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GOVERNMENT OF PAKISTAN
PORT QASIM AUTHORITY

TENDER AND CONTRACT DOCUMENTS

FOR CONSTRUCTION OF LIGHT HOUSE

VOL. II : TECHNICAL SPECIFICATIONS

DECEMBER 1975

JAPAN INTERNATIONAL COOPERATION AGENCY

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TECHNICAL SPECIFICATIONS

TABLE OF CONTENTS

DIVISION 1

GENERAL REQUIREMENTS

SECTION 1A

SCOPE OF WORK

1. GENERAL

   a. Work under this Contract shall be subject to VOLUME I, Parts 1 through 5 preceding these Technical Specifications.

   b. This section generally defines the Project as a whole and work under this CONTRACT and the work not in the CONTRACT.

2. SCOPE OF PROJECT

This project at Port Qasim, for the Port Qasim Authority, consists of construction of a new Iron Ore and Coal Berth and related facilities, Navigational Channels and Navigational Aids. The Iron Ore and Coal Berth is to be located in the Gharo Creek area approximately 30 kilometers up stream of the mouth of Phitti Creek in Sind province. When completed, the port is designed to serve 75,000 DWT vessels. Being a new port facility, the Project encompasses all types of work and components required to make such a facility operable. The Project being of such complexity that the Port Qasim Authority has decided to divided the various type of work and components into the following contracts.

1) Contract "A": Iron Ore and Coal Berth, and Related Facilities.

2) CONTRACT "B": Dredging of Navigational Channels.

3) CONTRACT "C": Construction of Navigational Aids including Light House, Leading Lights, Light Beacons and Related Facilities.

4) PROCUREMENT CONTRACTS: Procurement of certain Navigational Aids.

3. SCOPE OF CONTRACT "C"

This Contract consists of the construction of CONTRACT "C" Navigational Aids including Light House, Leading Lights, Light Beacons and related facilities and also includes but is not limited to the following items:-

3 cont'd.

a. Preparatory works including grubbing, surveying, sounding, soil investigation and appurtenant works.

b. Dredging or excavation, compaction, and disposal of all materials to depths and profiles as shown on the Drawings or as may be ordered by the Engineer.

c. Landing Place consisting of:

1) 5.0 m wide x 35.0 m long reinforced concrete pier with related facilities.

2) 3.0 m wide x m long reinforced concrete trestle type access passage.

3) 4.0 m wide x m long embankment type access passage.

d. Approach Road:

1.5 m wide x m long concrete paved road.

e. Light House consisting of:

1) Circular Tower Type Building of cast in-place reinforced concrete with spiral steel stair as access to lantern deck, white and black ceramic exterior finish, all interior finish, electrical and plumbing.

2) Supporting precast reinforced concrete piles 400 mm square in section by approximately 12 m long.

3) Lantern equipment including panel boards, electrical lines, generator and accessories required.

4) Appurtenant facilities.

f. Front and Rear Leading Lights

1) Circular Tower Type Building of cast in-place reinforced concrete, interior and exterior finished, all appurtenant works:

2) Supporting precast reinforced concrete piles 400 mm square in section by approximately 12 m long.

3) Lighting equipment including panels, electrical and gas lines and accessories required.

4) Appurtenant facilities.

g. Light Beacons

1) Circular pole type of cast in-place reinforced concrete on supporting precast reinforced concrete piles 400 mm square in section by approximately 12 m long.

2) Appurtenant facilities.

SECTION 1B

SITE CONDITIONS

1. GENERAL

   a. Work under this Contract shall be subject to VOLUME I, Parts 1 through 5 preceding these Technical Specifications.

   b. This Section is provided for general information only.

   c. Where the PQA and the Engineer have made investigations of climatic, maritime and subsurface conditions in areas where work is to be performed under the Contract, or in other areas, such investigations are made only for the purpose of study and design. The records of such investigations are not a part of the Contract and are shown solely for the convenience of the Tenderer or Contractor. It is expressly understood and agreed that PQA and Engineer assume no responsibility whatsoever in respect to the sufficiency or accuracy of the investigations thus made, the records thereof, or of the intepretations set forth therein or made by the Engineer in its use thereof and there is no warranty or guarantee, either express or implied, that the conditions indicated by such investigations or records thereof are representative of those existing throughout such areas, or any part thereof, or that unforeseen condition may not occur, or that conditions other than those indicated, may not be encountered.

2. SITE CONDITIONS

   a. Accessibility: Since there is no available access road to the Site, the Contractor will provide sea transportation which varies from approx. 6 to 40 km to the various sites from the temporary work yard.

   b. Climate

      1) Temperatures: The following table provides a list of compilation of the temperatures in degrees centigrade, which have been surveyed over a period of approx. 30 years.

Month	Mean Monthly		Extreme Values	
	Max.	Min.	Max. (1931-60)	Min. (1931-60)
	°C	°C	°C	°C
January	27.4	10.7	30.0	6.1
February	29.2	12.3	32.2	8.9
March	33.3	16.3	36.7	12.2
April	35.1	20.3	42.2	16.1
May	30.2	24.7	37.8	22.2
June	35.0	26.2	40.6	22.8
July	34.2	24.9	42.2	23.3
August	32.0	24.3	36.1	22.8
September	32.4	23.6	38.0	21.7
October	36.0	20.6	40.0	16.1
November	33.5	16.8	36.7	11.1
December	30.0	12.3	32.8	8.3

2) Humidity: Average relative humidity:

50% - 70% in January
80% - 90% in August

3) Precipitation: The Site belongs to the dry zones of Pakistan. The mean annual rainfall is 207 mm (8.16") and of this, approx. 96 mm (3.78") falls during the rainy month of July. The average number of rainy days in the year with precipitation of over 2.5 mm (0.1") is 9, of which 3 are to be expected in July.

Month	Average Rainfall (mm)	Mean Number of Rainy Days	Maximum Rain Fall in 24 Hours (mm)
January	9.1	0.9	41.7
February	11.4	0.8	40.4
March	5.8	0.3	53.3
April	2.0	0.2	104.4
May	0.3	0.1	30.7
June	7.4	0.4	182.1
July	96.0	3.2	222.5
August	50.0	1.8	278.1
September	14.5	0.5	206.0
October	2.3	0.1	38.9
November	2.0	0.2	37.8
December	6.4	0.5	46.5

c. Soils: The Contractor shall perform subsoil investigations of locations designated by the Engineer at the Site. All data shall be submitted to the Engineer for evaluation.

d. Maritime conditions:

1) Tides: M.H.H.W. (mean higher high water) and M.L.L.W. (mean lower low water) are taken at +2.90m and +0.55m, respectively above the chart Datum at Phitti Creek. The extreme recorded high water and extreme recorded low water are +3.95m and - 0.83m, respectively.

2) Tide current: Maximum and average velocities recorded at Gharo Creek are 3.6 knots per sec. and 1.6 knots per sec. at ebb tide, respectively.

3) Waves: Wave conditions at the proposed channel area are generally moderate even during the Southwest monsoon.

e. Seismic force: The Department of Meteorology and Geophysics of Pakistan recommends that seismic factors for horizontal (inertia) forces be taken as 0.10 g to 0.20 g.

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SECTION 1C

GENERAL REQUIREMENTS

1. GENERAL

a. Work under this Contract shall be subject to VOLUME I, Parts 1 through 5 preceding these Technical Specifications.

b. This Section sets forth supplementary and additional general requirements for this Contract.

2. NOTIFICATION REQUIRED FROM CONTRACTOR

a. Tests and Inspections: When, during the course of this project, and as required by these Specifications, various tests and inspections are required and scheduled, the Contractor shall notify the Engineer in advance of such tests and inspections to allow the Engineer to make preparations. Minimum advance notice shall be as follows:

1) When Required At or Near the Site: Notify the Engineer not less than 2 working days in advance.

2) When Remote From the Site: Notify the Engineer not less than 10 working days in advance.

b. Notice of Construction Delays:

1) Delays in work which may become the subject or basis of claims for time extensions for changes in Contract Price shall be immediately reported to the Engineer as soon as such condition becomes apparent.

2) Set forth and outline circumstances in written form and file with the Engineer within 5 working days.

c. Notice of Accidents and Fires: Inform the Engineer immediately of any accident, fire or other emergencies which arise on the Site, at Temporary Work Yard or at adjacent areas which may effect the work of this Contract.

3. PRIOR TO STARTING A PARTICULAR TYPE OR KIND OF WORK

a. Examine for relevant information, all Contract Documents and subsequent data issued to the Contractor.

b. Check approved submittals and verify dimensions at jobsite.

c. Consult manufacturers for instructions applicable to conditions under which work is to be done.

d. Inspect areas, surfaces or construction receiving the work. Start of work shall signify compliance with the above requirements and acceptance of previously completed works as being in satisfactory condition to achieve proper installations and first quality workmanship as intended under these Specifications.

4. DAMAGE AND RESTORATION

a. Damage to existing or newly placed facilities caused by movement of equipment or other operations, whether accidental or made necessary by reason of the Contract requirements, shall be restored or replaced as specified or directed by the Engineer.

b. Restoration shall be equal to structural qualities or performance capacities of original work; and finishes shall match appearance of, as nearly as possible, existing adjacent work. Restorations shall be subject to approval by the Engineer and shall be made as necessary at no added expense to the PQA unless otherwise particularly provided for.

c. Work not properly restored or were not capable of being restored as intended under these Specifications shall be removed and replaced as directed by the Engineer, at no added expense to the PQA.

5. MISCELLANEOUS PROVISIONS

a. The Contractor shall immediately refer to the Engineer any requirement shown or specified which the Contractor finds or believes to be:

1) not equal to industry standards for achieving a first quality installation as intended;

2) excessive in cost or effort to effect the intended results;

3) below standard, for proper enforcement of guarantees required;

4) or, at variance with governing laws, regulations, codes or standards.

b. WORK operations relative to any matter referred to the Engineer for consideration shall not proceed until receipt of appropriate instructions from the Engineer.

c. Inspection of Works and Materials: The Contractor shall immediately make a close and thorough inspection of all materials as delivered and all work in progress; shall promptly reject and return all defective materials and re-do any substandard work without waiting for their rejection by the Engineer; and shall check and verify adequate performance or satisfactory results of all tests and inspections before allowing subsequent work to proceed.

SECTION 1D

MATERIALS AND WORKMANSHIP

1. GENERAL

   a. Work under this Contract shall be subject to VOLUME 1, Parts 1 through 5 preceding these Technical Specifications.

   b. This Section sets forth supplementary and additional provisions relating to materials, products, equipment and workmanship required under this Contract.

2. MATERIALS

   a. All materials used in construction of the Permanent Works required under the Contract shall be of the first class quality.

   b. General: All materials used in the Permanent Works shall, unless otherwise stated in the respective sections of the Specifications, comply with the following general requirements and shall be procured in accordance with the procedures outlined in the following paragraphs.

   c. Grade of Material: When reference to a standard is made without indication of a specific grade, the materials shall comply with the suitable grade thereof to be selected in consideration of their purposes and approved by the Engineer.

   d. Trade Names of the materials indicated in the Contract Documents are intended only to show the standard of the materials on which the design of the particular work is based and also to avoid ambiguous descriptions of the materials on the Drawings and Specifications.

      The indication of the trade names, therefore, shall in no way be considered to limit the acceptability of other products of equal or better functions, performances, reliability and durability.

   e. Approval of Manufacturer and/or Material: Refer to SUBMITTALS-SECTION 1J for specific requirements.

   f. Order of Materials: After obtaining the Engineer's approval, the Contractor shall place the order for materials in accordance with the time schedule or at such other times as may be necessary. The Contractor shall forward copies in duplicate to the Engineer of all orders placed by him for the supply of materials to be used in the Permanent Works.

2 cont'd.

g. Package: All materials shall be delivered to the Site in such packages as are normally used for transporting the same to a tropical country and shall be identifiable in a manner acceptable to the Engineer.

3. WORKMANSHIP

The workmanship employed in all works shall be of the first class grade in the light of internationally recognized standards of practice and the whole shall be subject to the approval of the Engineer.

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SECTION 1E

PROGRAMME OF WORKS

1. GENERAL

   a. Work under this Contract shall be subject to VOLUME I, Parts 1 through 5 preceding these Technical Specifications.

   b. This Section sets forth supplementary and additional provisions relating to time schedules and construction programmes required under this Contract.

   c. References

      General Conditions of the CONTRACT (G.C.) Clause 14.

2. PROGRAMME OF WORK

   a. Times of submitting programmes shall be in accordance with G.C. 14.

   b. The following paragraphs set forth the specific type of programme required for the time schedules specified in G.C. 14.

      1) The programme shall include the time schedule of all Works in the form of PERT (Programme Evaluation and Review Technique), consisting of sufficiently detailed and subdivided "activities" and "events" so that the time schedule of any portion of any item of Works can be identified within an accuracy of one month or such a shorter range of time as may specially be required by the Engineer for particular portion of the Works. For this purpose the items of works in large quantities shall be divided into a number of suitable sections and the relationship of preceding events and succeeding events shall be clearly indicated. The time schedule shall indicate the times when the Contractor shall submit all drawings, data or other documents and samples or other matters in accordance with the provisions of the Specifications, and also the times when the Engineer shall approve (or return with comment) the same also in accordance with the Specifications or (if not specified) as per the reasonable schedule which the Contractor shall propose hereby.

      2) The programme shall be accompanied with sufficient data and information including all necessary particulars of constructional plant, temporary works, method of operation, work forces employed, etc. for all activities of several most critical passes to indicate the "pessimistic times" of such activities.

2.b. cont'd.

3) Should the Engineer consider any alteration or addition in the programme and time schedule, the Contractor shall conform thereto without additional cost to the PQA in so far such alterations or additions are reasonably foreseen as necessary.

When the programme and time schedule are approved, they shall be considered as an integral part of the Contract and the Contractor shall ensure that all works will, respectively, be completed within the times indicated on the time schedule except where the Engineer's written approval is obtained beforehand. Likewise, the Engineer and the PQA. will keep the agreed time schedule in respect of their obligations. Whenever necessary and whnever the progress of the actual works shows departure, the programme and time schedule shall be up-dated and submitted to the Engineer of for his approval. The time schedule shall suit the schedule of the works to be executed by others. The Contractor shall be responsible for collecting all necessary information and making appropriate coordination in respect of arrangement of schedule.

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SECTION 1F

TEMPORARY WORK

1. GENERAL

a. Work under this Contract shall be subject to VOLUME I, Parts 1 through 5 preceding these Technical Specifications.

b. This Section sets forth supplementary and additional provisions relating to temporary work, facilities and safeguards required for execution of works for this Contract.

c. Other Sections include temporary facilities for the Engineer and his Staff.

d. Temporary Work, facilities and safeguards specified or required, including coordination in changes of services and like activities, shall be provided for proper performance of the work; as necessary to comply with all statutory regulations; and necessary to expedite and properly execute the project work.

e. Temporary Construction shall be adequate for intended uses and for all loads imposed without excessive settlement, deflection or deformation. All parts and members shall be properly supported, wedged, braced and secured to prevent displacement or failure.

f. Temporary utilities and permanent utilities used for construction shall be adequate for intended uses and not overloaded or otherwise used or arranged in any manner endangering persons, premises or work. Connections shall be properly made; lines and wiring securely anchored in place; and protected against accidents.

g. Completion:

1) Upon completion of work, or before, if so required or directed, temporary structures, installations and utility services shall be disconnected and removed from the premises.

2) Exterior areas used for temporary installations or work shall be returned to their original condition, or work otherwise completed as required at such areas.

2. TEMPORARY UTILITIES AND SERVICES

a. Utilities and Services Available

1) Water:

2. a. cont'd

2) Electricity: The Contractor shall provide and maintain at his expense a generator including all wiring, meters and other accessories required for the system.

b. Payment of Utilities: The Contractor shall pay all utility charges at no additional cost to the PQA.

Install temporary meters where not otherwise provided by utility company.

c. Sanitary

1) Provide temporary toilet facilities, of the type approved by the Engineer, in sufficient quantity to adequately service the Temporary Work Yard and the Site.

2) Maintain facilities daily with cleaning and supplies.

d. Drinking Water: Provide and maintain canister coolers or connected drinking fountains of sufficient number to reasonably serve the project.

e. Construction Water: Provide and maintain temporary water service and distribution of adequate capacity for construction purposes. Include potable units, line extensions, hoses, valves, etc., as necessary.

f. Power and Lighting:

1) Provide and maintain temporary electric service and distribution; of adequate capacity for power, lighting and other construction needs. Including wiring, transformers, safety devices, connections, etc. as necessary.

2) Provide temporary lighting as necessary to properly and safely perform work at enclosed spaces or hazardous conditions. Likewise, provide for night protection as necessary.

3) Temporary electrical system shall comply with all codes or regulations.

g. Waste and Rubbish

1) Provide regular daily cleanup and removal of trash, waste, construction debris, etc., from Site and Temporary Work Yard.

2) Transport to disposal areas and dispose of waste and rubbish shall be arranged by the Contractor.

3. FIRST-AID AND FIRE PROTECTION

a. Emergency Calls: Determine locations of local or nearest

3. a. cont'd

available police, hospital or medical services; and maintain list at the Contractor's Site Office.

b. Fire Protection:

1) Establish appropriate emergency routes and procedures and submit plan to the Engineer.

2) Maintain fire extinguisher, connected hoses and other facilities necessary for reasonable fire protection action at the Site and Temporary Work Yard.

c. Minor Injuries: Provide and maintain at the Contractor's Site office reasonable bandage and sterilant materials for first-aid treatment of minor injuries.

4. CONSTRUCTION SAFEGUARD

a. Trenches intersecting thoroughfares shall be provided with bridges or other crossings suitable for safely carrying the type of traffic involved; with railings as necessary.

b. Open shafts, openings in floors, ramps, platforms and other conditions shall be protected by sturdy barricades or railings.

c. Scaffold, ladders, ramps, hoists, and other facilities shall be provided, maintained and operated as necessary.

d. Storage and shop areas shall be provided, arranged and maintained at approved locations as necessary to properly store, handle and fabricate the various materials and equipment required.

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SECTION 1G

TEMPORARY FACILITIES FOR THE ENGINEER AND HIS STAFF

1. GENERAL

   a. Work under this Contract shall be subject to VOLUME I, Parts 1 through 5 preceding these Technical Specifications.

   b. This Section sets forth only temporary facilities and equipment as shall be provided for the Engineer and his staff.

   c. This Section does not include any temporary work required by the Contractor for the execution and maintenance of the Works.

   d. The Contractor shall construct, provide, maintain, demolish and clear away, as required, and when instructed, the temporary facilities and equipment specified herein, all at his own expense.

2. OFFICE AND CABIN

   a. Provide one office for use of the Engineer and his staff, and one cabin for the use of the Engineer's inspectors.

   b. Office: Location of the office shall be within the workyard and living quarter area but exact position thereof shall be as directed by the Engineer. The office shall consist of the following.

      1) Two office rooms, each 5 m x 4 m floor area.

      2) One store room, 5 m x 4 m floor area.

      3) One toilet, 2 m x 2 m floor area.

      4) Enclosed corridor of 1.5 m width connecting all rooms.

      5) Car port with shelter for two cars.

      6) Paved or stabilized access road.

   c. Inspector's Cabin: Location of the inspector's cabin shall be near the office and as directed by the Engineer. The inspector's cabin shall consist of the following.

      1) One room, 4 m x 4 m floor area.

      2) One store room, 3 m x 3 m floor area.

      3) One toilet, 2 m x 2 m floor area.

3. CONSTRUCTION

a. Construct and furnish the office and inspector's cabin in accordance with the following brief specifications and as approved by the Engineer. All materials, equipment, furniture, etc. to be used in the works shall be new unless otherwise specifically permitted by the Engineer.

1)	Foundation:	Class C concrete for reinforced portion and Class E concrete for plain works.
2)	External wall:	Hollow concrete block, 20 cm wide.
3)	Partition wall:	Concrete block, 15 cm wide.
4)	Beam and column:	Reinforced concrete, Class C.
5)	Floor:	Class E concrete, trowel finish.
6)	Roof:	Steel or timber truss roof with asbestos or steel sheeting.
7)	Ceiling:	Suspended insulation board false ceiling.
8)	Door:	Wood flush door with external flyscreen and approved cylinder lock.
9)	Window:	Standard steel sash, burglar proof, glazed with clear glass for offices and obscured glass for toilet. Flyscreens and sunblinds are also required.
10)	Sanitary fitting:	One European W.C. for the office and one Eastern W.C. for the inspectors' cabin. Each toiler shall be equipped with a wash basin.
11)	Drainage:	Connect sanitary fittings to temporary drains and to septic tanks of approved type.
12)	Lighting:	Adequate fluorescent lighting with shade by ceiling and table lights shall be provided.
13)	Convenient outlet:	Convenient outlets for electricity shall be provided for each room.
14)	Air conditioners:	All rooms except toilet and store room shall be equipped with window type air conditioners of sufficient capacity to keep room temperature under 27°C at all times.

3. a. cont'd

15) Telephone: One exchange line for the office all extension lines for each room and inspector's cabin except for toilet and store room.

16) Internal finish: 1.5 cm thick plaster with emulsion paint finish, partly applied with fibre boards to pin-up drawings, etc.

b. The Contractor may provide a ready-made prefabricated office and cabin which are equivalent in area and number of rooms, as specified above if he has proposed the same in his tender and has received the Engineer's approval.

c. Provide the following furniture and equipment for the office and cabin where and as directed by the Engineer. All furniture and equipment are subject to the approval of the Engineer.

Furniture and Equipment	Quantity Required
Working desks, steel, w/5 or more drawers	3
Writing chairs w/arm rest	3
Typewriting desks w/drawers	2
Chairs	4
Filing cabinets, steel, 90 cm x 180 cm x 45 cm min.	3
Drawing racks	2
Safe, fire proof	1
Cupboards, steel, 90 cm x 180 cm x 45 cm min.	2
Book shelves, steel, 90 cm x 180 cm min.	2
Drawing table complete with chair	1
Typewriters, 18 inch carriage, English	2
Portable calculators, 16 digit, w/2 memories and root operation	2
Copying machine, electro-magnetic or other suitable type but capable of rapid production of clean copies from non-transparent originals, size, A-3 min.	1
Refrigerator, 160 litre capacity min.	1

Furniture and Equipment	Quantity Required
Plan chests, W/5 or more drawers	2
Table lamps	6
Black boards (150^{cm} x 90^{cm})	2

4. RESIDENCES FOR THE ENGINEER AND HIS STAFF

Provide and maintain 1 residence consisting of the following minimum requirements.

1) 3 bedrooms, complete with dining, kitchen and bathroom facilities.

2) All furnishings and utensils.

3) Air conditioned in all living, dining and bedroom areas.

4) A combination cook steward or one cook and one steward.

5. UTILITIES

a. Office and cabin shall be connected to electrical system and potable water supply.

b. Residences shall have all utilities paid.

6. TRANSPORTATION

a. Provide the Engineer and his staff with the following transportation:

1) 2, 4 wheel drive vehicles; Land Rover type; 4 passenger minimum; insulated steel top.

2) 1 inboard motor boat; 85 h.p. minimum, 4 passenger minimum.

b. All equipment shall be new and complete with all standard equipment and tools.

c. Provide licensed drivers for all vehicles and an operator for boat.

7. INSTRUMENTS

Supply the following instruments and equipment: made by the reputable manufacturers whose names shall be approved by the Engineer. The Contractor shall submit the general catalogues of the approved manufacturers for the Engineer's selection of each item of instruments and equipment.

7. cont'd

1) One automatic level, 10 minute reading, complete with tripod and other accessories.

2) Two levelling staffs, 3 m long, center-hinged.

3) One survey umbrella.

4) One measuring steel tape, calibrated, 50 m long with thermometer, and other accessories.

5) Two measuring steel tapes, same as above but 20 m long.

6) One ordinary thermometer.

7) One maximum and minimum thermometer.

8) One wet and dry thermometer.

9) Two insulated water carriers, 1 gallon capacity minimum.

8. OPERATION AND MAINTENANCE

a. The Contractor shall operate and maintain all temporary facilities and equipment required at his own costs and responsibility by repairing, renewing or replacing the works when the same are required and by supplying all necessary materials, articles and things including, but not by way of limitation, supply of water, electricity, fuel, stationery, petrol, oil, tyres, spare parts, etc., paying telephone bills and rendering of all other services which may be normally necessary for the efficient running of the office and residence of the Engineer.

b. Should the Contractor fail to maintain, repair or replace any work when the same is required or to supply any material, article or thing necessary within the times to be specified by the Engineer, the Engineer may execute or cause to be executed by others such maintenance, repair or replacing works and procure materials, articles and things from suitable sources and the Contractor shall pay therefor as certified by the Engineer or the Engineer shall have the right to deduct the sums from any money which is due or become due to the Contractor.

9. PROGRAMME

a. Contractor shall submit for approval outline drawings of the office and cabin and lists of trade names of the equipment, instruments and furniture within one week of signing the Contract.

b. Within three weeks of the Engineer's approval, the Contractor shall supply all vehicles.

c. Within two months of the Engineer's approval, the Contractor

9. c. cont'd

shall complete and hand over the office complete with equipment, furniture and instruments. The inspector's cabin shall be completed and handed over as necessary according to the programme approved by the Engineer.

d. The Engineer reserves the right to suspend any relevant works of the Contractor which, in the opinion of the Engineer, can not be executed without supervision of the Engineer, should the completion of the temporary works herein required be delayed.

10. REMOVAL AND CLEARING

a. Upon completion of the Contract or at such times as may be directed by the Engineer, the Contractor shall remove all temporary facilities and equipment from the Site which shall be left clear and in good order to the satisfaction of the Engineer.

b. All temporary works herein specified shall be the property of the Contractor upon removal thereof from the Site.

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SECTION 1H

TESTS AND INSPECTIONS

1. GENERAL

   a. Work under this Contract shall be subject to VOLUME I, Parts 1 through 5 preceding these Technical Specifications.

   b. This Section sets forth general provisions regarding tests and inspections required under this Contract.

   c. References

      1) PROGRAMME OF WORKS - SECTION 1E

      2) SUBMITTALS - SECTION 1J

2. TEST LABORATORY

   a. The Contractor shall construct a centralized laboratory in the vicinity of the Engineer's Office where all site required laboratory tests specified under various sections of the Specifications shall be carried out.

   b. The laboratory shall have sufficient working areas and shall be equipped with all necessary facilities, equipment, apparatus, tools, etc. and shall also be provided with a suitable store room.

   c. The Contractor shall run and maintain the laboratory. The Engineer shall, however, have the right to use the laboratory at any time he wishes. The Contractor shall supply one set of keys of the laboratory for the Engineer's custody. If so directed by the Engineer, the Contractor's activity in the laboratory shall be limited to the normal working hours and in the presence of the Engineer.

3. TESTS

   a. The Contractor shall carry out all tests required under the various sections of the Specifications except for the tests expressly stipulated to be made by others in the presence and under the supversion of the Engineer and the Contractor shall submit, to the Engineer, five copies of fully detailed test reports within one week of the completion of respective tests or within such times as may be specifically directed by the Engineer.

   b. The Contractor shall supply and maintain complete testing equipment, apparatus, tools, gages, instruments, etc. and shall

3. b. cont'd

provide all necessary materials, specialists and labour required for carrying out the tests.

c. The Contractor shall prepare and supply, as directed by the Engineer, all samples, test pieces, specimens, etc. required for the tests to be made by others as well as for the tests to be carried out by him.

d. The provisions of testing equipment, etc. and specialists and labour shall be made in consideration of the programme of works and on the basis that all specified tests can be completed within the normal working hours of one shift only except for the tests of such nature that they are to be carried out continuously.

e. All tests shall generally be carried out in accordance with the requirements and procedures of the referred standards or as directed by the Engineer.

As for the testing methods, other approved equivalent standards may be applied; in such case, the Contractor shall submit beforehand the copies of such standards for the Engineer's approval.

f. The tests shall be particularized if the purpose or normal title of such tests are specified.

1) For the estimation purpose, the requirements of ASTM, AASHTO, BS, ISO, JIS or similar standards shall be taken into account.

2) Where the tests are specified to be carried out in a manner directed by the Engineer, the requirements of above-mentioned standards for similar tests shall be taken into account for estimation purpose and the tests shall be considered also as specified.

g. Unless otherwise expressly stated, all tests and works in connection therewith shall be considered as incidental to the Permanent Works which require such tests and all costs thereof shall be deemed to be included in and covered by the Schedule Rates of the Pay Items.

4. INSPECTION AND TEST ALL MILL

a. If so specified or directed by the Engineer, all materials to be used in the Permanent Works shall be subject to tests at the mills by the inspecting Engineers who may be dispatched by the PQA at its own cost.

The Contractor shall ensure in his contracts with suppliers and sub-contractors that the inspecting Engineers will have access at all reasonable times to manufacturer's and suppliers' premises and be afforded every facility and conveniences for making inspections, taking samples, testing, etc.

4. cont'd

b. The samples shall be taken and the tests shall be carried out in the presence of the inspecting Engineers by the Contractor or by the manufacturers without cost to the PQA, all in accordance with the practice normally employed for the procurement of respective materials, unless stricter requirements are specified in the respective sections.

c. The Contractor shall submit five copies of test reports of the manufacturers as soon as practicable after the tests are completed.

5. SAMPLE OF MATERIAL AND WORKMANSHIP

Apart from sampling and testing materials at the mills, the Contractor shall furnish at his own cost samples of materials and workmanship in accordance with such reasonable requests of the Engineer for his approval of materials and workmanship.

Such samples maybe retained by the Engineer which will be used as the basis for approving the works and materials in the field.

6. TEST AT THE SITE

a. Notwithstanding any previous inspections and tests, all materials delivered to the Site shall be subject to examinations and tests, if so directed by the Engineer.

1) All such examinations and tests shall be carried out by the Contractor at his cost in the presence and under the supervision of the Engineer in accordance with the normal practice in respect of such examinations and tests if the same may be carried out by the Contractor with his staff and equipment available at the Site.

2) Otherwise, the tests shall be made at a laboratory approved by the Engineer at the cost of the PQA.

b. The Contractor shall submit the test reports if all tests are made by him as specified in 4. above.

c. The Engineer shall be at liberty to reject any materials which do not comply with the requirements of the Contract notwithstanding any previous approval thereof.

d. The Contractor shall not be entitled to any extra payment or extension of time for completion of the Works on account of the rejection of materials due to their non-compliance with the requirements or of the waiting time reasonably required for carrying out the examinations and tests.

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SECTION 1J

SUBMITTALS

1. GENERAL

a. Work under this Contract shall be subject to VOLUME I, Parts 1 through 5 preceding these Technical Specifications.

b. This Section sets forth general provisions regarding submittals required by the Contractor.

c. References

1) PROGRAMME OF WORKS - SECTION 1E

2) TESTS AND INSPECTION - SECTION 1H

2. CONTRACTOR SUPPLIED DOCUMENTS

The Contractor shall supply the following documents as required under various Sections of the Specifications or as requested by the Engineer.

1) Surveying and sounding drawings, and reports on subsoil investigations as required by the Specifications.

2) Drawings and calculations for all Temporary Wroks; this also includes drawings and calculations for any part of permanent structures which are fully or partially used as Temporary Works or as a support thereof.

3) Structural calculations for temporary construction and erection stages of the permanent structures, inclusive of determination of the strength and stability of already completed structural members, as well as of the stability of excavation embankments, retaining walls and the like, insofar as additional loads occur to them in the course of the execution of construction work.

4) Drawings and calculations in connection with any alternative proposal for design and execution of the special construction method or sequence for construction or erection of the permanent structures or parts thereof.

5) Shop drawings, calculations and specifications for special equipment or construction materials, for which the manufacturing firms normally do not supply shop drawings, at least brochures with sketches on basic shape, installation dimensions and the like must be supplied in order to enable the Engineer to make an evaluation and to carry out a check.

2. cont'd

6) Bar bending schedules for concrete works, as well as shop drawings and calculations for structural steel members.

7) Reports and records of all tests on material carried out by the Contractor or by his suppliers.

8) The records, reports and the like of definite construction measures to be supplied by the Contractor.

9) Drawings of site measurements and of settlement of accounts or quantity calculations, lists and the like.

10) As-built drawings for all Works showing all changes undertaken in the course of the construction work.

11) Brochures and technical literature of all equipment and fixtures which are to be permanently installed in the Works.

12) All instructions (in the form of lists, manuals and the like), which are required by the PQA for proper operation and for expert maintenance and repair of the structures and facilities.

3. NUMBER OF SUBMITTALS REQUIRED

a. Contractors Submittals: Submit 3 preliminary sets of all documents required.

b. Distribution shall be as follows:

1) 2 sets to the Engineer's Site office.

2) 1 set to the PQA head office..

3) All such documents shall be marked "Preliminary".

c. After review and checking the Engineering will return 1 set of documents to the Contractor.

d. Contractor shall correct or supplement the documents as required by the Engineer, after which he shall submit 6 copies and 1 reproducible ozalid, or equivalent copy, to the Engineer for his review.

1) If still not approved by the Engineer they will again be returned to the Contractor for corrections, supplementation and resubmittal.

2) If approved, the Engineer will mark each document approved and distribute them as follows:

a) Retain 1 copy for his file.

b) 1 copy each to the head office of the PQA and to the Site office of the PQA.

3. d. 2) cont'd

c) 3 copies to the Contractor.

d) The reproducible copy will be handed over to the Contractors Site office where a file of all such reproducibles shall be kept until the completion of the project at which time they will be submitted to the PQA at the same time as the Contractor submits his as-built drawings.

4. SHOP DRAWINGS

a. Shop Drawings shall mean and include all kinds of shop, assembly, installation and other working drawings inclusive of design calculations, specifications, data, catalogues and other information accompanying the working drawings.

b. The Contractor shall illustrate fully the requirements of the Contract Drawings and Specifications, and shall accurately show kinds and quantities of materials, methods of assembly, workmanships and all other information required for fabrication, erection and installation; the relationship with adjoining works shall also be properly shown.

c. Drawings shall be prepared to the approved standard sizes as far as practicable.

1) The drawings inclusive of any printed materials, illustrations, etc. shall be identified by project, titles and numbers and bound in sets.

2) No drawings will be checked by the Engineer unless they bear a stamp and signature indicating that the Contractor has checked them and that they have been carefully prepared by competent persons familiar with the works and that studies have been made of related works.

d. If any of the working drawings be rejected or returned with comments for corrections, the Contractor shall submit alternatives or corrected drawings as the case may be as directed by the Engineer and shall obtain, in all cases, the Engineer's approval before proceeding with the works.

No claim for delay caused by the disapproval of the drawings will be accepted if such disapproval is due to non-compliance of the works shown therein on the part of the Contractor to the Contract requirements or the procedure specified herein.

e. The submission of the drawings, in either the original submission or resubmission with corrections, shall constitute the evidence that the Contractor has checked all descriptions thereupon and has accepted and is willing to carry out the works as shown in a workmanlike manner and in accordance with the best standard practice.

4. cont'd

f. The Engineer's approval of the drawings will be general and shall not in any way relieve the Contractor from any of the duties required under the Contract.

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SECTION 1K

STANDARDS AND ABBREVIATIONS

1. GENERAL

   a. Work under this Contract shall be subject to VOLUME I, Part 1 through 5 preceding these Technical Specifications.

   b. This sections sets forth standards and abbreviations used and referred to in various Sections of the Technical Specifications.

2. STANDARDS AND ABBREVIATIONS

   a. In the Specifications references are made to the standards issued by the following organizations and referred to by the abbreviations shown.

	Organization	Abbreviation
1)	US Aluminum Association	AA
2)	US Architectural Aluminum Manufacturers Association	AAMA
3)	American Asphalt Institute	AAI
4)	American Association of State Highway and Transportation Officials	AASHTO
5)	American Concrete Institute	ACI
6)	American Institute of Steel Construction	AISC
7)	American Iron and Steel Institute	AISI
8)	American National Standards Institute	ANSI
9)	American Petroleum Institute	API
10)	American Railway Engineering Association	AREA
11)	American Society of Mechanical Engineers	ASME
12)	American Society for Testing and Materials	ASTM
13)	American Welding Society	AWS
14)	American Water Works Association	AWWS
15)	British Standards Institute	BS

2 cont'd.

16)	International Standards Organization	ISO
17)	Japanese Industrial Standards	JIS
18)	US National Fire Protection Association	NFPA
19)	US National Woodwork Manufacturers Association	NWMA
20)	US Plumbing and Drainage Institute	PDI
21)	Swedish Standards Institute	SSI
22)	U.S. Department of Commerce National Bureau of Standards	NBS
23)	U.S. Federal Specifications	Fed.Spec..
24)	U.S. Military Specifications	MIL
25)	Japan Water Works Association	JWWA

b. Where one of the above standards is referred to, the corresponding other standards listed above shall be considered to be equally applicable, provided that performance and functions of materials, or workmanship or methods of tests, etc. are equal to or better than those specified in the referred standard and provided that the quantity of the Works will not be increased on account of complying with the new standard.

The Contractor shall submit proof that when a standard other than that specified is proposed it is in fact equal to or better than the specified standard.

c. Such reference shall in every case be considered to be made to the latest edition of the standard including all revisions up to the date of invitations to tender, unless otherwise specially noted herein.

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SECTION 1L

INDEX OF DRAWINGS

DWG. NO	TITLE
	LIGHT HOUSE
II - 16	FINISHED SCHEDULE
II - 17	KEY PLAN & DETAILS OF JETTY AND APPROACH ROAD
II - 18	GENERAL PLAN
II - 19	ELEVATION
II - 20	PLAN & SECTION
II - 21	SECTIONS & DETAILS
II - 22	PLOT PLAN, ELEVATION & DETAILS
II - 23	PLANS, ELEVATION, SECTION & DETAILS
	REAR LEADING LIGHTS
II - 24	PLANS, SECTIONS & ELEVATION
II - 25	SECTION, ELEVATION & DETAILS
	LIGHTED BEACON
II - 26	PLANS, ELEVATIONS, SECTION & DETAILS
	LIGHT HOUSE
II - 27	STRUCTURAL DETAILS AND BAR ARRANGEMENT
II - 28	STRUCTURAL DETAILS AND BAR ARRANGEMENT
	FRONT LEADING LIGHTS
II - 29	DETAILS OF BAR ARRANGEMENT
	REAR LEADING LIGHT
II - 30	DETAILS OF BAR ARRANGEMENT
	LIGHTED BEACON
II - 31	DETAILS OF BAR ARRANGEMENT
II - 32	DETAILS OF PRECAST REINFORCED CONCRETE PILE
	LIGHT HOUSE
II - 33	ELECTRICAL INSTALLATIONS NO. 1 INDOOR ELECTRICAL WIRING PLAN
II - 34	ELECTRICAL INSTALLATIONS NO. 2 MENTIONS SPECIFICATIONS

DWG. NO.	TITLE
II - 35	LIGHTNING ROD EQUIPMENT (1) PLAN SECTION & ELEVATION
	LEADING LIGHTS
II - 36	GAS PIPING
II - 37	LIGHTNING ROD EQUIPMENT (2) PLAN SECTION & ELEVATION
II - 38	DETAIL OF LIGHTNING ROD EQUIPMENT (3)
II - 39	PLAN OF WATER SUPPLY PIPINGS AND EQUIPMENT (1)
II - 40	PERSPECTIVE LAYOUT AND DETAILS OF PIPINGS AND EQUIPMENT
II - 41	PLUMBING FIXTURE SCHEDULE AND DETAILS OF PERVIOUS CESS POOL
II - 42	DETAILS OF SEPTIC TANK
II - 43	DETAILS OF LANTERN & OPTICAL APPARATUS
II - 44	DETAILS OF OPTICAL APPARATUS

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DIVISION 2

SITE WORKS

SECTION 2A

SURVEY AND SOUNDING

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

This Section includes surveying and sounding and other miscellaneous work such as setting out or survey of levels.

3. REFERENCE

All survey shall be carried out in reference to Bench Marks or Monuments and Chart Datum designated by the Engineer.

4. SURVEYOR

All survey work specified in this Section shall be carried out by licensed surveyors. The Contractor shall submit in advance for the Engineer's approval, true copy of the licenses and qualifications of the surveyors to be employed for the works.

5. TOPOGRAPHIC AND HYDROGRAPHIC SURVEYS

a. At commencement of Work: The Contractor shall perform topographic and hydrographic surveys of the following:

1) For lighthouse, an area of apprximately 20,000 m^2.

2) For front leading light, an area of approximately 10,000 m^2.

3) For rear leading light, an area of approximately 10,000 m^2.

4) For light beacon an area of approximately 10,000 m^2.

The Engineer will determine exact locations of above-mentioned Surveys. The Contractor shall carry out survey by traversing, sounding and leveling. Prepare the topographic maps and hydrographic charts on plastic sheets in 1 : 500 and 1 : 1,000 scales.

5. a. cont'd

Maps and charts shall show facilities, structures and other salient features of the area within an accuracy of 1 : 3,000 in respect of their positions and shall have contour lines of 50 cm vertical intervals.

b. All stations shall be established by closed traversing with an error of closure of not more than 1 : 3,000 and return or closed leveling within an accuracy of 20 mm in one kilometer.

c. The Contractor shall submit, upon completion of the maps, the original and five copies thereof.

6. SETTING OUT OF WORKS

The Contractor shall set out the Works and shall be solely responsible for the accuracy of such setting out. The Contractor shall provide, fix and maintain all stakes, marks or the like which are necessary for the accurate setting out of the Works, and shall take all necessary precautions to prevent their removal of disturbance, all as approved by the Engineer.

7. FIELD NOTES, ETC.

Field notes, calculation sheets and all other documents shall be prepared in English language and in a manner to be approved by the Engineer. The Contractor shall sumit such notes and other documents on completion of the respective works or, if so required, during the progress of works for the Engineer's inspection thereof.

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SECTION 2B

SOIL INVESTIGATION

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

This Section includes soil investigation works which shall be carried out under the Contract.

3. GENERAL PROVISIONS

a. Except where otherwise permitted by the Engineer, all works shall be carried out in the presence and under the supervision of the Engineer.

b. The Contractor shall obtain in advance the Engineer's approval on general arrangements and equipment to be employed for the works.

c. The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the references thereto:

1) American Society for Testing and Materials (ASTM) Publications:

D1586-67	Penetration Test and Split-Barrel Sampling of Soil.
D2435-70	Test for One-Dimensional Consolidation Properties of Soil.
D2488-69	Description of Soils (Visual-Manual Procedure).

2) American Association of State Highway and Transportation Officials (AASHTO)

T86-70	Investigating and Sampling Soils and Rock for Engineering Purposes.
T89-68	Determining the Liquid Limit of Soils

3. c. 2) cont'd

T90-70	Determining the Plastic Limit and Plasticity Index of Soils
T99-70	The Moisture-Density Relation of Soils Using a 5.5-lb Rammer and a 12-in. Drop.
T100-70	Specific Gravity of Soils
T193-63	California Bearing Ratio
T207-70	Thin-Walled Tube Sampling of Soils
T208-70	Unconfined Compressive Strength of Cohesive Soils.

4. CONTRACTOR'S STAFF

The Contractor shall provide a qualified specialist and experienced staff for the works; their qualifications shall be submitted beforehand for the Engineer's approval.

5. LOCATION AND ELEVATION

The Contractor shall locate the sites for soil investigations based on the Engineer's instructions on maps, drawings, etc. and shall establish the levels of the ground and the various levels of the investigations. The Contractor shall be solely responsible for the accuracy of such locations and elevations.

6. BORING AND TESTS

a. Borings: A total of 17 borings are required as designated by the Engineer at the following locations:

1) 2 borings at lighthouse area.

2) 1 boring at front leading light area.

3) 1 boring at rear leading light area.

4) 1 boring for each light beacon area (total 13 borings).

b. Depths of Boring shall be up to EL-30 m unless otherwise directed by the Engineer.

c. Borings shall be made using rotary drilling method with suitable casing, and samples for identification of soils shall be taken at every 1.5 m and at any point where material changes in character. Each sample shall be kept in an approved sample bottle which shall be sealed and on which a label with the descriptions of the sample in accordance with ASTM D2488, shall

be fixed. The Contractor shall submit to the Engineer all samples in sealed bottles in a case for the permanent storage thereof.

d. During the boring operations the standard penetration tests shall be carried out at one meter intervals in accordance with ASTM D1586. Any other test required by the Engineer shall be carried out in accordance with the acceptable standards.

e. In addition, the Contractor shall take, by means of 10 cm dia. sampler, an appropriate number of undisturbed samples of the underlying clay layers from the borcholes made, and the following tests shall be performed on the undisturbed samples thus collected.

1) Liquid limit in accordance with AASHTO T89-68.

2) Plastic limit in accordance with AASHTO T90-70.

3) Natural moisture content in accordance with AASHTO T99-70.

4) Specific gravity in accordance with AASHTO T100-70.

7. REPORT

Within one week of completion of respective borings and tests or at such other time as may be directed by the Engineer, the Contractor shall submit, in five copies, the test report on the works completed, which shall cover all particulars of the boring and tests and shall include drawings to indicate locations and elevations of the boring and tests. Where consolidation tests are made, the report shall also include analysis on anticipated, short and long term settlement.

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SECTION 2C

EARTHWORK

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not herein.

2. SCOPE OF WORK

The work includes dredging, excavation, sheeting, bracing, embankment construction, filling, backfilling, and subgrade preparation.

3. GENERAL REQUIREMENTS

a. Preparation of Area: Prior to commencement of earthwork operations, areas to be excavated, or on which embankment is to be placed, shall be cleared, grubbed, and scraped. Earthwork shall not commence until an area has been prepared which is sufficient to allow efficient and uninterrupted progress. Area preparation shall proceed sufficiently in advance of earthwork so as to preclude hindrance of either operation.

b. The Contractor shall satisfy himself and shall be deemed to have satisfied himself as to the sources from which the fill materials shall be obtained, transportation on sea and land, levels and slopes of the fills shown on the Drawings, the requirements of compaction, possibility of settlement and all other particulars whatsoever in connection with the filling works.

c. The following publications listed below, but referred to thereafter by basic designation only, form a part of these Specifications to the extend indicated by the references thereto:

1) American Society for Testing and Materials (ASTM) Publications:

D422-63	Particle-Size Analysis of Soils.
D1556-64	Test for Density of Soil in Place by Sand Cone Method.
D1557-70	Test for Moisture-Density Relations of Soils, Using 10 lb. Rammer and 18 in. Drop.

3. c. cont'd

2) American Association of State Highway and Transportation Officials (AASHTO)

M145-66	Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes

d. Equipment: All equipment shall be subject to the approval of the Engineer. The Contractor shall submit prior to the Wroks the detailed descriptions and illustrations of each equipment, specially, the transportation equipments on sea and land to mobilize the required volume for the fill within the proposed period of the Construction schedule.

e. Submittals

1) Refer to SUBMITTALS-SECTION 1J

2) Shop Drawings: Submit complete drawings of cofferdams including proposed materials, methods of bracing, method of dewatering; including design calculations on all work.

4. TEMPORARY COFFERDAMS

a. The Contractor shall be responsible for the design and construction of all temporary cofferdams required for foundation and piling work.

b. Cofferdams shall be carried well below the bottom of the footings and shall be well braced and as watertight as practicable.

c. The interior dimensions of cofferdams shall provide sufficient clearance inside the wales for constructing forms and driving piles and to permit pumping outside the forms.

d. Cofferdams which are tilted or moved out of position by any cause during the process of sinking shall be corrected or enlarged so as to provide the necessary clearance.

e. In tidal waters cofferdam walls shall be vented at low water elevation to insure equal hydrostatic head both inside and outside of the cofferdam during the period of placing and setting of seals.

f. No shoring will be permitted in cofferdam which would induce stress, shock or vibration in the permanent structure.

g. After completion of the substructure, the cofferdams with all sheeting and bracing shall be removed at least to 60 cm below ground level or seabed, by the Contractor at his expense, and such removal shall be performed in manner that will not disturb the permanent structure.

5. DREDGING

The Contractor shall dredge and dispose all materials to depths and profiles as shown on the Drawings or as directed by the Engineer. The Contractor shall ensure that over-dredging in no instance exceeds 30 cm below the minimum depth shown on the Drawings. All dredging operations and disposal of dredged materials shall be conducted without interfering shipping and navigation of other traffic. Lights, marks, notices, etc. shall be exhibited at all times and places as may be required by the Engineer.

6. EXCAVATION

a. Excavation for Buildings and Structures shall conform to the dimensions and elevations shown on the Drawings. Excavation shall extend to a sufficient distance from walls and footings to allow placing and removal of forms, installation of services and inspection, except directly against excavated surfaces. When concrete is to rest on a surface other than rock, special care shall be taken not to disturb the bottom of the excavations, and excavation to the final grade level shall not be made until just before the concrete is to be placed. Such grading shall be done as may be necessary to prevent surface water from flowing into excavations.

b. Excavation of Pipe Culvert Lines and Drainage Basins shall be in straight lines along the alignments and grades shown, and unless otherwise shown, shall provide a minimum of 20 cm between the outsides of the pipe and drainage basin and the sides of the trench.

c. Over-Excavation: Excavation carried below the depths indicated, without specific directions, shall be refilled to the proper grade with suitable material and compacted thoroughly, except that in excavations for footings, the concrete shall be extended to the bottom of the excavations. All additional work of this kind shall be at the Contractor's expense.

7. MATERIALS

a. Riprap: Sound, durable stones, 5 kg to 10 kg in weight, taken from an approved quarry.

b. Armour Stone: Sound, durable stones min. 100 kg in weight, suitable for pitching, taken from an approved quarry.

c. Material for Backfill Above High Water Level shall consist of suitable excavated material or borrow of earth, sand, gravel, or other approved materials, and shall be free of roots, wood, scrap material, other vegetable matter and refuse.

d. Material Below High Water Level shall be granular material consisting of sand, gravel, crushed aggregate and other hard

7. d. cont'd

durable material, free of objectionable substances. Gradation shall be such that it allows suitable placement and sufficient compaction for in-water dumping operations.

8. BORROWS AND QUARRIES

The Contractor shall be responsible for all exploration, arrangement and development of borrows and quarries and transportation of all fill materials, riprap and armour stones to the Site.

9. FILL OR BACKFILL WORKS

a. Fill or Backfill for Buildings and Structures shall be placed, as far as practicable, as the construction work progresses. Backfilling against concrete shall be done only when directed by the Engineer. Backfill shall be placed in horizontal layers not more than 30 cm in loose thickness, with each layer being compacted.

b. Degree of Compaction: Unless otherwise specified, fill and backbill shall be compacted to 90 percent of the maximum dry density (ASTM D1557) in all but the top 15 cm, which shall be compacted to not less than 95 percent of the maximum dry density (ASTM D1557).

c. Fill or Backfill for Pipe Culvert Lines and Drainage Basins shall proceed as rapidly as practicable. Backfill shall be placed in horizontal layers and shall be compacted as follows.

1) Layers up to an elevation of 30 cm above the top of the pipe shall be more than 15 cm in loose thickness and the remainder of the layers above that elevation shall not be more than 15 cm in compacted thickness.

2) Backfilling against drainage basin shall be placed in horizontal layers not more than 36 cm in loose thickness with each layer being compacted to not more than 15 cm in thickness.

d. Embankment Works

1) Riprap: Dump or place riprap as uniformly as possible with the use of chutes or other suitable methods.

a) The placing operation shall be carried out with frequent checking of the work done.

b) Permitted tolerance in riprap elevations shall be $\pm$ 30 cm from elevations shown on the Drawings.

c) Outer face, facing water shall be placed, or adjusted after placing, to a constant slope to allow for even distribution of armour stone surface course.

9. d. cont'd

2) Sand Filling and Compaction: Filling materials shall be dumped or placed as uniformly as possible with use of chutes or other suitable equipment.

a) All fill below +3.0 meters does not require compactions.

b) All fill above +3.0 meters shall be compacted as follows:

- After fill below +3.0 meters has been placed, leveled and approved by the Engineer, the subbase fill shall be spread in successive horizontal layers not more than 30 cm in compacted depth.

- Fill material shall be pulverized when necessary and watered to the proximity of the optimum moisture content.

- Compact to a density of not less than 95% of maximum density obtained at optimum moisture content, determined by tests as listed below.

- Each layer of compacted fill shall be approved by the Engineer before proceeding with the successive layers.

- Compacted fill shall be brought up to lines and levels shown on the Drawings. Tolerance of finish to be within $\pm$3 cm of lines and grades shown.

- Properly protect all completed compacted fill from damage.

3) Armour Stone: After approval of riprap slopes and other preceding work, place armour stone on a uniform slope with a minimum thickness of 1.0 m. Maintain an even degree of thickness and uniformity of slopes as much as possible.

10. TESTS

a. The Contractor shall carry out all tests under the supervision of the Engineer and shall submit reports thereof within a week of the completion of each respective test.

b. Tests of Subbase Sand Fill: Tests shall consist of the following:

1) Grain size analysis: ASTM C422

2) Laboratory test of subbase fill material if material is of questionable classification: ASTM D2937

3) Field test of subbase fill in place: ASTM D1556.

4) Test of moisture-density: ASTM D1557.

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SECTION 2E

PRECAST CONCRETE PILES

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. CONCRETE WORK

Section 3A applies to this Section.

3. SCOPE

a. This Section includes fabrication and installation of all precast reinforced concrete piles required for the foundation of light house, leading light, light beacon, and related work.

b. Other Sections include concrete piles for buildings and steel pipe piles.

4. GENERAL PROVISIONS

a. Pile lengths for estimating purpose, shown on the Drawings and Bill of Quantities are based upon probable lengths remaining in place in the completed structure. The Contractor shall determine the final length of piles required to develop the specified bearing power for the minimum penetration and submit to the Engineer for approval or develop both the bearing power and minimum penetration, by means of the following test:

1) Drive a minimum of 1 test pile at location approved by the Engineer.

2) Drive test pile until an ultimate bearing power of 220 tons is obtained.

Calculations shall be based on bearing power formula approved by the Engineer.

3) Drive test pile with the same pile driver to be used in permanent work.

4) Test pile may be used in permanent structure upon approval of the Engineer.

4. cont'd.

b. Storage and Handling

1) Removal of forms, curing, storing, transporting and handling precast piles shall be done in such a manner as to avoid excessive bending stress, cracking, spalling or other injuries.

2) When storing, piles shall be stacked not over 3 tiers, using wooden sleepers under every tier.

5. SUBMITTALS

a. Refer to SECTION 1J.

b. Complete working drawings for the precast concrete piles shall be submitted in accordance with SECTION 1J for approval. The shop drawings shall show complete details including form work, inserts, reinforcing steel, quality of concrete, method of curing, and methods of operation.

6. MATERIALS

a. Cement, concrete and reinforcing steel shall conform to the applicable requirements of CONCRETE WORK - SECTION 3A, except as otherwise specified herein.

b. Concrete shall be Class C".

The Contractor shall be responsible for the design of concrete mixes and for meeting the strength requirements. All design mix calculations shall be submitted to the Engineer for approval prior to the start of the work.

c. Reinforcing Bars: ASTM A615, Grade 40, except deformations not required. Deformed bars may be used when approved by the Engineer.

d. Steel Plates for Pile Shoes and Caps: Structural steel conforming to ASTM A36.

7. FORMWORK

a. Forms and formed surfaces shall conform to the applicable portion of CONCRETE WORK - SECTION 3A.

b. Forms may be dressed lumber or steel plate.

c. A 5 cm chamfer strip shall be used in all four corners.

8. CASTING AND CURING

a. Piles shall be cast separately with length lying horizontally.

b. Concrete for each pile shall be placed continuously and compacted with vibrators.

c. Side forms shall not be removed for a minimum of 24 hours after placing concrete.

d. Piles shall be cured at least for 28 days. Wet curing shall be for the first 7 days, minimum.

e. Piles shall not be moved until the curing is completed and the specified concrete strength is attained.

9. DRIVING

a. Bearing Power of Pile: Each pile shall be driven until an ultimate bearing power of 220 tons per pile is developed.

1) The formula to be applied for the calculation of bearing power shall be approved by the Engineer.

2) All calculation sheets shall be submitted to the Engineer for approval.

b. Pile Driver: Piles shall be driven with any type of approved hammer such as drop hammer, steam or diesel hammer which has suitable energy to develop the required bearing power of pile.

c. Driving shall be done with suitable anvils or cushion to prevent undue damage of the pile top and with fixed leads which will hold the pile firmly in position and alignment and in axial alignment with the hammer to drive the pile in the required position as shown on the Drawings.

d. Driving of each pile shall be continuous without intermission until the pile has been driven to the final resistance.

e. Top of the pile shall be cut off true to line and elevation indicated on the Drawings.

10. TOLERANCE

a. Piles shall be driven as nearly as possible to the exact position shown on the Drawings, however, a maximum tolerance of plus or minus two (2) percent out of plumb and plus or minus ten (10) cm out of position will be permissible.

b. Any pile out of line or out of plumb to a greater extent than specified above shall be pulled out and driven or an additional pile driven as directed by the Engineer without additional cost to the PQA.

11. CONNECTION OF LOWER AND UPPER PILES

Connection of lower and upper piles shall be performed by electric arc welding. All welding work shall be in accordance with the requirements of welding specified under STRUCTURAL STEEL, SECTION 5A.

12. EXTENSIONS OR BUILD-UPS

Extensions, splices or build-ups on precast piles, when unavoidable, shall be made only with the Engineer's approval and as follows:

1) After the driving is completed, concrete at the top of the pile shall be cut off, leaving the reinforcing bars exposed for a length of eighty (80) cm. The final cut of the concrete shall be perpendicular to the axis of the pile.

2) Reinforcement of the same size and quality as that used in the pile shall be securely fastened to the exposed reinforcing bars and the necessary formwork shall be placed.

3) Immediately before placing concrete, the top of the pile shall be thoroughly cleaned, wetted and covered with a thick coating of neat cement, retempered mortar or other suitable bonding material. Concrete shall be of the same quality as that used in the pile.

4) Forms may be of wood or metal and shall conform to the shape, lines and dimensions shown on the Drawings and shall be substantialy and sufficiently tight to prevent leakage of mortar. Forms shall remain in place for not less than 7 days for wet curing and shall then be carefully removed.

13. RECORD OF WORK

a. Contractor shall keep records of the pile work and submit them to the Engineer at the time and in the manner as required.

b. An accurate record shall be kept of the date, time, total depth of penetration, rate of penetration and number of blows for every thirty (30) cm, penetration under last five (5) blows of hammer and kind and dimension of hammer used.

c. Any unusual phenomena such as pile lifting from its original seat during the operation of driving adjacent piles and where the required bearing power cannot be obtained shall also be recorded and reported to the Engineer without delay so that proper action may be taken.

* * * * *

DIVISION 3

CONCRETE

SECTION 3A

CONCRETE WORKS

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes all cast-in-place concrete and related work required.

b. This Section also sets forth general requirements applicable to other concrete work required under this Specification.

c. Each Section under which concrete work is required, as defined above, shall comply with requirements herein as applicable.

3. GENERAL PROVISIONS

a. Full co-operation shall be given to the other trades to install embedded items. Suitable templates or instruction will be provided for setting, items shall have been inspected, and tests for concrete or other materials or for mechanical operations shall have been completed and approved.

b. The following Publications listed below, but referred thereafter by basic designation only, form part of this Specification to the extent indicated by the reference thereto:

1) AMERICAN CONCRETE INSTITUTE (ACI), STANDARDS:

ACI 211.1-70	Recommended Practice for Selecting Proportions for Structural Concrete.
ACI 214-65	Recommended Practice for Evaluation of Compressive Test Results of Field Concrete.
ACI 305-72	Recommended Practice for Hot Weather Concreting.

ACI 315-70	Manual of Standard Practice for Detailing Reinforced Concrete Structure.
ACI 318-71	Building Code Requirements for Reinforced Concrete with Commentary.

2) AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATIONS:

A 82-72	Cold-Drawn Steel Wire for Concrete Reinforcement.
A 615-74	Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
A 616-72	Rail Steel Deformed and Plain Bars for Concrete Reinforcement.
A 617-72	Axle Steel Deformed and Plain Bars for Concrete Reinforcements.
C 31-69	Making and Curing Concrete Compressive and Flexural Strength Test Specimens in the Field.
C 33-74	Concrete Aggregates.
C 39-72	Compressive Strength of Cylindrical Concrete Specimens.
C 42-74	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
C 94-74	Ready Mixed Concrete.
C 143-74	Slum of Portland Cement Concrete.
C 150-74	Portland Cement.
C 171-69	Sheet Materials for Curing Concrete.
C 172-71	Sampling Fresh Concrete.
C 173-74	Air Content of Freshly Mixed Concrete by the Volumetric Method.
C 192-69	Making and Curing Concrete Test Specimens in the Laboratory.
C 231-74	Air Content of Freshly Mixed Concrete by the Pressure Method.
C 260-74	Air-Entraining Admixtures for Concrete.
C 309-74	Liquid Membrane-Forming Compounds for Curing Concrete.

3. b. 2) cont'd

C 330-75a	Lightweight Aggregate for Structural Concrete.
C 494-71	Chemical Admixtures for Concrete.
D 1751-73	Performed Expansion Joint Fillers for Concrete Paving and Structural Construction. (Nonextruding and Resilient Bituminous Types).

4. SUBMITTALS

a. Refer to SECTION 1J.

b. Shop Drawings: Showing all dimensions necessary for fabrication and placing of the reinforcing bars and accessories, typical details of formworks, scaffoldings construction methods, joints and falseworks together with stress and deflection analysis.

c. Samples requested by the Engineer shall be furnished and approved before delivery to the jobsite of materials.

d. Test Reports and Certificates: Certified copies of test reports, or other satisfactory evidence where so specified, and certificates shall be furnished in conformance with the provision of SECTION 1H and approval received before delivering certified or tested materials to the project site.

5. MATERIALS

a. Materials: Conform to the requirements specified below.

b. Admixtures: Admixtures containing chloride ions, or other ions producing deleterious effects, shall not be used.

1) Air-Entraining Admixtures: ASTM C260.

2) Admixture other than air-entraining agent shall conform to ASTM C494.

c. Aggregates for General Structural Concrete:

1) Course Aggregate: Conforming to ASTM C33 and having nominal sizes of 38.0 mm to 19.0 mm, 19.0 mm to 9.5 mm, 9.5 mm to No. 4. The material shall be well graded between the limits indicated and individually stockpiled. It is the Contractor's responsibility to blend the materials to meet the gradation requirements for various type of concrete as specified herein.

5.c. 1) cont'd

a. Nominal sizes for combined gradation shall be as follows:

ASTM Sieves	Nominal Size of Coarse Aggregates, % by weight passing	
	40 mm	25 mm
50.0 mm (2")	100	
38.0 mm (1-1/2")	95 - 100	-
31.8 mm (1-1/4")	-	100
25.0 mm (1")	-	90 - 100
19.0 mm (3/4")	35 - 70	-
16.0 mm (5/8")	-	25 - 60
9.5 mm (3/8")	10 - 50	-
No. 4	0 - 5	0 - 10

2) Fine Aggregate: ASTM C33 except for gradation which has been revised to meet local conditions. Unless otherwise required by the Engineer, grading of fine aggregate shall be as follows:

ASTM Sieves	% by Weight Passing
9.5 m (3/8")	100
No. 4	90 - 100
No. 8	80 - 100
No. 16	50 - 90
No. 30	25 - 60
No. 50	10 - 30
No. 100	2 - 10

a) Grading of fine aggregates shall be reasonably uniform and fineness modulus thereof shall not vary more than 0.2 from that of the representative sample on which mix proportions of concrete are based.

b) Due care shall be taken to prevent segregation.

d. Aggregates for Lightweight Concrete: Lightweight aggregates shall have the strength, weight, and gradation required to produce concrete having the characteristics specified hereinafter.

5. d. cont'd

1) Lightweight structural concrete aggregates. ASTM C330. Fine aggregate conforming to ASTM C33 may be substituted for part or all of the lightweight structural concrete fine aggregates provided the concrete meets the strength and unit weight requirements.

2) Size designation for combined gradation shall be as follows:

ASTM Sieves	Size of Coarse Aggregates, % by Weight Passing
	9.50 mm - 2.36 mm
12.50 mm (1/2")	100
9.50 mm (3/8")	80 - 100
No. 4	5 - 40
No. 8	0 - 20

e. Anchorage Items: Inserts for anchoring mechanical items to concrete shall be of standard manufacture and of types required to engage with the anchors to be provided and installed therein under other sections of these Specifications, and shall be subject to the approval of the Engineer.

f. Cement: Except when specifically approved by the Engineer, only one brand of cement shall be used for any individual structure. In determining the approved mix, only Portland Cement shall be used as the cementitious material.

1) Portland Cement: ASTM C150, Type II

2) High-Early Strength Portland Cement may be used for precast and prestressed concrete. Cement Type III shall conform to ASTM C150, with tricalcium aluminate limited to 8 percent.

g. Curing Materials

1) Impervious Sheet Materials: ASTM C171, type optional, except that polyethylene film, if used, shall be white opaque.

2) Burlap of commercial quality, non-staining type, consisting of 2 layers minimum.

3) Membrane Forming Curing Compound: ASTM C309, submit evidence that product conforms to specifications.

h. Form Materials, Coatings and Ties are specified in Paragraph FORMWORK.

i. Reinforcement:

1) Plain Bars conforming to ASTM A 615 or A 617, grade 40.

5. i. cont'd

2) Deformed Bars, conforming to one of the following:
ASTM A 615, grade 40 or
ASTM A 617, grade 40.

j. Expansion Joint Filler: Preformed joint filler conforming to ASTM D 1751 type and class suitable for the use intended.

6. SAMPLES AND TESTING

a. Refer to SECTION III.

b. Testing except as otherwise specified herein shall be performed by an approved testing agency as proposed by the Contractor and at no additional cost to the PQA.

c. Cement: Sampled either at the mill or at the site of the work and tested by an approved independent commercial or national testing laboratory at no additional cost to the PQA. Certified copies of laboratory test reports shall be furnished for each lot of cement and shall include all test data, results, and certification that the sampling and testing procedures are in conformance with the Specifications. No cement shall be used until notice has been given by the Engineer that the test results are satisfactory. Cement that has been stored, other than in bins at the mills, for more than 4 months after delivery to the site shall be retested before use. Cement delivered at the site and later found under test to be unsuitable shall not be incorporated into the permanent works.

d. Aggregates: Except for lightweight concrete, shall be tested as prescribed in ASTM C 33.

e. Aggregates for Lightweight Structural Concrete shall be tested as prescribed in ASTM C 330. Certified reports based upon tests within the preceding 3 months may be furnished provided the tests are used by the aggregate producer as controls in producing the aggregates and the aggregates are furnished from the same vein of the same basic source. Fine aggregates substituted for part of all of the lightweight structural concrete fine aggregates shall be tested as prescribed in ASTM C 33.

f. Reinforcement: Certified copies of mill certificates of tests shall accompany deliveries of steel bar reinforcement, spiral wires and mesh reinforcement. If required by the Engineer additional testing of the materials shall be made at the Contractor's expense.

g. Concrete Tests: Provide for test purposes, three sets of test specimen taken under the supervision of the Engineer from each 80 m^3 or fraction thereof of each class of concrete placed. At least one set of test specimens shall be provided for each class of concrete placed in each 8-hour shift. Each set shall consist of two test specimens, and shall be made from a separate batch. Samples shall be secured in conformance with ASTM C 172.

6. g. cont'd

Test specimens shall be made, cured, and packed for shipment in accordance with ASTM C 31. Cylinders will be tested by and at the expense of the Contractor in accordance with ASTM C 39. Test specimens will be evaluated separately, by the Engineer, for meeting strength level requirements for each class and type of concrete indicated and specified in conformance with chapter CONCRETE QUALITY of ACI 318. The standard age of test shall be 28 days, but 7 days tests may be used, with the permission of the Engineer, provided that the relation between the 7-day and 28-day strengths on the concrete is established by tests for the materials and proportions used. There will be deviations from this procedure. When samples fail to conform to the requirements for strength, the Engineer shall have the right to order a change in the proportions of the concrete mix for the remaining portions of the work at no additional cost to the PQA.

h. Test of Hardened Concrete in or Removed from the Structure: When the results of the strength tests of the control specimens indicate the concrete as placed does not meet the Specification requirements or where there is other evidence that the quality of the concrete is below the specification requirements, tests of on cores of in-place concrete shall be made in conformance with ASTM C 42.

Core specimens shall be obtained by the Contractor and shall be tested. Any deficiency shall be corrected; or if the Contractor elects, he may submit a proposal for approval, that a load test be made. If the proposal is approved, the load test shall be made by the Contractor and the test results evaluated by the Engineer in conformance with Chapter 20 of ACI 318. The cost of the load tests shall be borne by the Contractor. If any concrete shows evidence of failure during the load test, or fails the load test as evaluated, the deficiency shall be corrected. Any deficiency shall be corrected in a manner approved by the Engineer at no additional cost to the PQA.

i. Admixtures: All admixtures shall be tested and those that have been in storage at the project site for longer than 6 months shall not be used until proved by retest to be satisfactory.

1) Air-Entraining Admixture: Tested for conformance to the referenced specification under which it is furnished. The testing shall be conducted with cement and aggregate proposed for the project.

2) Other Admixtures if approved, tested for conformance to the referenced specification under which it is furnished. The testing shall be conducted with cement and aggregate proposed for the project.

7. STORAGE

Storage accommodations for concrete materials shall be subject to approval and shall afford easy access for inspection and identification of each shipment in accordance with test reports.

1) Cement: Immediately upon receipt at the Site, the cement shall be stored separately in a dry weathertight, properly ventilated structure, with adequate provision for prevention of absorption of moisture. Cement in bags shall not be stacked more than 13 bags high. The cement most likely to have been exposed to moisture or stored in bags for more than 3 months shall not be used unless proven by test to be in good condition.

2) Aggregate: Stored to assure good drainage, to preclude inclusion of foreign matter, and to preserve the gradation.

8. FORMWORK

a. Forms: Designed, constructed, and maintained so as to insure that, after removal of forms, the finished concrete members will have true surfaces free of offset, waviness or bulges and will conform accurately to the indicated shapes, dimensions, lines, elevations, and positions. Form surfaces that will be in contact with concrete shall be thoroughly cleaned before each use.

b. Design: Studs and wales shall be spaced to prevent deflection of form material. Forms and joints shall be sufficiently tight to prevent leakage of grout and cement paste during placing of concrete. Juncture of formwork panels shall occur at vertical control joints, and construction joints. Forms placed on successive units for continuous surfaces shall be fitted to accurate alignment to assure smooth completed surfaces free from irregularities. Temporary openings shall be arranged in wall and where otherwise required to facilitate cleaning and inspection. Forms shall be readily removable without impact, shock, or damage to the concrete.

c. Form Ties: Factory fabricated, removable or snap-off metal of design that will not allow form deflection and will not spall concrete upon removal. Bolts and rods that are to be completely withdrawn shall be coated with a non-staining bond breaker.

d. Chamfering: External corners that will be exposed shall be chamferred, beveled, or rounded, by moldings placed in the forms.

e. Coatings: Forms for exposed surfaces shall be coated with form oil or form-release agent before reinforcement is placed. The coating shall be a commercial formulation of satisfactory and proven performance that will not bond with, stain, or adversely affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor

8. e. cont'd

impede the wetting of surfaces to be cured with water or curing compounds. The coating shall be used as recommended in the manufacturer's printed or written instructions.
Forms for unexposed surfaces may be wet with water in lieu of coating immediately before placing of concrete. Surplus coating on form surfaces and coating on reinforcement steel and construction joints shall be removed before placing concrete.

f. Removal of Forms shall be in a manner to insure complete safety of the structure after the following conditions have been met. Where the structure as a whole is supported on shores, forms for beam and girder sides, and similar vertical structural members may be removed after 24 hours, provided concrete is sufficiently hard not to be injured thereby. Supporting forms or shoring shall not be removed until structural members have acquired sufficient strength to support safely their own weight and any construction and/or storage load to which they may be subjected, but in no case shall they be removed in less than 7 days nor shall forms used for curing be removed before expiration of curing period except as specified in paragraph curing. Care shall be taken to avoid spalling the concrete surface or damaging concrete edges. Wood forms shall be completely removed.

Control Test: If the Contractor proposes to remove forms earlier than the period stated above, he shall be required to submit the results of control tests showing evidence that concrete has attained sufficient strength to permit removal of supporting forms. Cylinders required for control tests shall be provided in addition to those otherwise required by this Specification. Test specimens shall be removed from molds at the end of 24 hours and stored in the structure as near the points of sampling as possible, shall receive insofar as practicable the same protection from the elements during curing as is given to those portions of the structure which they represent, and shall not be removed from the structure for transmittal to the laboratory prior to expiration of three-fourths of the proposed period before removal of forms. Cylinders will be tested by and at the expense of the Contractor. Supporting forms or shoring shall not be removed until control test specimens have attained strength of at least 160 kg/cm^2. The newly unsupported portions of the structure shall not be subjected to heavy construction or material loading.

9. REINFORCEMENT

a. Reinforcement: Fabricated to shapes and dimensions shown and shall be placed where indicated. Reinforcement shall be free of loose or flaky rust and mill scale, or coating, and any other substance that would reduce or destroy the bond. Reinforcing steel reduced in section shall not be used. After any substantial delay in the work, previously placed reinforcing steel for future bonding shall be inspected and cleaned. Reinforcing steel shall not be bent or straightened in a manner injurious to the steel or concrete.

9. a. cont'd

Bars with kinks or bends not shown on the Drawings shall not be placed. The use of heat to bend or straighten reinforcing steel will be permitted only if the entire operation is approved. Bars shall be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter, the resulting arrangement of bars including additional bars necessary to meet structural requirements shall be approved before concrete is placed. In slabs, beams and girders, reinforcing steel shall not be spliced at points of maximum stress unless otherwise indicated. Unless otherwise shown on the Drawings, laps or splices shall be as follows:

1) Deformed bars in tension; 30 times the diameter.

2) Deformed bars in compression; 25 times the diameter.

3) Plain bars with hook in tension; 40 times the diameter.

4) Plain bars with hook in compression; 30 times the diameter.

5) Other details of reinforcement shall conform to ACI 318.

b. Exposed reinforcement bars, inserts and plates intended for bonding with future extensions shall be protected from corrosion.

c. Supports provided in conformance with ACI 315 and ACI 318, unless otherwise indicated or specified.

d. Concrete Protection for Reinforcement.

1) The minimum concrete cover of reinforcement shall be as indicated on the Drawings.

2) Tolerance for concrete cover of Reinforcing Steel shall be as follows.

Minimum Cover	Maximum Variation
7.5 cm or more	9 mm
Less than 7.5 cm	6 mm

10. CLASSES OF CONCRETE AND USAGE

a. Strength Requirement:

1) Concrete of the various classes, indicated and as required under other sections, shall be proportioned and mixed for the following strengths:

10. a. cont'd

Class	Nominal Max Size of Aggregate In mm	Specified Compressive Strength 28 days, kg/cm^2
A-1	25	240
A-2	25	300
B	40	240
C	25	150
D	9.5	150

2) In addition to the above, the maximum permissible water-cement ratio by weight shall not be greater than 0.55.

b. Usage: Concrete of the various classes shall be used as follows:

1) Class A-1 concrete: For all structural concrete except retaining walls and footings.

2) Class A-2 concrete: For precast concrete work.

3) Class B concrete: For retaining walls and footings.

4) Class C concrete: For levelling concrete.

5) Class D concrete: For lightweight concrete with a minimum weight of not more than 1500 kg/m^3.

11. PROPORTIONING OF CONCRETE MIXES

a. Trial design batches and testing to meet requirements of the classes of concrete specified shall be the responsibility of the Contractor. The design mix shall be of consistencies specified hereinafter in paragraph SLUMP. Test for slump, unit weight, and air content shall be performed in the field under the supervision of the Engineer.

b. Entrained-Air Content: Air entrainment shall be produced by adding an air-entraining agent at the mixer. Air Content in concrete by volume of concrete shall be maintained at 3 to 5 percent, as determined by ASTM C 231.

c. Concrete Proportioning: Samples of approved aggregates shall be obtained in accordance with the requirements of ASTM D 75. Samples of materials other than aggregate shall be representative of those proposed for the Project and shall be accompanied by the manufacturer's test reports indicating compliance with applicable specified requirements. Trial mixes having proportions, consistencies and air content suitable for the work

11. c. cont'd

shall be made based on ACI Standard 211.1 using at least three different water-cement ratios which will produce a range of strength encompassing those required for the work. Trial mix shall be designed for maximum permitted slump and air content. The temperature of concrete in each trial batch shall be reported, For each water-cement ratio at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 39. From these test results, a curve shall be plotted showing the relationship between water-cement ratio and strength.

d. Average Strength: For each portion of the structure, proportions shall be selected so that the maximum permitted water-cement ratio is not exceeded and so as to produce an average strength to exceed the specified strength f_c' by the amount indicated below. Where production facility has a standard deviation record determined in accordance with ACI 214, based on 30 consecutive strength tests of similar mixture proportions as proposed, it shall be used in selecting average strenght. The average strength used as the basis for selecting proportions shall exceed the specified strength f_c' by at least.

1) 30 kg/cm^2 if standard deviation is less than 20 kg/cm^2.

2) 40 kg/cm^2 if standard deviation is 20 to 30 kg/cm^2.

3) 50 kg/cm^2 if standard deviation is 30 to 40 kg/cm^2.

4) 60 kg/cm^2 if standard deviation is 40 to 50 kg/cm^2.

5) If the standard deviation exceeds 50 kg/cm^2 or if a standard deviation record is not available, proportions shall be selected to produce an avearge strength at least 70 kg/cm^2 greater than the specified strength.

e. Corrective Additions to remedy deficiencies in aggregate gradations shall be used only on written approval of the Engineer.

f. Slump: Tests shall be made in conformance with ASTM C 143, and unless otherwise specified by the Engineer, slump shall be within the following limits:

	Slump for Vibrated Concrete
Structural Element	Maximum
Slab	18 cm
Concrete for Walls and Leveling Concrete except Retaining Walls	20 cm
Base Concrete	12 cm

12. BATCHING AND MIXING

a. The Contractor shall provide a semi-automatic or better batching plant and concrete mixing equipment having a sufficient capacity to satisfy concrete placement requirements.

b. Batching Plant

1) Location: On site.

2) Arrangement: Separate bins or compartments shall be provided for each size or classification of aggregate and for bulk portland cement. The compartments shall be of ample size and so constructed that the materials will be maintained separately so that the flow of each material into its batcher is stopped automatically when the designated weight has been reached. Aggregates may be weighed in separate weigh batcher with individual scales, or cumulatively on one weigh batcher with one scale. Bulk cement shall be weighed on a separate scale in a separate weigh batcher. Water may be measured by weight or by volume. If measured by weight, it shall not be weighed cumulatively with another ingredient. Batching controls shall be so interlocked that the charging mechanism cannot be opened until the scales have returned to zero. These requirements can be satisfied when actuated by one or more starting mechanisms, a semi-automatic batcher control shall start the weighing operation of each material and stop automatically when the designated weight of each material has been reached, interlocked in such a manner that the discharge device cannot be actuated until the indicated material is within the applicable tolerances. The plant shall be arranged so as to facilitate the inspection of all operations at all times. Suitable facilities shall be provided for obtaining representative samples of aggregate from each of the bins or compartments for test purposes. Delivery of materials from the batching equipment shall be within the following limits of accuracy.

Materials	Percent
Cement	1
Water	1
Aggregate	2
Admixtures	3

When aggregates are weighed cumulatively, the limit for aggregate applies to the total weight in the batcher after each aggregate size has been batched.

3) Water Batcher and Dispenser for Admixture: Equipment for batching water and admixtures shall be provided at the

batching plant or included with the paving mixer or truck mixers as required for the type of plant used.

a) Water Batchers: A suitable water measuring device shall be provided which will be capable of measuring the mixing water within the specified requirements for each batch. The mechanism for delivering water to the mixers shall be such that leakage will not occur when the valves are closed. The filling and discharge valves for the water batcher shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed.

b) Dispensers: An accurate mechanical device for measuring and dispensing each admixture shall be provided. Each device shall be capable of ready adjustment to permit varying of the quantity of admixture to be batched. Each dispenser shall be interlocked with the batching and discharging operations of the water so that each admixture is separately batched and discharged automatically in a manner to obtain uniform distribution throughout the batch in the specified mixing period. When use of truck mixers makes this requirement impracticable, the admixture dispensers shall be interlocked with the sand batcher. Admixtures will not be combined prior to introduction into water or sand.

4) Moisture Control: The plant shall be capable of ready adjustment to compensate for the varying moisture contents of the aggregate, and to change the weights of the materials being batched. An electric moisture meter shall be provided for measurement of moisture in the fine aggregate. The sensing element shall be arranged so that the measurement is made near the batcher charging gate of the sand bin or in the sand batcher.

5) Scales: Adequate facilities shall be provided for the accurate measurement and control of each of the materials entering each batch of concrete. The weighing equipment shall conform to the applicable requirements of NBS Handbook 44 or other international standard for scales, except that the accuracy shall be within 0.2 percent of scale capacity. The Contractor shall provide standard test weights and any other auxiliary equipment required for checking and operating performance of each scale or other measuring device. Each weighing unit shall include a visible springless dial which shall indicate the scale load at all stages of the weighing operation, or shall include a beam scale with a beam balance indicator which will show the scale in balance at zero load and at any weighing operation, or shall include a beam scale with a beam balance indicator which will show the scale in balance at zero load and at any beam setting. The indicator shall have an over and under travel equal to at least

5 percent of the capacity of the beam. The weighing equipment shall be arranged so that the plant operator can conveniently observe all dials or indicators.

6) Recorders:

a) An accurate recorder or recorders shall produce a graphical or digital record of the scale reading after each of the aggregates and cementitious materials has been batched prior to delivery to the mixer and after the batchers have been discharged (return to zero reference). The weights or volumes of water and admixtures shall also be recorded if batched at a central batching plant.

b) Each recorder shall be housed in a cabinet which shall be capable of being locked.

c) The charts or tapes shall clearly indicate the different types of mixes used by stamped letters, numerals, colored ink or by other suitable means. The charts or tapes shall be so marked that variations in batch weights of each type of mix can be readily observed.

d) The charts or tapes shall show time of day (stamped or pre-printed) at intervals of not more than 15 minutes.

e) The recorded charts or tapes shall become the property of the PQA.

f) The recorders shall be placed in a position convenient for observation by the plant operator and the Engineer.

g) All weighing, indicating, recording, and control equipment shall be sufficiently protected against exposure to dust, moisture, and vibration so that there is no interference with proper operation of the equipment.

h) The recorded weights or volumes when compared to be weights or volumes actually batched shall be within the following limits of accuracy:

Material	Percent
Cement	2
Water	2
Aggregate	4
Admixture	6

12. cont'd

c. Concrete Mixers: Stationary mixers, truck mixers, or paving mixers of approved design. The mixers shall have a rated capacity of at least 0.76 m^3 of mixed concrete, and shall not be charged in excess of the capacity recommended by the manufacturer. Mixtures shall be capable of combining the materials into a uniform mixture and of discharging this mixture without segregation. Stationary and paving mixers if used shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixers or mixing plant shall include a device for automatically counting the total number of batches of concrete mixed. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer on the nameplate. The mixing periods specified herein are predicated on proper control of the speed of roration of the mixer drum or blades, and on proper introduction of the materials into the mixer. The acceptability of truck mixers will be determined by uniformity tests as required by ASTM C 94. The mixing time for stationary or paving mixers will be increased when such increase is necessary to secure the required uniformity and consistency of the concrete. Excessive overmixing requiring additions of water will not be permitted. The mixers shall be maintained in satisfactory operating condition, and mixer drums shall be kept free of hardened concrete. Mixer blades shall be replaced when worn down more than 10 percent of their depth. Should any mixer at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired.

1) Stationary Mixers: The mixing time for each batch after all solid materials are in the mixer, provided that all of the mixing water is introduced before one-fourth of the mixing time has elapsed, shall be one minute for mixers having a capacity of 0.76 m^3, for mixers of larger capacities, the mixing time shall be increased 15 seconds for each additional 0.76 m^3 or fraction thereof of concrete mixed. When stationary mixer is used for partial mixing of the concrete (shrink mixed) the mixing time in the stationary mixer may be reduced to the minimum necessary to intermingle the ingredients (about 30 seconds).

2) Truck Mixers: Conform to the requirements of ASTM C 94, including requirements for uniformity of concrete. When a truck mixer is used either for complete mixing (transit-mixed) or to finish the partial mixing done in a stationary mixer, in the absence of uniformity test data, each batch of concrete shall be mixed not less than 70 nor more than 100 revolutions of the drum at the rate of rotation designated by the manufacturer of the equipment as mixing speed and at the capacity designated at ASTM C 94. If the batch is at least 0.38 m^3 less than the rated capacity, in the absence of uniformity test data, the number of revolutions at mixing speed may be reduced to not less than 50. Any additional mixing shall be done at the speed designated by the manufacturer of the equipment as agitating speed. Each truck shall be equipped with two counters from which

12. c. 2) cont'd

it shall be possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed.

3) Paving Mixers used at the site of the work. For paving use, paving mixers shall be equipped with boom and bottom-dump bucket to handle the concrete from the mixer to the form. The bucket shall be of adequate size to handle the complete batch of concrete mixed, and the boom shall be of sufficient length to permit discharge of the concrete into its final position in the form. Paving mixers may be either single compartment drum or multiple compartment drum type. A sled or box of suitable size shall be attached to the mixer under the bucket so as to catch any spillage of concrete that may occur when the mixer is discharging into the bucket. For use other than paving, the boom is not required; the mixer may discharge directly into the bucket to be used for final placement. Multiple compartment drum paving mixers shall be properly synchronized, and the paving mixers shall be properly synchronized, and the mixing time shall be determined by including the time required to transfer the concerete between compartments of the drum. If no uniformity test data are available, the mixing time for each batch, after all solid materials are in the mixer drum, provided that all the mixing water is introduced before one-fourth of the mixing time has elapsed, shall be 1 minute for mixers having a capacity of 0.76 m^3 for mixers of larger capacities, the minimum mixing times shall be increased 15 seconds for each additional 0.76 m^3 or fraction thereof of concrete mixed.

4) Sampling: Provide suitable facilities and labor for obtaining representative samples of concrete for the Contractor quality control and the PQA quality assurance testing. All necessary platforms, tools, and equipment for obtaining samples shall be furnished by the Contractor.

13. JOINTS

a. No reinforcement, corner protection angles or other fixed metal items shall be run continuous through joints containing expansion-joint filler, through crack-control joints in slabs on grade, or through joints between slabs on grade and vertical surfaces.

b. Premolded Expansion Joint Filler

1) Joints with Joint Sealant: At expansion joints in concrete slabs to be exposed, and at other joints indicated to receive joint sealant, premolded expansion-joint filler strips shall be installed at the proper level below the elevation with a slightly tapered, dressed-and-oiled wood strip temporarily secured to the top thereof to form a groove not less than 20 mm deep. The wood strip shall be

13. b. 1) cont'd

removed after the concrete has set. The groove, when surface dry, shall be cleaned of foreign matter, loose particles, and concrete protrusions, then filled approximately flush with joint sealant so as to be slightly concave after drying.

2) Finish of concrete at joints: Edges of exposed concrete slabs along expansion joints shall be neatly finished with a slightly rounded edging tool. Refer to SECTION 3F for joint sealer.

c. Construction Joints: Unless otherwise specified herein, all construction joints shall be subject to approval of the Engineer. Concrete shall be placed continuously so that the unit will be monolithic in construction. Fresh concrete may be placed against adjoining units, provided the set concrete is sufficiently hard not to be injured thereby. Joints not indicated shall be made and located in a manner not to impair strength and appearance of the structure. Placement of concrete shall be at such rate that surfaces of concrete not carried to joint levels will not have attained initial set before additional concrete is placed thereon. Lifts shall terminate at such levels as are indicated or as to conform to structural requirements as directed. Where horizontal construction joints are required, a strip of 25 mm square-edged lumber, beveled to facilitate removal, and oiled, shall be tacked to the inside of the forms at the construction joint. Concrete shall be placed to a point 25 mm above the underside of the strip. The strip shall be removed 1 hour after the concrete has been placed, any irregularities in the joint line leveled off with a wood float, and all laitance removed. Prior to placing additional concrete, horizontal construction joints shall be prepared as specified in paragraph BONDING herein.

14. PREPARATION FOR PLACING

Hardened concrete, debris and foreign materials shall be removed from interior of forms and from inner surfaces of mixing and conveying equipment. Reinforcement shall be secured in position, and shall be inspected, and approved before placing concrete. Runways shall be provided for wheeled concrete-handling equipment; such equipment shall not be wheeled over reinforcement nor shall runways be supported on reinforcement.

15. PLACING CONCRETE

a. Concrete shall be handled from mixer to transport vehicle to place of final deposit in a continuous manner, as rapidly as practicable, and without segregation or loss of ingredient until the approved unit of work is completed. Placing will not be permitted when the sun, heat, wind or limitations of facilities furnished by the Contractor prevent proper finishing and curing of the concrete. Concrete shall be placed in the forms, as

15. a. cont'd

close as possible in final position, in uniform approximately horizontal layers not over 30 cm deep. Forms splashed with concrete and reinforcement splashed with concrete or form coating shall be cleaned in advance of placing subsequent lifts, Concrete shall not be allowed to drop freely more than 1.5 m in unexposed work nor more than 1.0 m in exposed work; where greater drops are required, a tremie or other approved means shall be employed. The discharge of the tremies shall be controlled so that the concrete may be effectively compacted into horizontal layers not more than 30 cm thick, and the spacing of the tremies shall be such that segregation does not occur. Concrete to receive other construction shall be screeded to the proper level to avoid excessive shimming or grouting. Conduits and pipes shall not be embedded in concrete unless specifically indicated.

b. Time Interval between Mixing and Placing: Concrete mixed in stationary mixers and transported by nonagitating equipment shall be placed in the forms within 30 minutes from the time ingredients are charged into the mixing drum. Concrete transported in truck mixers or truck agitators shall be delivered to the site of the work and discharged completely in the forms within 45 minutes from the time the ingredients are discharged in the mixing drum. Concrete shall be placed in the forms within 15 minutes after discharge from the mixer at the jobsite.

c. Hot Weather Requirements: Temperature of concrete during the period of mixing, transport and/or placing shall not be permitted to rise above 33°C. Any batch of concrete which has reached a temperature greater than 33°C at any time in the aforesaid period shall not be placed but shall be rejected, and shall not thereafter be used in any part of the permanent Works.

1) Control Procedures: Provide water cooler facilities and procedures to control or reduce the temperature of cement, aggregates and mixing/handling equipment to such temperature that, at all times during mixing, transporting, handling and placing, the temperature of the concrete shall not be greater than 33°C.

2) Cold Joints and Shrinkage: Where cold joints tend to form or where surfaces set and dry too rapidly or plastic shrinkage cracks tend to appear, concrete shall be kept moist by fog sprays, or other approved means, applied shortly after placement, and before finishing.

3) Supplementary Precautions: When the afore-mentioned precautions are not sufficient to satisfy the requirements hereinabove, they shall be supplemented by restricting work to evening or night. Procedure shall conform to American Concrete Institute Standard ACI 305.

d. Conveying Concrete by Chute, Conveyor or Pump: Concrete may be conveyed by chute, conveyor, or pump if approved in writing. In requesting approval, the Contractor shall submit his entire

15. d. cont'd

plan of operation from time of discharge of concrete from the mixer to final placement in the forms, and the steps to be taken to prevent the formation of cold joints in case the transporting of concrete by chute, conveyor or pump is disrupted. Conveyors and pumps shall be capable of expeditiously placing concrete at the rate most advantageous to good workmanship. Approvals will not be given for chutes or conveyors requiring changes in the concrete materials or design mix for efficient operation.

1) Chutes and Conveyors: Chutes shall be of steel or steel-lined wood, rounded in cross section, rigid in construction, and protected from overflow. Conveyors shall be designed and operated, and chute sections shall be set, to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients, loss of mortar, or change in slump. The chute and conveyor shall be provided with a device to prevent segregation. The chute and conveyor shall be thoroughly cleaned before and after each run. Waste material and flushing water shall be discharged outside the forms.

2) Pumps shall be operated and maintained so that a continuous stream of concrete is delivered into the forms without air pockets, segregation or change in slump. When pumping is completed, concrete remaining in the pipeline shall be ejected, and wasted without contamination of concrete already placed. After each operation, equipment shall be thoroughly cleaned and the flushing water shall be wasted outside the forms.

16. COMPACTION

Immediately after placing, each layer of concrete shall be compacted by internal concrete vibrators supplemented by hand-spading, rodding, and tamping. Tapping or other external vibration of forms will not be permitted unless specifically approved by the Engineer. Vibrators shall not be used to transport concrete inside forms. Internal vibrators submerged in concrete shall maintain a speed of not less than 7,000 impulses per minute. The vibrating equipment shall at all times be adequate in number of units and power to properly consolidate all concrete. Spare units shall be on hand as necessary to insure such adequacy. Duration of vibration shall be limited to time necessary to produce satisfactory consolidation without causing objectionable segregation. The vibrator shall not be inserted into lower courses that have begun to set. Vibrators shall be applied at uniformly spaced points not further apart than the visible effectiveness of the machine.

17. BONDING

Before depositing new concrete on or against concrete that has set, the surfaces of the set concrete shall be thoroughly cleaned so as

17. cont'd

to expose the coarse aggregate and be free of laitance, coatings, foreign matter and loose particles. Forms shall be retightened. The cleaned surfaces shall be moist, but shall be without free water when concrete is placed.

18. SETTING OF BASE PLATES

a. Preparation: After being plumbed and properly positioned, base plates shall be provided with full bearing with damp-pack bedding mortar, except where expansive grout is indicated. The space between the top of concrete or masonry bearing surfaces and the bottom of the plate shall be approximately 1/24 of the width of the plate, but not less than 13 mm for plates less than 30 cm wide. Concrete surfaces shall be rough, clean, free of oil, grease, and laitance, and shall be damp. Metal surfaces shall be clean and free of oil, grease and rust.

b. Mortar: Damp-Pack bedding mortar shall consist of one part portland cement and 2.5 parts of fine aggregate, suitable to the work required, proportioned by weight and not more than 17 liters of water per bag of cement. The space between the top of the concrete bearing surface and the bottom of the plate shall be packed with the bedding mortar by tamping or ramming with a bar or rod until the voids are completely filled.

19. FINISHES OF CONCRETE OTHER THAN SLAB

a. Within 12 hours after forms are removed, surface defects shall be remedied as specified herein. Temperature of the concrete, ambient air and mortar during remedial work including curing shall be above 10°C. Fins and loose material shall be removed. Honeycomb, aggregate pockets, voids over 13 mm in diameter, and holes left by the rods or bolts shall be cut out to solid concrete, reamed, thoroughly wetted, brush-coated with neat cement grout, and filled with mortar. Mortar shall be a stiff mix of 1 part portland cement to not more than 2 parts fine aggregate passing the No. 16 mesh sieve, and minimum amount of water. The color of the mortar shall match the adjoining concrete color. Mortar shall be thoroughly compacted in place. Holes passing entirely through walls shall be completely filled from the inside face by forcing mortar through to the outside face. Holes which do not pass entirely through the wall shall be packed full. Patchwork shall finish flush and in the same plane as adjacent surfaces. Exposed patchwork shall be finished to match adjoining surfaces in texture and color. Patchwork shall be damp-cured for 72 hours. Ambient temperature shall not be less than 10°C. Dusting of finish surfaces with dry material or adding water to concrete surfaces will not be permitted.

b. Exterior Exposed Walls and Soffits: All exterior exposed walls and soffits not covered by marble or mortar shall receive special surface finish as follows.

19. b. cont'd

1) Special Surface Finish: Special surface finish shall consist of finishing the surfaces of the structure as necessary to produce smooth, even surfaces of uniform texture and appearance, free of unsightly bulges, depressions and other imperfections. The degree of care in building forms and character of materials used in form work will be a contributing factor in the amount of additional finishing required to produce smooth even surfaces of uniform texture and appearance, free of unsightly bulges, depressions and other imperfections, and the Engineer shall be the sole judge in this respect.

2) After completion of the ordinary surface finish, areas which do not exhibit the required smooth, even surface of uniform texture and appearance shall be sanded with power sanders or other approved abrasive means until smooth, even surfaces of uniform texture and appearance are obtained. The use of power carborundum stones or disks will be required to remove bulges and other imperfections.

20. CONCRETE FINISHES FOR SLABS

a. Slabs Receiving Concrete Paving: After concrete is placed and consolidated slab shall be screeded or struck off. No further finish is required.

b. Smooth Finish: Required only where specified; screed concrete and float to required level with no coarse aggregate visible. After surfaces moisture has disappeared and laitance has been removed the surface should be finished by float and steel trowel.

c. Broom Finish: Required for paving, stairs and landing; the concrete shall be screeded and floated to the required finish level with no coarse aggregate visible. After the surface moisture has disappeared and laitance has been removed, surface shall be float finished to an even, smooth finish. The floated surfaces shall be broomed with a fiber bristle brush in a direction transverse to the direction of the main traffic.

d. Tolerance: Smooth and broom finished surfaces shall be true to plane with no deviation in excess of 3 mm in any direction when tested with a 3 m straight edge.

21. CURING

a. Concrete shall be protected against moisture loss, rapid temperature change, mechanical injury from rain or flowing water, for a minimum period of time given below:

Type II Cement	7 days
Type III Cement.	5 days

21. cont'd

b. Concrete shall be maintained in a moist condition at temperature above 10°C throughout the specified curing period and until remedial work is started under paragraph FINISHES OF CONCRETE OTHER THAN SLABS. Curing activities shall be started as soon as free water has disappeared from the surface of the concrete after placing and finishing. Formed under-surfaces shall be moist cured with forms in place for the full curing period or, if forms are removed prior to the end of the curing period, by other approved means. Curing shall be accomplished by any of the following methods or combination thereof, as approved.

c. Moist Curing: Unformed surfaces shall be covered with burlap or mats, wetted before placing and overlapped at least 15 cm. Burlap or mats shall be kept continually wet and in intimate contact with the surface. Where formed surfaces are cured in the forms, the forms shall be kept continually wet. If the forms are removed before the end of the curing period, curing shall be continued as on unformed surfaces, using suitable materials. Burlap shall be used only on surfaces that will be unexposed in the finished work and shall be in two layers.

d. Impervious-sheet Curing: All surfaces shall be thoroughly wetted with a fine spray of water and be compeltely covered with waterproof paper, polyethylene sheeting or with polyethylene-coated burlap having the burlap thoroughly water-saturated before placing. Covering shall be laid with light-colored side up. Covering shall be lapped not less than 30 cm and securely weighted down or shall be lapped not less than 10 cm and taped to form a continuous cover with completely closed joints. Sheets shall be weighted to prevent displacement or billowing from winds. Coverings shall be folded down over exposed edges of slabs and secured by approved means. Sheets shall be immediately repaired or replaced if tears or holes appear during the curing period.

e. Membrane-forming Compound Curing: Before applying curing compound, tops of joints that are to receive sealant shall be tightly closed with temporary material to prevent entry of the compound and to prevent moisture loss during the curing period. The compound shall be applied on damp surfaces as soon as the moisture film has disappeared. The curing compound shall be applied by power spraying using a spray nozzle equipped with a wind guard. The compound shall be applied in a two-coat, continuous operation at a coverage of not more than 10 m^2 per liter for each coat. When application is made by hand sprayers, the second coat shall be applied in a direction approximately at right angles to the direction of the first coat. The compound shall form a uniform, continuous, adherent film pinholes or other imperfections. Surfaces subjected to rainfall within 3 hours after compound has been applied, or surface damaged by subsequent construction operations within the curing period, shall be immediately resprayed at the rate specified above. Membrane curing compound shall not be used on surfaces that are to receive any subsequent treatment that depends on adhesion

21. e. cont'd

or bonding to the concrete. Membrane curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam. Where membrane-forming curing compounds are permitted, permanently exposed surfaces shall be cured by use of a non-pigmented membrane-forming curing compound containing a fugitive dye. Where non-pigmented type curing compounds are used, the concrete surface shall be shaded from the direct rays of the sun for the curing period. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

22. EXTERIOR CEMENT MORTAR FINISH

a. Bonding Agent: A manufactured product specifically formulated for bonding concrete to concrete and suited for exterior exposure.

b. Admixture: Waterproofing agent specifically formulated for use with cementitious materials; use only in accordance with manufacturer's specifications.

c. Mix: Mixing Proportion shall be in accordance with requirements specified under sub-clause 11 PROPORTIONING OF CONCRETE MIXES of this Section.

d. Surface of concrete receiving mortar shall be free from all dust and breakers or curing agents prior to application of bonding agent.

e. Apply bonding agent in accordance with manufacturer's specifications just prior to application of mortar.

f. Apply mortar by hand trowels to thickness shown with finish surface troweled to a dense hard smooth finish.

g. Cure in accordance with requirements specified under the SECTION, PLASTER - 9B.

h. After mortar has cured a minimum of 7 days saw cut expansion joints, as shown on drawings, at a maximum of 3 meters on center.

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SECTION 3B

CONCRETE PAVEMENT

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

This Section includes all cast-in-place concrete pavement;

3. GENERAL PROVISIONS

a. Setting out: The Contractor shall properly set out the positions of various surface and structures and establish bench marks to indicate the levels of surface, all as necessary and as approved by the Engineer. Such setting out and bench marks shall be effectively protected until the pertinent works are completed in a manner to be approved by the Engineer.

b. Reconditioning of Sub-grade: If any settlement of the subgrade has occurred prior to commencement of pavement works the Contractor shall rework subgrade to conform to the specified level at his own expenses and obtain the Engineer's approval.

c. Concrete Work Section applies to this section.

d. The following publications listed below, but referred to thereafter by basic designation only, form a part of these Specifications to the extent indicated by the reference thereto:

1) American Society of Testing and Materials (ASTM) Publication:

C293-74	Flexural Strength of Concrete

2) American Association of State Highway and Transportation Officials (AASHTO)

T-180-70	Moisture-Density Relations of Soil. Using a 5.5 lb. Rammer and a 12-in. Drop.
T-193-63	California Bearing Ratio

4. MATERIAL

a. Material for subbase course shall consist of crasher-run rock size from 0.005 mm to 50 mm or other materials as approved by the Engineer.

b. Cement - ASTM C-150 Type II.

c. Fine Aggregate shall conform to the requirements of CONCRETE WORKS - SECTION 3A.

d. Coarse Aggregate shall conform to the requirements of CONCRETE WORKS - SECTION 3A except that the gradation shall be as follows:

Sieve Size	% Passing by Weight
20 mm	100
10 mm	70 - 90
5 mm	0 - 5

5. MIXING PROPORTION

Air-entrained concrete shall be used and standard for concrete proportioning shall be as follows:

1)	Design flexural strength at 28 days in accordance with ASTM C 293	20 kg/cm^2
2)	Slump	5 cm max.
3)	Air content of freshly mixed concrete	3 - 5%

6. EQUIPMENT

Rollers for compaction of subbase course shall be vibrating roller of at least 2.8 ton weight. All equipment and major tools are subject to the approval of the Engineer.

7. SPREADING AND COMPACTING OF SUBBASE COURSE

a. Immediately following final spreading and smoothing, subbase course shall be compacted and watered to the designed surface levels respectively by means of equipment approved by the Engineer. Rolling shall progress gradually from one side to the other, and shall continue until all the designated surfaces have been rolled to the satisfaction of the Engineer. Any irregularities or depressions that develop shall be corrected by adding or removing material until the surface is smooth and uniform. The material shall be both bladed and rolled until a smooth, even surface as been obtained.

7. cont'd

b. Subbase course shall be compacted to produce the minimum required field CBR of 20 in accordance with AASHTO T-193, 20 minimum with proper water spray determined in accordance with AASHTO T-180, method D.

8. PREPARATION OF PLACE OF DEPOSIT

Prior to placing of concrete, the surface of the subbase course shall be leveled to even texture.

9. CONCRETE PLACING

a. When concreting is once started, it shall be carried on as a continuous operation until a section as specified by the Engineer is completed.

b. No concrete that has partially hardened or has been contaminated by foreign materials shall be deposited, nor retempered concrete be used.

c. The aggregate and mixing water shall be cooled to maintain the concrete temperature below 33°C.

d. The surface of the newly laid pavement shall be protected and kept damp by means of a water fog applied with approved spraying equipment or other method as approved by the Engineer.

e. No concrete shall be placed when the air temperature exceeds 33°C.

10. FINISHING

The top surface shall be screeded, troweled and broom finished to a uniform even surface, the edges of all slabs along the forms and at construction joints shall be carefully finished with an edging tool to form a smooth rounded surface after the brooming has been completed.

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DIVISION 4

MASONRY

SECTION 4B

BRICK WORK

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes brickwork used as a protective coat over membrane waterproofing; and related work.

b. Other Sections include light weight concrete and elastomeric membrane.

3. GENERAL PROVISIONS

The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

American Society for Testing and Materials (ASTM) Publications:

C62-75a	Building Bricks (Solid Masonry Units made from Clay or Shale)
C144-70	Aggregate for Masonry Mortar.
C150-74	Portland Cement.
C207-49 (1968)	Hydrated Lime for Masonry Purposes.

4. MATERIAL

a. Brick: ASTM C62 except when the local manufactured product commonly used in building construction in Pakistan is used and approved by the Engineer.

b. Aggregate: ASTM C144.

c. Portland Cement: ASTM C150, Type II.

d. Hydrated Lime (if required): ASTM C207.

5. INSTALLATION

a. Review details and incorporate minor adjustments as necessary to the construction work such as layouts, lines and levels established or required.

b. The Contractor responsible for all proportioning, mixing and other operations necessary to provide first quality and durable workmanship intended under these specifications.

c. When Complete:

1) Appearances neat and uniform throughout.

2) Exposed surfaces clean and free from chipped or broken masonry units.

3) Joints tight and free from porosity or cracks.

4) Exterior work watertight.

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DIVISION 5

METALS

SECTION 5A

STRUCTURAL · STEEL

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes all fabrication and erection of structural steel; and related work.

b. Other Sections include miscellaneous metal work, and other miscellaneous items specified in conjunction with other Sections.

3. GENERAL PROVISIONS

a. The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto.

1) American Institute of Steel Construction (AISC) Publication:

Specification for the Design, Fabrication and Erection of Structural Steel for Buildings (February 12, 1969). With Commentary, Supplement No. 1 (November 1, 1970), and Supplement No. 2 (December 8, 1971).

2) American Society for Testing and Materials (ASTM) Publications:

A 36-74	Structural Steel
A 153-73	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A 307-74	Carbon Steel Externally and Internally Threaded Standard Fasteners
A 325-74	High-strength Bolts for Structural Steel Joints including Suitable Nuts and Plain Hardened Washers.

3. a. cont'd

3) American Welding Society (AWS) Publication:

D1. 1-72 & Rev. 1-73	Structural Welding Code

b. The AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings shall govern the work. Welding shall be in accordance with the AWS Code D1.1 and as herein specified or other standard approved by the Engineer.

c. Certification: Two (2) certified copies of mill test reports including names and locations of mills and shops shall be furnished for all structural steel in accordance with the required Specifications.

d. Responsibility for Errors: The Contractor shall be responsible for all errors of detailing fabrication and for the correct fitting of the structural members.

e. Storage of Materials: The Material shall be stored out of contact with the ground in such manner and location as will minimize contamination and deterioration.

4. SUBMITTALS

a. Refer to SUBMITTALS - SECTION 1J.

b. Complete shop drawings for all structural steel work shall include all shop and erection details.

1) Members and connections for any portion of the structure not shown on the contract drawings shall be detailed by the fabricator and indicated on the shop drawings.

2) All welds shall be indicated by standard welding symbols of the AWS.

5. MATERIALS

a. All steel shall conform to ASTM A36.

b. Bolts, Nuts and Washers for steel to steel connections shall conform to ASTM A325.

c. All other Bolts, Nuts and Washers shall conform to the requirements of ASTM A307, Grade A.

6. WELDING

a. All welding work shall be performed in accordance with the requirements of AWS D1.1. The Contractor shall develop procedures for welding all metals included in the work. Welding

6. a. cont'd

shall not be started until welding procedures, welders, welding operators and tackers have been qualified as specified herein. Qualification testing shall be performed by an approved testing laboratory, or by the Contractor if approved by the Engineer. Costs of such testing shall be borne by the Contractor.

b. Welding Procedure Qualification: Qualification of welding procedures shall be in accordance with the requirements of AWS D1.1. The Contractor shall submit two (2) copies of the welding procedure qualification and test results for each type of welding to be performed to the Engineer for approval.

c. Welder, Welding Operator and Tacker Qualification: Each welder, welding operator and tacker assigned to work on this project shall be qualified by tests using equipment, positions, procedures, base metal and electrodes that will be encountered in his assignment. Certification that each welder, welding operator and tacker is qualified in accordance with the requirements of AWS D1.1 shall be furnished to the Engineer for approval.

d. Welding Materials: All welding equipment, electrodes, welding wire and fluxes shall be capable of producing satisfactory welds when used by a qualified welder or welding operator using qualified welding procedures. All materials shall conform to the requirements of AWS D1.1.

e. Welding Procedures: The Contractor may use any of the welding procedures covered in AWS D1.1.

f. Tests and Inspections: Welds shall be inspected visually and min. 10% of all butt welds and min. 5% of all fillet welds to be designated by the Engineer shall be examined by radiographic, liquid penetrant, magnetic particle or ultrasonic methods, alone or in combination to determine conformance to the acceptance requirements specified herein. All testing shall be performed by an approved testing agency selected and paid for by the Contractor. Tests shall be performed in the presence of the Engineer. All tests shall be certified and submitted to the Engineer for approval.

Acceptance Requirements: Welds are acceptable if inspection indicates conformance with the requirements of AWS D1.1, Section 8, Paragraph 8.15 "Quality of Welds".

7. FABRICATION AND ERECTION

a. Fabrication and assembly of the structural steelwork shall be done in the shop to the greatest extent possible, and shall be in accordance with the applicable provisions of the AISC Specification.

b. Erection of structural steel shall be in accordance with the applicable provisions of the AISC Specification.

8. PRIME PAINTING

All structural steelwork, except surfaces of steel to be encased in concrete, and surfaces to be field welded and contact surfaces of friction-type high-strength bolted connection shall be painted in accordance with the applicable requirements of PAINT - SECTION 9C.

9. GALVANIZING

Galvanizing, where called for, shall conform to the requirements of ASTM A153.

The weight of the zinc coating shall not be less than 550 gram/m^2 of coated surface unless otherwise specified.

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SECTION 5B

MISCELLANEOUS METAL WORKS

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes miscellaneous metal work; and related items.

b. Other Sections include structural steel, railings and ladders, light house cupola and various miscellaneous metal items in conjunction with other Sections.

3. GENERAL PROVISIONS

a. The Contractor shall verify all measurements and shall take all field measurements necessary before fabrication.

b. Exposed fastenings shall be compatible material, shall generally match in finish, and shall harmonize with the material to which fastenings are applied.

c. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included.

d. Miscellaneous bolts and anchors, rebates, lugs brackets supports, braces and connections necessary for completion of the miscellaneous metal work shall be provided.

e. Joint exposed to the weather shall be formed to exclude water.

f. The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

1) American Society for Testing and Materials (ASTM)

A36-74	Structural Steel
A48-74	Gray Irons Castings

3. f. 1) cont'd

A120-73	Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Stee Pipe for Ordinary Uses
A123-73	Zinc (Hot-Galvanized) Coating on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Plates, Bars and Strip.
A153-73	Zinc Coatings (Hot-Dip) on Iron and Steel Hardware.
A307-74	Carbon Steel Externally and Interally Threaded Standard Fasteners.
A386-73	Zinc Coating (Hot-Dip) on Assembled Steel Products.
A467-72	Machine and Coil Chain

2) American Welding Society (AWS)

D1.1-72 & Rev. 1-73	Structural Welding Code.

3) U.S. Federal Specifications (FS)

QQ-F-461C	Floor Plate, Steel, Rolled

4. SUBMITTALS

a. Refer to SUBMITTALS - SECTION 1J.

b. Shop Drawing, along with catalog cuts and templates, erection and installation details for all miscellaneous metal items shall indicate thickness, type, grade, class of metal and dimensions; and shall show construction details, reinforcement, anchorage and installation with relation to the construction.

5. MATERIALS

a. Materials shall conform to the requirements specified for the particular item; and where these requirements are not specified in detail, the materials shall be suitable for the intended usage of the item. The materials listed below shall conform to the respective specifications and other requirements as designated below.

b. Steel Plate, Shapes and Bars shall conform to the requirements of ASTM A36.

c. Bolts, Nuts and Washers shall conform to the requirements of ASTM A307, Grade A and shall be galvanized.

5. cont'd

d. Steel Piping shall be seamless black steel pipe conforming to the requirements of ASTM A120 and shall be standard weight unless otherwise shown on the Drawings.

e. Expansion Bolts: Wedged type or metal expansion shield type; fiber sheaves not permitted.

f. Chain: ASTM A467, Class MS; galvanized.

g. Raised Pattern Steel Floor Plate: FS QQ-F-461C, Class 1, Pattern B, 10 or 13, thickness as shown.

h. Frames and cover shall be fabricated from gray iron casting conforming to the requirements of ASTM A48.

6. GALVANIZING AND PRIMING

a. Galvanizing, where called for, shall conform to the requirements of ASTM A123, ASTM A153 and ASTM A386 as applicable. The weight of the zinc coating shall not be less than 550 gram/m^2 of coated surface, unless otherwise specified.

All galvanized steel in contact with preservative treated wood or concrete shall be coated with bituminous paint on the contact surfaces.

b. Prime Painting where called for shall be prime painted in the shop after fabrication.

1) Omit priming from the following areas:

a) Steel surfaces to be encased in concrete.

b) Surfaces to be field welded.

2) Preparation of surfaces, prime paint and workmanship shall comply with PAINTING - SECTION 9C.

7. MILL TESTS CERTIFICATE

Unless requirement is waived in writing, the Contractor shall submit to the Engineer two (2) copies of mill test reports certifying that materials meet specified ASTM requirements.

8. STORAGE OF MATERIALS

The Material shall be stored out of contact with the ground in such manner and location as will minimize contamination and deterioration.

9. DISSIMILAR MATERIALS

Where dissimilar metals are in contact, the surfaces shall be protected with a coat of bituminous paint, to prevent galvanic or corrosive action.

10. WORKMANSHIP

Miscellaneous metalwork shall be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching shall produce clean true lines and surfaces. Welding, shall be continuous along the entire area of contact, except where tack welding is permitted. Exposed connections of work in place shall not be tack welded; welds shall be ground smooth. Exposed surfaces of work in place shall have a smooth finish. Where tight fits are required, joints shall be milled to a close fit. Corner joints shall be coped or mitred, well formed and in true alignment. Metal work shall be accurately set to establish lines and elevations and securely fastened in place. Work shall be executed and finished in accordance with approved drawings, cuts, details and samples.

11. SCHEDULE OF MISCELLANEOUS METAL ITEMS

a. Listings herein indicate primary or principal items of work only and such listings are not entirely comprehensive nor complete.

b. Drawings of different discripline interrelate and necessarily overlap and duplicate certain aspects of work required. Correlate drawings to avoid duplicating work required and to provide all items necessary to complete the work as intended under this Contract.

c. Steel Stairs and Landings

1) Raised pattern steel floor plate.

2) Welded construction.

3) Exposed edges ground smooth and slightly rounded.

4) Bolts inexposed areas oval head.

5) Provide all expansion shields and other accessories required.

d. Mooring Bitts: Steel pipe, constructed as shown in the Drawings.

e. Mooring Rings: Welded construction, hot-dip galvanized after fabrication.

11. cont'd

f. Chain and Hooks

1) Provide for all gas cylinders as shown in the Drawings.

2) Provide ceiling hook directly over floor hatch in front leading light.

g. Angle Frames for Openings

1) Sizes of openings, angles and anchors as shown in the Drawings.

2) Hot-Dip galvanize after fabrication, restraighten frames as required.

* * * * *

SECTION 5C

RAILINGS AND LADDERS

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes all galvanized steel and stainless steel railings and ladders:

b. Other Sections include miscellaneous metals, metal hatches, other stainless steel work and painting.

3. GENERAL PROVISIONS

a. The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

American Society for Testing and Materials (ASTM) Publications:

A36-75	Structural Steel
A53-73	Welded and seamless Steel Pipe
A167-74	Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip
A276-75	Stainless and Heat-Resisting Steel Bars and Shapes
A307-74	Carbon Steel External and Internally Threaded Standard Fasteners
A312-74	Seamless and Welded Austenitic Stainless Steel Pipe
A525-73	Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, General Requirements

3. cont'd

b. Submittals

1) Refer to SUBMITTALS - SECTION 1J

2) Shop Drawings:

a) Submit shop drawings for all railings, including splices and attachments.

b) Identify location and type indicated.

c) Indicate railings in related and dimensional position with elevations at scale 1:48 and details at scale of 1:4 or larger.

d) Control details and dimensions not governed by field conditions.

e) Indicate all required field measurements.

3) Submit for the Engineer review, manufacturer's assembly and installation instructions.

c. Location of Materials:

1) Galvanized railways and ladders shall be used of interior locations.

2) Stainless steel railways and ladders shall be used at all exterior locations.

4. MATERIALS

a. Carbon Steel Pipe: ASTM A53, Grade B, schedule 40, except hydrostatic test not required; sizes as shown in the Drawings. Finish: Galvanized, ASTM A525, class 1.25.

b. Stainless Steel Pipe: ASTM A312, type 316; sizes as shown in the Drawings.

c. Steel Shapes: ASTM A36; shapes as shown in the Drawings. Finish: Galvanized, ASTM A525, class 1.25.

d. Stainless Steel Shapes: ASTM A274, type 316; shapes as shown in the Drawings.

e. Fittings

1) Carbon Steel: ASTM A36, 1010 low alloy carbon plate.

2) Stainless Steel: Fabricated of plate, ASTM A167, alloy 316.

4. cont'd

f. Bolts and Fastenings:

1) For stainless steel: Same as alloy as other stainless steel.

2) For plain steel: ASTM A307, except oval head or flush type where subject to contact with hands.

g. Cement: Hydraulic, quick-setting, ASTM C595, factory prepared with accelerator.

5. FABRICATION

a. Cut materials square within 2° and to lengths within 3 mm.

b. Remove burrs from cut edges.

c. Form bends to uniform radius, free from buckles and twists, with finished surfaces smooth.

d. Close exposed ends of steel pipe by welding 4.762 mm thick steel plate in place.

e. Where posts are set into concrete, furnish 100 mm long matching sleeves.

f. Where posts are set on stair stringers, weld 5 mm thick plate to bottom, for field welding to springer.

g. Welding:

1) Miter and cope intersections of posts and rails within 2°, fit to within 0.5 mm and weld all around.

2) Thoroughly fuse without undercutting or overlap.

3) Remove spatter, grind exposed welds to blend and contour surfaces to match those adjacent.

4) Discoloration of finished surfaces will not be acceptable.

h. Form and assemble joints which will be exposed to the weather so as to exclude water.

i. Chain with eye, snap hook and staple across gap where shown; stainless steel where used in the exterior.

j. Fabricate miscellaneous hand holds as shown on the Drawings.

6. FINISHES

a. Stainless Steel Work: Mill finish; touch up and fill and welds as required.

6. cont'd

b. Steel Pipe Rail: On all welds and non-galvanized items shop prime with zinc-rich primer as specified under PAINTING - SECTION 9C.

c. Steel Ladders and other non-galvanized items shall be hot-dipped galvanized in accordance with ASTM A385 or A123.

7. PRODUCT DELIVERY, STORAGE AND HANDLING

a. Delivery of Materials: Deliver, store and handle components in such manner as to prevent damage to finished surfaces.

b. Storage of Stainless Steel Materials:

1) Store components in dry, clean location, away from uncured concrete and masonry.

2) Cover with waterproof paper, tarpaulin or polyethylene sheeting.

c. Handling: Keep handling minimum.

d. Protection: Maintain protective covering on pipe until installation is complete and other trades are off.

8. INSTALLATION

a. Install sleeves 100 mm deep in concrete, for posts.

b. Setting Posts:

1) Clean dust and foreign matter from the base of posts.

2) Moisten interior of hole and surrounding surface with clean water.

3) Mix cement with water and stir until a smooth, creamy consistency is produced.

4) Pour mixture into annular space until it overflows the hole.

5) Wipe off excess and leave 3 mm build-up, sloped away from post.

6) Brace railing until grout sets.

c. Set posts plumb and aligned to within 6 mm in 3.6 m.

d. Set rails horizontal or parallel to the rake of steps to within 6 mm in 3.6 m.

8. cont'd

e. Assemble connections end to end and splice joints by using internal sleeves, bonded by adhesive.

f. Expansion Joints

1) Provide at intervals of not more than 12 m on centers.

2) Provide slip joint with internal sleeve extending 50 mm beyond each side of joint.

3) Fasten to one side using adhesive.

4) Locate joints within 300 mm of posts.

g. Support wall ladders on brackets as shown.

9. CLEANING

a. Wash stainless steel thoroughly using clean water and soap; rinse with clean water.

b. Do not use acid solution, steel wool or other harsh abrasive on stainless steel.

10. TREATMENT OF FIELD WELDS

Touch up welds by application of 2 coats of paint as specified under finish dry film thickness of 2 mils.

11. REPAIR OF DEFECTIVE WORK

Remove defective work and replace with material that meets specification requirements.

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DIVISION 6

WOOD AND PLASTICS

SECTION 6A

CARPENTRY

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requir ments essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes all carpentry measured for this project; and related work.

b. Other Sections include work similar to, adjacent to, or connecting to work under this Section. Examine all drawings and specifications to determine exact extent of work required under this Section.

3. GENERAL PROVISIONS

a. Submittals

1) Refer to SUBMITTALS - SECTION 1J.

2) Material List: Submit list of materials furnished hereunder.

b. Work subject to review and approval by the Engineer prior to milling, cutting or erection. Verify conditions at site; work to field dimensions as required.

c. Carpentry finishing shall be performed by experienced and competent workmen; and in accordance with best standards of trade practices. When complete, exposed surfaces shall be free from dents and tool marks, unsanded rough or torn faces and corners, and other defects.

d. Furnish all nails, screws, adhesives and other installation accessories necessary for proper erection and completion of carpentry work.

e. Door Frames: Back primed and dried prior to setting.

3. cont'd

f. Protect materials against damage by handling, weather or other causes.

4. WOOD FRAMES

a. Material: Locally available hardwood for paint finish.

b. Stop shall be of type approved by the Engineer.

5. STORAGE OF DOORS

a. Wood:

1) Stack flat on (50 x 100 mm) lumber, laid 12 in (30 cm) from ends and across center.

2) Under bottom door and over top of stack provides plywood or corrugated cardboard to protect door surface.

3) Store doors in area where there will be no great variations in heat, dryness, and humidity.

b. Metal (including frames)

1) Store doors upright, in a protected dry area, at least 1 inch (25 mm) or more off the ground or floor and at least 1/4 inch (6 mm) between individual pieces.

2) Follow special storage and handling requirements of manufacturer.

3) Protect exposed finish surfaces of prefinished items with masking tape.

6. INSTALLATION OF WOOD DOORS

a. Fitting and Machining:

1) Fit doors for width by planing; for height by sawing.

a) 13 mm from bottom.

b) 3.2 mm maximum from top.

c) Bevel lock and hinge edges 3.2 mm in 51 mm.

2) Machine doors for hardware to clearance tolerances as specified.

3) Seal all job site cut surfaces with two coats of prime paint before final hanging of doors.

6. cont'd

b. Installation

1) Follow door manufacturer's written instructions for all installation work.

2) Clearances:

a) Allow maximum of 3.2 mm at jamb and head for job fit doors.

b) Allow maximum of 5 mm over threshold or saddle.

c. Adjust and Clean

1) Replace or rehang doors which are hingebound and do not swing or operate freely.

2) Refinish or replace job finished doors damaged during installation.

7. INSTALLATION OF METAL FRAMES

a. Exercise care in setting of frames to maintain scheduled dimensions, hold head level and maintain jambs plumb and square.

b. Secure anchorages and connections to adjacent construction.

c. Wherever possible, leave frame spreader bars intact until frames are set perfectly square and plumb, and anchors are securely attached.

d. Allow for expansion movement as required.

8. INSTALLATION OF METAL DOORS

a. Apply hardware in accordance with hardware manufacturer's templates and instructions.

b. Adjust operable parts for correct function.

c. Remove hardware, with the exception of prime-coated items, tag, box, and reinstall after finish paint work is completed.

d. Prime Coat Touch-up:

1) Immediately after erection, areas where prime coat has been damaged shall be sanded smooth and touched up with same primer as applied at shop.

2) Remove rust before the above specified touch-up is applied.

3) Touch-up shall not be obvious.

8. d. cont'd

4) Before job painting is started, finish on frame and doors shall comply with finish on approved sample.

e. Protect installed hollow metal work against damage from other construction work.

9. ASBESTOS CEMENT CEILING BOARD

a. Material: Flat asbestos cement board conforming to ASTM C 459, 6 mm thick.

b. Install with self tapping phillips head flat head screws at 30 cm on centers at each support; all screw heads set flush.

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DIVISION 7

THERMAL AND MOISTURE PROTECTION

SECTION 7A

SEALANTS

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes all sealants required for the projects; and related work.

b. Other Sections include sealants for elastomeric waterproofing and ceramic tile.

3. GENERAL PROVISIONS

a. The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

1) American Society for Testing and Materials (ASTM) Publications:

D412-68	Tension Testing of Vulcanized Rubber

2) American National Standards Institute (ANSI)

A116.1	Two-Component Elastomeric Sealing Compounds for the Building Trade

3) United States Federal Specifications (FS)

TT-S-00227E (Am.3)	Sealing Compound Elastomeric Type, Multi-component (For Calking, Sealing and Glazing in Buildings and other Structures)
TT-S-00230C (Am.2)	Sealing Compound Elastomeric Type Single-component (For Calking, Sealing and Glazing in Building and other Structures)

3. cont'd

b. Submittals

1) Refer to SUBMITTALS - SECTION 1J.

2) Material List; including producer's technical data, specification and installation instructions.

3) Certificate of Materials from approved sealant manufacturers indicating compliance with specified standards or other approved standards.

c. Correlate with work under other Sections or Division. Provide instructions necessary for proper construction and treatment of joints required to receive sealant work.

d. Sealant Installations and Related Preparatory Work:

1) Perform in accordance with manufacturer's instructions applicable to conditions encountered or prevailing at the Project Site.

2) Arrange for consultation with manufacturer's representatives as or when necessary to obtain any clarifying, modifying or other supplementary instructions.

e. Protection Work:

1) Protect adjacent construction and finishes as necessary.

2) Protect sealant work as necessary during and following installation until properly cured.

f. Prior to Starting Work:

1) Store materials in well protected locations.

2) Joint surfaces receiving sealants shall be clean and sound.

3) Do not proceed with work where joints are found not in proper condition.

4. MATERIALS-GENERAL

a. Material Required: Producers' standard types and formulations, factory prepared and packaged under well governed scientific quality control procedures.

b. Minor Differences in composition or color between similar items of different producers will be permitted when approved by the Engineer.

c. Auxiliary primers, thinners, separators and cleaners provided as necessary; in types produced or approved by the manufacturer of primary sealant material with which they are used.

4. cont'd

d. Colors for exposed materials as selected from manufacturers' full range of standard series available.

e. Specific type or grade variations of materials required only as recommended by their manufacturers as best for installation condition encountered.

f. Type Designations assigned at titles herein are for convenience of reference only and do not relate to standards or manufacturers' numbers.

g. Provide Materials in types and assemblies for locations specified; regardless of whether or not each and every detail and location is so indicated; and regardless of whether details and locations are noted as sealant, calking, mastic, packing, or other term.

h. Sealants elastomeric type only throughout. Putties and other oil based materials are not permitted.

i. Sealant Types Specified have been selected to cover a wide variety of conditions. All types included herein may not be required for this Project.

5. TYPE A - SEALANT FOR FLOORS

a. Extent: Exterior and interior building joints in floors and decks; excluding exterior slabs on grade abutting building structure, unless otherwise shown or specified.

b. Sealant: Multi-part polyurethane type conforming to F.S. TT-S-00227E (Am. 3), Type II, Class A; complying with following requirements:

1) Shore Hardness, when placed and cured: 30 minimum, 40 maximum.

2) Solids: 99 percent minimum.

3) Shrinkage: 0.8 percent maximum.

4) Ultimate Elongation, per ASTM D 412: 350 percent.

5) Recovery, conditioned 3 days at 48.9°C and 16 hours at 23.9°C, and
a] Held for 5 minutes: 99 percent
b] Held for 24 hours : 80 percent

6) Adhesive Strength, tested per ANSI A116.1 when applied to stainless steel, concrete and glass using manufacturer's primers and after immersion in water 4 days at 23.9°C. 30 pounds per square inch. (2.1 kg/cm^2).

5. cont'd

c. Backing Filler:

1) Extruded, rectangular solid neoprene strips not less than Shore 60 hardness.

2) Strip widths as necessary for neat force-fit into the joints required.

3) Strip thickness under sealant 1.25 cm minimum, 2.5 cm maximum, or as necessary to achieve sealant recesses of uniform depths and to meet specified requirements for sealant depths.

d. Depth of sealant when installed, from finish floor surface to top of backing filler, shall not be less than 1.25 cm for joint up to 2.5 cm wide, nor less than 1.85 cm for wider joints.

e. Finish Surface of sealant shall be approximately level with adjacent finish floor surfaces and may be slightly concaved, Where joint edges are rounded or eased, sealant shall be recessed just sufficient to avoid contact with such edges.

6. TYPE B - SEALANT FOR MARBLE

a. Extent: Exterior building joints in marble.

b. Sealant: Multi-part polyurethane type conforming to F.S. TT-S-00227E (Am. 3), Type II, Class A.

c. Backing Filler:

1) Extruded neoprene or foam urethane strips.

2) Form, shape and size to suit joints where required and to provide firm resistance during sealant installation.

d. Depth of sealant when installed, at its thinner section shall not be less than 1 cm for joints up to 1.85 cm wide; nor less than 1.25 cm for wider joints.

7. TYPE C - SEALANT FOR COMPRESSION JOINTS

a. Extent: Exterior joints mechanically secured and exerting continuous and permanent compression on sealant.

b. Sealant: Polyisobutylene tape, 2.35 mm thick by 3.75 cm wide, preformed in proper backed and rolled strips.

8. TYPE D - SEALANT FOR GENERAL EXPOSED WORK

a. Extent: Exposed exterior and interior joints throughout project

8. a. cont'd

other than where specified Types A or B are required; and may be used in lieu of Type C when approved.

b. Sealant: One-part polysulphide type conforming to F.S. TT-S-00230C (Am. 2), Type II, Class B.

c. Backing Filler: As specified for Type B Sealant.

d. Depth of sealant when installed, at its thinnest section, shall not be less than 0.65 cm for joints up to 1.85 cm wide; nor less than 1 cm for wider joints.

9. TYPE E - SEALANT FOR GENERAL CONCEALED WORK

a. Extent: Concealed exterior and interior joints throughout the Project other than where specified Types A, B, C or D are required. Type D may be used in lieu of Type E.

b. Sealant: One part polysulphide polymer base type conforming to F.S. TT-S-00230C (Am. 2), Type II, Class B.

c. Backing Filler: Any suitable type compatible with sealant to provide sufficiently firm back up for sealant installation, except not required for joint widths less than 1 cm.

d. Depth of sealant when installed, at its thinnest section, not less than 0.65 cm; except when used at plaster or other like materials less than 1.85 cm thick, apply Type E sealant for full depth of joint formed by such materials.

10. PREPARATION

a. Clean sealant joint surfaces free from dirt, dust, laitance or other matter or particles inhibitive to complete and secure adhesion; using whatever procedures are necessary.

b. Remove any temporary materials set or used to form joints for sealants.

c. Prime joint surfaces in accord with sealant manufacturer's instructions and recommendations applicable to substrate materials.

11. INSTALLATION

a. Sealant installed prior to adjacent asphaltic, elastomeric waterproofing, finish painting or other work which may contaminate joint surfaces.

b. Backing Fillers installed in longest single lengths available and practicable, and set by forcing straight into the joint

11. b. cont'd

pocket. Stretching fillers lengthwise to aid installation not permitted. Set fillers to required depths using wood or other gauging tools formed for the purpose.

c. Sealants extruded into place; accurately applied in one continuous operation; to full joint or pocket depths and width required; with sufficient pressure to assure complete and continuous contact and adhesion.

d. When Complete, sealants shall have full and complete adhesion with contact surfaces; shall have a thoroughly neat, extruded appearance to shape and sight lines required; and shall be watertight throughout.

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SECTION 7B

ELASTOMERIC MEMBRANE WATERPROOFING

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes elastomeric membrane waterproofing for roofs, decks and water tanks; and related work.

b. Other Sections include concrete protective course.

3. GENERAL PROVISIONS

a. The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

American Society for Testing and Materials (ASTM)

D 412-68	Tension Testing of Vulcanized Rubber
D 471-75	Changes in Properties of Elastomeric Vulcanizates Resulting from Immersion in Liquids
D 476-73	Titanium Dioxide Pigments
D 573-67 (1972)	Accelerated Aging of Vulcanized Rubber by Oven Method
D 624-73	Tear Resistance of Vulcanized Rubber
D 1149-64 (1970)	Accelerated Ozone Cracking of Vulcanized Rubber
D 2240-75	Indentation Hardness of Rubber and Plastics by Means of a Durometer

b. Applicator shall be a company regularly providing work of the types required and having not less than 2 years installation experience.

3. cont'd

c. Submittals

1) Refer to SUBMITTALS - SECTION 1J.

2) Shop Drawings: Show layout of sheets, location of field splices, types of splices and termination details.

3) Samples: Submit the following

a) Membrane material: 300mm x 300mm
b) Splicing tape: 300mm
c) Splicing cement: 0.00096 m^3
d) Bending adhesive: 0.00095 m^3
e) Manufacturer's certificate of compliance
f) Manufacturer's printed instructions for installation of membrane, including procedures and materials for flashing, splicing and bending.

4. PRODUCT DELIVERY, STORAGE, AND HANDLING

a. Deliver materials to project site in manufacturer's unopened original packaging.

b. During loading, transporting, and unloading exercise care to prevent damage to materials.

c. Do not cut, tear, or puncture elastomeric sheet.

d. Store materials on site in enclosures or under protective coverings.

e. Assure that materials are kept clean and dry.

f. Store materials off the ground.

5. MATERIALS

a. Elastomeric Sheet:

1) Ethylene Propylene Diene Monomers (EPDM) material meeting the following physical properties:

Property	Test Method	Specifications
Hardness, Shore A	ASTM D 2240	60 ± 10 points
Tensile Strength	ASTM D 412	1400 psi minimum
Elongation at Break	ASTM D 412	300% minimum
Brittleness Temperature	ASTM D 476	-75°F.
Tear Resistance	ASTM D 624 (Die B)	200 lbs. per lin. inch, minimum

5. a. cont'd

Property	Test Method	Specifications
Resistance to Heat Aging Change in original properties after 7 days at 240°F., or 28 days at 150°F.	ASTM D 573	
Hardness, Maximum increase		15 points
Elongation, Maximum Reduction		30%
Tensile strength, Maximum Loss		15%
Resistance to Ozone Condition after exposure to 100 pphm ozone in air for 10,000 hrs. at 100°F. (sample under 20% strain)	ASTM D 1149	No cracks
Resistance to Water Absorption increase in volume after 3 days immersion at 212°F.	ASTM D 471	0.5% maximum

2) Thickness: 2.38 mm at decks and roofs; 3.18 mm at water tanks.

3) Size: Largest possible sheet size that can conveniently be handled on the job site to minimize field joints.

b. Splicing Tape, Cement and Bonding Adhesive: As recommended by membrane manufacturer.

6. INSTALLATION

a. Inspection:

1) Examine surfaces scheduled to receive elastomeric membrane waterproofing to assure that they are smooth, dry, and free from conditions that will adversely affect execution, permanence, or quality of work.

2) Do not install elastomeric membrane waterproofing until other work which penetrates membrane has been completed.

b. Preparation of Surfaces:

1) Sweep clean and surfaces on or against which waterproofing is applied, removing loose and foreign materials.

2) Remove fins, sharp edges, oil, and grease.

c. Installation

1) Positioning Membrane:

6. c. 1) cont'd

a) Place membrane waterproofing sheet in final position without stretching.

b) Allow membrane to relax 30 minutes minimum before making splices or bonding to substrate.

c) Overlap adjacent sheets for splicing.

2) Applying Adhesive:

a) Spread adhesive in 15 mm strips over both mating surfaces at decks and roofs; spread adhesive completely over both mating surfaces at water tanks.

b) Place membrane in bond position without stretching, taking care to avoid trapping air.

c) Roll with dry roller to remove air pockets.

3) Splicing:

a) Clean overlapping areas with heptane, hexane, or white gasoline.

b) Overlap sheets 8 mm minimum.

c) Joint overlaps with splicing cement and tape to form splice in accordance with manufacturer's instructions.

4) Flashings: Flash all pipes, conduits and other penetrations through waterproofing, using membrane manufacturer's recommended procedures.

7. FLOOD TESTING

a. Plug all drains on horizontal surfaces.

b. Use sand bags or other means to restrict run-off.

c. Flood decks and roofs with water to a depth of 50 mm and allow to stand at least one hour.

d. Fill tanks with water to within 50 mm of the top and allow to stand 12 hours.

1) Any noticable drop in waterlevel shall be sufficient to indicate leaks in membrane.

2) Repair all leaks and retest.

8. PROTECTION

Restrict all traffic on membrane until protection course of concrete is installed.

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SECTION 7C

SHEET METAL

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes sheet metal flashing, louvers; and related work.

b. Other Sections include hatches, sealants and other miscellaneous sheet metal items.

3. GENERAL PROVISIONS

a. The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

1) American Society for Testing and Materials (ASTM) Publications:

A167-74	Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Stirp.
A276-75	Stainless and Heat-Resisting Steel Bars and Shapes.

2) Sheet Metal and Air-Conditioning Contractors National Association (SMACCNA)

Architectural Sheet Metal Manual Sept. 1969

Architectural Sheet Metal Specification 1967

3) Federal Specification (FS)

L-S-125B	Screening, Insect, Non-metallic

b. Sumittals

1) Refer to SUBMITTALS - SECTION 1J.

3. b. cont'd

2) Shop drawings shall be submitted for all items.

4. MATERIALS

a. Sheet Metal: Stainless Steel ASTM A167, type 302 or 304, soft temper.

1) Miscelaneous Bars and Shapes: ASTM 276 type 302 or 304.

2) Minimum Thickness:

a) Louver Frame: 0.914 mm

b) Louver Blades: 0.69 mm

c) All other items: 0.457 mm

b. Roof Drains and Vents: Where Plastic is shown provide polyvinylchloride rigid plastic pipe sections with screened ends.

c. Insect Screens: F.S. L-S-125, type II.

d. Fasteners: Stainless Steel.

5. FABRICATION

a. Fabricate in accordance with approved shop drawings and SMACCNA standards.

b. Louver blades weather resistant type with top edge turned back to prevent rain from entering.

1) All blades at 45° angle.

2) Removable screen backing.

c. Where louvers are to be set in windows coordinate with METAL WINDOWS - SECTION 8C for proper size.

d. Louver thickness as required for wall, door and window construction.

6. INSPECTION

a. Verify that substrates are smooth and clean to the extent needed for sheet metal work.

b. Do not start sheet metal work until conditions are satisfactory.

c. Before installing sheet metal verify shapes and dimensions of surface to be covered.

7. INSTALLATION

a. General:

1) Install work watertight, without waves, warps, bucklets, fastening stresses or distortion, allowing for expansion and contraction.

2) Hem exposed edges.

3) Angle bottom edges of exposed vertical surfaces to form drips.

b. Install sheet metal in accordance with SMACCNA standards.

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SECTION 7D

HATCHES

1. GENERAL

VOLUME 1, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes roof and floor hatches; and cast iron waterproof door on rear leading light.

b. Other Sections include metal doors.

3. GENERAL PROVISIONS

a. The following publication listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

American Society for Testing and Materials (ASTM) Publications:

A27-73	Specification for Mild to Medium Strength Carbon Steel Castings for General Use.
A48-74	Specification for Gray Iron Casting.
A167-74	Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
A276-75	Stainless and Heat-Resisting Steel Bars and Shapes.

b. Submittals

1) Refer to SUBMITTALS - SECTION 1J.

2) Shop drawings and/or catalog cuts shall be submitted indicating size, weight and mounting requirements of each item.

3) No equipment shall be ordered prior to the approval of the Engineer.

4. MATERIALS

a. Floor Hatch for below grade water tank; cast iron manhole cover; including setting ring.

b. Roof Hatches: ASTM A167; stainless steel, type 316; 3.15 mm thick minimum, mill finish.

Miscellaneous shapes as required: ASTM A276.

c. Door at rear leading light: Cast iron, including frame.

d. Gaskets: Closed cell neoprene gasket material.

5. FABRICATION

a. Roof Hatches:

1) Form to shapes from single sheet where possible as shown on Drawings, remainder shall be welded construction.

2) All hatches lockable by means of padlocks from either side.

3) Gasket between frame and cover with a latching mechanism which will draw cover to frame.

4) Each hatch shall be completely watertight when latched.

b. Door at Rear Leading Light.

1) Construct as for ships bulkhead hatch except lockable on exterior by padlock.

2) Tighten door against gasket and frame by means of clamping arms at key points on the door.

3) Frame shall be fitted to door and gasket and shall be designed for installation in concrete.

4) Hinge system shall be designed as an integral part of frame and door system and shall be of a type which will not rust.

5) Door and frame shall be factory primed and finished painted to withstand extreme salt air exposure.

Submit proposed paint system for the Engineer's approval.

6. INSTALLATION

a. Each hatch or door shall operate smoothly without bind.

b. Gasket material shall be attached to one surface securely so that it will remain in its proper position.

c. Hatch or door found to be loose or not waterproof when closed shall be replaced at no additional cost to the PQA.

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DIVISION 8

DOORS AND WINDOWS

SECTION 8A

HOLLOW METAL WORK

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes furnishing all hollow metal doors and frames; and related work.

b. Other Sections include

1) Installation of hollow metal work
2) Wood doors
3) Finish hardware
4) Glass and glazing
5) Grouting of frames
6) Painting
7) Louvers

3. GENERAL PROVISIONS

a. The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

American Society for Testing and Materials (ASTM) Publications:

A 167-74	Stainless and Head-Resisting Chromium-Nickel Steel Plate, Sheet and Strip
A 526-71	Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality

b. Submittals

1) Refer to SUBMITTALS - SECTION 1J.

3. b. cont'd

2) Shop Drawings:

a) Submit shop drawings covering each type of door and frame, frame conditions, and complete anchorage details, supplemented by suitable schedules covering doors and frames.

b) Show glass and louver opening sizes and locations in doors.

c) For frames too large to ship in one piece, locate and detail field splice joints and indicate complete instructions for making field splices.

4. PRIMARY MATERIALS

a. GALVANIZED SHEET STEEL

1) ASTM A 526, Commercial Quality; pre-galvanized not less than 275 grams per square meter.

2) Galvanizing doors and frames after fabrication not permitted.

3) Thickness not less than as specified, before sheets are galvanized.

b. STAINLESS STEEL SHEET:

1) ASTM A 167, Type 302 or similar as best suited to the work of types required.

2) Thickness not less than as specified.

3) Finish: No. 4 exposed surfaces.

4) Strippable paper protected.

5. FRAMES FOR FLUSH DOORS

a. Frames shall be combination buck, frame and trim type.

b. Minimum Thickness: Both stainless steel and galvanized, 1,613 mm.

c. Brake-Form Steel Sheets:

1) Provide profiles and shapes free of warp, buckles, fractures, or other defects.

2) Form stops integral with frames unless otherwise shown.

5. cont'd

d. Corners and connections shall be either welded with exposed welds ground flush and smooth or mechanically assembled (knock-down) type at the Contractor's option.

e. Anchors:

1) Provide an anchor at each jamb for each 2 feet 6 inches (75 cm) or door height or fraction thereof.

2) Vary anchor types to provide positive fastening to adjacent construction.

3) Secure a metal clip angle at bottom of each jamb member for anchoring to floor, with a minimum of 2 fasteners.

6. FLUSH DOORS

a. Face Sheets: Both stainless steel and galvanized; 1.311 mm thick.

b. Internal Stiffeners:

1) Minimum 1.00 mm thick steel.

2) Space at not over 152 mm centers.

3) Spot weld to face panels at maximum 127 mm intervals.

4) Vertical edges of face panels shall be joined and welded on maximum 152 mm centers, then ground smooth and filled with mineral filler to conceal seams.

7. NARROW STILE ENTRANGE DOORS AND FRAMES

a. Doors shall have stiles and rails of minimum 1.311 mm thick with reinforced and welded or mechanically assembled joints.

b. Glass stops shall be of minimum 1.00 mm thick steel designed for flush glazing.

c. Frames shall be of minimum 1.413 mm thick steel with welded joints, complete with transom bar.

d. Push and Pull Bars: Standard manufactured stainless steel push and pulls bars of 22 mm diameter minimum; each push and pull 228 mm high; offset at 45° angle; provide one push and one pull for each door.

8. PREPARATION FOR FINISH HARDWARE

a. Prepare doors and frames to receive hardware:

8. a. cont'd

1) Hardware supplier shall furnish hollow metal manufacturer approved hardware schedule, hardware templates, and samples of physical hardware where necessary to insure correct fitting and installation.

2) Preparation includes sinkages and cut-outs for mortise and concealed hardware.

b. Provide reinforcements for both concealed and surface applied hardware:

1) Drill and tap mortise reinforcements at factory, using templates.

2) Install reinforcements with concealed connections designed to develop full strength of reinforcements.

9. FINISH

a. Galvanized Steel Doors and Frames:
Touch up all abrasions in galvanized surface and all joints with Zinc Rich Primer specified under PAINTING - SECTION 9C.

b. Stainless Steel Doors and Frames:
All joints ground flush and repolished to match finish specified.

Finish joints free from burrs, pits, scratches, discoloration or other evidence of welding and grinding.

10. DELIVERY

a. Deliver the hollow metal work in manner to prevent damage and deterioration.

b. Provide packaging made of material such as cardboard or other containers, separators, banding, spreaders, and paper wrappings to protect hollow metal items.

c. Protect exposed finish surfaces of prefinished items with masking tape.

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SECTION 8B

WOOD DOORS

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes furnishing all wood doors; and related work.

b. Other Sections include

1) Carpentry
2) Sheet metal louvers
3) Finish hardware
4) Glass and glazing
4) Painting

3. GENERAL PROVISIONS

a. The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

1) U.S. Commercial Standards (CS)

CS 171-58 w/amend	Hardwood Veneered Doors (Solidcore, Hollowcore and Panel and Sash)
CS 262-63	Water Repellent Preservative Non-pressure Treatment for Millwork

2) National Woodwork Manufacturers Association (NWMA)

NWMA I.S. 1-69	Wood Flush Doors

b. Submittals

1) Refer to SUBMITTALS - SECTION 1J.

2) Shop Drawings: Show details of door construction:

a) Full size molding section detail for light and louver installation.

3. b. 2) cont'd

b) Face veneer species.

3) Door Schedule: Indicate opening identifying symbol, sizes, and light and louver cutout sizes and locations.

4. PRODUCT DELIVERY

Delivery:

1) Deliver the doors to the Site after plaster and cement are dry and building has reached average prevailing relative humidity of locality.

2) Seal all four edges of doors when delivered to the Project Site,

5. MATERIALS

a.	Door Standard:	CS 171	Sound Grade
b.	Adhesives:	CS 171	Type I exterior
c.	Core:	Glued block	
d.	Water Repellent Preservative:	CS 282	

6. FABRICATION

a. Moisture Content: 12% maximum at time of fabrication for all wood material.

b. Glued block core: Core blocks 64 mm maximum width bonded together, and joints staggered in adjacent rows.

a) Bond face panels to core.
b) Stile and rail edge bands, 13 mm minimum width, bonded to core.

c. Face Panels:

1) Face panels of two or more veneer plies, total minimum thickness 1.6 mm before sanding.

2) Bond hardwood venner to core construction.

d. Light Openings: Moldings and glass stops of hardwood of mill option species.

e. Louvers: Cut opening in doors for installation of metal louvers.

7. ALLOWABLE TOLERANCES FOR FABRICATION OF DOORS

a. Size: Not prefit: ±1.5 mm, overall dimensions.

b. Maximum warp: 6 mm.

c. Squareness: Length of diagonal measured on face of door from upper right corner to lower left corner between length of diagonal measured on upper left corner to lower right corner; maximum difference of 6 mm.

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SECTION 8C

METAL WINDOWS

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. I-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes stainless steel windows and screens; and related work.

b. Other Sections include stainless steel doors, frames and louvers.

3. GENERAL PROVISIONS

a. The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

1) American Society for Testing and Materials (ASTM) Publications:

A167-74	Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
A276-75	Stainless and Heat-Resisting Steel Bars and Shapes.

2) Federal Specification (FS)

L-S-125B	Screening, Insect, Non-metallic

b. Submittals

1) Refer to SUBMITTALS - SECTIONS 1J.

2) Samples: Complete window and screen of type to be installed on project.

3) Shop Drawings:

a) Showing construction of all parts, metal thicknesses, installation and erection details including connections, anchorage, fastening, and sealing methods.

3. b. 3) cont'd

b) Sections of typical members, dimensioned elevations, frame sizes, spacing of anchors and fasteners, and details of accessories.

4) Manufacturer's Recommended Installation and Maintenance Procedures.

c. Delivery, Storage and Handling:

1) Store windows in upright position on the ground with dunnage.

2) Protect from weather and damage.

3) Store as close as possible to the point of installation.

4. MATERIAL

a. Stainless Steel Sheet and Plate: ASTM A167, Type 302 or 304.

b. Stainless Steel Bars or Shape: ASTM A276, Type 302 or 304.

c. Fasteners and Hardware: Manufacturer's Standard.

d. Screening: FS L-S-125B, Type II, color as approved.

5. FABRICATION

a. Conform to the drawings; may be welded or mechanically assembled.

b. Welding:

1) Finish surfaces free of distortion and discoloration.

2) Remove weld spatter and welding oxide from finished surfaces.

3) Grind weld beads flush with exposed surfaces and polish to blend with adjacent finish.

c. Mechanical Assemblies:

1) Fit corner joints rigid and weather tight.

2) Fasteners concealed when window is installed and closed.

3) Rotating parts assembly:

a) Stainless steel to non-metallic.

b) Stainless steel to stainless steel.

5. cont'd

d. Hardware:

1) Attach with corrosion-resistant fasteners.

2) Accessible for adjustment and replacement from inside building without damage to windows.

e. Mullions and Muntins: Support to permit movement from expansion and contraction without damage to window assembly.

f. Screens:

1) Rigid frames holding screening in place with removable splines.

2) Frame finish to match window frame.

g. Fixed Windows: Glazed from interior.

h. Finish: All exposed stainless steel parts with No. 4 finish (AISI)

6. INSPECTION

a. Assure that window openings conform with dimensions and tolerances shown on the Drawings.

b. Check that surfaces to contact windows are free of debris.

c. Do not proceed with installation until unsatisfactory condisions are corrected.

7. INSTALLATION

a. Comply with manufacturer's instructions for installation of units, hardware, operators, and other components.

b. Set units plumb, level, and true to line, without warp or rack of frames or sash.

c. Anchor frames solidly to surrounding construction to prevent distortion or misalignment.

d. Apply protective coating to separate stainless steel from galvanically incompatible materials.

8. ADJUST AND CLEAN

a. Adjust movable units to operate smoothly and to be weather tight when closed.

b. Lubricate hardware and moving parts.

8. cont'd

c. Clean stainless steel surfaces and remove excess sealants.

d. Remove debris from work site.

e. Leave window units in closed position to protect against dirt and elements.

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SECTION 8D

GLASS AND GLAZING

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes glass and glazing; and related work.

b. Other Sections include glass for lantern; windows and doors receiving glass.

3. GENERAL PROVISIONS

a. The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

1) Federal Specifications (FS)

DD-G-451C & Int Am-3	Glass, Plate, Sheet Figured, (Float, Flat, for Glazing, Corrugated, Mirrors and Other Uses).
DD-G-1403A	Glass, Plate (Float), Sheet, Figured, and Spandrel (Heat Strengthened and Fully Tempered).

2) Commercial Standards (CS)

CS230-60	Vinyl Plastic Weatherstrip.

3) Flat Glass Marketing Association (FGMA) Publication:

Glazing Manual (1971 Edition)

b. Submittals

1) Refer to SUBMITTALS - SECTION 1J.

2) Submit 250 mm by 300 mm glass samples, factory labeled, of each of the following for approval before work is started:

3. b. 2) cont'd

a) Wire Glass - showing mesh configuration and thickness of glass.

b) Figured Glass - showing pattern design and thickness of glass.

3) Submit manufacturer's printed installation instructions for each of the following for approval before the work is started:

a) Wire Glass

b) Tempered Glass

c) Glass-setting Materials

c. Delivery and Storage: Glazing compounds shall be delivered to the site in unopened containers, labeled plainly with the manufacturer's names and brands. Glass and setting materials shall be stored in safe, dry locations and shall not be unpacked until needed for installation. Handling and installation of materials shall be in a manner that will protect them from damage.

4. MATERIALS

a. Glass shall be provided in locations indicated on the Drawings or specified and shall conform to the requirements of specification DD-G-451, unless specified otherwise. Glass for doors shall not be less than 6 mm thick for full-glazed stile-and-rail doors, unless indicated or specified otherwise.

b. Sheet Glass: Type II, class 1, quality q6, double strength shall be provided for glazing openings not indicated or specified otherwise.

c. Plate or Float Glass: Type I, class I, quality q6, 1/4-inch thick (6 mm).

d. Wire Glass: Type III, class I, kind A, form 1, mesh m1, 6 mm thick and shall meet the requirements of ANSI Standard Z97.1.

e. Tempered Glass: Specification DD-G-1403, kind FT, condition A, 6 mm thick minimum.

5. SETTING MATERIALS

a. Preformed Glazing Sealants: Suitable type approved for the application and in accordance with the section entitled Glazing Materials of the FGMA Glazing Manual, unless specified otherwise. The use of nonskinning compound, nonresilient-type preformed sealers and preformed impregnated-type gaskets will not be permitted. Metal sash putty will not be permitted.

5. a. cont'd

When flexible vinyl gasket channels are used, the material shall conform to Commercial Standard CS230.

b. Glazing Accessories: As required to supplement the accessories provided with the items to be glazed and to provide a complete installation, including glazing points, clips, shims, angles, beads, setting exposed in the finished work shall have a finish that will not corrode or stain while in service.

6. INSTALLATION

a. General: The sizes to provide the required edge clearances shall be determined by measuring the actual opening to receive the glass. Labels shall be left in place until the installation is approved. Movable items shall be securely fixed, or in a closed and locked position until glazing compound has thoroughly set.

b. Glass Setting:

1) Items to be glazed may be shop or field glazed using glass of the quality and thickness specified or indicated.

2) Preparation of surrounds and glazing, unless otherwise specified or approved, shall be in conformance with the details and general conditions governing glazing in the FGMA Glazing Manual.

3) Windows and wood doors may be glazed in conformance with one of the glazing methods described in the standards under which they are produced, except the face puttying method illustrated and described in Commercial Standard CS163 will not be permitted.

4) Glass for which the manufacturer's printed installation instructions are submitted and approved as specified shall be handled and installed in accordance with the manufacturer's instructions.

5) Beads or stops which are furnished with the items to be glazed shall be used to secure the glass in place.

c. Sheet Glass shall be cut and set with the visible lines or waves running with horizontal dimensions.

d. Cleaning: Glass surfaces shall be thoroughly cleaned with labels, paint spots, putty, and other defacement removed, and shall be clean at the time the work is accepted.

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SECTION 8E

FINISH HARDWARE

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section include all finish hardware required for the project and related work.

b. Other Sections include wood and metal doors and frames.

3. GENERAL PROVISIONS

a. The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

Federal Specifications (FS)

FF-H-106a & Am-1 & Int. Am-9	Hardware, Builders'; Locks and Door-Trim
FF-H-00111b (GSA-FSS)	Hardware, Builders', Shef and Miscellaneous
FF-H-116c & Int. Am-5 (GSA-FSS)	Hinges, Hardware, Builders'
FF-H-121c	Hardware, Builders' Door-Closing Devices

b. Hardware shall conform to the applicable requirements of the Federal Specifications listed herein, unless otherwise specified. Modifications to hardware, required by reason of construction characteristics, shall be such as to provide the specified operation of functional features.

c. Submittals

1) Refer to SUBMITTALS - SECTION 1J.

3. c. cont'd

2) Samples: Submit if requested by the Engineer.

3) Hardware Schedule: List all materials to be furnished; include hardware set identification.

d. Packing and Labeling: Hardware shall be delivered to the project site in the manufacturer's original packages; each article of hardware shall be individually packaged in the manufacturer's substantial commercial carton or container, properly marked or labeled so as to be readily identifiable with the permanent hardware schedule. Keys shall be tagged or otherwise identified with the door for which its cylinder is intended.

e. Templates

1) The Contractor shall furnish templates required by the manufacturer of the doors and door-frames so as to enable the door manufacturer to make proper provision in his work to receive the specified hardware and deliver his products to the project site on schedule.

2) Where two or more articles of hardware are to be mounted on the same door, the Contractor shall effect proper coordination between the manufacturers of the different articles in order that each manufacturer may furnish templates that will allow installation of his hardware without interference with the installation and operation of other hardware.

4. HARDWARE FINISH: All finish shall conform with the US Federal Specification listed below:

a. Exterior Hinges: US 32D

b. Interior Hinges: USP

c. Lock and Door Trim: US 32D

d. Door Closers: Alum.

e. Door Stops: US 32D or 26D

5. KEYING

a. Cylinder locks shall be keyed in sets or subsets as directed by the Engineer. Keys shall be supplied as follows:

1) Cylinder locks: 3 change keys each lock

2) Master keyed sets: 3 keys each

5. cont'd

b. The keys shall be turned over to the Engineer properly tagged and designated as to location, and arranged in a container in sets or subsets as scheduled, for ease in setting up the system in the key cabinet.

6. LOCKETS LATCHSETS, LOCK TRIM AND DOOR TRIM

a. Conform to FS FF-H-106.

b. Locks, Locksets and Latchsets: Series 161.

1) The locksets, latchsets, and deadlocks supplied for the project shall be the products of single manufacturer.

2) Cylinder shall have five pins. Deadlock cylinders to be installed on stainless steel entry door adapted to narrow-stile case. Finish shall be US32D.

3) Mortise-type locks and latches for doors 45 mm thick and over shall have standard-bevel front. Lock fronts for double-acting doors shall be rounded.

c. Trim for series 161 bored-type locks and latches shall be No. 4.

7. MISCELLANEOUS HARDWARE

a. Conform to FS FF-H-111

b. Flush Bolts shall be type 1045 as indicated in paragraph: HARDWARE SETS. Flush bolts shall be provided at top and bottom of the inactive leaf of pairs of doors and shall be mortised in lock edge of door.

c. Door Holders: Types hereinafter specified.

d. Strikes for flush bolts shall be regular or angle (reverse hand). A dustproof strike shall be provided for each foot bolt for openings without thresholds. A box strike shall be provided for openings with thresholds as indicated in paragraph: HARDWARE SETS.

8. BUTTS AND HINGES

a. Hinges of the following types shall conform to FS FF-H-116.

b. Extra Heavy Weight Butts on entry door.

c. Number and size of butts as recommended in paragraph 6, notes, of FS FF-H-116.

8. cont'd

d. Hinges with nylon or oil-impregnated bearings may be furnished in lieu of the ball-bearing hinges specified.

e. Exterior Door with Closer: Type 2106, T2106, 2107, T2107, 2117, T2135, T2145, or T2155, as applicable.

f. Interior Door with Closer: Type 2107 or T2107, as applicable.

g. Interior Doors without Closer: Type 2127 or T2127, as applicable.

9. DOOR-CLOSING DEVICES

a. Conform to FS FF-H-121.

b. Surface-Type Closers shall be type 3001. Closers shall be provided with a clock-key or capped valve. Size requirements shall conform to table I of FS FF-H-121, including the footnote. Closers for outswinging exterior doors shall have standard or long parallel arms as required for the particular opening. Closers for interior doors that are within 125 mm of a partition shall have standard parallel arms. Surface-type closers shall be the products of one manufacturer only.

10. MISCELLANEOUS REQUIREMENTS

a. Thresholds: Type 3560A and 3560C shall conform to FS FF-H-121; extruded aluminum.

b. Fastenings of proper type, size, quantity, and finish shall be supplied with each article of hardware. Machine screws and expansion shields shall be used for attaching hardware to concrete, stone, or other masonry. Fastenings exposed to the weather in the finished work shall be of brass, bronze, or stainless steel, as applicable. Six bolts, where used on reverse-bevel exterior doors equipped with half-surface or full-surface hinges, shall employ one-way screws or other approved tamperproof screws. Screws for the jamb lead of half-surface, half-mortise, and full-surface hinges attached to structural steel frames shall be the one-way type or other approved tamperproof type.

11. HARDWARE SETS

HW-1 (Main Entry)	Butts as required. Deadlock 86P 2 Flush bolts 1045 2 Door closers 3001P x HA Threshold

11. cont'd

HW-2	(Rest Room)	Butts as required. Door pull 436 Push plate 465R Door closer 3001P Door stop 1330 Kick plate 1227
HW-3	(Storage and Battery Room)	Butts as required. Lockset 161D-4
HW-4	(All other interior doors)	Butts as required. Latchset 161N-4
HW-5	(All hinged roof hatches and door to rear leading light)	Padlock FS FF-P-101, type EPB, 44 mm size, with chain.

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DIVISION 9

FINISHES

SECTION 9A

METAL FRAMING AND LATHING

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein:

2. SCOPE

a. This Section includes metal studs, suspended ceiling framing, lathing; and related work.

b. Other Sections include metal and wood door frames, cement plaster, asbestos cement board ceiling finish and electrical work.

3. GENERAL PROVISIONS

a. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

American Society for Testing and Materials (ASTM) Publications:

C645-75	Non-Load (Axial) Bearing Steel Studs, Runners (Tracks) and Rigid furring Channels for Screw Application of Gypsum Board.
C646-72	Steel Drill Screws for the Application of Gypsum Sheet Material to Light Gage Steel Studs.

b. Submittals

1) Refer to SUBMITTALS - SECTION 1J.

2) Manufacturer's Literature: Furnish written instructions for installation of partition, ceiling suspension systems, and lathing materials.

3. cont'd

c. Design Criteria: Ceiling support system shall limit deflection of finished ceiling to less than 1/360 of span.

4. MATERIALS

a. Non-Loadbearing Prefabricated Steel Screw Studs: Cold formed galvanized steel comforming to ASTM C645 except metal thickness 1.046 mm.

1) Shape: Roll formed channel with punched openings along web and knurled flanges.

2) Furnish floor and ceiling tracks of acceptable stud manufacturer's regular type for stud specified.

b. Channel:

1) Fabrication: Cold rolled steel with factory applied rust-resistant paint.

2) Thickness: 1.61 mm

3) Minimum weight per 1,000 linear ft. (310 linear m.):

a) Depth 19 mm: 136 kg.

b) Depth 38 mm: 215 kg.

4) Channel Depths:

a) Horizontal stiffeners, bracing, and anchors: 19 mm.

b) Main ceiling runners: 38 mm.

c) Cross furring for suspended ceilings: 19 mm.

c. Furring Channel, Screw Type:

1) Cold formed galvanized steel.

2) Minimum thickness: 0.55 mm.

3) Plain or knurled face to receive screws.

d. Flat Expanded Metal Lath: Fabricated from cold rolled steel; furnish galvanized; diamond mesh weighing 1.84 kg/m^2.

e. Metal Accessories General:

1) Shapes used as grounds: Sized and dimensioned to provide for required plaster thicknesses.

4. e. cont'd

2) Flanges:

a) Designed to permit complete embedment of accessory in plaster.

b) Provide for alignment and attachment to underlying surface.

f. Corner Beads:

1) Fabrication: Minimum 0.55 mm galvanized steel.

2) Small nose type, expanded short flanges.

g. Casing Beads:

1) Fabrication: Minimum 0.70 mm galvanized steel.

2) Style: Square end.

h. Cornerite:

1) Fabrication: Minimum 0.95 kg/m^2 flat expanded metal lath.

2) Shape to fit 90° internal corner with minimum 50 mm legs each side.

i. Striplath:

1) Fabrication: Minimum 0.95 kg/m^2 flat expanded metal lath.

2) Minimum width: 100 mm.

j. Ceiling Hangers: Threaded rod; 5.5 mm in diameter; zinc coated.

Provide hangers with loop or other deformation for positive binding in concrete.

k. Tie Wire: Galvanized annealed steel wire; 18 gauge minimum

l. Screws: ASTM C646 and as follows.

1) Power-driven, flat head, self-drilling, self-tapping galvanized.

2) Minimum size:

a) 19 mm. No. 6.

b) Minimum engagement of screw head: Two strands or rib of metal lath; use washer if necessary.

5. INSTALLATION-GENERAL

a. Wire-tying:

1) Use single strand 16 gauge or double strand 18 gauge tie wire.

2) Splicing: Double wrap-tie.

3) Horizontal stiffeners to channel brackets: Figure eight-tie.

4) Framing members perpendicular to each other: Saddle-tie.

b. Deflection Relief:

1) Cut studs short where abutting underside of concrete construction.

2) Do not abut end studs to concrete walls.

3) Secure ends of horizontal stiffeners to abutting concrete walls.

c. Fastenings for Wall supported Items:

1) Provide reinforcement in wall to receive fastenings.

2) Anchor reinforcement to studs.

3) Provide supplemental studs to receive fastenings.

6. ERECTION OF NON-LOADBEARING SCREW STUDS-HOLLOW PARTITIONS

a. Floor and Ceiling Tracks:

1) Align floor and ceiling tracks.

2) Attach to concrete with hardened concrete nails.

3) Wire-tie to ceiling grillage.

4) Attach tracks to structure at maximum of 600 mm o.c. (on centers)

b. Screw Studs:

1) Plumb and align studs.

2) Space studs 400 mm o.c.

3) Attach studs to floor and ceiling track by crimping flange.

4) If necessary, splice studs by nesting with minimum lap of 200 mm.

6. cont'd

c. Horizontal Stiffeners:

1) Brace studs with steel channel stiffeners placed horizontally on inside of partition.

2) Spacing: Maximum 1.4 m o.c. vertically.

3) Wire-tie horizontal stiffeners to each stud.

d. Framing Around Door Openings:

1) Hollow metal door frames:

a) Install stud at each jamb of hollow metal door frames continuous for full height of partition.

b) Screw stud to jamb anchors of frame.

c) Wire-tie a second stud to stud at door jamb, nested to form box.

2) Attach section of floor track horizontally to head of frame.

a) Install jack studs at 400 mm o.c. over head of door frame.

b) Attach jack studs to floor track and anchor top in same manner as provided for full studs.

e. Form corners and intersections of partition with three studs.

f. Place studs forming internal corners 50 mm from point of partition intersection.

7. INSTALLATION OF SUSPENDED CEILINGS

a. Hangers

1) Attaching hangers to concrete:

Embed wire loops, hooks, wire hairpins, or hanger inserts in concrete and attach hangers in accordance with manufacturer's instructions.

2) Space hangers 300 cm o.c. and within 150 mm of perimeter walls.

3) Locate hanger within 150 mm of ends of main runner channels.

4) Attach lower end of hanger to main runner channel by wire tying.

a) Prevent twisting and turning of main runner channel.

7. a. 4) cont'd

b) Develop full strength of hanger.

b. Main Runner Channels:

1) Spacing: 1.2 m o.c.

2) Locate main runner channel within 150 mm of parallel walls.

8. INSTALLATION OF METAL LATH

a. Install with long dimension running perpendicular to supports.

b. Lap diamond-mesh lath minimum 13 mm at sides.

c. Stagger end laps from row to row.

d. Lap ends over supports.

e. Insert lath as far as possible into re-entry space of metal frames and notch to pass around jamb anchors.

f. Secure Lath to Supports:

1) Spacing of fasteners: 150 mm o.c.

2) Metal supports and adjacent lath: Self-tapping screws.

9. INSTALLATION OF METAL ACCESSORIES

a. Fasten in place using wire ties, or hardened concrete nails as required to prevent dislodging or misalignment by subsequent operation.

b. Fasten at both ends and maximum 300 mm o.c. along sides.

c. Bring grounding edge of accessories to true lines, plumb, level and straight.

d. Install accessories to provide required depth of plaster and to bring plaster surface to required plane.

e. Connect lengths of accessories as recommended by the manufacturer to assure a continuous line.

f. Where plaster abuts dissimilar materials, terminate with plaster casing bead.

g. Install accessory beads to provide minimum 3 mm clearance between structural units and termination point of surface to receive plaster finish.

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SECTION 9B

CEMENT PLASTER

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes cement plaster applied to metal lath and to cement wall and ceiling surfaces; and related work.

b. Other Sections include lathing, painting and concrete work.

3. GENERAL PROVISIONS

a. The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

American Society for Testing and Materials (ASTM) Publications:

C6-49 (1968)	Normal Finishing Hydrated Lime
C91-71	Masonry Cement
C144-70 (1975)	Aggregate for Masonry Mortar
C150-74	Portland Cement
C631-70	Bonding Compounds for Interior Plaster

b. Submittals

1) Refer to SUBMITTALS - SECTION 1J.

2) The manufacturer's certificate that materials meet specification requirements.

3) The manufacturer's written recommendations, proportion mixes, and installation instructions for factory prepared finish materials.

c. Hot weather requirements: Protect cement plaster from uneven and excessive evaporation during hot, dry weather.

3. cont'd

d. Protection:

1) Screen openings with plastic film when building is subject to hot, dry winds or temperature differentials of more than 10°C.

2) Protect finished surfaces installed prior to plastering by covering with plastic sheet.

3) Maintain protection in place until completion of work.

4. MATERIALS

a. Cement:

1) Portland Cement: ASTM C150, Type I or II.

2) Masonry Cement: ASTM C91-71.

b. Normal Finishing Hydrated Lime

ASTM C6-49 , Type N, maximum unhydrated oxide content 8% by weight.

c. Aggregates:

1) ASTM C144

2) Gradation:

a) Base coat:

U.S. Standard Sieve	Percent Retained by Weight (±2%) Minimum	Maximum
4.75 mm	...	0
2.36 mm	0	10
1.18 mm	10	40
600 µm	30	65
300 µm	70	90
150 µm	95	100

b) Finish coat: Same as base coat gradation, and all sand to pass 2.36 mm sieve.

d. Water: Clear and free from substances harmful to plaster.

e. Admixtures: Cattle or goat hair, or pure manila fiber, 13 mm to 51 mm long, free from grease, oil, dirt, and other impurities.

4. cont'd

f. Bonding Compound:

1) ASTM C 631 nonoxidizing, non crystallizing.

2) Unaffected by reapplication of moisture.

5. PRODUCT DELIVERY, STORAGE, AND HANDLING

a. Deliver the manufactured materials in original unopened packages or containers, with manufacturer's label intact and legible.

b. Keep cement and lime dry, stored off ground, under cover, and away from damp surfaces.

c. Remove wet and deteriorated materials from project site.

6. MIXES

a. Mixing:

1) General:

a) Accurately proportion materials for each plaster batch with measuring devices of known volume.

b) Size batches for complete use within maximum of one hour after mixing.

c) Retemper plaster stiffened from evaporation, but do not use or retemper partially hydrated cement plaster.

d) Do not use frozen, caked, or lumping materials, and remove such materials from job site immediately.

e) Use moist, loose sand in mix proportions.

f) Withhold 10% of mixing water until mixing is almost complete, then add as needed to produce necessary consistency.

2) Mechanical Mixing:

a) Clean mixer of set or hardened materials before loading for new batch.

b) Maintain mixer in continuous operation while adding materials.

3) Hand Mixing:

a) Do not hand mix unless authorized by the Engineer.

b) Use waterproof mixing boxes and water barrels when mixing in building.

6. cont'd

b. Mix Proportions by Volume:

1) Dash bond coat: One part portland cement and 0-2 parts sand.

2) Base coats:

a) One part portland cement and 0-1/12 parts lime, or one part portland cement and 1-2 parts masonry cement.

b) Sand for first coat: 2.1/4-4 parts per unit volume of cementitious materials.

c) Sand for second coat: 3-5 parts per unit volume of cementitious materials.

d) Hair or fiber: Maximum 0.45 kg
42.3 kg of cementitious materials; for first coat on metal lath only.

3) Finish coat:

a) One part portland cement and 3/4-2 parts lime.

b) Three parts sand per unit volume of cementitious materials.

c) Coloring agent: Maximum 10% by weight of cement.

4) Scratch coat for all tile shall be same as base coats.

7. INSPECTION

a. Verify that surfaces to be plastered are free of dust, loose particles, oil, and other foreign matter which would affect bond of plaster coats.

b. Examine construction grounds, and accessories to insure that finished plaster surfaces will be true to line, level, and plumb, without requiring additional thickness of plaster.

8. PREPARATION

a. Wet absorptive base with fine fog spray of clean water to produce uniform moist condition.

b. Apply bonding agent as recommended by the manufacturer's instructions.

9. APPLICATION

a. General:

1) Apply cement plaster by hand.

2) Interrupt cement plaster only at junctions of plaster planes, at openings, or at control joints.

3) Tool through second and finish coats to produce "V" joint at intersection of frames or other items of metal or wood which act as plaster grounds.

4) On two coat work tool through finish coat to produce "V" joint at intersection of frames or other items of metal or wood which act as plaster grounds.

5) Apply second coat to first coat, bringing out to grounds, flat to true surface, and free of imperfections which would reflect in finish coat.

6) Reconsolidate second coat by floating, and roughen to assure bond with finish coat.

7) Nominal plaster thicknesses over metal lath.

a) First coat: 10 mm

b) Second coat: 0 mm

c) Third coat (finish): 3 mm

8) Measure thickness from back of metal lath.

9) Nominal plaster thickness over concrete.

a) First coat: 10 mm

b) Second coat (finish): 3 mm

b. Base Coats:

1) Over metal base:

a) Apply with sufficient material to form keys through metal lath.

b) Embed and fill spaces of lath and scratch vertical surfaces horizontally.

c) Scratch horizontal surfaces in one direction only.

2) Over solid bases:

a) Apply second coat with sufficient pressure to issure tight contact with first coat.

9. b. 2) cont'd

b) Bring surface to true and even plane.

c) Float to uniformly rough surface to provide bond for finish coat.

c. Finish Coats:

1) Apply plaster to nominal thickness and fill out to true even plane.

2) Trowel finish to true even surface after moisture has left surface.

d. Curing:

1) Maintain moist conditions by fog spray or vapor barrier.

2) Cure base coats minimum of 48 hours after application.

3) Cure finish coat for minimum of 7 days.

10. ADJUST AND CLEAN

a. Patching:

1) Upon completion point-up plaster around trim and other locations where plaster meets dissimilar materials.

2) Cut out and patch defective or damaged plaster.

b. Cleaning:

1) Remove plaster and protective materials from expansion beads, perimeter beads, and adjacent surfaces.

2) Remove stains from plaster surfaces that would adversely affect subsequent finishes.

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SECTION 9C

PAINTING

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes exterior and interior painting; and related work.

b. Other Sections include prefinished and shop primed items.

3. GENERAL PROVISIONS

a. The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

1) U.S. FEDERAL SPECIFICATIONS: (FS)

TT-E-489F	Enamel, Alkyd, Gloss (For Exterior and Interior Surfaces)
TT-E-505a & Am-3	Enamel, Odorless, Alkyd, Interior, High Gloss, White and Light Tints
TT-E-509b & Am-1	Enamel, Odorless, Alkyd, Interior, Semigloss, White and Tints
TT-E-543a & Am-1	Enamel, Interior, Undercoat, Tints and White
TT-P-19c	Paint, Acrylic Emulsion, Exterior
TT-P-55b & Am-2	Paint, Polyvinyl Acetate Emulsion, Exterior
TT-P-641F	Primer Coating; Zinc Dust-Zinc Oxide (for Galvanized Surfaces)
TT-P-645	Primer, Paint, Zinc-Chromate, Alkyd Type
TT-S-179a	Sealer Surface: Pigmented Oil, Plaster and Wallboard

2) U.S. FEDERAL STANDARDS (FS)

No. 141a & Change Notices 1,2,3,4	Paint, Varnish, lacquer, and Related Materials; Methods of Inspection, Sampling, and Testing.

b. Submittals

1) Refer to SUBMITTALS - SECTION 1J.

2) Color Samples:

a) Prepare (at the project site) on cardboard.

b) Make samples not less than 30 cm square.

c. Include on Label of Containers:

1) Manufacturer's name.

2) Type of paint.

3) Manufacturer's Stock number.

4) Color

5) Instructions for reducing, where applicable.

6) Label analysis

7) Federal Specification Number.

d. Sampling of Materials:

1) When requested by the Engineer, obtain test samples from material stored at project site or source of supply.

2) Select samples at random from sealed containers.

e. Fungus Control: Organic coating shall show no fungus growth when tested as specified in Federal Test Method Standard No. 141, Method 6271.1.

1) Request review of first finished room, space, or item of each color scheme required by the Engineer for color, texture, and workmanship.

2) Use first acceptable room, space or item as project standard for each color scheme.

3) For spray application, paint surface not smaller than 10 square meters as project standard.

4. PRODUCTS DELIVERY, STORAGE AND HANDLING

a. Delivery of Materials:

1) Deliver sealed containers with labels legible and intact.

2) Segregate at source of supply and deliver to the Project site in advance of need so as to allow 30 days for testing.

b. Storage of Materials:

1) Store only acceptable project materials on the Project site.

2) Store in a suitable location.

3) Restrict storage to paint materials and related equipment.

4) Comply with health and fire regulations.

5. JOB CONDITIONS

a. Environmental Requirements:

1) Comply with the manufacturer's recommendations as to environmental conditions under which coatings and coating systems can be applied.

2) Do not apply finish in areas where dust is being generated.

b. Protection: Cover or otherwise protect the finished work of other trades and surfaces not being painted concurrently or not to be painted.

6. MATERIALS

a. Select primary products of the coating system from the products of a single manufacturer.

b. Secondary products not specified by name and required for the job shall be "best grade" or "first line" products of a reputable manufacturer.

c. Material List:

Type of Paint	FS Number
Ferrous Metal Primer	TT-P-645
Galvanized Metal Primer	TT-P-641, Type II
Primer-Sealer	TT-S-179
Enamel-Undercoat	TT-E-543
Exterior Enamel	TT-E-489
Exterior Masonry Paint	TT-P-19 or TT-P-55, Type II

6. c. cont'd

Interior Semi-Gloss Enamel	TT-E-509
Interior Gloss Enamel	TT-E-505

7. COLORS

a. Colors of paints shall match color chips submitted to and approved by the Engineer.

b. Limit exterior colors to 4 exclusive of trim and accent.

c. Limit interior wall colors to 6.

d. Limit deep tone colors to 1.

8. MIXING AND TINTING

a. Deliver paints and enamels ready-mixed to the job site.

b. Accomplish job mixing and job tinting only when acceptable to the Engineer.

c. Mix only in mixing pails placed in suitably sized non-ferrous or oxide resistant metal pans.

d. Use tinting colors recommended by the manufacturer for the specific type of finish.

e. Fungicidal agent shall be incorporated into the paint by the manufacturer.

9. INSPECTION

a. Examine surfaces scheduled to receive paint and finishes for conditions that will adversely affect the execution, permanence or quality of the work and which cannot be put into an acceptable condition through preparatory work as included below.

b. Do not proceed with surface preparation or coating application until conditions are suitable.

10. PREPARATION OF SURFACE

a. Plaster and Mortar:

1) Fill narrow, shallow cracks and small holes with spackling compound.

2) Rake deep, wide cracks and deep holes.

a) Dampen with clear water.

b) Fill with thin layers of patching plaster.

10. a. cont'd

3) Allow to dry and sand smooth.

b. Concrete and Exterior Mortar

1) Fill cracks and irregularities with portland cement grout to provide uniform surface texture.

2) Etch with 5% solution (by weight) of muriatic acid.

c. Ferrous Metal Surfaces: Prepare surface in accordance with recommendations and directions of the manufacturer of rust-inhibitive primer.

d. Galvanized Metal:

1) Clean the surface with mineral spirits to remove oily residue.

2) Dry with clean cloth.

11. APPLICATION

General Requirements:

1) Do not apply initial coating until moisture content of the surface is within limitations recommended by the paint manufacturer.

Test with moisture meter.

2) Apply paint with suitable brushes, rollers, or spraying equipment.

a) Rate of application shall not exceed that as recommended by the paint manufacturer for the surfaces involved.

b) Keep brushes, rollers, and spraying equipment clean, dry, free from contaminates and suitable for the finish required.

3) Comply with the recommendation of product manufacturer for drying time between succeeding coats.

4) Vary slightly the color of successive coats.

5) Sand and dust between each coat shall be cleaned to remove defects visible from a distance of 1.5 meters.

6) Finish coats shall be smooth, free of brush marks, streaks, laps or pile up of paints, and skipped or missed areas.

Finished metal surfaces shall be free of skips, voids or pinholes in any coat when tested with a low voltage detector.

11. cont'd

7) Inspection:

a) Do not apply additional coats until completed coat has been inspected by the Engineer.

b) Only inspected coats of paint will be considered in determining number of coats applied.

8) Leave all parts of moldings and ornaments clean and true to details with no undue amount of paint in corners and depressions.

9) Make edges of paint adjoining other materials or colors clean and sharp with no overlapping.

10) Apply primer on all work before glazing.

11) Change colors at door where colors differ between adjoining spaces or rooms and where door frames match wall colors.

12) Refinish whole wall where portion of finish has been damaged or is not acceptable.

12. CLEANING

a. Touch up and restore finish where damaged.

b. Remove spilled, splashed, or splattered paint from all surfaces.

c. Do not mar surface finish of item being cleaned.

d. Leave storage space clean and in condition required for equivalent spaces in project.

13. PAINTING SCHEDULE

a. Surfaces not to be painted:

1) Stainless steel.

2) Pre-finished wall, and floor coverings.

3) Items with factory applied final finish.

4) Concealed ducts, pipes, and conduits.

b. Painting Schedule:

1) Ferrous Metals:

a) First coat metal primer over shop primer with primer compatible with shop coat.

13. b. 1) cont'd

b) Second and third coats exterior enamel.

c) Minimum total dry film thickness shall be 5 mils.

2) Exterior Concrete and Mortar:

First and second coat exterior masonry finish.

3) Interior Wood: Trim and Doors

a) First coat enamel undercoat.

b) Second and third coats gloss interior enamel.

4) Interior Concrete, Mortar, Asbestos Cement Board and Plaster-Enamel:

a) First coat primer-sealer.

b) Second and third coats semi-gloss interior enamel.

c) Second and third coats gloss interior enamel in lavatory.

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SECTION 9D

CERAMIC TILE

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes ceramic wall and floor tile; and related work.

b. Other Sections include lathing, plastering cement mortar floors and plumbing.

3. GENERAL PROVISIONS

a. The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

1) AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

A108.1-1967	Glazed Ceramic Wall Tile installed with Portland Cement Mortar
A137.1-1967	Ceramic Tile

2) AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATIONS:

C144-70	Aggregate for Masonry Mortar
C150-74	Portland Cement

b. Submittals

1) Refer to SUBMITTALS - SECTION 1J.

2) Samples: Submit in duplicate.

a) Glazed tile: Minimum of four tiles per panel.

b) Trim shapes: Each type and shape.

4. MATERIAL

a. General Requirements: Standard Grade, ANSI A137.1

b. Glazed wall tile:

1) Conforming to Section 5, ANSI A137.1

2) Edges: Cushion

3) Finish: Colored matte glaze

4) Nominal face sizes: 100 mm square

5) Color: As selected by the Engineer from manufacturers standard color line.

c. Unglazed natural clay type ceramic mosaic tile:

1) Conforming to Section 6a, ANSI A137.

2) Edge: Square

3) Nominal face size: 30 mm square

4) Color: One color only, as selected by the Engineer from manufacturers standard color line.

d. Trim shapes and base:

1) Same type as glazed wall tile; Section 4.2, ANSI A137.1.

2) Include bases, caps, stops, returns, trimmers and other shapes to finish installation.

3) Color and finish: Match wall tile.

e. Portland Cement Mortar and Grout

1) Portland Cement: ASTM C150, Type I or II.

2) Sand: ASTM C144

3) Water: Clean and Potable

f. Expansion Joint Material

1) Silicone rubber type sealant Class A or B, color to blend with adjacent surface.

2) Back-up material:

a) Flexible and compressible type.

b) Non-staining and compatible with sealants used.

5. PRODUCT LABELING, DELIVERY AND HANDLING

a. Deliver materials in the manufacturer's original sealed containers.

1) Labels legible and intact identifying brand name and contents.

2) Tile cartons grade-sealed by the manufacturer in accordance with ANSI A137.

3) Grade-seals unbroken.

b. Store materials under cover in the manner to prevent damage of contamination.

6. INSTALLATION

a. General

1) The Contractor shall be responsible for determining proportions, curing and other operations necessary to achieve first quality, sound and durable work.

2) Protect all adjacent surfaces against damage by tilework; protect tilework against traffic until well cured.

3) Penetrations: Cut tile to avoid irregular appearances. Completely seal around exposed and concealed penetrations. Grind and rub smooth cut tile edges.

4) Wall and base work shall precede floor work.

5) Slope floors to drains.

b. Clean all tile. Inspect joints; repoint and reclean as necessary. Provide sealer for unglazed tile and cement type grouts; apply as per manufacturers instructions.

c. Tile chipped, cracked, stained, hollow sounding when tapped; loose or otherwise damaged or improperly set shall be removed and replaced using new matching material as directed. Discolored or improperly made joints shall be repaired as directed.

7. SYSTEMS

a. Floor Tile

1)	Substrata:	Concrete slab
2)	Mortar:	Cement type
3)	Grout:	Cement type

b. Wall Tile

1)	Substrata:	Plaster scratch coat
2)	Mortar:	Cement type
3)	Grout:	Cement type

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DIVISION 10

SPECIALTIES

SECTION 10A

METAL PARTITION

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

This Section includes metal partition in location and arrangement shown; and related work.

3. GENERAL PROVISIONS

a. Submittals

1) Refer to SUBMITTALS - SECTION 1J.

2) Shop drawings and/or catalog cuts shall be submitted.

b. Supply templates or layouts to jobsite or elsewhere as necessary for related preparatory work under other Sections.

4. METAL PARTITIONS

a. Compartments:

1) Style: Flush panel style; floor supported, overhead braced.

2) Face Panels: Stretcher-leveled prime quality steel, galvanized.

3) Partitions: 2.5 cm thick, 1 mm minimum faces.

4) Pilasters: 3.6 cm thick, 1.3 mm minimum faces.

5) Doors: 2.5 cm thick, 0.85 mm minimum faces.

6) Sound deaden all cores.

7) Trim panel edges using 0.85 mm oval sections; reinforce corners.

8) Internally reinforce for surface mounted accessories.

9) Finish: Prime painted, enamel finished; colors as selected.

b. Accessories:

1) Pilaster Supports: Concealed adjustable devices; two anchors each unit.

2) Stirrup Brackets and Angles: Cast nonferrous alloy, chrome finish.

3) Cover Shoes: Stainless steel; at each pilaster.

4) Hardware: Standard types, including gravity or torsion hinges, bumpers, keepers; chrome finish.

5) Fastenings: Chrome or stainless steel.

6) Equip pilasters with leveling and anchoring units.

c. Installation:

1) Install as per approved layouts; erected to plumb, true to line, securely anchored and free from dents and scratches.

2) Field painting for making repairs will not be permitted.

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SECTION 10B

SPECIAL ACCESSORIES

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

This Section includes miscellaneous special accessories; and related work.

3. GENERAL PROVISIONS

a. The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

Underwriters Laboratories Inc (UL)

Fire Protection Equipment List

b. Submittals

1) Refer to SUMITTALS - SECTION 1J.

2) Shop drawings and/or catalogue cuts shall be submitted indicating sizes, types and mounting requirements.

3) No equipment shall be ordered prior to the approval.

c. In advance of related work under other Sections, provide layouts, templates or instructions necessary for proper construction of supporting work.

d. Identify factory packages and items for location; and deliver complete with installation instructions and fastenings necessary for assembly or mounting.

e. Finishes: Stainless steel - US32D stainless steel or US26 polished chrome, including exposed fastenings; unless otherwise specified.

4. SPECIAL ACCESSORIES

a. Fire Extinguishers:

1) ABC Multi-purpose; U. L. rated 2A:10B; C.

2) (457 mm) high, (203 mm) wide, (108 mm) case diameter; manufacturer's standard finish.

3) Wall bracket mounted as directed.

4) Two nos. required.

b. Mirrors:

1) Style: 60 cm x 90 cm mirror size.

2) Frame: Type 304 Stainless Steel; one-piece, roll formed; 2.3 mm x 2.3 mm angle profile with back return flange; corners mitered, welded and polished smooth.

3) Mirror: Polished plate glass, mirror quality, 6 mm thick; electro-silvered and -copperplated; 10 year guarantee quality.

4) Backing: Galvanized steel sheet, 1 mm secured to frame using screws.

5) Wall Hanger: Galvanized steel, 1 mm by 25 mm wide strap assembly; with toggle bolts for wall connections and theft-proof type screws for securing mirror.

6) One each location shown.

c. Toilet Paper Holders:

1) Style: Surface mounted; for standard core rolled tissue.

2) Materials: Steel body; polished chrome plated.

3) One at water closet location.

d. Towel Bars:

1) Style: surface mounted.

2) Materials: Type 304 stainless steel.

3) Bar: 2.25 cm square tube; length 60 cm.

4) Brackets: With concealed type mountings.

5) Four Nos. required.

4. cont'd

e. Soap Dish:

1) Style: Surface mounted

2) Materials: Type 302 stainless steel

3) Body: One-piece, seamless; with integral soap drain ribs.

4) One for each shower and lavatory location.

f. Shelf:

1) Constructed as shown on the Drawings.

2) Baked channel finish to match toilet partition.

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DIVISION 11

EQUIPMENT

SECTION 11A

KITCHEN EQUIPMENT

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section whether or not referred to herein.

2. SCOPE

a. This Section includes kitchen equipment, and related work.

b. Other Sections include connection of plumbing.

3. GENERAL PROVISIONS

Submittals

1) Refer to SUBMITTALS - SECTION 1.1.

2) Shop drawings and/or catalogue cuts shall be submitted indicating size, equipment included and mounting requirements.

3) No equipment shall be ordered prior to the approval.

4. EQUIPMENT

a. Stove: Size as shown, with the following features:

1) Propane operated.

2) 3 burner top minimum.

3) Oven with controls for temperature regulation in British "Mark" system or in Degrees Centigrade.

4) Oven light: wired for local voltage.

5) Gas hose minimum 3 meters long.

4. cont'd

b. Kitchen Cabinets Prefabricated: Consisting of:

1) Prefabricated metal bodies; baked enamel finish.

2) Stainless steel countertops:

Where sinks are included top and sinks shall be one piece.

3) Plumbing fittings; faucets; drains; etc., trough and including trap.

4) Drawers with metal drawer guides.

5) The entire cabinet assembly shall be ready to move in, connect with water and drain only.

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DIVISION 13

SPECIAL CONSTRUCTION

SECTION 13A

LIGHTHOUSE LANTERN

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes lighthouse lantern complete including cupola, air terminal for lightning arrester system, base for anemometer; and related work.

b. Other Sections include ladder and lighting equipment.

3. GENERAL PROVISIONS

a. Design Criteria: The lantern shall be designed to withstand wind velocity of 36 m/s.

b. Submittals

1) Refer to SUBMITTALS - SECTION 1J.

2) Shop Drawings: Show complete working drawings, templates, installation details, type, grade and class of metals.

3) Design Calculations: Submit calculations showing compliance with design criteria.

c. Materials and parts necessary to complete the lantern, even though such work is not definitely shown or specified, shall be included.

d. Exposed fastenings shall be compatible material, shall generally match in color and finish, and shall harmonize with the material to which fastenings are applied.

e. The Contractor shall verify all measurements and shall take all field measurements necessary before fabrication.

f. Joint exposed to the weather shall be formed to exclude water.

4. GENERAL DESCRIPTION

a. Basic cast metal, self flashing with sufficient allowance for tie downs to comply with design criteria.

b. Glazing Frame:

Triangular bronze mullions formed into V structural components; maintain the minimum number of mullions to satisfy design requirements.

Each mullion designed to accept glass, externally glazed, with brass or bronze cover plate secured with brass screws.

c. Cast metal cap with integrally designed gutters to remove condensation water from interior and water from exterior.

Down spout from exterior.

d. Cupola of copper sheet, 2 mm min. thickness; vented top and inner condensation cone as shown on the drawings.

e. Air terminal for lightning arrestor system as shown, with conduit and cable from terminal to base.

Provide 3 meters extra length on cable to allow for connection to remainder of system.

f. Glass: Polished or float plate glass with high transparency, resistant to scratching ability to withstand rapid change in temperature, attack of salt water and weather.

g. Provide base for anemometer.

5. INSTALLATION

a. Installation when complete shall be completely watertight.

b. Dissimilar metals shall be separated by gasket materials.

c. Extra Material: Provide 4 extra glazing panels.

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DIVISION 15

MECHANICAL

SECTION 15A

PLUMBING

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

2. SCOPE

a. This Section includes complete plumbing system; fixtures, septic tank, equipment and related work and materials.

b. Other Section include

1) Gas piping and cylinders for emergency navigational aid lamps.

2) Sink and fixtures in kitchen.

3. GENERAL PROVISIONS

a. The following publications listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the reference thereto:

1) American Society for Testing and Materials (ASTM) Publications:

A 74-72	Cast Iron Soil Pipe and Fittings
A 120-73	Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Use.
B 32-70	

2) US Federal Specifications F.S.

WW-P-5416	Am-4	Plumbing Fixtures, Land Use

3. cont'd

b. Submittals

1) Refer to SUBMITTALS - SECTION 1J.

2) Materials List indicating types, sizes, finishes, etc., as applicable for equipment, fixtures, materials, devices and accessories proposed.

3) Service Manuals as specified and, in addition, copies of approved material lists, shop drawings and other submittals; list of expendable itmes indicating types, sizes and other data; and names and addresses for all vendors.

c. Supervision; Contractor shall personally, or through an authorized and competent representative, constantly supervise the work and shall, so far as possible, keep the same foreman and workmen on the job from commencement to completion.

d. Workmanship shall be first quality throughout as intended under these specifications. Workmen shall be competent and well experienced.

e. Contract Drawings:

1) The Contract Drawings are diagrammatic only to indicate general extent and general arrangement of work required. Contractor shall coordinate and adjust layouts and provide work and materials as necessary to meet job requirements and provide complete installation as intended under these specifications.

2) Carefully examine all the Drawings. Report any data not clear or discrepancies or interferences to the Engineer. Such work in question shall not be performed until so directed by the Engineer.

f. Inspection: Work and materials under this Section shall be subject to inspections at all times by the Engineer.

4. MATERIALS

a. Equipment, fixtures and other items shall be complete with all necessary accessories and auxiliary materials.

b. Items required shall be or conform to the following, as applicable:

1) In sizes to properly fit the spaces provided, including due allowance for maintenance access for operative equipment.

2) Standard catalog types, with all standard features or with special features indicated.

4. b. cont'd

3) Permanently identified with the manufacturer's labels.

4) Items of same type shall be of same manufacture where possible.

5) Exposed fittings, drains, etc., at interior finished spaces shall be polished chrome plated, unless otherwise shown or specified.

c. Pipe and Auxiliary Materials:

1) Sanitary and Waste, below Grade ASTM A 74, Extra Heavy C.I. pipe and fittings; neoprene gasketed bell and spigot joints, or may be no-hub joints.

2) Waste, Vents and Rain Water Lines Above Grade:

a) Over 2": ASTM A 74, Standard Weight C.I. pipe and fittings.

b) 2" and less: ASTM A 120, Schedule 40, Standard Weight, galvanized steel pipe; cast iron drainage fittings.

3) Water: ASTM A 120, Schedule 40, galvanized steel.

4) Sleeves Through Concrete: Approved galvanized pipe or sheet metal.

5) Hangers, Brackets, Anchors and Connections to Structure: Provide as required and approved.

6) Solder: ASTM B32; alloy as required; except lead alloy not permitted for domestic water line work.

d. Air Chambers: 12" vertical line size capped stub; each fixture.

e. Fixtures

1) Water Closet: Close-coupled siphon-jet water-closet combination, Outfit VW9, with elongated seat with cover Type CETW.

2) Urinal: Wall-hanging wash-out urinal, Outfit VU13W, with flush-valve supply and chair carrier.

3) Lavatories: Vitreous-china flat-slab lavatory, Outfit VL24F.

4) Showers: Exposed type, consisting of shower head, arm, concealed shower valve, and stop valve with slotted head and union, for use with cold-water only.

5. CONSTRUCTION

a. Systems make-up and exact arrangements shall be at the Contractor's option to determine, subject to approval by the Engineer, except as particularly shown or specified.

b. Install, set, secure, connect, service, start up and adjust proprietary items as per the manufacturer's instructions.

c. Penetrations, sleeves, access panels, escutcheons and other auxiliary work shall be provided as necessary. Roof penetrations shall have metal flashing and counterflashing.

d. Exposed Items required to be Field Painted: Furnish prime painted. Elsewhere, furnish items factory finished as per the manufacturer's standards.

f. Clean equipment and fixtures free from dust and debris.

g. Equipment shall be controlled as shown or specified. Furnish all valves and other controls as required as work under this Section, including electrical when so required.

h. Piping - As Applicable or Required:

1) Types as specified unless otherwise shown; sized as necessary for capacity of services required and to provide uniform pressure throughout structure; except not less than specifically required by the equipment manufacturer for proper operation.

2) Arrange and support free from overstressing, rattles, and hammering; provide hangers, anchors, insulators, chambers, etc., as necessary. Keep openings plugged during construction.

3) Joints: Standard make-up for types required; per the manufacturer's instructions as applicable; free from unnecessary stresses and without leaks when complete.

i. Fittings - As Applicable or Required:

1) Stops and Valves: Provide for each fixture and piece of equipment unless provided with integral stops; sized to line size required; and set in accessible locations as per the standard practices.

2) Unions: Provide at each connection to valves or equipment, in accessible locations.

3) Drain Valves: Provide at pipe low points; relief valves plumbed to spill on site or as approved by the Engineer.

4) Nipples: Copper or brass at fixture supplies.

5. i. cont'd

5) Reducing Fittings: For changes in line size; bushings not permitted.

6) Traps: Provide for equipment and fixtures connected to sanitary systems, except items with integral traps.

7) Provide isolating couplings, flanges or unions at connections between dissimilar metals.

8) Cleanouts: Provide at sewer terminal end and intermediate locations required. At interiors, position to side of foot traffic areas, in locations approved by the Engineer. Verify before setting or rough-in.

j. Provide services, rough-ins and final connections for appliances, etc., furnished and set by others.

6. TESTING, CLEANING AND ADJUSTING

a. Pressure Test each section of each piping system before enclosing or covering up. Repair and retest when and as necessary.

b. Thoroughly rinse completed water systems free from foreign matter; fill with fresh water, add chlorine to 50 parts min. per million and hold for 3 hours min., repeat when tests indicate less than 5 PPM after 3 hours. Thereafter, flush systems as required. Post all supply outlets and maintain until completion of flushing.

c. Operate equipment and fixtures and adjust as necessary. When complete, systems and components shall meet and maintain required performance and shall operate quietly and free from superfluous noises and rattles.

7. SEPTIC TANK

a. Type: Prefabricated, fiberglass construction; designed for treatment of waste of 8 persons minimum with the following approximate dimensions:

1) Length: 2.5 m
2) Width : 1 m
3) Height: 1.3 m

b. Tank shall be compartmentalized into 7 zones:

1) Putrified areas: 2
2) Primefilter area: 1
3) Oxidizing area: 2
4) Disinfection area: 1
5) Sterilized area: 1

7. cont'd

c. Septic Tank shall be installed in accordance with manufacturer's written specifications.

8. PERCOLATION TANK AND CATCH BASINS

a. Construct at the location as shown on drawings.
Prior to commencement of the work, the Contractor shall submit the design to satisfy the intended purpose for approval of the Engineer.

b. Covers shall be cast iron.

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DIVISION 16

ELECTRIC

SECTION 16A

GENERAL REQUIREMENTS FOR ELECTRICAL WORK

1. GENERAL

VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications: and apply to this Section, whether or not referred to herein.

2. SCOPE OF WORK

a. This Section sets forth general requirements applicable to all electrical work for this Contract.

b. This Section shall become a part of the following Sections.

Section 16B, LIGHTING EQUIPMENT FOR LIGHTHOUSE
Section 16C, LIGHTING EQUIPMENT FOR LEADING LIGHTS
Section 16D, LIGHTING EQUIPMENT FOR LIGHTED BEACON
Section 16E, LIGHTNING ARRESTORS
Section 16F, INTERNAL LIGHTING, SOCKET OUTLETS AND WIRING

3. GENERAL REQUIREMENTS

a. All works contained herein shall be subject in every respect to the approval of the Engineer or the Engineer's representative. The work covered by this Contract shall be carried out with the regulations issued by the local Ministry of Electricity or agencies.

b. Where there is more than one manufacturer involved in supplying the equipment, then the erection work shall be done by the personnel of respective manufacturer of the equipment or the manufacturer of that certain type of equipment, should certify that the personnel employed for erection of the equipments are capable of erecting work on this Contract independently.

c. Equipments manufactured under licence shall be certified by the licenced firm for respective portion of the work.

4. SUBMITTALS

a. Refer to SUBMITTALS - SECTION 1J.

b. The Contractor shall submit three sets of detail of all electrical equipment and emergency electrical system covered by this Division of the Specification, together with all dimensioned drawings and on the request of the Engineer, the Contractor shall submit sample of any material or equipment with manufacturer's published data or any other description, in the English language.

c. The Contractor shall submit a proposed method of shop testing all navigational and lighting, including emergency equipment. After test method is agreed to and approved by the Engineer such tests shall become part of the Contract at no additional cost to the PQA.

d. The Contractor shall provide and submit six bound volumes of instruction manuals for operation and maintenance before taking over of entire electrical works covered under this Division of the Specification. These manuals shall include at least the following:

1) Manufacturer's technical catalogues, dimensional drawings and wiring diagrams for each and every type of equipment installed.

2) Operating instructions for various equipment and systems.

3) Maintenance manuals for various equipment and systems.

4) Spare parts list along with part numbers of various components for all equipments.

5) Copies of all warranties and manufacturer's guarantees issued in respect of any equipments supplied and installed.

5. MATERIALS AND WORKMANSHIP

a. Materials General: All materials shall be new and of the best of their respective kinds suitably tropicalized and adequately protected against the prevailing climatic condition of Pakistan.

b. Unless otherwise indicated, the Contractor shall obtain similar types of electrical equipment from the same manufacturer wherever practicable. Also the components within any equipment shall as far as possible be produced and assembled from the same manufacturer. Equipment locally assembled and comprising components from different manufacturers will not be accepted unless prior written approval of the Engineer has been obtained.

5. cont'd

c. The Engineer reserves the right to reject even after the contract is signed, material or equipments submitted by the Contractor for the required electrical and associated services if the said material or equipment does not comply with the requirement of the Specification, (unless the Contractor had drawn the attention of the Engineer in writing to any deviations in his offer and such deviations were accepted at the time of adjudication), the Contractor shall be required to resubmit other material or equipment that will comply with the specification.

d. No order shall be placed by the Contractor for major material or equipment unless written approval of the Engineer has been obtained. The Contractor shall report monthly progress of the purchase orders to the Engineer submitting to him a copy of the orders.

e. If the Contractor wishes to offer alternative or substitute material to those included in the Technical Specifications, or further details, the Contractor shall first obtain the written approval of the Engineer before attempting to install these materials. Where due to non-availability of any material, or for any other reason the Contractor desires to substitute another brand or type of material for the one specified, he shall submit his application to the Engineer accompanied with the following:

1) Samples of the proposed materials with all necessary technical informations.

2) Detailed comparison of the properties of both items.

3) Detailed price analysis of both items.

4) Explicit reasons for desiring the change.

f. Workmanship: The works shall be executed in a neat, substantial and workmanlike manner. All workmanship shall be strictly first class in every respect and shall be performed only by skilled workmen.

6. ENCLOSURE FOR ELECTRICAL EQUIPMENT

a. All enclosures of electrical equipment shall be of the totally-enclosed, dust-protected and vermin-proof type provided with suitable gaskets to prevent the ingress of dust and sand.

b. Lock and key shall be provided for each enclosure to prevent unauthorized operation and a master key shall also be provided for similar enclosures supplied from one manufacturer.

7. LABELLING

a. General: All electrical equipment shall be provided with permanently attached to it in a conspicuous position a name plate or label designation the service of the particular equipment. These name plates and labels shall be of non-corrosive material with engraved lettering in English and of contrasting colours. The inscriptions shall be approved by the Engineer.

1) A label written in English shall be provided for all instruments, relays, control switches, push buttons, indication light, breakers, etc., In case of instruments, instrument switches and control switches where the function is indicated on the dial plate or on the switch escutcheon on plate, no label is required.

2) Relays shall be identified by labels or otherwise show the function or device number.

3) Instruction plates showing in English the sequence diagrams or cautions for maintenance shall be fitted on the inside of the front door or the switch boards.

b. Circuit Labels shall be made from synthetic resin with letters engraved in English. The size of the circuit label shall be subject to approval of the Engineer.

In case of indoor circuit breakers, starters, etc., transparent plastic material with suitable contrasting colours and engraved lettering shall be acceptable.

c. Material of labels shall be submitted to the Engineer for approval.

d. Cables: Each cable when installed shall have permanently attached to it at each end and at intermediate positions as may be considered necessary by the Engineer, non-corrosive metal plates upon which shall be engraved or stamped, the identification number of the cable, voltage, rating, conductor size and make.

The cable identification numbers shall comply to the cable schedules which shall be prepared by the Contractor according to the actually laid cables. These cable schedules shall indicate the cable numbers, cable sizes, voltage, termination and connections at each end and cable route.

8. INSPECTION AND TESTING DURING MANUFACTURE

a. The Engineer shall be entitled at all reasonable times during manufacture to inspect, examine, and test on the Contractor's premises the materials and workmanship of all equipment to be supplied under the Contract, and if part of the said plant is being manufactured on other premises the Contractor shall

8.a. cont'd.

obtain for the Engineer permission to inspect, examine, and test as if the said plant were being manufactured on the Contractor's premises. Such inspection or testing, if made, shall not release the Contractor from any obligation under the Contract.

b. Above test and inspection may be carried out by internationally recognized authority appointed by the Contractor alternately or by other agency whose name has been approved by the Engineer.

c. Routine tests for various equipments shall be carried out and any material or works which do not comply to the specification or do not pass the specified test, shall be replaced or made good at the Contractor's expense.

d. The Contractor shall also submit copies of all type test certificates for various equipment and if the Engineer is not satisfied with the results of any type test then such type test shall be repeated at the Contractor's expense.

e. Where the Contract provided for tests on the premises of the Contractor or of any sub-contractor the Contractor shall provide such assistance, labour, materials, electricity, fuel, stores, apparatus, and instruments as may be requisite and as may be reasonably demanded to carry out such tests efficiently.

9. NOTICE OF TEST ON SITE

a. The Contractor shall give to the Engineer in writing 21 day's notice of the date after which he will be ready to make the tests in completion. Unless otherwise agreed, the tests shall take place within 10 days after the said date, on such day or days as the Engineer shall in writing notify the Contractor.

b. If, in the opinion of the Engineer, the tests are being unduly delayed, he may give a notice in writing to call upon the Contractor to make such tests within 10 days from the receipt of the said notice and the Contractor shall make the said tests on such day within the said 10 days as the Contractor may fix and of which he shall give notice to the Engineer. If the Contractor fails to make such tests within the time aforesaid the Engineer may himself proceed to make the tests. All tests so made by the Engineer shall be at the risk and expense of the Contractor. If any portion of the works fail to pass the tests, tests of the said portion shall, if required by the Engineer or by the Contractor, be repeated within a reasonable time upon the same terms and conditions until satisfaction of the Engineer.

10. COMPLETION TESTS

a. The Contractor shall give in writing 14 days advance notice to the Engineer of the date for the completion tests.

10. cont'd

b. Adjustment: Prior to the tests, the Contractor shall adjust all equipment and works to ensure the proper operation thereof and shall be solely responsible for the correctness of the same.

c. Tests: The Contractor shall carry out the completion tests in the presence and under the supervision of the Engineer. Items and method of the tests shall be as directed by the Engineer.

The Contractor shall furnish all necessary equipment, tools, instruments, materials, labour, etc., for carrying out the tests. The Contractor shall submit for approval all data of the tests.

11. SPARE PARTS AND TOOLS

a. Upon completion of the works and before the date of commencement of the Defects Liability period, the Contractor shall submit to the Engineer all spare parts and tools required by the specifications.

b. All spares supplied shall be identical in all respects to their original equipment or component and shall be provided with a card on which is indicated the manufacturer's name and address, parts list and catalogue number and all other relevant information which would facilitate the ordering of further similar items in the future. All these items shall be suitably wrapped to prevent deterioration when stored for extended period in tropical climate. The wrapper shall also bear a clear printed marking for identification.

c. For easy identification of spare parts, following information shall also be prepared and included in the Maintenance Manual:

1) Manufacturer's list or stock number for every parts of the equipment.

2) Where practicable, pictorial index or identification of parts with exposed view illustrations shall be included for components which otherwise can not be easily identified with nomenclature or number only.

3) For equipment assembled by a manufacturer with components procured from other manufacturers each component shall be identified with the component manufacturer's list or stock number.

d. The Contractor shall also furnish two complete set of new special tools for each particular equipment. These tools shall be housed in a suitable lockable steel cabinet and located at the place designated by the Engineer.

12. TRAINING

a. The Contractor shall provide maintenance and operational training of navigational aid lighting to one engineer assigned by the PQA for the said purpose.

b. Training shall be for a minimum of 10 working days.

c. All training shall be imparted in the English language. Trainer will have a good knowledge of both technical and conversational English.

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SECTION 16B

LIGHTING EQUIPMENT FOR LIGHT HOUSE

1. GENERAL

   a. VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

   b. GENERAL REQUIREMENTS FOR ELECTRICAL WORK applies to this Section.

2. SCOPE

   a. This Section includes normal and emergency lighting for light hours; and related work.

   b. Other Sections include other elements of electrical work required for the Contract.

3. GENERAL REQUIREMENTS

   a. If the Engineer or the testing as herein provided, the Contractor shall proceed with the tests. It shall in no way relieve the Contractor of full liability for the quality, proper operation and performance of the equipment.

   b. No shipment of the Equipment shall be made before the factory testing is completed with the result satisfactory to the Engineer.

   c. The Contractor shall be obliged to conduct additional testing, if deemed necessary by the Engineer.

   d. The integrated maintenance for the various equipment to be installed should be considered, and the logistic support as to the maintenance equipment, materials, parts and/or component shall be made in accordance with this consideration.

4. TOOLS

   a. The Contractor shall supply all tools necessary for proper day to day maintenance of the equipment.

   b. The tools and the costs of all tools shall be listed in the maintenance manual and along with the unit instruction manual for the maintenance of the equipment.

4. cont'd

c. Two complete sets of special tools shall also be supplied.

5. SPARE PARTS

a. The list of spares shall be based upon a recommended list supplied by the Contractor and approved by the Engineer.

b. The Contractor shall recommend spares necessary to maintain the equipment for a period of two (2) years. He shall indicate which spares are required for station level maintenance, following the same philosophy of maintenance as expressed in the specifications.

c. The list of spares to be supplied under these specifications shall be included in the Tender.

d. After the two (2) years period or within the two (2) years if required, the Contractor shall supply on a reimbursement basis the requested spares without undue delay on receipt of orders for spares from the PQA.

6. MAINTENANCE MANUAL

a. The maintenance manuals shall cover all routine periodic inspection, testing, alignment, adjustments, and any other maintenance procedures.

b. Test equipment and tools required for equipment and maintenance shall be called out.

c. Periodic maintenance schedules and recommended logs for recording maintenance data shall be included.

7. MAINTENANCE, OPERATION & SUPERVISORY SERVICES

a. The equipment, shall be exclusively maintained, operate and supervised by the PQA after the final acceptance, during the Maintenance period.

b. If the Contractor considers it necessary, he may retain a few of his supervising engineers at his own cost to avoid difficulties in replacements free of cost and freight of each item, part and whole of assemblies that fail to function according to the specifications and the specified tests during the Maintenance period.

8. LOCATION OF COMPONENTS

a. Optical Apparatus: Inside lantern.

b. Lamp Changer: Center of lens.

8. cont'd

c. Solar Battery: On deck over high water tank; wired to switch-board.

d. Switch Board: In battery room; wired to lamps through inside of light house tower and to lead Acid battery.

e. Lead Acid Battery: In battery room.

f. Emergency Lens Lamps: Inside lantern, directly above optical apparatus.

g. Gas Cylinders: In battery room.

h. Piping: Connecting all cylinders to emergency lens lamps; including manifolds, manifold pipes, pipecoils, pressure gauges and all other equipment necessary for a complete system.

9. OPTICAL APPARATUS

a. General: Optical apparatus shall consist of panel lens or reflection lamps, rotating device and pedestal.

b. Panel lens (or Reflection lamps)

1)	Type:	Moulded glass or Reflection lamp
2)	Number of panel lens (lamps):	4
3)	Stationary intensity:	80,000 candelas or more in use, 150W lamp tube or less (total wattage)
4)	Horizontal divergency:	3° or more
5)	Focal plane:	350 mm from bottom of lens base

c. Rotating device:

1)	Rotating method:	Motor and gear
2)	Rate of motor:	DC 24V 5W or less
3)	Material of base:	Cast iron

d. Pedestal:

1)	Material:	Steel
2)	Finished:	Grey paint

e. Spare Parts: Manufacturer's recommended standard parts, including:

9. e. cont'd

1) Rotating motor: 1 pc.

2) Panel lens: 1 pc.

f. Accessories and Tools: Manufacturer's recommended standards.

10. LAMP CHANGER

a. General: Lamp changer shall be so designed that if normal lamp tube fails, standby lamp tube shall take over the operation in normal position automatically.

b. Lamp tube

1) Lamp tube: 24V-150W or less (total)

2) Number of lamp tube: 2 pcs. normal and standby.

c. Body of Lamp Changer: Main material brass.

d. Spare Parts: Manufacturer's recommended standard parts. including:

1) Lamp changer complete: 1 set

2) Lamp tubes: 20 pcs.

11. SOLAR BATTERY

a. General: This solar battery shall be used for the electric charging of the lead acid battery, specified below, as a power source for optical apparatus specified above and shall be designed to comply with the following conditions.

1) Annual duration of sunshine at the Port Qasim is 2980 hours.

2) Current requirement per day of the optical apparatus are as follows.

a) Lamp tube: 24V 150W or less (total)
b) Rotating motor: 24V-5W, or less
c) Working hours per day: 13 hours

3) Charging efficiency of the lead acid battery (600AH, 24V) is taken as 90%.

4) Wiring loss is taken as 5%.

b. The characteristics of the silicon solar battery element are as follows:

At solar battery temperature of 25°C and incident sunshine energy 100 MW/cm^2.

11. b. cont'd

1) Open circuit vol age: Over 0.55V/cell

2) Short circuit current: Over 22mA/cm^2

3) Optimum operating voltage: Over 0.42V/cell

4) Optimum operating current: Over 20mA/cm^2

5) Optimum output: Over 8mW

c. The capacity of the solar battery to be used in this lighthouse for the characteristics specified in paragraph b. shall be:

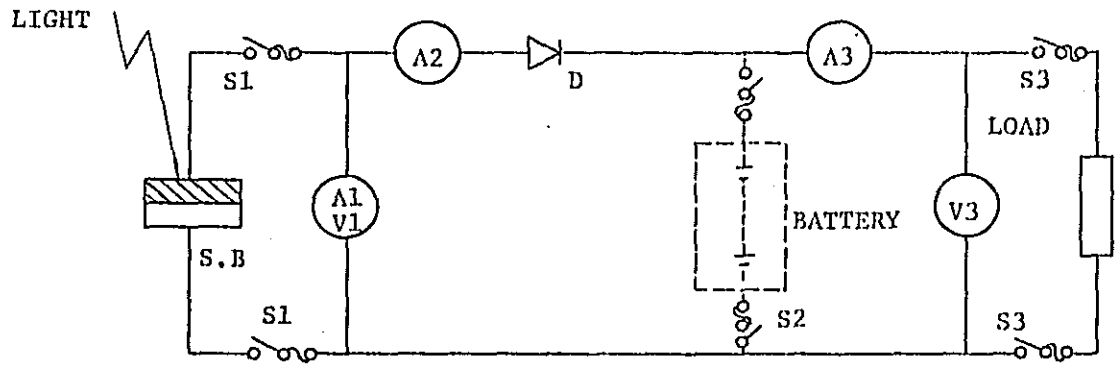
1) Optimum output: Over 596W,

2) Optimum operating voltage: Over 33.6V,

3) Optimum operating current: Over 17.74A

d. Frame and Fixture: The frame and fixture of the solar battery shall be stainless steel and shall withstand a wind velocity 70 m/sec.

e. Switch board shall be of steel with the following equipment fitted on board.



S_1 : Knife switch for solar battery

S_2 : Knife switch for storage battery

S_3 : Knife switch for load

A_1 : Short-circuit ammeter

V_1 : Open-circuit voltmeter

A_2 : Charge-current ammeter

A_3 : Load-current ammeter

D : Blocking diode

11. cont'd

f. Accessories

1) Cable: $3.5mm^2$ x 3C x 20 m
To connect solar battery to switch board with connectors.

2) Manufacturers recommended standards including:

- Portable engin-generator: DC 36V-20A or more 1 set.

g. Spare Parts: Manufacturers recommended standard parts for long-term operation; including:

1) Fuse: 10 pcs each

2) Solar cell: 20% of total quantities

3) Locking Diode: 20% of total quantities

h. Tests and Inspection: The following tests shall be carried out in the presence of the Engineer.

1) Power Test: Performed to confirm the designing function and capacity.

2) Electric Insulation Test: Between solar battery panel and terminal with 500V megger. (10M or more)

3) Electric Withstand Test: DC 500V for one (1) minute.

12. LEAD ACID BATTERY

a. General: This Battery shall be the electrical source for lighthouse lamps and shall be charged by the solar battery; power discharged from only during lamps operational period of nights and bad weather.

b. Lead acid battery: 600AH 1.3V (nominal) 12 cells

c. Accessories: Manufacturers recommended standards; including:

1) Connecting cable: 0.35 mm^2 x 2C x 20 m to connect the battery to the switchboard.

2) Spare Parts: Manufacturer's recommended standard parts; including:

1)	Distilled water:	18	2 bottles
2)	Electrolyte:	18	2 bottles

13. EMERGENCY EQUIPMENTS

a. Lens

1)	Lens:	360° dioptric drum lens, cut and polished
2)	Base:	Cast iron
3)	Inside diameter:	500 mm
4)	Focal height:	425 mm
5)	Type of flasher:	Group-flash
6)	Burner size:	Cluster burner 300 ℓ/hour
7)	Focal height of flasher:	400 mm
8)	Light character:	GPFL (4) 30 sec. duration of flashing time 0.5 sec.
9)	Stationary intensity intensity:	4000 candelas or more
10)	Fixing hole:	4-holes of 17 mm at 212 mm square
11)	Total weight:	Approx. 150 kg
12)	Spare Parts: parts; including:	Manufacturers recommended standard

a) Flusher completed 1 set
b) Burner: 10 pcs.

b. Gas Cylinders

1)	Type:	Acetylene 7000 litres
2)	Nominal charge:	7000 liters
3)	Available gas quantity:	5800 liters
4)	Weight:	70 kg or less

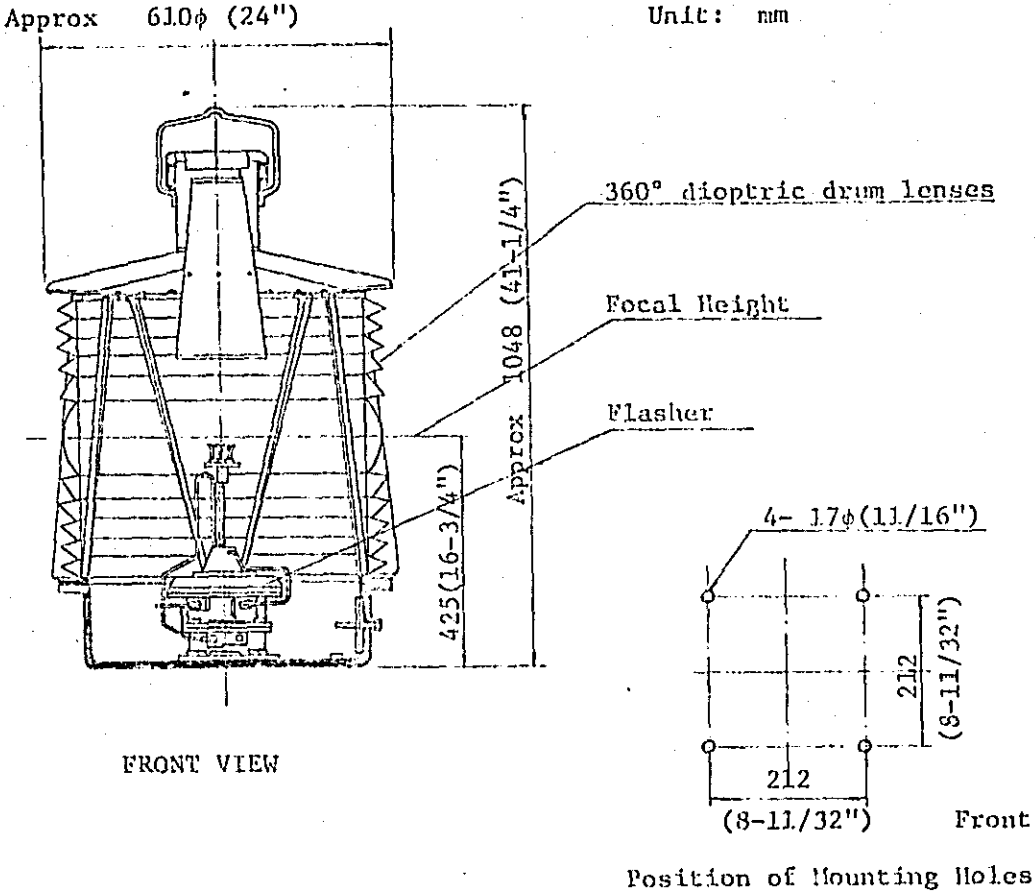
c. Installation Material

1)	Pipe coil:	Front cylinder to manifold	15 pcs.
2)	Manifold pipe for 5 cylinders		3 pcs.
3)	Manifold:	3 Ways with gauge stand and stopped valves	2 pcs.

13. c. cont'd

4)	Pressure gauge:	2 pcs.
5)	Wooden base pad:	15 pcs.
6)	Spare Parts: Manufacturers recommended standards including:	
	a) Pipe coil:	5 pcs.
	b) Manifold pipe:	2 pcs.
	c) Manifold:	1 pc.
7)	Accessories and Tools: Manufacturers recommended standards.	

Fig. 1 LENS LAMPS FOR LIGHTHOUSE (EMERGENCY EQUIPMENT)



Lens Lamp's Size

Inside diameter of lens:	500 mm
Inner focal height:	400 mm
Focal height:	425 mm
Net weight, (complete):	150 kg (330 lbs)

Flasher's Size & Function

Focal height:	400 mm
Net Weight:	Approx. 12 kg (25 lbs)
Flash characteristics:	Group-Flash
Duration of Flashing:	0.9 sec.
Duration of Darkness:	6.1 sec.

* * * * *

SECTION 16C

LIGHTING EQUIPMENT FOR LEADING LIGHTS

1. GENERAL

   a. VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

   b. GENERAL REQUIREMENTS FOR ELECTRICAL WORK applies to this Section.

2. SCOPE

   a. This Section includes lighting and emergency lighting for leading lights, and related work.

   b. Other Sections include other elements of electrical work required for the Contract.

3. GENERAL REQUIREMENTS

   a. If the Engineer or the PQA waives the right of inspecting or testing as herein provided, the Contractor shall proceed with the tests. It shall in no way relieve the Contractor of full liability for the quality, proper operation and performance of the equipment.

   b. No shipment of the Equipment shall be made before the factory testing is completed with the result satisfactory to the Engineer.

   c. The Contractor shall be obliged to conduct additional testing, if deemed necessary by the Engineer.

   d. The integrated maintenance for the various equipment to be installed should be considered, and the logistic support as to the maintenance equipment, materials, parts and/or component shall be made in accordance with this consideration.

4. TOOLS

   a. The Contractor shall supply all tools necessary for proper day to day maintenance of the equipment.

   b. The tools and the costs of all tools shall be listed in the maintenance manual and along with the unit instruction manual for the maintenance of the equipment.

4. cont'd

c. Two complete sets of special tools shall also be supplied.

5. SPARE PARTS

a. The list of spares shall be based upon a recommended list supplied by the Contractor and approved by the Engineer.

b. The Contractor shall recommend spares necessary to maintain the equipment for a period of two (2) years. He shall indicate which spares are required for station level maintenance, following the same philosophy of maintenance as expressed in the specifications.

c. The list of spares to be supplied under these specifications shall be included in the Tender.

d. After the two (2) years period or within the two (2) years if required, the Contractor shall supply on a reimbursement basis the requested spares without undue delay on receipt of orders for spares from the PQA.

6. MAINTENANCE MANUAL

a. The maintenance manuals shall cover all routine periodic inspection, testing, alignment, adjustments, and any other maintenance procedures.

b. Test equipment and tools required for equipment and maintenance shall be called out.

c. Periodic maintenance schedules and recommended logs for recording maintenance data shall be included.

7. MAINTENANCE, OPERATION & SUPERVISORY SERVICES

a. The equipment, shall be exclusively maintained, operate and supervised by the PQA after the final acceptance, during the Maintenance period.

b. If the Contractor considers it necessary, he may retain a few of his supervising engineers at his own cost to avoid difficulties in replacements free of cost and freight of each items, parts and whole of assemblies that fail to function according to the specifications and the specified tests during the Maintenance period.

8. LIGHT PROJECTOR

a. Spare Parts: Manufacturers recommended standard parts including:

8. a cont'd

1) Light projector completed: 2 sets

2) Lamp tube: 40 pcs.

b. Accessories: Manufactures recommended; standards including:

Cable: $2.0\ mm^2 \times 3C \times 30\ m$
To connect switch board to projector.

9. SOLAR BATTERY

a. General: Solar battery shall be used for electric charging of the lead acid battery specified herein as a power source or the optical apparatus and shall be design to comply with the following coddditions.

1) Annual duration of sunshine at the Port Qasim is 2980 hours.

2) Current requirement per day for the optical apparatus is:

a) Lamp tube: 120V-0.77A,
b) Working hours per day: 13 hours

3) Charging efficiency of the lead acid battery (100AH or 200AH, 12V) is taken as 90%.

4) Wiring loss is taken as 5%.

b. The characteristics of the silicon solar battery element at solar battery temperature of 25°C and insident sunshine energy $100mW/cm^2$ are as follows:

1) Open circuit voltage: Over 0.55V/cell

2) Short circuit current: Over $0.45\ mA/cm^2$

3) Optimum operating voltage: Over 0.42V/cell

4) Optimum operating current: Over $20mA/cm^2$

5) Optimum output: Over 8mW

c. The capacity of the solar battery for the characteristics specified above shall be:

1) Optimum output: Over 10.8W for front light
over 28.6W for rear light

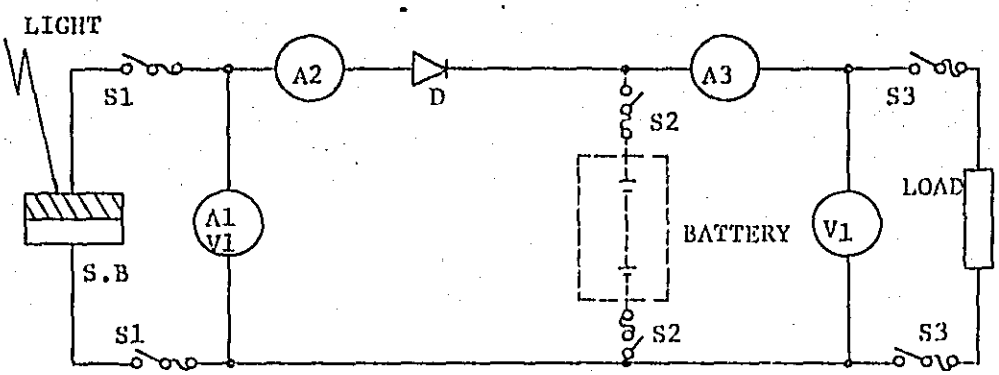
2) Optimum operating voltage: Over 16.8V.

3) Optimum operating current: Over 0.64A for front light, and
over 1.7A for rear light.

9. cont'd

d. Frame and Fixture: The frame and fixture of solar battery shall be of stainless steel and shall withstand a wind velocity of 70 m/sec.

e. Switch Board: Switch board shall be made from steel with the following equipment mounted on board.



S_1 : Knife switch for solar battery

S_2 : Knife switch for storage battery

S_3 : Knife switch for load

A_1 : Short-circuit ammeter

V_1 : Open-circuit voltmeter

A_2 : Charge-current ammeter

A_3 : Load-current ammeter

D : Blocking diode

f. Accessories: Manufacturer's recommended standards including:

Cable:	3.5 mm^2 x 2C x 20 m To connect solar battery to switch board with connector

g. Spare Parts: Manufacturer's recommended, standard parts for long term operation in climatic conditions encountered at the site, including:

1)	Fuse:	10 pcs each
2)	Solar cell:	20% of total quantities
3)	Blocking Diode:	20% of total quantities

h. Test and Inspection: The following tests shall be carried out in the presence of the ENGINEER.

1) Power test shall be performed to confirm the design function and capacity.

9. h. cont'd

2) Electric insulation test between solar battery panel and terminal with 500V megger. (100M or more)

3) Electric withstand test: DC 500V for one (1) minute.

10. LEAD ACID BATTERY

a. General: This battery shall be used as a power source for leading lights and shall be charged by the solar battery. Power is discharged from lead acid batteries to lamps during the night and bad weather.

b. Quantity

Lead acid battery:	2.4V 100AH 6 cells for front leading light
	2.4V 200AH 6 cells for rear leading light

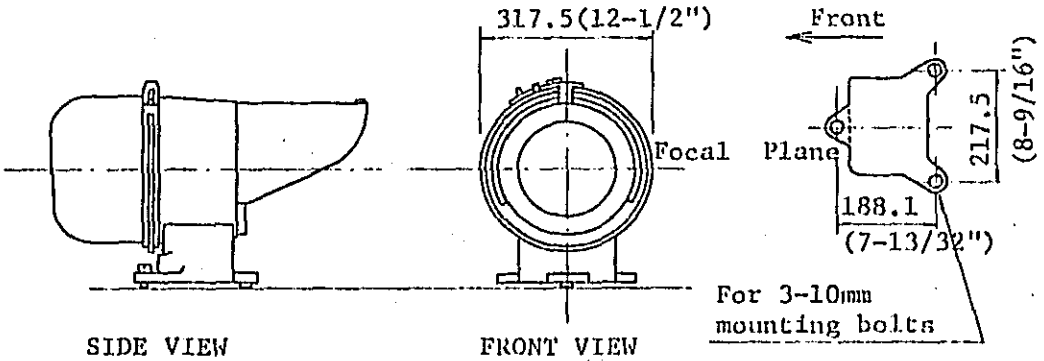
c. Accessories: Manufacturers recommended standards including:

Connecting cable:	0.35 mm^2 x 2C x 20 m battery to switch board

d. Spare Parts: Manufacturers recommended standard parts including:

1)	Distilled water:	18ℓ	2 bottles
2)	Electrolyte:	18ℓ	2 bottles

11. FIG.2 LEADING LIGHT PROJECTOR Unit: m



Lamp		Beam Candelas Power
Voltage	Amperes	Flat Light
12.0V	0.77A	30,000 candelas

11. cont'd

Flasher mechanism:	Transistor flasher: 12V, DC
Light characteristics:	Occulting 6 sec (4-2) for rear light and single Flas flashing time 0.5 sec. for front light.
Lamp Changer:	12V DC, automatic changed mechanism with 4-lamp
Lamps:	Pre-focused 12V, 0.77A
Sun Switch:	12V, DC Requires 10 foot-candelas to turn on, 30 foot-candelas to turn off.
Weight:	15 kg or less
Structure:	Watertight construction and molded fiberglass, stainless steel and anodized aluminum.

12. EMERGENCY EQUIPMENT

a. Lantern: Refer to Fig. 3.

1)	Main material of body:	Bronze and copper.
2)	Lens:	Cut and polished
3)	Type of beam:	Narrow
4)	Type of flasher:	Single-flash
5)	Fixing holes:	4 holes of 20.5 mm at PCD 340 mm
6)	Focal height:	390 mm
7)	Total height:	920 mm
8)	Approx. weight:	95 kg or less
9)	Stationary intensity:	26,000 candelas or more.
10)	Horizontal divergency:	Approx. 4°
11)	Light character:	Occ W 6 sec (4-2) for rear light F W 2 sec flashing time 0.5 sec. for front light.

12) Spare Parts: Manufacturer's recommended standard parts; including:

a)	Burner:	10 pcs
b)	Flasher completed:	2 sets (each 1)

12. cont'd

b. Gas Cylinder

1)	Type:	Acetylene
2)	Nominal charge:	7000 liters or more
3)	Available gas quantity:	5800 liters or more
4)	Approx. weight:	70 kg or less

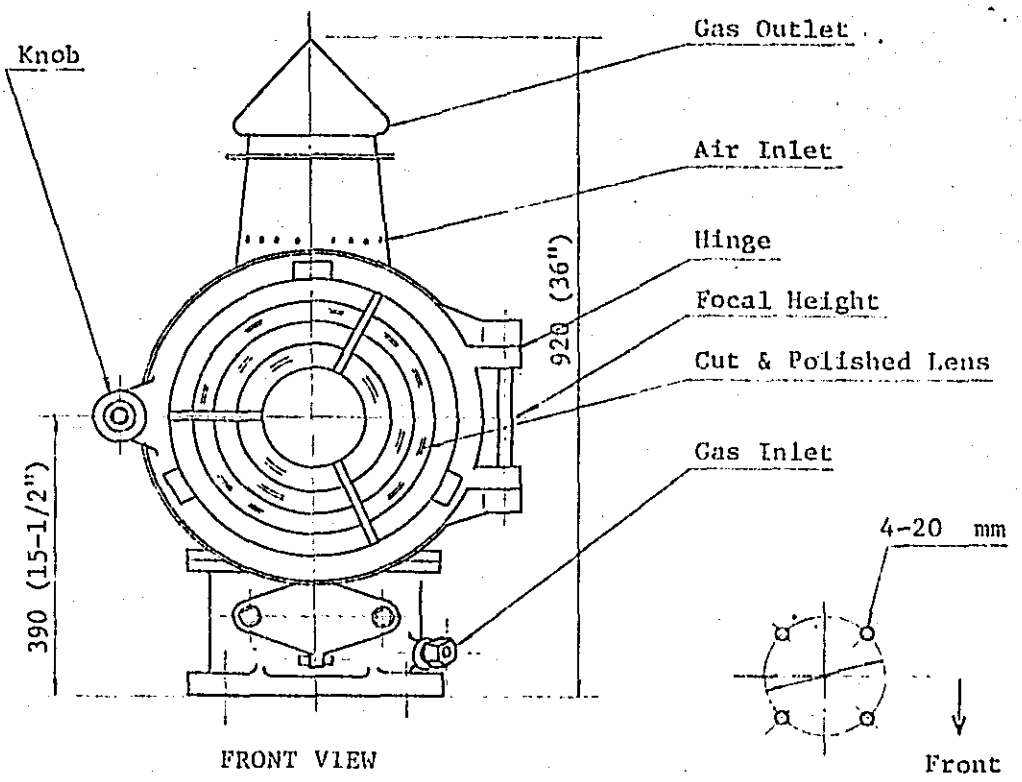
c. Installation Material

1)	Pipe coil	23 pcs.
2)	Manifold pipe for 5 cylinders	5 pcs.
3)	Manifold with stop valve 3 ways:	2 pcs.
4)	Pressure gauge:	2 pcs.
5)	Wooden base pad:	23 pcs.

6) Spare Parts: Manufacturer's recommended standard parts, including:

a) Pipe coil
b) Manifold pipe

13. FIG. 3 LEADING LIGHT LANTERN



Position and Diameter of Mounting Holes

Size & Structure

Type of Beam:	Narrow
Lens:	Cut & Polished
Type of Flasher:	Single-flash
Focal height of Flasher:	390 mm
Weight:	95 kg or less
Material & Structure:	Made of Bronze & Copper fully protected against rain, storms and insects.

SECTION 16D

LIGHTING EQUIPMENT FOR LIGHTED BEACON

1. GENERAL

a. VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

b. GENERAL REQUIREMENTS FOR ELECTRICAL WORK applies to this Section.

2. SCOPE

a. This Section includes lighting and emergency lighting for light house; and related work.

b. Other Sections include other elements of electrical work required for the Contract.

3. GENERAL REQUIREMENTS

a. If the Engineer or the PQA waives the right of inspecting or testing as herein provided, the Contractor shall proceed with the tests. It shall in no way relieve the Contractor of full liability for the quality, proper operation and performance of the equipment.

b. No shipment of the equipment shall be made before the factory testing is completed with the result satisfactory to the Engineer.

c. The Contractor shall be obliged to conduct additional testing, if deemed accessary by the Egnineer.

d. The integrated maintenance for the various equipment to be installed should be considered, and the logistic support as to the maintenance equipment, materials, parts and/or component shall be made in accordance with this consideration.

4. TOOLS

a. The Contractor shall supply all tools necessary for proper day to day maintenance of the equipment.

b. The tools and the costs of all tools shall be listed in the maintenance manual along with the unit instruction manual for

4. b. cont'd

the maintenance of the equipment.

c. Two complete sets of special tools shall also be supplied.

5. SPARE PARTS

a. The list of spares shall be based upon a recommended list supplied by the Contractor and approved by the Engineer.

b. The Contractor shall recommend spares necessary to maintain the equipment for a period of two (2) years. He shall indicate which spares are required for station level maintenance, following the same philosophy of maintenance as expressed in the specifications.

c. The list of spares to be supplied under these specifications shall be included in the Tender.

d. After the two (2) years period or within the two (2) years if required, the Contractor shall supply on a reimbursement basis the requested spares without undue delay on receipt of orders for spares from the PQA.

6. MAINTENANCE MANUAL

a. The maintenance manuals shall cover all routine periodic inspection, testing, alignment, adjustments, and any other maintenance procedures.

b. Test equipment and tools required for equipment and maintenance shall be called out.

c. Periodic maintenance schedules and recommended logs for recording maintenance data shall be included.

7. MAINTENANCE OPERATING & SUPERVISORY SERVICES

a. The equipment, shall be exclusively maintained, operate and supervised by the PQA after the final acceptance, during the Maintenance period.

b. If the Contractor considers it necessary, he may retain a few of his supervising engineers at his own cost to avoid difficulties in replacements free of cost and freight of each items, parts and whole of assemblies that fail to function according to the specifications and the specified tests during the Maintenance period.

8. LANTERN

a.	Main material of body:	Polyester resin and glass-fiber.
b.	Lens:	140 mm glass moulded.
c.	Fixing holes:	4 holes of 18 mm at PCD 340 mm M16 bolts at 200 mm PCD for internal fixing
d.	Focal height of flasher:	325 mm
e.	Focal height of lantern:	350 mm
f.	Over all height:	780 mm

9. FLASHER

Type	Burner in liters	Character	Flashing time in sec.	Static intensity in candelas (or more)	Quantity
Group-flash	20	GPFL(4) 8 sec	0.5	105	1 set
Group-flash	20	GPFL(2) 6 sec	0.5	105	3 sets
Group-flash	20	GPFL(3) 6 sec	0.5	105	3 sets
Single-flash	20	Occ 4 sec	2.5	105	2 sets
Single-flash	20	Occ 5 sec	3.0	105	2 sets
Single-flash	20	FL 2 sec	0.5	105	2 sets
Single-flash	20	FL 3 sec	0.5	105	2 sets

a.	Focal height:	325 mm
b.	Fixing holes:	4 holes of 7 mm at 170 mm PCD
c.	Weight:	10 Kg or less

10. GAS CYLINDER

1.	Quantity:		68 pieces
2.	a.	Type:	Acetylene
	b.	Nominal charge:	7000 liters or more

10. 2 cont'd

c.	Available gas quantity:	5800 liters or more
d.	Approx. weight:	70 kg or less

11. GLASS CYLINDER

1.	Quantity:	17 pieces	
2.	a. Type:	For lantern with 140 mm lens	
	b. Transmission factor:	20 percent or more	

12. INSTALLATION MATERIAL

Installation material per one set consists of the followings:

1)	Steel housing:	For 4 cylinders	1 set
2)	Pipe coil:	From cylinder to manifold pipe 1 m of length with nipples	4 pcs.
3)	Manifold pipe:	For 4 cylinders	1 pc.
4)	Manifold:	3 days with gauge stand and stopped valves	1 pc.
5)	Pressure gauge:		1 pc.
6)	Clamp:		4 pcs.
7)	Wooden base pad:		4 pcs.

13. SPARE PARTS, ACCESSORIES AND TOOLS

Manufacturers recommended standards including:

1)	Burner	50 pcs.
2)	Pipe coil	15 pcs.
3)	Manifold pipe	15 pcs.
4)	Manifold	15 pcs.

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SECTION 16E

LIGHTNING ARRESTORS

1. GENERAL

   a. VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

   b. GENERAL REQUIREMENTS FOR ELECTRICAL WORK applies to this Section.

2. SCOPE

   a. This Section includes lightning arrestor systems on lighthouse and rear leading light; and related work.

   b. Other Sections inlude lighthouse lantern.

3. GENERAL REQUIREMENTS

   a. Submittals

      1) Refer to SUBMITTALS - SECTION 1J.

      2) Material List: Submit all items for approval.

   b. The exact layout of cable may vary from location shown in the Drawings but any change shall be submitted to the Engineer for approval prior to commencement of work.

4. MATERIAL

   a. Cable: Multiple strand copper cable size as shown on the Drawings.

   b. Copper Grounding Plates: As shown on the Drawing.

   c. Air Terminal (for rear leading light) as shown on the Drawings; natural anodized finish.

5. CONDUIT PIPE

   a. General: All conduit pipe for lightning rod cable shall be rigid plastic pipe.

5. cont'd

b. Installation:

1) Conduit in concrete shall be installed as close to middle as practical without disturbing reinforcement.

2) Joints and bends in conduit shall be fabricated in accordance with conduit manufacturer's written instructions.

3) Terminal and junction boxes shall be so placed as to allow cable above ground to be replaced throughout life of installation.

4) Terminal boxes on exterior of structures shall be waterproof.

5) Conduit and accessories shall be kept clean during construction.

6. INSTALLATION

a. Cable above ground floor shall be drawn into conduit.

Provide additional pull boxes as required for this installation.

b. No cable joints permitted inside conduit.

c. Termination of cable shall be made by compressing connectors or lug.

d. Where cable is bent radius of curvature shall be more than 6 times cable diameter.

e. Generally it is desirous to maintain as straight a line between the air terminal and the grounding plate as possible.

The Contractor shall take this into consideration when laying out system.

f. Provide gasket at base of air terminal and secure in approved location.

* * * * *

SECTION 16F

INTERNAL LIGHTING, SOCKET OUTLETS AND WIRING

1. GENERAL

   a. VOLUME I, Parts 1 through 5 preceding these Technical Specifications and Div. 1-GENERAL REQUIREMENTS contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

   b. GENERAL REQUIREMENTS FOR ELECTRICAL WORK applies to this Section.

2. SCOPE

   a. This Section includes internal lighting, socket outlets and wiring; and related work.

   b. Other Sections include other electrical work required under this Contract.

3. DISTRIBUTION BOARDS

   a. General: Distribution board shall comprise of a totally enclosed dust protected and vermin proof, factory fabricated board complete with main breaker, branch breakers, neutral terminals and internal wiring between the main breaker and branch breakers.

   b. The conductors for internal wiring shall be high conductivity copper busbars coloured for phase identification and shall be capable of carrying the load required continuously.

   c. The enclosure shall be wall, surface mounting type, sheet steel with hinged doors which can be opened without any obstruction through 180°, and a second cover to protect the inside wires of the board.

4. 600 VOLT GRADE POLYVINYL CHLORIDE INSULATED WIRES (PVC-insulated wires)

   a. Conductors shall have a minimum cross-sectional area of 2.5 sq.mm for lighting and socket outlet.

      Conductor shall be of stranded copper.

4. cont'd

b. Installation method: Wires shall be drawn into conduit pipings, junction boxes, pull boxes, outlet boxes, switch boxes, distribution boards and terminal boxes etc. unless otherwise specified.

1) Cable shall be drawn into conduit after the conduit have been finally fixed and cleaned out.

2) No wire joints shall be permitted inside conduit.

3) All wiring to lighting fixtures and socket outlets shall be terminated at the fittings itself and further cabling extension for other purpose shall not be made.

4) Jointing and terminating of this wires shall be made by compressing connectors or lug.

5. CONDUIT PIPE

a. All conduit pipe for concealed wiring to interior lighting and socket outlet shall be of polyvinyl chloride.

b. Surface wiring shall be covered with polyvinyl chloride cap molding.

c. All junction boxes, draw-in boxes and inspection fittings shall be so placed that the cables can be inspected and, if necessary withdrawn and re-run throughout the life of the installation.

6. LAMPS AND LIGHTING FIXTURE

a. General: Lamps and lighting fixture shall be of commercial standard types and shall be furnished and installed as required.

b. Lamps of the proper type, wattage and voltage rating shall be furnished and installed in each fixture.

Lamps shall be delivered to the project in their original cartons and installed in the fixtures just prior to the completion of the project.

c. Lighting Fixtures shall be suitable for trouble free operation in the system voltage specified, and complete with all internal wiring.

Accessories such as strap, mounting plates, nipples or brackets shall be provided for proper installation.

d. Wall mounting type lighting fixtures shall be screwed to outlet box or fastened with insert studs, and ceiling mounting type fixtures shall be either tightened with bolts fastened to structural materials, or reflection shade shall be supported with screws.

6. cont'd

e. Types of light fixtures shall be as shown on the Drawings.

7. LOCAL SWITCHES AND SOCKET OUTLETS

a. General: Local switches and socket outlets shall be of flush type and shall have overlapping metal plate with rounded corners and bevelled edges.

Switch box and outlet box shall be of galvanized cast iron or steel with adjustable grids, except that moulded plastic boxes shall be used in corrosive atmosphere.

b. Local Switches:

1) All local switches shall be of 15 ampere rating.

2) Local switches shall be one way, two way or intermediate types as required.

3) Where more than one phase occurs in a switch box the phases shall be permanently barriered and each phase box shall have its own lid.

4) A second lid shall be fixed over these phase box lids in order to present a clean "one plate" finish.

5) The mounting height shall be 1.35 meters.

c. Socket Outlets:

1) Socket outlets shall be the three rectangular pin type, and the rating capacity shall be 13 ampere.

2) Socket outlet shall have bakelite inserts around the pin apertures and shall be shuttered on the live and neutral outlet so that the entry of the earth pin of the plug into the earth outlet of the socket opens the shutter.

3) Not more than two conductors shall be connected into one terminal of any socket.

4) The mounting height shall be 30 cm above the floor unless otherwise shown on the Drawings.

8. MISCELLANEOUS FIXTURES

a. Provide diesel engine generator as shown and specified on Drawings.

b. Provide fan in location shown with automatically closing shutters when fan is off.

* * * * *