

REPUBLIC OF LEBANON
MINISTRY OF ENERGY AND WATER
COUNCIL FOR DEVELOPMENT AND
RECONSTRUCTION

**REHABILITATION OF HERMEL
EXISTING RESERVOIRS**

TENDER DOCUMENTS - VOLUME II

TECHNICAL SPECIFICATIONS

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TECHNICAL SPECIFICATIONS

Part I: General

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Part I: General

PART I. GENERAL

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PART I. GENERAL

1.1- GENERAL

The bill of quantities does not purport to be either exhaustive or explanatory of all the obligations and duties of the Contractor who shall be deemed to have satisfied himself as to the correctness and sufficiency of the rates and prices entered by him in the bill of quantities all of which shall cover all his obligations under the Contract (including those in respect of the supply of goods, materials, plant or services or contingencies) and all matters and things necessary for the proper execution and completion of the works and the remedying of any defects therein and which may reasonably be inferred to be necessary for the works as described in the Contract Documents whether expressly mentioned therein or not.

Works in the present bill of quantities will be remeasured on completion and valued at the rates inserted by the Contractor hereinafter in accordance with the Contract Documents.

The Contractor shall be deemed to have visited the Site, to have taken into account all local and existing conditions. The Contractor's attention is drawn to the location of some works without permanent access.

The Contractor should take all necessary measurements with local owners to insure his access to some project parts where no access is expropriated. The expenses of such works are considered included in the mobilization items.

The Contractor shall be responsible for preparing and constructing any necessary associated design and design changes, which shall be submitted to the approval of the Engineer and shall be at no extra cost to the Employer.

The unit prices are to be fully inclusive value of the works described in the specifications, in the drawings, in the bill of quantities or ordered by the Engineer for proper execution of the works and Contract.

The rates entered against the items defined in this bill of quantities shall cover the construction of all the works that shall include but not be limited to the supply of material, labor, tools, equipment and transport to the various parts of the project (easy to access or not) and all costs and profits required for the proper completion of all the works (structures, pipelines, etc ...) under this Contract without any exception and without any reservation. All the works shall be executed as described in the Conditions of Contract, Specifications, Bill of Quantities, Drawings, technical rules and as directed by the Engineer. All material used in construction shall be of best quality and in compliance with the specifications and shall be approved by the Engineer prior to the beginning of the works. The rates shall also include but not be limited to the following (if not included in separate items):

- Installation and maintenance of site equipment and temporary facilities, dismantling and removal of site equipment and temporary facilities after completion of the works,
- Construction and maintenance of all access roads including safety measures and traffic regulation,
- Supplying material, labor, tools, equipment, machinery and all the required items for the completion of the works and for the subsequent operation, maintenance and repair. All goods, materials, equipment and accessories shall be submitted to the Engineer for approval,
- Testing of material, testing during construction, testing of water quality, pressure tests for pipes and accessories and all the required tests in conformity with the specifications and as directed by the Engineer,
- Supply, transport, installation, testing, site watching and fencing, etc ... and all related requirements and expenses,

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- Preparation of drawings, reports and all the required office work in order to complete the works with the related expenses,
- All trial pits necessary to locate existing services and to determine ground condition and to localise the potential archeological sites.
- Protection of public and private properties, preservation of the existing utilities and indemnification against all damages caused by the construction activities,
- All the necessary safety measures, barriers, signs, lightings, etc ... to ensure the safety of the workers, people and traffic and to settle the boundaries of the work zone day and night,
- Guiding and protecting traffic and pedestrians through areas of construction including the construction of roads and pathways, the erection of signs, barriers and lighting,
- Insurance of works, equipment, personnel and insurance against accidents,
- All costs pertaining to the Contractor work area (stores, workshops, repair zones, etc ...),
- All taxes and customs fees,
- Supply of water and power including piping and wiring to all parts of the project and all related costs,
- Supply of fuel, oil, spare parts, etc ... for all the vehicles, machines and other equipment,
- Providing qualified personnel, technicians, workmen, etc... needed for the proper execution of all works and their related charges (salaries, pensions, etc ...),
- Supply of Survey and inspection facilities for the Engineer and executing all survey works to position pipelines, structures, monitor the progress and verify the locations (X, Y, Z) of all constructions and prepare topographic layouts to be submitted to the Engineer as hard and soft copy.

1.2- ITEM DESCRIPTION

A detailed description of the items and of the conditions under which and the manner in which the work is to be done and measured is set out inside the bill of quantities.

1.3- RATES AND PRICES

The Contractor shall be deemed to have inserted against each item in the bill of quantities such rates and prices as he may deem necessary to cover the requirements of the Contract. Where neither price nor rate is entered against an item it shall be deemed to be "nil" and measured accordingly. The term "included" or any such similar term shall be deemed to be nil. Rates and prices shall be inserted in the rate column of the bill of quantities.

The unit prices inserted in the bill of quantities are to be the full inclusive value of the work described in the specifications and in this preamble and shall cover the cost of all labor subsistence and traveling, materials, temporary work, structural plant, watching and any other cost whatsoever, together with all risks, liabilities and obligations set forth or implied in the Contract Documents.

It should be noted that no payment will be provided by the Client for Materials and Plant brought to the site by the Contractor for incorporation in the Permanent Works.

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1.4- MEASUREMENT

The price shall include all necessary for completion of the works and shall include the prices for all necessary building work such as forming box outs, supports plinths, cable trenches, and the like and all necessary safety and access works including guards, handrails, fire fighting equipment and the like.

All measurements in the bill of quantities are strictly net. The principle of net measurements shall apply to all works executed. All quantities measured for payment shall be measured by the Engineer on the basis of actual net quantities of work fixed in position.

Net measurements shall be done according to the net dimensions. The net dimensions are the dimensions shown on the contract drawings. In case of lack of details on some drawings and in case of design changes approved by the Engineer, the Contractor shall prepare and submit to the approval of the Engineer any necessary associated drawings, and accordingly, the net dimensions shown on the above drawings and approved by the Engineer shall be the base for the measurements.

Lump sum items shall not be subject to remeasurement and shall include the prices of all necessary equipment, construction, installation, testing and commissioning among others. The lump sum entered in the bill of quantities shall include the price for a complete installation as described in the bill of quantities, specifications and other documents forming this Contract.

The quantities given in the bill of quantities are the estimated quantities. In no sense shall such quantities be considered as limiting or extending the amount of the work to be done by the Contractor and of the materials to be supplied by him. The Contractor shall be responsible for checking quantities and for making any necessary surveys and investigations prior to placing any order for materials.

1.5- ITEMS TO BE FULLY INCLUSIVE

Unless otherwise stated, the rates and prices for all items shall be fully inclusive of all that is necessary to fulfill the liabilities and obligations arising out of the Contract and shall include but will not be limited to:

- Mobilization / demobilization of all resources and equipment necessary for the execution and completion of the works
- Survey and Design where expressly required by the Contract,
- Labor and all associated costs,
- Materials, goods, equipment, all consumable, accessories and all associated costs,
- Provision of plant,
- Temporary works (including all safety measures to be taken by the Contractor for a 24/24h whole protection on the site),
- Establishment charges, overheads and Contractor's profit,
- All bonds and insurances,
- Employer's facilities,
- Tests and all associated costs (if not included in separate items),
- Payments of duty and taxes on imported materials and equipment,
- Protection of public and private properties,

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- Any damage occurred on the site must be repaired at the Contractor's expense,
- All access roads (temporary or not: allowing free passing over or across for vehicles and personnel in the neighborhood),
- Succeed running and moving of all equipment in perfect conditions,
- Provide operation and maintenance manuals,
- All work, services and materials which according to the true intent and meaning of the Contract may be reasonably inferred as necessary for completion of the works as described in the drawings, specifications, bill of quantities, or in the Contract, whether expressly mentioned or not,
- All duties, obligations, liabilities and responsibilities which the Contract places upon the Contractor in connection with or in relation to the Contract,
- All costs of detailed survey, design, royalties and supply to the Engineer of all necessary drawings and documents. All necessary drawings, as-built drawings and documents will also be computerized by the Contractor and supplied to the Engineer as well,

1.6- COVERAGE

Where the bill of quantities does not include separate items for Contractor's equipment, temporary works, and facilities for the Engineer and the like, the Contractor shall be deemed to have covered his obligations in these respects in the rates and prices for permanent works.

1.7- ABBREVIATIONS

The following abbreviations are used in the Bill of Quantities:

Sq.	Square	mm	Millimeter
Cu.	Cubic	m	Meter
unit	Unit	km	Kilometer
hr	Hour	%	Per Cent
kg	Kilogram	dia.	Diameter
Prov. Sum	Provisional Sum	ha	Hectare
DN	Nominal Diameter	L	Linear
PN	Flange Pressure Rating	EO	Extra Over
L.S.	Lump Sum	PI	Provisional Item
kW	Kilowatt	BOQ	Bill Of Quantities
m ³	Cubic Meter	month	Month
m ²	Square Meter	HVAC	Heating Ventilation & Air Conditioning
dm ³	Cubic Decimeter	set	set
O&M	Operating & Maintenance	l.m.	Linear meter
day	Day	P.S.	Provisional Sum

1.8- DEFINITION OF RANGE OF DIMENSIONS

A hyphen between two dimensions means a range of dimensions, which includes all dimensions exceeding that preceding the hyphen but not exceeding that following the hyphen.

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1.9- PRICE SCHEDULES

Where in the bill of quantities or specification there is a schedule or subsidiary bill setting out the quantities of materials, plant and work which comprise a unit of work measured as a lump sum under a single item in a part of the bill of quantities, the said quantities shall not be subject to measurement but may be used by the Engineer in valuing any variation to the lump sum item and for the purpose of scheduling payments.

1.10- SOME DEFINITIONS

The following definitions shall apply to items in the bill of quantities:

Extra-Over

Any “Extra-Over” (EO) item shall be measured and paid in addition to the measurement of the basic item to which it relates.

Included

Where the term included is used in the Preamble or in the bills any items stated to be included within another item shall not be subject to measurement and their costs shall be deemed to be included within the rates of the billed item.

Provisional Items

Provisional Items shall be used at the discretion of the Engineer and only if ordered or required by the Engineer in writing.

1.11- DEALING WITH WATER

Items in the bill of quantities shall be deemed to include for dealing with water flows and keeping the works free of water.

1.12- WATER AND POWER

Unless otherwise explicitly stated in the Contract, water and power for the purpose of constructing, cleaning, testing, and commissioning the works shall be provided by the Contractor at his own expense, and shall not be measured separately.

1.13- DISPOSAL SITES

All disposal sites shall be provided by the Contractor in accordance with the local authorities and shall not be used by the Contractor prior to the approval of the Engineer. Preparatory works shall be carried out by the Contractor if required by the local authorities or by the Engineer.

1.14- TRANSPORT OF MATERIAL

All materials shall be transported at the Contractor's expense from and to all works sites (including Contractor work area, storage areas, etc ...) whether these sites are accessible or not. The Contractor shall bear all charges related to access roads construction unless a separate item for access roads construction is included in the bill of quantities.

PART I. GENERAL

1.15- TESTS

The Contractor shall conduct all required tests (pressure test for the piping system, pumping tests for wells, etc ...) and shall supply all necessary labour, measuring equipment, instruments and accessories to complete the tests as specified in the technical documents and as directed by the Engineer.

1.16- ADOPTED CONVENTIONS FOR DUCTILE IRON AND POLYETHYLENE PIPES

a- Pumping and Gravity Transmission Lines

Pumping and gravity transmission lines material shall be Ductile Iron (DI). To convert from inch to ND (mm) multiply by 25.

b- Distribution Lines

- For pipes of diameter greater than or equal to 10 in, distribution Lines material shall be Ductile Iron (DI). To convert from inch to ND (mm) multiply by 25.
- For pipes of diameter less than or equal to 8 in, distribution lines material shall be High Density Polyethylene (HDPE). To convert from inch to OD (mm), see below:

8 in	Is equivalent to	OD 225 mm
6 in	Is equivalent to	OD 180 mm
5 in	Is equivalent to	OD 140 mm
4 in	Is equivalent to	OD 110 mm
3 in	Is equivalent to	OD 90 mm
2 in	Is equivalent to	OD 63 mm
1.5 in	Is equivalent to	OD 50 mm
1 in	Is equivalent to	OD 32 mm
0.75 in	Is equivalent to	OD 25 mm
0.5 in	Is equivalent to	OD 20 mm

Part II: Rehabilitation of Water Tanks

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PART II-REHABILITATION OF WATER TANKS

2- REHABILITATION OF WATER TANKS

2-1 Description

The following specifications include procedures, materials and workmanship for the rehabilitation of existing water tanks. Rehabilitation works will include, but will not be limited to structural repairs and general building rehabilitation. Repair works may include, for each water tank, some or all of the following works:

- Repairs to cracked concrete.
- Sealing joints and cracks to prevent leakage.
- Sealing of pipe penetrations including replacement of some pipes.
- Repairs to damaged concrete and fair faced concrete.
- Repairs and replacement of corroded reinforcement.
- Removal and replacement of plaster and rendering.
- Major structural demolition and reconstruction.
- Internal and external tanking and waterproofing including removal and replacement of the existing roof waterproofing system.
- Painting.
- Earthworks.
- Construction of additional retaining walls.
- Access road rehabilitation or construction of an access foot stair.
- Removal and replacement of cement tiles, concrete floor finishing, stone cladding and inclined stone tiling.
- Repair, repaint or replacement of miscellaneous metalwork, access ladder covers and the like.
- Repair and completion of the roof drainage system.
- Demolition of existing water meter chamber and construction of a new chamber for water meters and air valves.
- Cleaning and general restoration.

A list of the proposed rehabilitation works is shown, for each water tank, on the related tender drawings.

(For all the rehabilitation works, refer also to the preliminary and design reports achieved by the Consultant).

The procedure for the rehabilitation of water tanks shall be for the Contractor to first undertake an initial Site Survey. This survey will determine the general nature and condition of the site, the structure, pipework and ancillaries. Based upon the results of this survey, the Engineer together with the Contractor shall plan and undertake a detailed structural inspection/survey. This detailed survey, in addition to the results of the water tank test (Described in Part IV Mechanical works – Section 4-M) will identify the extent and nature of any defects which in the opinion of the Engineer needs to be rehabilitated or repaired. The Engineer will instruct the Contractor as to the extent and method of rehabilitation or repair to be implemented. In the case

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of major defects, the Engineer may instruct the demolition and reconstruction of the structure either in whole or in part.

Only structural repairs are defined beneath for water tanks.

2-2 Site Survey

The Contractor shall record the existing conditions of the site, the structure and its associated equipment and shall produce dimensioned drawings of the structure comprising plans and sections at a scale of not less than 1:100 and dimensioned plans and layouts of any existing mechanical and ancillaries.

The drawings and condition survey shall be supported by photographs and shall be submitted to the Engineer for approval within 10 days of the survey. The cost of the site survey of water tanks should be considered to be included in the unit rates of the bill of quantities.

2-3 Structural Survey

The Engineer together with the Contractor's engineer accompanied by adequate support staff shall inspect the structure to assess its condition and determine the scope of the rehabilitation work. The survey shall include a cover meter survey and rebound hammer survey of concrete surfaces.

Structural surveys may need to be undertaken in stages involving a number of visits by the Engineer and Contractor. The scope of work may be amended by the Engineer, as necessary, to incorporate the findings of the surveys.

To facilitate the structural surveys it may be necessary to remove existing plastering and rendering, clean the structure, excavate to expose buried surfaces, provide temporary accesses and scaffolding, and carry out water tightness testing or other preparatory work. The preparatory work to be undertaken will be instructed by the Engineer after receipt from the site survey. Further instructions may be issued by the Engineer during the course of the detailed survey and the rehabilitation works. The cost of this work is considered to be included in the unit rates of the bill of quantities.

2-3-1 Cover Meter Survey

Cover meter surveys shall be carried out using normal methods and equipment. On plane members the direction of reinforcement with least cover shall be determined. The cover meter head shall be moved across the surface of the concrete along a line in a direction perpendicular to the direction of reinforcement with least cover and with the head oriented in the direction which enables the cover to that reinforcement to be measured. The lines along which the cover meter head is moved shall be approximately 500 mm apart. The cost of this work is considered to be included in the unit rates of the bill of quantities.

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2-3-2 Rebound Hammer Survey

Rebound hammer for testing the hardness of concrete shall be carried out in accordance with International codes and standards as instructed by the Engineer. The cost of this work is considered to be included in the unit rates of the bill of quantities.

2-4 Access

The Contractor shall provide suitable and safe means of gaining access to all repair areas to enable the works to be carried out and the Engineer to carry out surveys inspections.

2-5 Contractor's Method Statement

Prior to commencing rehabilitation the Contractor shall submit for approval a detailed method statement which shall include.

- A program detailing the proposed sequence and duration of each item of work.
- Details of any necessary disruption to the operation of the works and the Contractor's proposed methods of providing any temporary service.
- Details of all detailed method statements.
- Details of all materials to be used in the rehabilitation works together with all necessary technical documents, catalogues and samples.
- Descriptions of any items including pipework, mechanical and miscellaneous work related to rehabilitation including proposed schedule of design, procurement and delivery.

The cost of the preparation of the method statement for water tanks rehabilitation should be considered to be included in the unit rates of the bill of quantities.

2-6 Mechanical Rehabilitation Works for Water Tanks

2-6-1 Water Tank Test

The purpose of this test is to detect any default in the water tank structure such as leakage and to test all mechanical equipment (pipes, fittings and accessories) before starting the civil, architectural and mechanical works for the water tank rehabilitation.

The water tank test should be performed for all the water tanks that have to be rehabilitated and should follow the procedure described here below:

- a- **Visual inspection:** Before starting the test the Contractor should perform a visual checking, in the presence of the Engineer, of the installed mechanical parts according to the original design and to the attached tender drawings. A list of all the missing and defected mechanical parts should be submitted for the approval of the Engineer.
- b- **Installation of the mechanical parts needed for the test:** All mechanical parts, that are revealed missing or defected by visual inspection and are necessary for

PART II-REHABILITATION OF WATER TANKS

achieving this test, should be installed, replaced or repaired before starting this test.

- c- **Filling with water:** The Contractor must insure that all gate valves at the outlet side are closed then fill the water tank with water, till the ceiling level. The water tank should be kept filled with water for a minimum of 24 hours.
- d- **Civil works inspection:** At this stage the Contractor must perform a civil works inspection on the water tank in order to detect any possible leakage.
- e- **Mechanical works inspection and repair:** Then the Contractor must test the performance of the mechanical installation including pipes, fittings and accessories. First of all the Contractor must check that the valves are not leaking while they are closed, then he should check the fittings and other accessories for leakage. If so he must tighten the bolts and check the gaskets for any defects. The pipes should be checked also for any possible leakage or any obstruction inside the pipes. The Contractor should repair any mechanical part to be kept (not to be replaced because of minor damages). Once the checking is done the Contractor must empty the tank by using every possible combination of valve opening in order to test the valves at flow conditions.
- f- **Washout and overflow checking:** Check the installed water tank washout system and the overflow system after being finished all civil and mechanical tests.
- g- **Water tank test report:** A detailed report on the civil and mechanical parts behavior and observations must be submitted to the Engineer in order to fix any defect found. This report shall include also a list of the additional works that the Contractor judges to be necessary to carry out according to the operation test findings for the approval of the Engineer. The report must be submitted within one week after the test achievement.

2-6-2 Dismantling of Steel and Hydraulic Accessories

The water tank rehabilitation works include dismantling and disposal of steel accessories and hydraulic parts revealed to be defected resulting from a visual inspection or consequently to the water tank test. These works concern the following:

- Defected installed steel accessories, such as the steel opening frame and cover of water tank and the valves and water meters chambers, steel ladder, drainage pipes,....
- Defected installed hydraulic parts, such as pipes, fittings and accessories, inside the water tank, valves chamber and water meters chamber and the connection between them.
- The disposal of the dismantled accessories should be as instructed and directed by the Engineer (disposal sites where permitted or on tips allocated by the Contractor at his own responsibility or delivered to the local water authority where requested).

PART II-REHABILITATION OF WATER TANKS

2-7 Concrete Removal

2-7-1 General

Where existing concrete is to cut out it shall be removed over the areas defined by the Engineer. The Contractor shall ensure that the cutting out is done in such a manner so as not to cause permanent damage to the surrounding structure.

Where practicable, concrete shall be removed by disc cutting, grinding or similar cutting methods and not by percussive tools.

Where percussive methods are approved by the Engineer, the size and power of tool shall be the minimum appropriate.

Before removing any concrete the Contractor shall provide and erect any temporary propping necessary to ensure the safety of the structure.

The Contractor shall be liable for making good of his own expense any damage arising from cutting out.

Where concrete is to be removed the surface of the concrete over the area to be removed, shall be cut by a grid of straight lines using a disc cutter or similar and the concrete removed by chiseling or by percussive tools.

2-7-2 Removal of Unsound Concrete

1. Removal for concrete replacement. The minimum depth of removal shall be the greater of the following :
 - a. A depth no less than 1cm and not greater than the distance from the rearmost point of exposed reinforcement to sound concrete.
 - b. The depth necessary to reach sound concrete.

Should the removal depth exceed 15 cm, the Project manager may order supplementary anchoring as part of the replacement procedure. The sides of the cavity shall be made at a slight angle, so that the width of the base of the cavity is greater than the opening at the surface, thereby providing a key.

2. Removal for patching material replacement. Feather edges shall not be permitted. The minimum patch depth shall be 1 cm as measured from the theoretical plane of the original concrete surface.

2-7-3 Corroding Reinforcement

Where the reinforcement bars are corroded, concrete shall be removed to a depth of 25mm behind and along the actively corroding bars until a continuous length of 50 mm of bar which is free from active corrosion is exposed.

The Contractor may be directed by the Engineer to supplement or replace the existing bars with new bars. Bars to be replaced shall be cut out and not removed by burning.

Replacement reinforcement shall be adequately fixed and tied in position such that it will not be displaced during the subsequent reinstatement works.

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Where corroding reinforcing bars are to be retained they shall be brushed and cleaned by grit blasting or other method approved by the Engineer and submitted by the Contractor. Cleaning shall be carried out in such a way to include the hidden faces at the backs of bars and at the intersection of bars. Abrasives shall be new, clean and dry and of a grade suitable for the preparation of steel to the qualification required above. The exposed reinforcement shall be thoroughly washed down with clean water.

2-7-4 Surface Cleaning

Cleaning of structures shall be undertaken to remove all dirt or other contaminants, previous coatings, paint, moss, plant growth and the like, as directed by the Engineer. Cleaning shall be by methods that cause no damage to the existing structure. The Engineer may instruct a change in the method if the method adopted causes damage to the surface or is otherwise unsuitable or ineffective.

Where instructed by the Engineer cleaning shall be by:

- a) Grit blasting (wet, dry or vacuum blasting).
- b) High pressure water jetting, steam cleaning employing wax free detergents together with power scrubbing as necessary.

Before cleaning begins, the Contractor shall remove all surface attachments from the areas to be cleaned or from positions that obstruct access. Unless otherwise directed. All inserts and fixings which have been cast in or mortared into pockets or otherwise attached to the concrete shall be protected or removed from the area to be cleaned.

Before cleaning commences, trials shall be carried out on areas at typical locations to the approval of the Engineer.

2-7-5 Reinforcement Protective Treatment

Where directed by the Engineer reinforcement shall be coated with a polymer modified cement based primer or slurry coat prior to reinstatement of the concrete. All exposed surfaces of the bars shall be coated with the primer within 3 hours of cleaning. Any reinforcement remaining uncoated at the end of a 3 hours period shall be recleaned.

2-8 Concrete Repair Methods

Defective concrete shall be cut out and reinstated by either a proprietary repair method or in the case of large volumes, by recasting with new concrete. Any defective or corroded reinforcement will either be cleaned and protected by a corrosion protection system or replaced.

Concrete repair methods shall include, but shall not be limited to, the following:

- Hand application of resin based mortars
- Hand application of cementitious mortars.
- Sprayed concrete and mortar
- Recasting with concrete

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The Contractor will determine and submit to the Engineer the extent of the concrete to be removed and will select the appropriate repair method and material of repair depending upon the nature and extent of the defect. Repair methods and materials of repair shall be submitted to the Engineer's approval.

In general hand applied resin based mortars and cementitious mortars will be used for patch repairs to areas of less than 0.5 m² and depths less than 100 mm. Re-casting into formwork will be used for the reinstatement of large volumes and sprayed concrete (Gunite) will be used to cover large areas.

2-9 Reinstatement of Concrete

2-9-1 General

Prior to placing repair materials in any section of the works, all profile guides, formwork and reinforcement shall be fully fixed and cleaned over the entire area of the proposed repair. All dust, debris and loose material shall be removed from the area of the repair.

Plant and tools used for mixing, transportation and spraying of repair materials shall be kept clean and free from accumulated deposits of repair material.

Repair materials shall be mixed and applied in accordance with the manufacturer's recommendations as approved by the Engineer. The entire contents of a pack (or any other type of container) shall be mixed at one time.

Transportation of the repair materials to the point of application shall be such as to prevent contamination, segregation or loss of fine constituent materials.

Repair materials shall be placed in position in as short time as possible after mixing and within times stated in the manufacturer's recommendations. The repair material shall be placed in layers not exceeding those recommended by the manufacturer and approved by the Engineer.

Repairs shall not proceed if the air temperature or concrete substrate temperature is 5°C or less, or such higher temperature as may be recommended by the manufacturer and shall cease if the air temperatures falls below this minimum.

Repair may proceed at low temperatures if specific planned and approved procedures are implemented. These may include:

- (a) Provision of heated tenting which envelopes the repair area and produces an environment with a sustainable air temperature in excess of the minimum.
- (b) Where approved by the manufacturer warming materials and the substrate to a temperature above 5°C. The method of warming shall be such that the materials are not damaged and are not caused to dry out in the case of cement based repair materials.
- (c) Insulating the completed or partially completed repairs in accordance with good practice for winter concreting.

In general the concrete reinstatement patching shall be done as follows:

- 1- Horizontal or essentially horizontal locations. Concrete or approved patching material shall be used. Class A concrete shall be placed only at locations where removal depths average out greater than 8 cm. Patching material shall be placed only at locations where removal depths average out less than 8 cm. Average depths shall be determined by a measurement procedure acceptable to the Engineer.

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- 2- Vertical or essentially vertical locations. Concrete or approved patching material shall be used. Concrete shall be restricted to the depth limitations noted for horizontal locations. Average depths shall be determined by a measurement procedure acceptable to the Engineer.
- 3- Overhead. Approved patching material shall be used. Lift thicknesses shall not exceed 2 cm, unless formwork or anchoring devices are employed.

2-9-2 Materials

Where the repair system comprises two or more materials the Contractor shall ensure that the repair materials are compatible and shall submit to the Engineer certificates provided by the manufacture confirming that the proposed repair materials are compatible.

Where possible repair materials, other than replacement concrete, shall be pre-batched.

All materials shall be mixed, applied and cured in accordance with the manufacturer's recommendations as approved by the Engineer or as otherwise instructed by the Engineer.

2-9-3 Formwork

Formwork necessary to reform arises, profiles, rebates, soffits, and the like shall be so constructed that it remains true to line and level under the loads and pressure imposed by the repair materials.

Formwork shall be struck without causing damage to the repair materials, and the Contractor shall be responsible for determining the age at which the repair material attains a sufficient strength to support its self weight and any other loads which may be imposed thereon.

All profiled guides and formwork shall be coated and/or adequately treated such that they do not absorb water from the repair mortar and do not discolor/contaminate the repair mortar or surrounding concrete.

2-9-4 Epoxy Mortar

2-9-4-1 Description

Epoxy mortar is a blend of high strength aggregates bonded together with epoxy resin, designed for speedy and permanent repairs, to concrete. The mortar shall provide shrinkage-free hardening and abrasion and impact-resistance. The mixed material is applied to a suitably prepared and primed surface. It is supplied as a three pack material in pre-weighed quantities ready for on site mixing and use.

2-9-4-2 Preparation of Concrete Surface

The surface to be prepared will be sandblasted after which it will be thoroughly cleaned and dried prior to epoxy bonding course.

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All grease, chemical contamination, dust, cement, laitance, and loose concrete must be removed by scrabbling or light bush hammering to provide a sound substratum.

2-9-4-3 Priming Surfaces

Surfaces to be repaired shall be primed with an epoxy primer. The epoxy mortar shall be applied when the primer starts to gel but is still tacky, normally between 30 minutes and one hour. If the concrete has absorbed the primer, or the primer has dried, a second primer coat should be applied.

2-9-4-4 Technical Properties

The Contractor shall submit catalogues from manufacturers for approval of the Engineer. It shall conform to the following properties:

	<u>NORMAL TYPE</u>	<u>L.P. TYPE</u>
Compressive strength	70-80N/mm ²	50-60N/mm ²
Flexural Strength	20-25N/mm ²	15-20N/mm ²
Bond Strength to concrete	2-3N/ mm ²	2-3N/mm ²
Young's Modulus	27.000N/mm ²	27.000N/mm ²
Mixing Ratio	1 part epoxy to 3 parts silica sand	

where: Normal type : Have storage conditions above 0°C, max. 25°C.

L.P. type : Have storage conditions above 10°C, max. 35°C.

2-9-4-5 Application

The mixed material should be applied to the surface with a steel trowel, ensuring that it is pressed firmly into cracks to ensure positive adhesion. Epoxy coatings shall be kept dry and above 16°C.

2-9-4-6 Safety

For health and safety, the instruction of the epoxy manufacturer should be followed.

2-9-5 Epoxy Resin Bonding Agent

2-9-5-1 Description

Epoxy resin bonding agent is a solvent-free bonding agent, based on selected epoxy resins. After application to old concrete surfaces, it shall provide a perfect bond for new concrete. It is supplied as a two component bonding agent ready for mixing with a slow speed electric drill.

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2-9-5-2 Preparation of Concrete Surface

All surfaces must be clean, free from standing water and all loosely adhering particles. Cement laitance must be removed and the surfaces to be treated must be roughened.

2-9-5-3 Technical Properties

The Contractor shall submit catalogues from manufacturers for approval of the Engineer. It shall conform to the following properties:

- Compressive Strength 60-70N/mm²
- Flexural Strength 30-35N/mm²
- Tensile Strength 8-20N/mm²
- Bond Strength to Concrete 2.5-3N/mm² (concrete failure)

2-9-5-4 Application

The mixed material should be applied to the surface by brush, roller or spray, ensuring that it is well brushed in on damp surfaces. New concrete should be poured within specified time when the material is still tacky.

2-9-5-5 Safety

For health and safety, the instruction of the epoxy manufacturer should be followed.

2-9-6 Cementitious Mortars.

Cementitious mortars shall be high strength polymer rich proprietary products which produce a dense durable mortar that exhibit minimum shrinkage on drying.

The polymer shall be acrylic, styrene-butadiene rubber or similar polymer which is durable in damp or wet conditions.

Cement shall comply with the Specifications except that cement to BS4027 shall not be used.

The mortar shall exhibit high bond strength and excellent adhesion and shall be free of chloride compounds.

The total chloride content of the mortar arising from the cement, aggregate and any other source shall not exceed 0.1% of chloride ion by mass of cement. The chloride content of the cement shall be determined in accordance with BS EN 196-21 and that of the aggregate in accordance with BS S 12: Part 1 17. The use of calcium chloride is prohibited.

It shall be non toxic suitable for contact with drinking water and it shall demonstrate excellent resistance to long term water immersion.

The minimum strength properties measured in accordance with BS 6319 at 28 days shall be as follows:

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- Compressive Strength 50 N/mm²
- Tensile Strength 5 N/mm²
- Flexural Strength 10 N/mm²

2-9-7 Sprayed Concrete

Sprayed concrete shall be microconcrete (Gunite) material.

The material shall be a proprietary pre-batched microconcrete supplied by a manufacturer who operates quality assurance procedures approved by the Engineer. It shall be cementitious with graded non-reactive aggregate modified with polymer, super plasticisers and silica fume and pre-bagged in the required proportions. Only water shall be added to the mix on site.

The water cement ratio shall not be less than 0.32 or greater than 0.45 and shall comply with the manufacturer's instructions.

The proportion of silica fume shall not exceed 10% by mass of cement.

The total chloride content shall not exceed 0.1% mass of cement. Calcium chloride or admixtures containing chloride salts shall not be used. The chloride content of the constituents of the mix shall be determined as follows:

- Cement - BS EN 196-21
- Aggregate - BS 812: Part 117
- Admixtures - BS 5057: Part 1

Maximum aggregate size shall be 3 mm.

There shall be no expansion agents contained in or added to the repair material.

The material shall exhibit excellent adhesion to the existing concrete and shall exhibit low shrinkage.

It shall have low water absorption and shall demonstrate excellent resistance to long term water immersion.

The minimum strength properties at 28 days shall be as follows:

- Compressive strength 45 N/mm²
- Flexural strength 10 N/mm²
- Adhesive Strength 3 N/mm²

There shall be no change in source or type of material, manufacturer supply, mix proportions or method of mixing without the approval of the Engineer. Such approval will only be given after further site trials have been carried out to the satisfaction of the Engineer.

2-9-8 Concrete

Concrete used in recasting shall comply with the specification to give a 28 day characteristic strength of 35 N/mm².

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Approved water reducing additives, superplasticizers, accelerators, may be used subject to satisfactory testing and the Engineer's approval.

2-9-8-1 Priming

Concrete surfaces within the repair area shall be treated with a suitable bonding aid or primer which is compatible with the repair material.

Priming coats or bonding aids shall be thoroughly worked into all hollows and crevices in the prepared surface and around the reinforcement if required.

If at any time the primer or bonding aid completely dries out before over-laying, the repair surface shall be re-prepared generally by complete removal of the dried primer or bonding aid or as specified by the manufacturer of the repair materials.

When using cementitious based repair mortars the concrete substrate shall be thoroughly wetted to obtain a saturated surface dry condition. Any surplus water shall be remoistened before reinstatement begins.

2-9-8-2 Filling Resin Based and Cementitious Mortar

Mortars shall be applied in self supporting layers and in any case not exceeding the thickness specified by the manufacturer of the mortar.

Each layer shall be thoroughly worked and compacted into the repair zone and around or between reinforcing bars. The technique employed shall ensure that no air is entrapped and that full contact with the primed substrate is achieved.

Successive layers shall be applied as soon as the preceding coat has become sufficiently stiff to support the weight of the additional build-up layer but is still adequately tacky to provide bonding. The time between layers shall be in accordance with manufacturer's recommendations. If sagging occurs the material shall be completely removed and reapplied at a reduced thickness.

If at any time the last layer applied completely dries out before over-laying, the surface shall be prepared according to the manufacturer's recommendations.

The final build-up layer within a repair shall not be less than 10 mm thick and shall be leveled off or profiled to produce a smooth finish.

The repair shall be cured by the method and for the period recommended by the manufacturer of the repair system. During this period the temperature of the material shall not be allowed to drop below the minimum specified by the manufacturer and the repair shall be shaded from direct sunlight. Curing membranes shall only be permitted where they are recommended by the manufacturer.

2-9-8-3 Filling Sprayed Concrete

Delivery equipment shall be demonstrated to the satisfaction of the Engineer in site trials. The equipment shall deliver a conical uniform discharge stream of uniformly mixed material at the proper velocity from the discharge nozzle at all heights of the work.

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Once placed, the applied material shall be capable of being profiled and steel trowel finished to a high standard without detrimental effects.

2-10 Specific Works

2-10-1 Crack Repairs

Cracks requiring repair shall be categorized by the Engineer as follows:

- Live cracks.
- Major cracks.
- Stable structural cracks.

• Repair of Live cracks

Live cracks shall be chased out using a grinding machine to a minimum depth of 30mm and width of 15 mm.

The rebate shall be cleaned of loose material, primed and filled with a gun applied polyurethane sealant onto a debonding tape within the rebate.

• Repair of Major Cracks

Cracks classified by the Engineer as major live cracks shall be repaired by cutting out and subsequent restatement of the concrete.

Reinstatement shall be in accordance with the Engineer's instructions. A joint bridging strip shall be applied over the crack where instructed by the Engineer.

Where the Engineer instructs the concrete shall be cut out over sufficient width and depth to enable examination and any repairs to the reinforcement.

• Repair of Stable Structural Cracks

Stable structural cracks shall be filled with proprietary materials applied by pressure injection such that the crack is completely sealed.

Materials shall be polyurethane resin, epoxy resin or liquid silicate. Polyurethane foam may be used as directed by the Engineer for crack sealing in wet conditions.

The material shall exhibit low viscosity and good adhesion to dry or moist concrete. On curing, the material shall form a hard mass impermeable to water.

2-10-2 Repair around pipe penetrations

Leaks around pipe penetrations, shall be repaired as follows:

1. Where pipes are in good condition the Contractor shall chase out a 20 x 20 mm rebate around the pipe and fill the rebate with gun application of elastomeric polyurethane mastic sealant and provision of a butyl flashing ring.
2. Where pipes must be removed and new pipes installed the Contractor shall break out and remove the existing pipe. The new pipe shall be installed complete with a puddle flange,

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and concrete shall be placed from both sides of the wall. The Contractor shall ensure a good bond will be formed between old and new concrete.

2-10-3 Repair of leaking joints and Cracks

Repairs to leaking joints and cracks shall be directed by the Engineer be made on the internal water face using a proprietary joint bridging strip, with a minimum thickness of 2 mm and made of an inert flexible strip such as Hypalon (By Dupont) or equivalent material.

The adhesive shall be an epoxy resin compatible with the concrete and the flexible strips suitable for use in damp conditions. Full contact between the flexible strip and the concrete shall be ensured by means of a roller.

Surface preparation shall be by grit blasting or other approval method to remove all laitance and in accordance with the manufacturer's requirements.

2-10-4 Refurbishment of Roof Structures

Where directed by the Engineer, all existing internal and external roof screeding, rendering and debris shall be removed from the roof and any defective concrete repaired.

The installation of new waterproofing membrane, thermal insulation and concrete protection of the roof of the water tank shall be done if required by the Engineer and with the same material used for new water tanks and described elsewhere.

2-11 Valve Chamber and Reservoirs Cleaning

These works shall include the works indicated on drawings or as defined by the Engineer.

All cleaning shall be thorough and shall include all operations necessary to remove all sediments, stones,... loose concrete from the walls, underside of the roof slab of manholes. This procedure is intended to include, but is not limited to, the following work:

- Removal of overburden.
- Cleaning with water jetting, wire brushing, or other approved means.
- Removing of any sand and debris from bases.
- Dredging or any other necessary cleaning process
- Flushing with water
- Removing of all sand and debris jetted or dredged and disposal of same to an approved location.

2-12 Waterproofing Protective Coating For Water Retaining Structures

2-12-1 Description

This coating shall be a surface-applied material which waterproofs and protects concrete in depth and shall be suitable for use in water retaining structures. It consists of rapid-hardening

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Portland cement, specially treated quartz sand, and a compound of active chemicals. It is supplied in powder form and needs only to be mixed with water prior to application.

2-12-2 Preparation of substrate

All concrete to be treated with this coating must be clean and have an “open” capillary system. Laitance, dirt, grease, etc. should be removed by means of high pressure water jetting, wet sandblasting or wire brushing. Faulty concrete in the form of cracks, honeycombing etc. should be made good. Surfaces must be carefully pre-watered prior to the application of the coating. The concrete surface must be damp but not wet.

2-12-3 Mixing

The powder material is mechanically mixed with clean water to a consistency of thick oil paint. Approximate mixing ratio is 0.8 parts water to 2 parts powder (by volume).

Materials mixed shall be as can be used within 20 minutes. Mixture should be stirred frequently. If mixture starts to set, no water should be added, the mixture should be stirred to restore workability.

2-12-4 Application

The mix is applied by masonry brush or appropriate power spray equipment. When two coats are specified the second coat shall be applied while the first coat is still “green”.

2-12-5 Post Treatment

The treated surfaces should be kept damp for a period of five days and must be protected against direct sun, wind and frost by covering with polythene sheeting, damp hessian or similar.

2-12-6 Safety

The use of rubber gloves and goggles during mixing and application is recommended.

2-12-7 General Requirements

Waterproofing material shall be applied to interior concrete surfaces.

It is made of cement base, sand, and other chemical. It is composed of two contents:

- Powder: Mixed of cement and other mixes as specified by the Engineer
- Liquid: Resin base and other mixes as specified by the Engineer

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The above product must be:

- Waterproofing
- Weather and chemical product resistant
- Suitable for potable water, not harmful nor poisoning nor unhealthy

Before placing waterproofing on concrete surfaces, mastic of hydraulic cement base shall be used in concrete holes and cracks which provides a complete blockage to water. This mastic is a mixture of powder placed in special can closed tightly and shall be mixed with water before usage as directed by the Engineer.

2-13 Plaster Works

2-13-1 Description

This work shall consist of furnishing and installation of Portland cement plaster for the areas designated on the Plans or where specified. Work shall begin after the Contractor's request to start work has been approved.

2-13-2 Materials

Portland Cement

Portland cement shall conform to LIBNOR.

Water

Water shall be clean, pure and free from all deleterious substances.

Aggregates

The aggregate shall be natural sand, clean, sharp, free from impurities and conforming to granularly hereafter described.

Hydrated lime

Lime shall be used only where mentioned and after being approved by the Engineer.

Quantities used in the mixtures must be approved by the Engineer.

Waterproofing additive

Waterproofing additive shall be a brand approved by the Engineer.

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2-13-3 Plaster Mixes

Designation

Plaster work shall be designated as follows :

- a. Ordinary Interior Plastering : Plaster work applied to interior surfaces.
- b. Ordinary Exterior Plastering : Plaster work applied to exterior surfaces.
- c. Water Resistant Exterior Plastering : Plaster work containing waterproofing additive applied to exterior surfaces.
- d. Tyrolean Plastering : Plaster work applied to exterior surfaces.

Batching and mixing

Mixing of the ingredients shall be done either manually or mechanically. In both cases, measurement of cementitious material should be based on full bag increments of cement whenever possible.

Manual mixing

The mixing process shall be done in a clean area away from natural soil and any other substances. First, the dry ingredients shall be mixed before any water is added. Then water is added only enough to produce a workable mix. The volume of the sand shall be measured in calibrated boxes such that each volume of plaster requires a whole number of 50 Kg cement bags. The mortar shall be used in the first half hour after its preparation and before it starts to set.

Mechanical mixing

Portland cement plaster shall be mixed in a paddle drum mixer for 3 to 10 min. Excessive mixing which could be detrimental to the quality of the plaster shall be avoided. Only sufficient water shall be added to produce a suitably plastic mortar.

2-13-4 Preparation of Surfaces

Before proceeding with the plaster work, the substrates and the conditions under which the work is to be installed shall be examined and any unsatisfactory conditions detrimental to the proper and timely completion of the work shall be corrected. The following background conditions shall be satisfied before coatings are applied :

- Adequately true and level to achieve specified tolerance
- Adequately fixed
- Free from contamination and loose layers
- Adequately prepared to give a good bond
- Free of any coating of bituminous compound or any other detrimental waterproofing or damp-proofing agent.

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2-13-5 Samples

One square meter of each plastering sample shall be executed before starting the plaster work. The approved samples shall be kept until all the plastering work is finished. Plaster work shall be of a quality the same or better than the sample.

2-13-6 Protection

All fixtures, frames, inserts and other contiguous work shall be protected from rusting, soiling or clogging due to plastering.

2-13-7 Plaster Coats

Unless otherwise specified plaster work shall consist of three coats :

- 1- Scratch coat which is the first coat
- 2- Brown coat which is the second coat
- 3- Finish coat which is the final coat and can be replaced or covered with decorative plastering.

2-13-8 Application of Plaster

General

Immediately prior to the application of plaster, surfaces shall be thoroughly sprayed with water few hours before plastering and all free water shall be allowed to run off.

All arises, corners and internal angles shall be straight and level or plumb.

Plaster shall be made good up to frames and skirting and around fittings and pipes. Angles shall be rounded to a 5 mm radius.

Undercoats and finish coats shall be protected from the weather until they have set and shall not be allowed to "dry out" or "sweat out" to the detriment of the surface and shall be kept covered with damp sacking or other approved means for the period specified.

Thickness guide markers of porcelain tiles splinters or similar markers shall be placed at the rate of one marker per square meter of surface to be plastered.

Unless otherwise specified the surface of the plaster shall be rendered smooth and level by the use of a felt. Rough patches, ridges or any other flaws shall not be permitted.

Plastering shall be executed under almost horizontal light so that any flaw such as undulations, ridges, etc. can be detected and repaired.

A straight edge, a plumb, a spirit level, a square and an electric lamp shall always be kept at the site so it can be possible to check the plastering work.

Plaster work containing cracks, blisters, pits, checks or discoloration will not be accepted. Such plaster shall be removed and replaced with new plaster. Patching of defective work will

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be permitted only when approved. Such patching shall match existing similar work in texture and color as determined by the Engineer. Moistening must occur twice a day.

The Contractor shall provide easy and secure access to all surfaces to be plastered.

Plastering is forbidden when one of the following weather condition occur:

- Temperature below 5 degrees C.
- Dry air (Unless approved by the Engineer)
- Rainy day (Unless approved by the Engineer)
- Hot weather (Unless approved by the Engineer)

Application of coats

Scratch Coat Plastering

This coat shall be a plastic workable mix. It shall be laid on with sufficient material to form full key with the base material. It shall be cross raked and allowed to set for 48 hours before applying brown coat. It shall be continuously damp during the entire period between coats.

This coat is not to be used on interior or rough surfaces.

This coat is to be used on exterior and flat surfaces.

Properties of the ingredients in the plaster mix shall be as follows:

- 600 Kg Portland Cement for 1 cubic meter of sand, or 1 part Portland Cement for 3 part sand.
- Sand granulometry: 0.1 - 0.3 mm. Particles less than 0.1 mm shall be less than 10%.

Using of lime for exterior plastering coat is forbidden.

Scratch coat thickness shall be between 5 and 8 mm.

Brown Coat Plastering

The scratch coat shall be moistened with water before applying the brown coat. The water sheen on the surface of the scratch coat shall be allowed to disappear before applying the brown coat. If the prewetting operation interferes with the proper floating of the plaster surface, it may be reduced or eliminated depending upon the moisture condition of the scratch coat. The brown coat shall be hand-troweled with enough force to key this coat to the scratch coat. After obtaining the desired thickness, it shall be rodded to a plane surface. Sufficient stiffening shall be allowed to occur prior to floating. The brown coat shall be damp proofed for a period of 5 to 15 days depending on weather conditions.

Proportions of the ingredients in the plaster mix shall be as follows:

- 600 Kg Portland Cement for 1 cubic meter of sand
- Sand granulometry: 0.1 - 0.5 mm.

Using of lime for exterior plastering coat is forbidden.

Brown coat thickness shall be between 5 and 8 mm.

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Finish Coat

Finish coat shall not be applied until brown coat has cured for seven days. Before application of finish coat, wet brown coat to a true, even surface and trowel in a manner that will give a level, even surface of sandy texture, free from trowel marks, checks and other blemishes.

Care should be taken to apply finish coat continuously between natural breaks in the surface plane. On multiple-level staged walls, lower levels of plaster in the same panel shall be continued immediately to avoid joining stains, shouldering and texture variation. The finish coat shall be moistened for at least three days; thereafter it shall be protected against rapid drying until properly, thoroughly cured.

Proportions of the ingredients in the plaster mix shall be as follows:

- 600 Kg Portland Cement for 1 cubic meter of sand.
- Sand granulometry: 0.1 - 2 mm.

Using of lime for exterior plastering coat is forbidden.

Thickness of the finish coat is between 5 and 8 mm.

When Tyrolean coat is applied as a finish coat, plaster shall have the same characteristics of cement plaster, but with finishing layer of white cement sprayed with a machine in many passes to get a homogeneous rough surface.

The roughness of the finished layer is as per sample approved by the Engineer.

Approximate thickness is 10 mm.

Proportions of the ingredients for Tyrolean coat are:

- 1 part Portland Cement
- 4 part fine sand

Internal Plastering

Internal plastering shall be applied in two coats of minimum total thickness of 15 mm on vertical faces and 10 mm on ceilings (excluding the thickness of any initial dash coat).

On vertical faces the plaster shall be applied in widths not exceeding one meter between screed laths prepared and set up true and plumb.

The finished faces of plaster shall be true to shape and angle even in all directions, free of cracks and trowel marks to the complete satisfaction of the Engineer.

The plastering of each face between two corners shall be carried out in one operation and work must in no case be interrupted and continued the following day, all reveals for jambs, lintels shall be plastered in one operation with the respective wall faces.

At least one day shall elapse between the execution of consecutive coats of plaster.

Floated coat for tiled surface shall be applied as for internal plastering in general. It shall be plumb, true and level and shall bring the finished tiled face to required plane.

The surface of floated coats should be left with a steel float finish.

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External Plastering

External plastering shall be applied in two coats to a minimum total thickness of 20 mm. The finishing surfaces of plaster shall be true to shape and angle even in all directions, free of cracks and trowel marks to the complete satisfaction of the Engineer.

Tolerances and permissible deviations

- The finished plaster shall be straight, true, square with adjoining work, smooth where required, free from imperfections impairing appearance or performance. Angles shall be plumb and true.
- A 3 m. ruler placed on the surface in any direction shall not show a tolerance more than 3 mm.

2-14 Painting

2-14-1 Description

This work shall consist of painting work as shown on the plans.

2-14-2 General Requirements

Unless specified otherwise, the Contractor shall:

Have painting work conform to D.T.U. Standard No. 59.1 or BS 6150.

Provide samples showing the brand, quality, ingredients and shall be approved by the Engineer.

Supply all paints, primers, varnishes, distemper, oil, etc. ready mix in original sealed containers bearing the brand maker's name identifying the contents and giving directions for its proper use.

Have painting materials to be of the best quality products of recognised manufacturer's and shall be subject to the approval of the Engineer. The quality of the finishing colors shall be capable of giving three years minimum satisfactory performance under conditions of high temperatures and humidity, and capable of withstanding temperatures of up to 40 degrees C for long periods without color change. Paints shall also be resistant to oils, acids and alkalis.

Execute all paint works for flat concrete, plaster, wood, or steel as shown on drawings or as required by the Engineer.

Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning. Program cleaning and application so that contaminants from cleaning process will not fall on wet, newly-painted surfaces. Paint shall only be applied on a properly brushed surface, so as to eliminate all loose sand or mortar particles.

Not be undertaken the application of paints in a temperature over 30 degrees C or below 5 degrees C, in a humid atmosphere over 80% and when weather is dry, in a dusty or foggy, or rainy weather, or on frozen or overheated surfaces.

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Take every precaution to keep down dust before and during painting and decorating operations. No paint shall be applied to surfaces structurally or superficially damp and all surfaces shall be free from condensation, effloresce, crease, oil, dirt and like before the application of each coat.

Have primed or undercoated wood or metal not to be left in an exposed or unsuitable situation for an undue period before completing the painting. No exterior or exposed painting shall be carried out during adverse weather conditions.

Have metal hardware and door furnishings not required to be painted to be fitted first and then removed before any painting processes are commenced. When all painting is completed the fittings shall be cleaned and refixed.

Keep clean all brushes, pails, kettles and the like used in carrying out the work and free from foreign matter. They shall be cleaned before being used for different types or classes of materials.

Use the undercoats, primers and the like manufactured or recommended by the manufacturer of the finishing paint and notwithstanding anything herein specified and shall prepare the surfaces, mix and apply the materials in accordance with the manufacturer's specification and as required on the drawings.

Not allow tile mixing of materials of different brands. No dilution of materials will be allowed except as detailed by the manufacturer. All paints for the site shall be ready mixed for use and brought on site in their original containers as supplied by the manufacturer.

Submit complete color charts for the paints to the Engineer for approval and the preparation of the color schedules. The number of coats and film thickness required is the same regardless of the application method. Do not apply succeeding, coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce an even smooth surface in accordance with the manufacturer's directions.

Apply additional coats when undercoats, stains, or other conditions show through final coat of paint until paint film is of uniform finish, color, and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.

Extend coatings in exposed surfaces to maintain the system integrity and to provide desired protection.

Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only before final installation of equipment.

Paint interior surfaces of ducts, where visible through registers or grills, with a flat, non-specular black paint.

Paint back sides of access panels and removable or hinged covers to match exposed surfaces.

Finish interior of wall and base cabinets and similar field-finished casework to match exterior.

Finish exterior doors on tops, and side edges same as exterior faces.

Sand lightly between each succeeding enamel or varnish coat.

Omit primer on metal surfaces that have been shop-primed and touch unpainted.

Remove before painting commences, all hardware, furniture and accessories for doors and windows, together with any exposed electrical installation in walls. Upon completion of all

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paint work, all such hardware, furniture and accessories etc. shall be re-installed and left in a good working order.

Have all woodwork to be painted to be reasonably dry and humidity must be less than 12% and its surface shall be cleaned and made smooth by sanding it with sand paper obliquely across the grain. The surfaces shall then be dusted off with a dusting brush and wood glue completely removed.

Have concrete surfaces to be painted to be washed down first and then allowed to dry. Any efflorescence present shall be thoroughly removed, and the areas so affected shall be given a coat of porous alkali-resistant primer. After any traces of grease have been removed, the surfaces shall be painted with two coats of emulsion paint of the copolymer acrylic type. Any cracks in walls shall be cleaned, filled and puttied up then left to dry before application of paint.

Follow the manufacturer's instructions on the use of paint and shall be delivered to the site unopened with the original cover.

Submit for approval all types of paint he intends to use with manufacturer's certificate showing the following physical properties:

- Viscosity
- Adherance
- Durability
- Abrasion
- Permeability
- Resistance to washing
- Stability of color

All tests shall meet the requirements of U.N.P. and the Contractor is the sole responsible for these materials and their use for the particular job.

Have mastic base water for gaps filling components for concrete or plaster to be composed of the following materials:

- Sealer 8.5%
- Water 25%
- Powder 40%
- Zinc 20%
- Oil 6.5%

2-14-3 Particular Specifications

Emulsion Paint

The Contractor shall provide, store and apply emulsion paint to substrates with the following requirements complementary to the general specifications including all needed materials, accessories, tools and scaffolding.

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Emulsion based flat finish, to be used in water thinnable paint systems applied on interior and exterior walls and ceilings

Recommended thinner	Sweet water
Volume of thinner	0-5%
Description	Superior quality thixotropic paint based on a copolymer emulsion. Alkaline resistant
Mass Density	Approx. 1.4g/cm ³
Solid Contents	31-33% by volume, depending on colors
Overcoating intervals	min. 2 hours
Flash point	> 65degreesC - Din 53213
Type of application	Spray, brush or roller
Total thickness of paint	7-8 dry mils
Number of coats	To the satisfaction of the Engineer and the following minimum application
Plastered walls and ceilings	Cleaning - Sealer - Putty - Sanding- Undercoat - Putty - Sanding - Paint – Checking –Paint
Masonry Concrete Cleaning	Masonry filler – Sanding – Undercoat - Putty - Sanding - Paint – Checking –Paint
External walls and ceilings	Cleaning - Sealer - Putty - Sanding-Undercoat Paint Putty Sanding - Paint – Paint

Acrylic Paint

The Contractor shall provide, store and apply emulsion paint to substrates with the following requirements complementary to the general specifications including all needed materials, accessories, tools and scaffolding.

Emulsion based semi-gloss finish to be wed in water thinnable paint systems applied on interior and exterior walls and ceilings.

Recommended thinner	Sweet water
Volume of thinner	0-5%
Description	High quality semi-gloss water borne thixotropic paint based on a pure acrylic emulsion. Alkaline resistant.
Mass Density	Approx. 1.2g/cm ³
Solid Contents	Approx. 34-36% by volume depending on colors
Overcoating intervals	min. 2 hours
Flash point	> 65 degrees C - Din 53213
Type of application	Spray, brush or roller
Total thickness of paint	7 - 8.5 dry mils

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Number of coats	To the satisfaction of the Engineer and the following minimum application
Plastered walls and ceilings	Cleaning - Sealer – Putty - Sanding- Primer - Putty - Sanding - Paint – Checking -Paint
Masonry Concrete	Cleaning - Masonry filler – Sanding – Primer - Putty - Sanding – Paint
External walls and ceilings	Cleaning - Sealer - Putty - Sanding-Primer Paint – Putty – Sanding – Paint

Oil Paint

The Contractor shall provide, store and apply oil paint to substrates with the following requirements complementary to the general specifications including all needed materials, accessories, tools and scaffolding.

Finishing coat in an alkyd system applied on interior and exterior walls and ceilings.

Recommended thinner	Thinner flash point = 39 degrees C
Volume of thinner	0-5%
Description	High glass coating on alkyd resins
Mass Density	Approx. 1.0g/cm ³
Solid Contents	40-50% by volume, depending on color
Overcoating intervals	min. 16 hours
Flash point	> 39° C - Din 53213
Type of application	Spray, brush or roller
Total thickness of paint	8 dry mils
Number of coats	To the satisfaction of the Engineer and the following minimum application.
Plastered walls and ceilings	Cleaning - Sealer - Putty - Sanding- Undercoat - Putty - Sanding - Paint - Checking -Paint
Masonry Concrete	Cleaning - Masonry filler - Sanding - Undercoat - Putty - Sanding - Paint -
External walls and ceilings	Cleaning - Sealer - Putty - Sanding-Undercoat Paint Putty Sanding -Paint

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Epoxy Paint

The Contractor shall provide, store and apply epoxy paint to substrates with the following requirements complementary to the general specifications including all needed materials, accessories, tools and scaffolding.

General purpose, epoxy based, corrosion resisting, adhesion primer for steel, galvanized steel, aluminum and synthetic.

Recommended thinner	Thinner flash point = 26°C
Volume of thinner	0-5%
Description	Epoxy solvent-free heavy abrasion and chemical resistant coating – Epoxy paint applied after Epoxy primer coating to the recommendation of the manufacturer.
Mass Density	Approx. 1.4g/cm ³
Solid Contents	57% by volume
Overcoating intervals	Approx. 7 days
Flash point	Base and hardener
Type of application	Spray, brush or roller
Total thickness of paint	Min. 140 microns cured film
Number of coats	To the satisfaction of the Engineer and the following minimum application
Plastered walls and ceilings	Cleaning - Sealer - Putty - Sanding-Undercoat - Putty - Sanding - Paint - Checking - Paint
Masonry Concrete	Cleaning - Masonry filler - Sanding- Undercoat - Putty - Sanding - Paint
External walls and ceilings	Cleaning - Sealer - Putty - Sanding-Undercoat Paint - Putty - Sanding - Paint

Anti-Acid Paint

The Contractor shall provide, store and apply Anti-acid paint to the substrates with the following requirements complementary to the general specifications, with all needed materials, accessories, tools and scaffolding.

Epoxy enamel coating applied on interior and exterior walls and floors.

Recommended thinner	Depends on the epoxy paint Manufacturer's recommendation.
Description	Epoxy resin chemical coating highly resistant to extreme chemical attack, preferable bisphenol type.
Solid Contents	Approx. 40% by volume

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Pigment concentration	Approx. 20% by volume
Overcoating intervals	min. 8 hours
Flash point	26°C
Type of application	Spray, brush or roller
Number of coats	To the satisfaction of the Engineer and the following minimum application Cleaning – Primer – Paint

2-14-4 Paint on Concrete or Plaster

The Contractor shall prepare concrete or plaster surfaces to be painted as follows:

- Concrete or plaster surfaces shall be allowed to dry completely.
- Any signs of salt present shall be brushed away with steel brush then wait for a week. If salt reappears, it shall be brushed again and treated with phosphoric acid and zinc chloride.
- Check all cracks and holes in the concrete and putty them in a special mastic.
- Sand paper concrete and plaster surfaces.
- Clean concrete and plaster surfaces from all dust, sand, oil, etc.
- Surfaces shall receive one or more applications of putty filler until smooth surface is obtained to the Engineer's approval.
- Emulsion paint shall be applied by brush or roller and shall consist of a priming coat and two coats of paint internally and a priming coat and three coats of paint externally.
- Oil paint shall be applied by roller or brush and shall consist of a priming coat, two under coats and one finishing coat of paint.

The finishing coat of paint shall be applied after the completion of the electrical installation, sanitary work and false ceiling.

No oil paint shall be applied when the humidity exceeds 70% RH

Interior Oil Or Water Base Paint On Concrete Or Plaster With Mastic

After preparing concrete or plaster surfaces, painting shall be executed as follows:

- First coat - Prime coat (paste)
 - Apply first mastic layer. When dries, sand it with sand paper and clean it from dust.
- Second coat - 50% less fluid than the first coat.
 - Apply second mastic layer. When dries, sand it with sand paper and clean it from dust.
- Third coat - Color coat as required.
 - Check mastic and sand it with sand paper it, then apply mastic at needed locations.

Finally, apply two paint coats in conformity with the color approved by the Engineer either by brush or roller.

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If the required paint is water base, mastic and prime coat shall be water base too. If the required paint is oil base, mastic and prime coat shall be oil base too.

Oil Or Water Base Paint On Concrete Or Plaster Without Mastic

After preparing concrete or plaster surfaces to be painted either inside or outside, painting shall be executed as follows:

- Applying a base coat with the required color.
- Repairing small holes with mastic then rubbing it with rough cloth until the textures matches the wall on it.
- Finally, applying two paint coats in conformity with the color approved by the Engineer either by brush or roller.

If the required paint is water base, mastic and prime coat shall be water base too. If the required paint is oil base, mastic and prime coat shall be oil base too.

Exterior Paint Protection On Concrete

Concrete surfaces shall be prepared to paint by a base coat, then paint brush with the required paint with one coat to reach a transparent cover, or two coats to reach a complete colored paint as required by the Engineer.

Coarse Texture Or Scratch Paint On Concrete Or Plaster

Interior or exterior concrete surfaces shall be prepared to paint by a base coat the same color as the final coat, then applying the paint either by the roller or spray as required by the Engineer.

2-14-5 Metal Work

Metal shall be prepared for paint as follows:

- All metalwork shall be cleaned free from all rust, scales, grease, oils and any other surface stains and painted with one coat of priming paint applied by brush .
- Cracks and holes shall be filled with steel mastic and sand cleaned, then dusted.
- Two prime coats matches the specified color if possible.
- Two coats of finish paints as required by the Engineer.

Steelworks delivered to the Site primed shall be cleaned of impurities and damage to the priming paint made good with priming.

Metalwork which is concealed shall be prepared and primed as above and shall be painted with two undercoats and one finishing coat of paint applied by brush.

In cases where protection coat against chemical effects such as chlorine is used (Chlorine bottle's door room), special prime and base paint shall be used to resist such effects as approved by the Engineer.

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2-14-6 Safety & Cleanliness

Unless specified otherwise, the Contractor shall:

keep all painted works until the end of the project. In case of damages or deterioration, the Contractor shall repair them on his own expense as required by the Engineer.

During progress of work, remove from site discarded materials, rubbish, cans and rags at end of each work day.

Upon completion of painting work, clean window glass and other paint-spattered surfaces.

Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

Protect work of other trades whether to be painted or not, against damage by painting and finishing work. Correct damage by cleaning, repairing or replacing, and repainting, as directed by the Engineer.

Provide "Wet Paint" signs in Arabic/English and laborers' native languages as required to protect newly-painted finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of painting operations.

At completion of work by other trades, touch-up and restore all damaged or defaced painted surfaces

Finally, at the end of the project, the Contractor shall deliver all paint work in a perfect way.

2-15 Natural Stone Cladding

2-15-1 Natural Bump Stone (Rough Finish)

Stone shall be from the best quarries and approved by the Engineer.

It shall meet the following requirements:

- No hollow sounding.
- Free of defects.
- Weighs at least 2.5
- Breaking strength greater than 600 Kg/cm²

Natural bump stone shall not be affected by ice or any porosity signs. The size of stones shall follow the requirements of the drawings.

The Contractor shall submit a sample for the Engineer's approval and shall stay at site during the whole period of cladding.

2-15-2 Bush Hammer Natural Stone (Smooth Finish)

Stone shall be from the best quarries and approved by the Engineer.

Stone shall not be affected by ice and shall be free of any scratches, cracks or defects to give an even appearance. Under the hammer, stone shall give a clear sound.

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It shall meet the following requirements:

- Resistance to breaking: 600Kg/cm² at least.
- Weighs: 2.5 at least.

The Contractor shall submit a sample for the Engineer's approval and shall stay at site during the whole period of cladding.

2-15-3 Mortar

Mortar for laying the stone and pointing shall be composed of 600 kg CPA 250/315 cement for 1 cubic meter of sand. The thickness is 3 cm of the mortar after stone has been laid. The quantity of water to be used in the preparation of mortar shall be only that required to produce a mixture sufficiently workable for the purpose intended. Mortar shall be used as soon as possible after mixing and shall show no visible signs of setting prior to use. Retempering of mortar will not be permitted.

The materials of mortars shall be measured out in their correct proportions and shall first be thoroughly mixed together in a dry state by turning them over upon a clean wooden stage until they are of a homogeneous appearance in consistency and color. Clean water shall then be added while the mixture is being turned over until it.

2-16 Fences and Gates

Fences generally shall be in accordance with the relevant parts of BS 1722 Part 1 1986.

Chain link fencing shall be Type PLC.213 Grade A with high plastic covered chain link mesh. The mesh and line wires shall be galvanized prior to being plastic covered.

The straining posts, intermediate posts shall be manufactured and erected complete as specified in BS 1722. The fencing shall be true to line and vertical, following the profile of the ground, previously graded so as to prevent access beneath the bottom wire.

Gates shall be hung on reinforced concrete column, and shall be truly vertical.

Ornamental fabricated metalwork fences and gates shall be constructed of mild steel bar, strip or tube in accordance with the Drawings. All welded joints and drillings for bolts shall be made before painting, and all bolts, nuts and washers shall be galvanized or plated with two coats of bituminous paint.

2-17 Ladders

Ladders shall comply with BS 4211 and shall be of galvanized steel.

Stringers shall be extended 1000 mm above the upper platform and suitably opened out for access, or where ladders are below manhole covers, separate hand holds shall be fixed to the upper platform.

After fabrication, ladders under manhole covers shall be dipped with hot galvanized.

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2-18 Test of Disinfection of Potable Water Reservoirs

Provide equipment, gauges, temporary connections, chlorine and water needed for flushing and disinfection after all work has been completed.

After the completion of the work, the Contractor must fill the reservoirs with clear water mixed with chlorine dose of 20 mg per liter and,

- 1- Wait for 24 hours, then measure residual chlorine by taking a sample to the lab and perform a bacteriological test in the presence of the Engineer. If any harmful signs appear, disinfection process must be redone and another sample must be taken until the test gives a results acceptable to the Engineer.
- 2- Wait for an additional 48 hours and check if the water level stays as it was. If not, the Contractor has to fix the reservoirs on his own expense and restart the test

The cost of these tests are considered to be included in the unit rates of the materials and works related to the pipes and reservoirs mentioned in the Bill of Quantities.