, based on pane dimensions and the design wind pressure at Cl. 7.7.2.1, with minimum thicknesses of 3.0 mm (sheet/plate glass), 4.0 mm (figured glass), and 6.8 mm (wired glass) applying only to small panes in sheltered, non-wind-exposed locations.

No glazing work shall be carried out during rain or when frames/glass are wet; frames shall be cleaned before glazing compound application; glass shall be set in full glazing-compound beds, held with snap beads or glazing channels; all glass shall be cleaned on completion.

7.7.42 PAINTING WORK (REFERENCE)

Painting work under this clause shall be governed by Cl. 7.7.22–7.7.23 of this Section, which shall take precedence over any corresponding provision in Section 1 "General Provisions."

7.7.43 INTERIOR FINISH WORK

This clause covers Vinyl Composition Tile, acid-proof vinyl tile, vinyl base, fiber-cement board, acoustic board, suspended ceiling, ceiling access, insulation, room nameplates, accordion partition, and toilet partitions. Samples and shop drawings shall be submitted for approval before work commences.

Floor tile shall be asbestos-free Vinyl Composition Tile (VCT), 300 × 300 × 3 mm, conforming to ASTM F1066, resistant to alkali, grease, and oils, bonded with a compatible adhesive. Board used for the applications previously specified as asbestos cement board shall be asbestos-free fiber-cement board conforming to ASTM C1186 or ISO 8336, chamfered where necessary, fixed with countersunk stainless-steel screws. Asbestos-containing products shall not be used anywhere in the Works.

Fixing shall not commence until the base is dry and clean, following manufacturer's specification, submitted for approval, with adequate precaution against offset/gap/unevenness and suitable protection until finishing is complete. Acid-proof vinyl tile shall match the shape/dimensions of the VCT above. Vinyl base shall be per manufacturer's recommendation, 100 mm height unless otherwise indicated.

Acoustic ceiling board shall be incombustible, perforated rock-wool, 12 mm thick, fixed with adhesive or nails; base board shall be gypsum board conforming to JIS A 6901 or ASTM C1396, Grade 2, 9 mm thick.

Suspended ceiling shall use a lightweight suspension system: main runners of cold-rolled zinc-coated light-channel steel (38×15×1.6 mm) per JIS G 3350 or ASTM A653, at 90 cm centres, suspended by 6 mm dia. steel hanger bars with adjustable nuts, grid levelled to within 1:500; cross furring of cold-rolled zinc-coated M-section (23×23 mm) at 30 cm centres, perpendicular to main runners, secured by wire clips. Installation shall be per manufacturer's specification, by skilled workers.

Insulation boards under the roof slab shall be selected to achieve the roof U-value/thermal-resistance target established under the Green Building criteria at Cl. 7.7.2.1; where 25 mm wood-wool cement board (JIS A 5404) does not achieve the target, rigid insulation board (XPS/EPS or PIR) shall be used as an alternative or supplement, subject to approval.

Ceiling access panels shall be located for lighting/HVAC-duct maintenance, 600×600 mm, frame of aluminum per JIS G 4100 or ASTM B221. Room nameplates shall be provided on all doors facing outdoors, corridors, and other rooms, size/material/wording designated by the Engineer. Accordion partitions and toilet partitions (melamine-coated waterproof plywood, stainless supports, galvanized square-tube connections) shall be as scheduled on the drawings.

7.7.44 SODDING AND PLANTING

The Contractor shall furnish all labour, equipment, and materials for sodding and planting work. Top soil shall be cleared of foreign matter, approved by the Engineer, hauled and placed when sufficiently dry; manure fertilizer shall be well-rotted and fly-free, mixed with top soil within 48 hours of arrival, with insecticide/larvaecide fly-breeding prevention as approved. Sod shall be planted in firm contact with the bed at minimum 70% coverage density, by skilled workers, with sandy soil top-dressing at 0.01–0.02 m^3/m^2. Ground shall be levelled and cleared of foreign matter before planting; watering equipment shall avoid damage to finished surfaces; seeded beds shall be protected by barricades and warning signage; sodded areas shall be maintained by the Contractor until taking over; and the site shall be cleaned of stones, roots, and debris on completion.

Planting shall comprise 25 trees and 38 m^2 of shrubbery, trees at approximately 4.0 m spacing for shade, shrubbery under 1.0 m, with soil condition surveyed and suitable soil imported as needed. Tree and shrub species should preferentially be native/indigenous or well-adapted to local climate and rainfall, to minimize long-term irrigation demand, confirmed with the Engineer before procurement. Trees shall be pruned by approximately one-fifth of leaf area before transport, retaining natural form, planted per the standard shrub-planting detail on the drawings (staking, guy wires at 120° spacing, earth saucer, fertilized backfill).

7.7.45 PLUMBING EQUIPMENT WORK

This clause covers water supply, sewage/air-vent, sanitary, and clarification-tank equipment work per the drawings. Shop drawings and test results shall be submitted for approval; spare parts for 3 years' normal operation shall be furnished unless otherwise specified. JIS references throughout this clause shall be read as "or an equivalent ASTM/ASME/ISO standard, subject to Engineer approval."

The drinking water tank shall be of earthquake-resistant construction, F.R.P. sandwich-panel with non-alkali fibreglass facing and rigid closed-cell foam core, with insecticide-netted overflow/air-vent connections, locking manhole, elevated-tank support steelwork, steel ladder, and breakwater cover, as scheduled. All materials in contact with drinking water shall be certified safe for potable water contact per NSF/ANSI Standard 61 or an equivalent WRAS/DWI-approved listing. The elevated tank's support structure shall be designed for the seismic zone established at Cl. 7.7.2.1.

Hot water storage, pressure pump unit, water supply pump, sterilizing equipment, and water filter shall be furnished per the equipment schedule on the drawings. Pressure ratings expressed in kg/cm^2 shall be read as equivalent to the corresponding PN rating per ISO 7268/EN 1092. The chlorination equipment shall be set to maintain a free residual chlorine level of 0.2–0.5 mg/L at point of use, per WHO Guidelines for Drinking-water Quality and DPHE guidance.

Sanitary ware and fittings shall be European-standard high quality or equivalent to JIS A 5207/A 5514 (or ASME A112.19.2/ISO 3611, ASME A112.18.1/ISO 3822 equivalents), with visible accessories nickel-chromium plated, water closets and fixtures of approved European manufacture, sample, and design, per the fixture schedule on the drawings.

7.7.46 AIR CONDITIONING AND VENTILATION EQUIPMENT WORK

This clause covers all air conditioning and ventilation equipment per the drawings; shop drawings and test results shall be submitted for approval. Outdoor design conditions: 36°C DB maximum / 28°C WB / 12°C DB minimum. Indoor design conditions: 25°C DB / 60% RH maximum for the GIS Equipment Hall, per Cl. 7.7.2.1(c); 27°C DB (summer) / 22°C DB (winter) for other rooms.

The battery room shall be provided with dedicated, continuously operating (or charge-interlocked) forced ventilation designed to limit hydrogen gas concentration to below 1% by volume (25% of the Lower Explosive Limit), per IEC 62485-2 and IEEE 484, with air-change rate calculated from maximum battery charging current; ventilation fans and electrical fittings within the room shall be rated for the applicable hazard classification. General habitable-space ventilation shall meet the minimum outdoor-air requirements of ASHRAE 62.1.

Package air conditioning units shall use a refrigerant compliant with the Montreal Protocol (as amended by the Kigali Amendment) phase-down schedule applicable in Bangladesh at the time of manufacture; ozone-depleting refrigerants shall not be used.

Package units shall be factory-built and factory-tested (heat-pump type, hermetic compressor, cross-fin heat exchanger, AC 3-phase 400V 50Hz, high-pressure cutout, 3-year spare parts including one refrigerant charge and belt); fans shall be factory-tested, statically/dynamically balanced; ducts shall be galvanized steel sheet with bolted/gasketed flanges; refrigerant piping shall be phosphorus-deoxidized copper per JIS H3603, dimensions per ASTM B88.

Installation work (foundation, equipment, ductwork, piping, insulation, painting per Cl. 7.7.22–7.7.23) and testing (refrigerant air-tightness/vacuum/leak tests, factory and field performance tests, duct air-blow test) shall be carried out per the manufacturer's specification and this Specification, witnessed by the Engineer.

7.7.47 SECONDARY-ELECTRICAL WIRING

This clause covers control panels, switches, receptacles, conduit, wires, and outlet boxes for secondary wiring, per the drawings; scope allocation between primary electrical work and equipment-integral secondary wiring (cooling equipment panels, automatic controls, tank level alarms) shall be as defined in the drawings. Electrical equipment and materials shall meet the standards of the Japanese Electrical Manufacturers Association (JEM), supplemented by IEC 60364. Motors shall conform to the applicable Low-Voltage Three-Phase Induction Motor standard, per the equipment schedule on the drawings.

7.7.48 INDOOR LIGHTING, PLUG, AND TELEPHONE PIPING SYSTEM

Lighting fixtures shall be per the design drawings. Switches shall be mounted at a maximum of 1,200 mm above floor level; receptacles at 0.3 m above floor level; unless otherwise specified, per BNBC 2020 (accessible reach range).

Power source voltages: AC 3-phase 4-wire 415/230V 50Hz and DC 110V for the lighting panel; AC 1-phase 220V 50Hz for normal lighting/outlets/ventilation; DC 110V for emergency lighting. LED lighting shall be manually switched in the Control Room and sensor-based automatic in corridors/toilets/offices/electrical rooms; emergency (AC-failure) automatic lighting shall be provided in the Control Room, corridor, office, and electrical rooms, consistent with the means-of-egress requirement at Cl. 7.7.2.1(a). Exit sign lights shall be mounted above all exits of the Control Building. Telephone outlet boxes shall be provided for the Control Room, coordinated with the electrical scope of work.

Wires, wire connectors, rigid metal conduit and fittings, pull boxes, and wiring devices shall be per the schedule on the drawings (JIS C-series or equivalent IEC 60227 PVC-insulated cable and associated fittings). Emergency lighting fixtures shall conform to IEC 60598-2-22 or NFPA 101. Lighting panels shall be steel plate (≥1.6 mm body / ≥2.3 mm door), painted finish, catalogues and shop drawings submitted for approval. Molded-case circuit breakers shall conform to IEC 60947-2, and residual-current protective devices to IEC 61008/61009.

Rigid metal conduit installation shall be per the drawings: embedding/laying without affecting building strength/structure; cut ends neatly finished; bend radius ≥ 6 times internal diameter, ≤ 4 equivalent 90° bends between pull points; pull/junction boxes at conduit runs exceeding 30 m; switch/outlet boxes at all switch/receptacle/fixture points; low-voltage conduit kept clear of direct contact with communication/water/gas lines. Conduit and fittings shall be perfectly connected, with grounding-conductor resistance kept within 2 ohms to the end metal conduit. Pull/junction boxes shall be steel, ≥1.2 mm thickness, sized for the connected conduits, with access where concealed. Exposed main conduit shall run parallel with wall/ceiling, supported by inserts/bolts embedded in concrete at approximately 2 m spacing. Conduit shall be protected against moisture/water/dust entry, with cut ends capped during concrete work; conductivity checked after form removal. Wire connections shall be made only in metal/junction boxes or distribution boards, with conduit cleaned and bushed before wire pulling.

Heavy lighting fixtures shall be firmly supported using inserts/studs/bolts, with anti-swing provision where necessary; fixtures shall be installed in a workmanlike manner without interfering with equipment inspection. Lighting panels shall be firmly installed without interfering with equipment inspection. A performance test shall be made after installation is complete.

7.7.48.1 Grounding

The Control Building's earthing system shall be integrated with the overall substation grounding grid, designed in accordance with IEEE Std 80 (step/touch voltage criteria) and IEC 61936-1, with measured earth resistance at the building grid not exceeding 1 Ω (or the project-specific design value confirmed by soil-resistivity testing and fault-current analysis), verified by fall-of-potential test per IEEE Std 81. A secondary, purely building-services ground not otherwise bonded to the main grid may retain a 10 Ω target where it does not compromise the integrated grounding grid design.

All electrical equipment shall be grounded except: steel base, metal box, and steel equipment frame operating below AC 150V (to ground) in a dry location; metal conduit and metal accessories shall be grounded; metal enclosures/parts of discharge-lamp fixtures and ballasts shall be grounded except where the Engineer directs otherwise. Grounding resistance values shall be maintained at the specified levels throughout the year despite seasonal soil-moisture variation.

7.7.48.2 Sign, Signal and Annotation

Building signage shall comprise: directional/informational signage (room nameplates per Cl. 7.7.44, exit signs per Cl. 7.7.49), of durable, weather-resistant material appropriate to interior/exterior exposure, with a minimum IP54 rating for exterior-mounted electronic/LED signage; and hazard/safety signage, using standardized safety symbols and colour coding conforming to ISO 7010 or ANSI Z535, mandatory at all electrical hazard locations (switchgear rooms, battery room, cable basement, GIS switchyard access points), consistent with Cl. 7.7.2.1(a).

SECTION 7.8
Inspection And Testing of the Equipment

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SECTION 7.8: INSPECTION AND TESTING OF THE EQUIPMENT

7.8.1Factory Acceptance Tests and Post Landing Inspection

The Employer shall have the right to inspect / examine / test the equipment / goods / materials to confirm their conformity to the specification. The Employer shall be entitled at all reasonable time during manufacture to inspect, examine and test of equipment / goods / materials at the Contractor/Manufacturer's premises, workmanship and performance.

Inspection and testing before and after shipment / supply shall be in accordance with the relevant IEC standard. The below mentioned tests (not limited to) shall be carried out as per latest version of IEC Standard, unless otherwise mentioned in Bidding documents, at the Contractor/Manufacturer's premises, or other places where the test facilities are available.

7.8.1.1 Employer's Engineering Teams

Five (5) Engineering Teams (nominated by the Purchaser) will participate on the quality acceptance test (QAT) for the offered equipment at the manufacturer's plant and confirm their quality as per specification. The Purchaser's nominated "Engineering Team" consists of at least 3 (three) Engineers in each team shall have the witness of the QAT of the goods on the manufacturer's premises. The WZPDCL Engineering Team will be as follows:

	Nos. of Engineers	Name of Equipment
Team-1	3	33kV GIS Switchgear
Team-2	3	UG cable
Team-3	3	33kV PCM, 33kV VCB, 33kV CT, 33kV PT, 33kV Isolator and 33kV LA
Team-4	3	Battery & Battery Charger, AC/DC Distribution Panel, Station Auxiliary Transformer
Team-5	3	Substation Automation System

7.8.1.2 Plan and Program of FAT

The Contractor shall prepare & provide latest one (1) month after Contract's effective date for review and approval:

7.8.1.2.1 Plan for Factory Acceptance Test

The Plan for Factory Acceptance Tests shall contain, at least:

- All equipment, subject of FAT
- Contractor/Manufacturer/Factory/Testing Laboratory location & details
- Tentative date for submission of ITP
- Tentative date for FAT

7.8.1.3 Inspection & Test Plan & Program

For each Equipment, the Contractor shall prepare & provide – at least sixty (60) days in advance - for review and approval – following documentation:

7.8.1.3.1 Inspection & Test Plan & Program (ITP)

The Inspection & Test Plan & Program (ITP) shall contain, at least:

- IEC Standard(s), relevant for the Factory Acceptance Test

- Tests which shall be performed, in accordance with relevant IEC Standard(s)
- Testing procedures
- Acceptance Criteria
- Confirmation of the Quantity of the Equipment for testing
- Serial Numbers (if available)
- Staring date (and time, if available)
- Ending date (and time, if available)
- Draft FAT Report & FAT Protocol

Also, Inspection & Test Plan & Program (ITP) shall contain information about:

- Nearest Airport & details
- Hotel opportunity
- Invitation letter, if required
- VISA requirement, if any

When the Employer intends to attend the test, Employer shall promptly inform the Contractor accordingly in writing, so that Contractor can take an action. If the Employer don't attend at the place so named on date, which the Contractor has stated in his notice, the Contractor may proceed with the tests, which shall be deemed to have been made in the Employer's presence, and shall forth with forward to the Employer duly certified copies of test readings.

7.8.1.4 Final ITP

After that, the Contractor shall prepare & provide – at least fifteen (15) days in advance - following documentation:

7.8.1.4.1 Final, detailed ITP

The Final, Detailed Inspection & Test Plan & Program shall contain, at least:

- Final, Detailed Plan & Program of FAT
- Flight ticket(s)
- Hotel reservation(s)
- Manufacturer/Factory/Testing Laboratory's Representative(s) contact details
- Contractor's Representative(s) contact details
- Routine Test Reports, if available

7.8.1.5 Testing abroad

If the offered goods are manufactured outside the Employer's country, then WZPDCL's Inspection Team, of three (3) Engineers in each team, shall have to conduct Technical Orientation and Quality Test Witness at the Contractor/Manufacturer's factory premises.

The cost incurred for this purpose shall be borne by the Contractor and shall be deemed the cost in this regard is included in the offered price.

The cost of Air Tickets (both way) from Bangladesh to Manufacturer's Country (place of Technical Orientation and Quality Test Witness), Hotel Accommodation, fooding and lodging etc. will be borne by the contractor. Other than this the contractor will pay a standard amount of pocket money (Euro 100) per day (including journey period). The period for this purpose is more or less 7 (Seven) days (Excluding Journey time). All the cost of this purpose shall be deemed is included in the offered price.

7.8.1.6 Testing in Bangladesh

If the offered goods are manufactured inside the Employer's country, then WZPDCL's Inspection Team, of