

EMPLOYER'S REQUIREMENT FOR MECHANICAL & ELECTRICAL WORKS

CHAPTER 07 WORK ITEMS

CHAPTER 7

EMPLOYERS REQUIREMENT

WORK ITEMS

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CHAPTER 7 EMPLOYERS REQUIREMENT WORK ITEMS

7.1 Brief Description of the project

The Contract is for construction of new Pump Station of 295,500 m³/day (65 Imp MGD) capacity at Gharo to improve the water supply of water deficit areas of Karachi.

The Pump Station shall have 6 pumps, 4 Duty and 2 standby. The pumped water will be conveyed by a manifold to a newly rising main of 1800 mm (72 inches) diameter upto the existing Forebay about 11.1 km away from the Gharo pump house. The general layout arrangements of E & M and civil works as well as limits of the Contract Work are shown on the Conceptual Drawings.

7.2 General

The Contractor may submit alternative proposals for electrical and mechanical plant and civil works which in his opinion are more innovative, cost effective and facilitating plant operation. The Contractor shall justify his proposals by providing examples of satisfactory operation of similar plants working under similar environmental conditions as prevailing at the proposed site area. In addition to other requirements of the Contract, he shall provide the methodology for controlling vibration, sound and heat to keep them within acceptable limits.

The works shall be executed in accordance with the latest issues (or their updated amendments) of standards and codes referred to in this Chapter.

The Contractor shall submit the names of the plant manufactures and their work place / country for all Work Items for the Employer's review.

7.3 Employer's requirements: Mechanical works

7.3.1 Introduction

The Contractor shall provide all plant and equipment of the pump house including valves, surge control equipment, suction and discharge pipe work, manifold, delivery main, flow meter, Overhead Gantry/Crane and all required services and equipment to construct a pump house of the highest operative condition. The Contract Work shall be within the limits as shown on the Conceptual Drawings.

The hydraulic characteristics of the intake works, the screen chambers, and pump suction pipe work shall be checked by setting up a sump model test.

It may be noted that diameters of pipes / specials shown on the Conceptual Drawings or those specified in the main Work Items are the internal diameters.

7.3.2 Work Item No.1: Pump intake sump model test

The test in general shall conform to ANSI/HI 9.8-2012. Vendor shall provide a complete set of ANSI Hydraulic institute standard for pumps as per hydraulic combine standard version 3.2 on CD ROM

- a. The general objective of the model test is to achieve a good flow distribution and freedom from swirl vortices and air entrainment within the intake system and all pipe work under all pumping regimes in varying flows upto $3.42 \text{ m}^3/\text{sec}$ plus a 20% margin.
- b. The particular requirement is to investigate flow conditions and to determine whether any design modifications to the intake chambers shown on the Tender Drawings or those proposed by the Employer are required to improve pump suction conditions for eliminating vortices at maximum, normal and minimum water levels in the intake channels.
- c. The model shall extend from the inlet channel to the pumps and shall include the screen chambers, suction channel, pump sump, pump bell mouths and suction pipe work as shown on the Tender Drawings. The pumps themselves will be simulated as regards major external geometry and fitted with free rotating vanes at the bell mouth throats to register swirls. Flow may be provided by service pumps remote from the model. The test facility, pipe work, valves and flow meters will be such as to enable all operational combinations of flow to be reproduced from minimum to maximum water levels in the pump sump.
- d. Operating conditions to be tested shall include the minimum, intermediate and maximum liquid levels and flows. For multiple pumps, all possible combinations of operating conditions should be included.
- e. Vortex observations and swirl measurements shall be made for all tests. Still photographic documentation of typical tests showing vortexing or other flow problems shall be made.
- f. The final report of the model study shall include: intake or piping design, model description, scaling and similitude criteria, instrumentation. Test procedure, results (data tabulated and plotted), recommended modifications and conclusions. The report shall contain photographs of the model showing the initial and final designs, drawings of any recommended modifications, and photographs of relevant flow conditions identified with dye or other tracers. A brief video tape of typical flow problems observed during the tests shall be made and submitted.
- g. The acceptance criteria for the sump model test of the final design shall be the following:
 - (1) Free surface and Sub-Surface vortices entering the pump must be less severe than vortices with coherent (dye) cores. Dye core vortices may be acceptable only if they occur for less than 10% of the time or only for infrequent pump operating conditions.
 - (2) Swirl angles, both the short term (10 to 30 second model) maximum and the long term (10 minute model) average indicated by the swirl meter rotation, must be less than 5 degrees. Maximum short term (10 to 30 second model) swirl angles up to 7 degrees may be acceptable, only if they occur less than 10% of the time or for infrequent pump operating conditions. The swirl meter rotation should be reasonably steady, with no abrupt changes in direction when rotating near the maximum allowable rate.

- (3) Time averaged velocities at point in the throat of the bell or at pump suction shall be within 10% of the cross-sectional area average velocity. Time varying fluctuations at a point shall produce a standard deviation from the time averaged signal of less than 10%.
- (4) For the special case of pump with double suction impellers, the distribution of flow at the pump suction flange shall provide equal flows to each side of the pump within 3% of the total pump flow.

7.3.3 Work Item No 2: Manual coarse screen

- 1 No-Manual cleaning coarse screen of welded construction attached to built-in steel support beams of MS to BS 4360 Grade 43A spanning the width of the channel placed at about 75° to the horizontal axis having a head loss not exceeding 4mm at $4.44 \text{ m}^3/\text{sec}$ flow rate.

12 x 50 mm flat bars with 75mm spacing between bars welded onto the frame shall retain all incoming floating matter of larger sizes. Lifting lugs for removing screen assembly from its position without interrupting plant operation shall be provided on the frame.

- 2 No-Hand rakes of sturdy design for manual cleaning of the screen from a RCC platform above maximum water level shall be supplied Access to the platform from ground level will be via a steel ladder.

The screen assembly and rakes shall be in stainless steel to BS 970 Grade 316 and access ladder shall be hot dip galvanized in accordance with BS 729.

The debris from the C.I platform shall be lifted in a skip built in stainless steel by means of a geared motor assembly having manual override up to the ground level with a rope, drum and pulley system. Limit switches for up and down travel and other required equipment shall also be provided for avoiding possibility of over-travel. Power supply for the motor may be taken from the screens control panel or from the L.V switch board by cables laid in a concrete duct.

7.3.4 Work Item No.3: Chain Hauled Raking Bar Screens

- 2 No-One duty and one standby chain hauled raking bar screens, each capable of passing a design flow of $3.42 \text{ m}^3/\text{sec}$ having 12mm spacing between bars all of welded construction attached to steel support beams spanning the width of the channel and suitable for installation in concrete work. Head loss across each bar screen shall not exceed 50 mm at the design flow.

A mechanical raking mechanism shall be provided for each bar screen of the electrically driven chain hauled type complete with a drive motor, gear box and controls and shall be capable of cleaning the bar screen of all debris such as logs, weeds etc. from the incoming, flow.

The rakes shall discharge debris at ground level into skips built in stainless steel placed behind raking head at deck level. One duty and one standby skip

shall be provided for each bar screen. Skips shall be suitable for manual handling.

The raking assembly shall be controlled by differential pressure transducers mounted upstream and downstream of the screens for start and stop of the rakes on rising and falling pressure differential. Overriding manual control and local and remote electrical controls from distribution board and PLC/SCADA system shall also be provided. The control and operating facilities shall be designed so that the two screens can be operated simultaneously from a central control panel.

In the event of debris free water passing through the screen for long periods a timer will ensure that the rakes are turned three times a day.

Raking assembly shall be removable in the event of failure so that bar screens can be cleaned by hand raking. Two sets of hand rakes of sturdy design shall be provided.

The screen assembly and rakes including hand rakes shall be in stainless steel to BS 970 Grade 316.

In the event of failure of the screen, provision shall be made for lifting the whole screen assembly for maintenance without interrupting flow.

The Contractor shall provide control and electric cables in concrete ducts between pumping station and the screen control switch gear.

7.3.5 Work Item No. 4: Central flow Band Screen

- 2 No- One duty and one standby central flow band screens spanning, the width of the channel each capable of passing a design flow of $3.42 \text{ m}^3/\text{sec}$ having a stainless steel 2.0 mm square aperture mesh suitable for removal of filamentia from weeds and floating algae matter present in raw water without causing blockage of the screen. Head loss across each screen and back opening, when clean shall not exceed 150mm at duty flow.

Each band screen shall be capable of two speed operation complete with motor, gear box and controls and shall be automatically controlled by differential pressure signals from pressure transducers mounted upstream and downstream of each screen monitoring the head loss across the screen.

The control mechanism will ensure that when the pressure difference across the screen starts to rise the screen will start and turn at slow speed and the wash water actuated isolating valve will open and allow wash water to wash the screen. If pressure difference continues to rise, the screen will switch to fast speed automatically with wash water still on. Any further rise in pressure differential will alarm and trip the screen. In the event of debris-free water passing through the screen for long periods, a timer will ensure that the screen turns at least three times a day. Overriding manual control for local and remote operation shall be provided for slow and fast speeds Control and operation of the screen from PLC/SCADA system shall also be provided.

Band screen shall be washed by high pressure water jets each delivering a

minimum 50 l/min at the required pressure with jet spacing of 140mm approximately. Wash water shall be taken from the pump delivery main. The Contractor shall provide all necessary pipe work, valves, a duplex filter with a mesh sized to prevent blocking of jets, duty and standby pressure reducing valves, pressure gauges and motorized control having facility for manual operation.

The Contractor may propose alternative mesh cleaning system provided that it is simpler, better and more effective.

Band screen control and washing facilities shall be designed so that the two screens can be operated simultaneously from a central control panel or from PLC/SCADA system.

Screen washing shall discharge via a chute to a debris pit where solids shall be collected in a skip made in stainless steel suitable for manual handling and wash water returned to screen chamber at inlet to the screen. One duty and one standby skip shall be supplied with each screen.

The Contractor shall provide wash water pipe work and control and electric cabling in concrete ducts between pumping station and the screen channel. Necessary hooks, tackles etc. shall be provided to lift the screening assembly without interrupting the plant operation.

7.3.6 Work Item No. 4: Penstocks

- 4 No-Rectangular faced penstocks of sectional frame for an operational off- seating pressure of one bar exceeding the top of the door.

The penstocks shall be suitable for installation in the two screening streams, each having two penstocks one located upstream and the other downstream of the screens for isolation of the screening stream whenever required for maintenance works.

Each penstock shall be capable of passing a design flow of 3.42 m³/sec and shall be of adequate width to allow unhampered and streamlined flow to and from the screens in all stages of operation from 25% to 100% of the flow. The penstocks shall be provided with extension shafts and headstocks for manual operation from the floor level. Motorized operation gear and accessoriness shall also be provided.

The penstocks shall be of the flat back type with rising stems of stainless steel and guide rails for channel mounting frames and gates made of epoxy coated mild steel, adjustable wedges having bronze faces on the Side, bottom and top. Penstocks shall be of flush bottom type and shall have flush invert with adequate sealing arrangement.

7.3.7 Work Item No. 6 Pumps

- 6 No -Four Duty and two Standby Centrifugal Pumps single stage of vertical spindle split casing type with removable axial suction and discharge branches coupled to vertical cardan shaft (a shaft with universal joint at one or both ends) electric motors through extension shaft.

Pumps shall be suitable for continuous operation individually or in parallel.

Pumps shall be installed in a dry pit and motors mounted on the main floor

directly above the pumps. The pumps shall draw water from the suction well via bellmouths & isolating suction valves and discharge via check valves provided with flexible couplings and butterfly valves into a common delivery manifold of 1800 mm dia.

Pumps shall be fitted with renewable casing, and impeller wear rings and renewable shaft sleeves in the region of bearings and glands.

Pump rotating assemblies shall be dynamically balanced and the pump thrust shall be carried by heavy duty grease lubricated ball/roller bearings mounted on top of the pump casings and the lower bearings shall be of the cutless rubber type or equivalent lubricated by water being pumped.

Each pump shall be fitted with packed gland. For sealing purposes, water shall be taken from the pump through a duplex filter, one of which shall act as standby. Two pressure gauges, one before the filter and the other after the filter complete with alarm and indication shall be provided on the instrumentation panel of the switchboard. Gland leakage water shall be collected in a turndish and piped to the drainage sump.

Foundation base plates of pumps shall be of C.I. steel of sturdy design and shall be provided with necessary holding down bolts for anchoring in lateral concrete foundation blocks and fixing pump casings with base plates.

Pumps shall be fitted with discharge pressure gauges calibrated in meters head for indication on the discharge branches as well as on the instrumentation panel of the switchboard. The estimated total head for the pumps is 86.0 m but the Contractor shall determine the actual total head on the basis of his layout, designs and equipment supplies including that of the pumping main shown on the Conceptual Drawings. Motors shall drive pumps by means of cardan shafts with spline universal couplings.

The contractor shall present the head curves for the pumps with clearly marked duty points and the Net Positive Suction Head Required (NPSH_r) curves. The bidder shall clearly calculate and present the Net Positive Suction Head Available (NPSH_a). In order to calculate the NPSH available, pump placement relative to the minimum water level, minimum water level on the suction side, entrance and exit losses in suction pipe, frictional losses, vapor pressure, and any other relevant information would be very clearly presented.

The contractor shall check the minimum Submergence of the pump intake to reduce the probability that strong free surface area core vortices will not occur.

Pump bearing temperature sensor shall be provided.

Chemical analysis report given in Annexure-A to be verified for pump design.

Characteristics of one pump shall be as per design:

- Duty discharge rate 0.855 m³/sec (16.25 imperial MGD)
- Duty head 86.0 m estimated and to be tested in accordance with BS 5316: Part 2

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(ISO 3555)

- Efficiency 86% minimum
- Power required at pump shaft 850kW approximately
- Speed of pump shaft 740 rpm approximately
- Working pressure 13 bars
- Test pressure 20 bars or surge pressure whichever is greater
- Suction pipe/ Column Pipe work dia. 600 mm
- Delivery pipe work dia. 600 mm
- Suction/ delivery flanges to BS 4504, PN 16
- NPSH Required To be provided by Bidder
- NPSH Available To be provided by Bidder
- Submergence To be provided by bidder

Material of construction shall be as follows or superior:

Pump casing and foundation	grey cast iron to BS 1452 grade 220
Pump impeller	stainless steel
Pump shaft	stainless steel
Shaft sleeves	chrome steel
Casing and impeller wear rings	special bronze to BS 1400
Cardan shaft	Steel

The bidder shall show following levels on his Tender Drawings:

- a. Motor room floor level
- b. Pump room floor level
- c. Suction channel bed level
- d. Maximum, average and minimum levels in the suction well/Sump
- e. Height of ceiling from floor level of motor room

The bidder shall fix the centre line of his pumps such that the NPSHa is

sufficiently greater than the NPSHr at the minimum suction well level so that a cushion of 2.0 m is available for pumping without vortex formation and cavitation free operation.

This provision is essential in view of frequent level drops in the suction channel.

Pump operation shall be controlled from the 11 kV motor panels and the PLC/SCADA control panel. Motors shall be started by push buttons from the control panels. Level electrodes shall be installed in the pump suction well to provide alarm and to stop pumps and inhibit them from starting in the event of low water level in the suction well. Timers shall also be incorporated to ensure that pumps do not stop simultaneously in the event, of low water level.

Motor stools shall be mounted on sole plates and should be easily removable to enable complete pump assemblies to be lifted through the motor floor opening.

The Contractor shall provide extension shaft with flexible couplings and intermediate bearings, if required. In case of provision of intermediate bearings steelwork supports shall be so arranged that not more than one bearing is supported from each steel structure. Facilities for greasing intermediate bearings shall be provided by means of access ladders.

Non-reversing ratchets shall be provided to prevent reverse rotation of pump/motor assemblies in the event of reverse flow during periods when non-return valves remain open for bypassing surge pressures.

7.3.8 Work Item No. 7: Suction branches/Column Pipe

6 No-Column Pipes each of 600 mm dia, for vertical pumps hydraulically pressure tested to 20 bars for a maximum working pressure of 13 bars and each branch capable of passing a design flow of 0.855 m³/sec.

The pipe work including specials shall be in mild steel of minimum wall thickness 12 mm and minimum grade of steel Grade B.

Work item No. 7 shall comprise following Sub-work items. The Contractor may claim payment against sub-work item, if he so desires.

Each suction branch shall comprise of:

Sr. #	Sub-work item	Quantity	Brief description
1	7 - 1	1	Ductile iron bellmouth to BS 4772 or equivalent for grouting in concrete wall and for connection with gate valve of 600mm dia.
2	7 - 2	1	600mm dia. gate valve complete with integral bypass having a gate valve of 100 mm dia. and provided with an electrically operated actuator type A. complying to clause 2.3 of the

			specification, valume – II.
3	7 - 3	1	600mm dia. flexible slipout joint with seal applied between collars and bolt fitted in-between butterfly valve and conical pipe.
4	7 - 4	1	Flanged MS conical pipe of length to connect suction branch of the pump with the flexible slipout joint having a minimum wall thickness of 12mm minimum grade of steel shall be grade B
5	7 - 5	2	Compound pressure gauges, one on the suction branch and the other on the instrumentation panel.

7.3.9 Work Item No. 8: Discharge branches

- 6 No-Discharge branches each of 600 mm dia. for vertical pumps hydraulically pressure tested to 20 bars for a maximum working pressure of 13 bars and each branch capable of passing a design flow of 0.855 m³/sec for connection between discharge flanges of pumps and six flanged pipe courses each 600 mm dia. welded on the delivery manifold

The pipe work including specials, flexible joints and bends shall be in mild steel of minimum 12 mm wall thickness and the minimum grade of steel shall be Grade B.

Each discharge branch shall be supported with a thrust block as shown on the Conceptual Drawings.

The Contractor may claim payment against each Sub Work Item, if he so desires.

Each discharge branch shall comprise of:

S. No.	Sub-Work Item	Quantity	Brief description
1	8-1	1	Flanged MS conical piece of length to connect discharge branch of the pump with lower 45° bend of 600mm.
2	8-2	1	Flanged 45° MS bend of 600 mm diameter.
3	8-3	1	Length flanged MS pipe piece 600 mm diameter to connect one end of upper 45° bend with flanged pipe coarse welded on the delivery manifold.
4	8-4	1	Length flanged MS pipe piece 600 mm diameter to connect butterfly valve with the other end of the upper 45° bend, if required.
5	8-5	1	600 mm dia. MS flexible slipout joint with seal applied between collars and bolts fitted just after the discharge branch of pump.
6	8-6	1	750 mm dia. Butterfly/check valve complete with bypass having a gate valve of 100 mm and

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			provided with an electrically operated actuator Type A complying to Clause 2.32 of the Specification, Volume –II.
7	8-7	1	600 mm dia., non-return valve.
8	8-8	2	Compound pressure gauges and flow meters, one on the discharge branch and the other on the instrumentation panel.
9	8-9	-	Surge computations by computer programming shall be based on actual site conditions including the hydraulics of the pumping main shown on Conceptual Drawings and shall be submitted by the Contractor for Employer's review. The Contractor shall propose protective system or additional equipment, if required, for mitigating surge pressures and for safe operation of the pumping system without any extra cost to client. All connections to rising main shall be checked for safety against surge. Compound pressure gauges, one on the discharge branch and the other on the instrumentation panel shall be installed. Provision of surge vessels may be considered, if required by the Contractor.

7.3.10 Work Item No. 9: Delivery manifold

Work Item No .9 shall comprise following Sub Work Items. The Contractor may claim payment against each Sub Work Item, if he so desires.

S. No.	Sub-Work Item	Quantity	Brief description
1	9-1	Length	Delivery manifold of telescopic type with lower end 900mm dia. and upper end of 1500 mm dia. made of minimum 15 mm MS plates with welded on six flanged pipe courses each of 600 mm dia. having a minimum wall thickness of 12 mm for connecting six discharge branches, hydraulically tested to 20 bars for a maximum working pressure of 13 bars and capable of passing a design flow of 3.42m ³ /sec. Two flanged pipe connections of 450 mm dia. of ms having a minimum wall thickness of 12 mm shall also be provided for connecting pressure relief valves minimum Grade of steel shall be Grade B. The manifold shall be flanged at both ends. One end shall have a blank flange of 900mm

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			dia. and the other end shall be connected to 1500 mm dia. butterfly valve.
2	9-2	2	Compound pressure gauges one on the manifold and the other on the instrumentation panel.
3	9-3	1	450 mm dia. butterfly valves for manual operation for isolating pressure relief valves.
4	9-4	1	450 mm dia. pressure relief valves for releasing transient surge pressures above 9 bars or as required.
5	9-5	1	1500 mm dia. MS flexible slipout joint with seal applied between collars and bolts fitted in-between butterfly valve and delivery manifold flanges.
6	9-6	1	1500 mm dia. butterfly valve for manual operation with bypass having a gate valve of 150 mm diameter.
7	9-7	1	1500mm X 1800mm MS expander made of 15mm MS plate for connecting delivery manifold with delivery main.

7.3.11 Work Item No. 10: Delivery main/Rising Main

Work Item No.10 shall comprise of following Sub Work Items. The Contractor may claim payment against each Sub Work Item, if he so desires.

S. No.	Sub-Work Item	Quantity	Brief description
1	10-1	Length	Delivery main of 1800 mm dia. made of minimum 15 mm MS plates for connecting with delivery manifold and delivering pumped water to a dedicated rising main of 1800mm dia. minimum grade of steel shall be Grade B. The main shall be hydraulically tested to 20 bars for a maximum working pressure of 13 bars and shall be capable of passing a design flow of 3.42 m ³ /sec.
2	10-2	As per req.	1800 mm dia. flexible slipout joint with seal applied between collars and bolts fitted in between flow meter and delivery main flanges.
3	10-3	As per req.	1800 mm dia. butterfly valve for manual operation with bypass having a gate valve of 100 mm diameter.
4	10-4	2	1800 mm dia. electromagnetic flow meter for a designed flow rate of 3.42 m ³ /sec complete with flow signal converters/transmitters for displaying flow rate and total flow inside the flow meter chamber as well as on the pump station panel and SCADA. The flow meter shall

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			be installed in a RCC chamber in accordance with manufacturer's instructions and with a minimum of five diameters straight pipe upstream and two diameters downstream.
5	10-5	As per req.	1800 mm dia. flanged MS bends as shown on Conceptual Drawings. (if required).
6	10-6	As per req.	Double acting automatic air release valve with gate valve of 300 mm dia. in a RCC chamber at suitable location.

7.3.12 Work Item No. 11: Drain pipe

- 1 - 600 mm dia. butterfly valve for manual operation for the drain pipe work by passing water in the pump sump.
- 1 - 600 mm dia. flexible slip out joint with seal applied between collars and bolts fitted in between pipe and butterfly valve.
- Length - 600mm dia. MS pipe work of minimum 10 mm wall thickness to act as drain pipe discharging into pump sump for emptying delivery main and manifold when required.

7.3.13 Work Item No. 12: Electric overhead gantry crane

- 1 No-Electric overhead traveling crane comprising a bridge assembly with hoist and having cross traverse and long travel facilities complete with all necessary gantry beams, rails and fixings to the building structure for a safe working load of 15 ton to facilitate handling of all equipment such as 11 KV motors, electric panels, pumps, valves and pipework installed in the pump house building with controls by means of divorced pendant.

An access platform 1000 mm wide in chequered in aluminum alloy shall be provided complete with hand railing on one side of the crane to facilitate maintenance of the pump house ceiling and lighting installations. The trolley shall have guard rails to provide access for crane maintenance.

One fixed access ladder with guards to provide a safe route to crane platform shall be included at one end of the motor room.

Load chains shall be of sufficient length to enable the hook to be lowered to the bottom of the pump chamber and shall be provided with a chain collecting box to hold the slack chain.

Adequate quantity of lifting beams, slings and all other tackle needed for handling all equipment shall be supplied with the crane.

The Contractor shall provide all necessary contactors, control cubicles and protection equipment necessary to operate the crane and provide adequate electrical protection against overload, phase and earth fault and failsafe protection in the event of an interruption in the power supply. All necessary ladders and platforms beside those specified above or in the Specification shall be provided.

7.3.14 Work Item No. 13: Dewatering pumps

- 2 No- Dewatering pumps of minimum 20 l/sec discharge at 10 m head, one duty and one standby, shall be provided in a sump in the pump chamber to pump gland leakage and drainage water during maintenance of pumps and pipework to the suction well. The pumps shall be complete with pipework, valves and float type level controls for automatic/manual and start/stop operations.

7.3.15 Work Item No.14: Access ladders, platforms and plate flooring

Work Item No.14 shall comprise of following Sub Work Items. The Contractor may claim payment against each Sub Work Item, if he so desires:

S. No.	Sub-Work Item	Quantity	Brief description
1	14-1	lot	Steel plate flooring covers on all openings and cable ducts in motor room of Durbar or non-slip pattern of minimum 4.5 mm thick steel plate hot dip galvanized after fabrication to BS 729.
2	14-2	lot	Hand railing consisting of double bar forged steel standards with tubular rails hot dip galvanized in accordance with BS 729 shall be provided around inlet chambers, screen chamber, pump sump, valve and flow meter chambers and other areas as required. All hand railing at ground floor viz motor room including that of balcony shall be stainless steel to BS 970 Grade 316

3	14-3	lot	Access ladders and platforms of minimum width 1000 mm made in checkered aluminum alloy in accordance with BS 1470 material H 30 TB to be provided in the pump basement (dry-pit) for access to all six pumps and all suction, discharge and non-return valves for facilitating O&M works as shown on Conceptual Drawings. Hand railing consisting of double ball forged steel standards with tubular rails hot dip galvanized in accordance with BS 729 shall be provided where required.
4	14-4	lot	Access ladders of sturdy design built-in steel, hot dip galvanized to BS 729, for installation in valve /flowmeter chambers, screening stream chambers, inlet chambers and pump sump etc.

7.4 Employer's Requirements: Electrical Works

7.4.1. General

Preliminary power demand estimates indicate that the pumping station will require a total supply of approximately 6.5 MVA at a supply voltage of 11 kV. K-Electric, the local power supply authority may be able to meet this demand by laying 11 kV cable feeders upto a substation / switch room to be located inside the pump house premises. This sub-station shall be constructed under the Contract and will be handed over to K-ELECTRIC for housing their 11 kV switchgear and metering equipment

The Contractor shall lay two 11 kV cable feeders of minimum 300 sq-mm size from the sub-station to the two incoming panels of the 11 kV switchboard to be provided in the pump house building. A bus coupler will ensure that, in case of failure or isolation of one feeder, the healthy feeder can supply power to any four duty pumps and one transformer.

6 No. 11 kV motors of vertical design shall drive the pumps installed in a dry-pit directly below the motors. Four pumping sets shall be working and two will be standby. Power factor correction equipment shall maintain the power factor above 0.90 lagging for economizing, the operational cost.

2 No. 11 KV/415 V, 250 KVA, transformers, one working and one standby, shall meet the LV power requirement of the pump house and other services provided at Site.

A PLC/SCADA system shall provide outputs to annunciation & control of all desired operations and perform all logical functions for complete monitoring and automatic operation of the pump house for acquisition and display of the desired data.

7.4.2. Work Item No.15: 11 kV switchboard

The 11 KV switchboard shall comply with the K-ELECTRIC specifications:

11 kV sheet steel, floor mounting, totally enclosed, compartmentalized, fully interlocked, air insulated, indoor type, suitable for operation at 11 kV, 75 kV BIL, 3 phase, 50 Hertz supply, completely wired and tested in accordance with relevant latest IEC standard or equivalent having rated peak withstand current of 45 kA, rated short circuit and comprising breaking current (1 sec) of 18 kA and rated short circuit making current of 45 kA.

2 No - Incoming panels from K-ELECTRIC each with:

- 1- Sheet steel floor mounting, housing.
- 1- Set of 3 phase, 1250 amps rating, HDHC heat shrunk, Raychem sleeved, round edged copper bus bars and all joints silver plated.
- 6- Single pole fixed and moving type isolating contacts having isolating facility in each phase.
- 1- Set of automatic safety shutters having padlocking facility.
- 1-1250 amps, motor operated having rupturing capacity of 20 kA / 1 sec, triple

pole, vacuum circuit breaker mounted on a rollout truck to facilitate vertical dropdown isolation and horizontal withdrawal.

- 1- Circuit breaker lowering mechanism fitted with removable operating handle.
- 1- Circuit breaker hand/motor charged spring closing mechanism of the trip free pattern complete with:
 - a. Voltage operated release.
 - b. Set of ON/OFF/EMERGENCY trip push buttons.
 - c. Mechanical ON/OFF position indicators.
 - d. Spring closing hand charging mechanism

The operating mechanism and stored energy shall allow the following sequence:

0-3 min - co-3 min - co

- 1- Set of indication lamps.
- 3 - Current transformers having ratio of 600/5/5 amps and with:
 - Core 1: 10VA, 1 M 5
 - Core 2: 15 VA, 5 P 20
- 1- 96 x 96 mm Ammeter scaled 0-600 Amp having suitable overload scale and with Ammeter selector switch, 3 way and off.
- 1- 96 x 96 mm Voltmeter scale 0-15 kV with voltmeter selector switch, 3 way and off.
- 1- 96 x 96 mm CT and PT operated power factor meter.
- 2- Single pole cast resin voltage transformers, ratio $11000/\sqrt{3} / 110\sqrt{3}$, 200 VA, accuracy class-I, 75 kV BIL, with primary protection fuses.
- 1- KWh meter, 3 phase, 3 wire with MD1 (30 min) suitable for CT and PT connections of 5A, 110 V and 50 Hz.
- 1- kVArh meter, 3 phase, 3 wire suitable for CT and PT connections of 5A, 110 V and 50 Hz.
- 1- 11 kV capacitive voltage detector in yellow phase on the circuit side.
- 1- Earthing switch equal to the rating of the switchgear.
- 1- Set of support insulator with creepage distance of 350 mm.
- 1- Auxiliary relay for contact multiplying.
- 1- 3 phase O/C, E/F & S/C relay (50/51/51N) with selectable tripping curve and three independent O/C, E/F & S/C thresholds including communication ports.
- 1- Under voltage relay.
- 1- Over voltage relay.

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- 1- Set of instrument fuses.
- 2- Sets of electrical & mechanical castel inter locks.
- 1- Operation counter meter
- 1- Anti-condensation heater with thermostat.
- 1- Designation label.

1 No - Bus coupler complete with:

- 1- Sheet steel floor mounting housing.
- 1- Set of 3 phase 1250 Amps rating HDHC heat shrunk, sleeved, round edged copper busbars and all joints silver plated.
- 6- Single pole fixed and moving type isolating contacts having isolating facility in each phase.
- 1- Set of automatic safety shutters having padlocking facility.
- 1- 1250 Amps motor operated having rupturing capacity as specified for incoming panel, triple pole, vacuum circuit breaker mounted on a rollout truck to facilitate vertical dropdown isolation and horizontal withdrawal.
- 1- Circuit breaker lowering mechanism fitted with removable operating handle.
- 1- Circuit breaker hand/motor charged spring closing mechanism of the trip free pattern complete with.
 - a. Voltage operated release.
 - b. Set of ON/OFF/EMERGENCY trip push buttons.
 - c. Mechanical ON/OFF position indicators.
 - d. Spring closing hand charging mechanism.
- 1- Set of ON/OFF indication lamps.
- 1- Set of electrical and mechanical interlocks.
- 1- Anti-condensation heater with thermostat.
- 1- Designation label.

6 No - Motor outgoing feeders each with:

- 1- Sheet steel floor mounting housing.
- 1- Set of 3 phase 1250 Amps rating HDHC heat shrunk, sleeved, round edged copper bus-bars and all joints silver plated.

6- Single pole fixed and moving type isolating contacts having isolating facility in each phase.

1- Set of automatic safety shutters having padlocking facility.

1- Minimum 630 Amps, motor operated having rupturing capacity as specified for incoming panel, triple pole, vacuum circuit breaker mounted on a rollout truck to facilitate vertical dropdown isolation and horizontal withdrawal.

1- Circuit breaker lowering mechanism fitted with removable operating handle.

1- Circuit breaker hand/motor charged spring closing mechanism of the trip free pattern complete with:

- a. Voltage operated release.
- b. Set of ON/OFF/EMERGENCY trip push buttons.
- c. Mechanical ON/OFF position indicators.
- d. Spring closing hand charging mechanism.

1- Set of indication lamps.

2- Current transformers having ratio of 150/5/5 amps and with

Core 1: 10 VA, 0.5 M 5

Core 2: 15 VA, 5 P 20

1- 96 x 96 mm flush mounted ammeter scaled 0-100 amps having suitable overload scale and with ammeter selector switch, 3 way and off.

1- Motor protection relay with following features.

- a. Thermal overload protection.
- b. Short circuit protection.
- c. Earth fault protection.
- d. Stalled rotor / mechanical jam.
- e. Prolonged start.
- f. Time between starts.
- g. Speed switch input.
- h. Programmable scheme logic.
- i. Eight RTDs.

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- 1- 11 kV capacitive voltage detector in yellow phase on the circuit side.
- 1-96 x 96 mm flush mounted CT and PT operated power factor meter.
- 1- 96 x 96 mm flush mounted operation hour counter.
- 2- Earthing switch, for short circuiting and earthing of disconnected system, should be rated as specified for incoming panel. It should be 3 poles with snap action closing mechanism and mechanical interlock with switching device and shall be equipped with 4 pole auxiliary switch.
- 1- Hooter
- 1- Set of instrument fuses.
- 1- Operation Counter meter.
- 1- Remote/local selector switch.
- 1- Anti-condensation heater with thermostat.
- 1- Designation label.

Note: Provision to be made for remote control of pumps from PLC/SCADA control desk.

2 No - Transformer feeders each with:

- 1- Sheet steel floor mounting housing.
- 1- Set of 3 phase, 1250 Amps rating HDHC heat shrunk, sleeved, round edged copper bus-bars and all joints silver plated.
- 6- Single pole fixed and moving type isolating contacts having isolating facility in each phase.
- 1- Set of automatic safety shutters having padlocking facility.
- 1- Minimum 630 Amps, motor operated having rupturing capacity of 20 kV/1 sec, triple pole, vacuum circuit breaker mounted on a rollout truck to facilitate vertical dropdown isolation and horizontal withdrawal.
- 1- Circuit breaker lowering mechanism fitted with removable operating handle.
- 1- Circuit breaker hand/motor charged spring closing mechanism of the trip free pattern complete with:
 - a. Voltage operated release.
 - b. Set of ON/OFF/EMERGENCY trip push buttons.
 - c. Mechanical ON/OFF position indicators.
 - d. Spring closing hand charging mechanism.
- 1- Set of ON/OFF indication lamps.

2- Current transformers, ratio of 50/5/5 amps having:

Core 1: 15 VA, 5 P 20

Core 1: 10 VA, 1 M 5

1- 96 x 96 mm flush mounted ammeter scaled 0-50 amps with ammeter selector switch 3 way and off.

1- 3 Phase digital 0/C, E/F and S/C relay (50/5/5IN) with selectable 3 tripping curves and 3 independent 0/C, E/F & S/C thresholds including communicating ports.

1- Earthing switch for short circuiting and earthing of disconnected system should be rated for peak current of 20 kA at 12 kV. It should be 3 pole with snap action closing mechanism and interlocking with switching device and shall be equipped with 4 pole auxiliary switch.

1- 96 x 96 mm) flush mounted operation hour counter.

1- Set of instrument fuses.

1- Anti-condensation heater with thermostat.

1- Designation label.

7.4.3. Work Item No.16: Capacitors

6 No-11 kV capacity 350 kVAr power factor correction units each equipped as under:

- a. Medium voltage capacitor for power factor correction to be provided with self-healing dielectric and very low losses suitable for direct coupling with motor terminals with backup fuses and fuse bases to be placed in a compartmentalized enclosure having IP42 protection close to the 11 kV switchgear.
- b. Capacitor shall be suitable for continuous operation at motor output rating plus a 3.5% margin for maintaining, power factor above 0.90 lagging.
- c. The actual active capacitor element shall consist of a large number of high quality, self-healing round MKP elements, which are wired to each other.
- d. Capacitor shall not contain chlorinated substances or presents ecological problems and shall be in accordance with IEC 60871.
- e. Capacitor containers shall be of sealed construction stainless steel suitable for outdoor / indoor use providing efficient heat transmission.
- f. Porcelain bushings shall be suitable for 11 kV voltage connections and for polluted conditions.
- g. Dielectric losses shall be below 0.20 W/kVAr at ambient temperature. Total capacitor losses shall not exceed 0.25 W/KVAr

- h. Capacitor residual voltage should reduce to below 75 V within 10 minutes after disconnection from the circuit.
- i. Power factor improvement relay shall maintain the power factor between 0.9 lagging and unity and shall not attain leading power factor. It shall also rotate the use of capacitors to maintain equal usage for all capacitors.
- j. Cooling / ventilating arrangement shall be provided.
- k. Life expectancy (permitted failure rate) shall be greater than 100,000.
- l. Power factor improvement capacitors shall not be required if the variable frequency drive (VFD) maintains the power factor above the Minimum required.

7.4.4. Work Item No.17: LV switch board

415 V 3 phase, 4 wire, 50 Hz sheet steel, floor mounting, totally enclosed, compartmentalized fully interlocked, air insulated type suitable for operation on low voltage supply, completely wired and tested in accordance with relevant IEC standard or equivalent having rupturing capacity of 50 kA/1 sec, equipped as under:

2 No - Incoming panels from transformers each with:

- 1- Sheet steel floor mounting housing.
- 1- Set of bus-bars, 400 amps rating. HDHC, heat shrunk, sleeved, round edged copper bus-bars and all joints silver plated.
- 1- Set of automatic safely shutters having padlocking facility.
- 1- 400 amps triple pole, withdrawable, quick make/break, moulded case circuit breaker with adjustable thermal and magnetic trip devices for overload and short-circuit protection and complete with under voltage release.
- 1- 96x96 mm, flush mounted CT operated ammeter scaled 0-400 amps along with a 3-way and off selector switch.
- 1- 96x96 mm flush mounted voltmeter, scaled 0-600 volts along with a position selector switch.
- 3- CTs of ratio 400/5 CTs shall be of 5VA, class-1 for metering.
- 1- Earth leakage relay with an appropriate CT.
- 2- ON/OFF indication lamps.
- 1- Set of electro-mechanical key interlock.
- 1- Set of instrument fuses.
- 1- Anti-condensation heater with thermostat.

1- Designation label.

1 No- Bus coupler complete with:

1- Sheet steel floor mounting housing.

1- Set of bus-bars, 600 amps rating HDHC heat shrunk Raychem sleeved, round edged copper bus-bars and all joints silver plated.

1- Set of automatic safety shutters having padlocking facility.

1- 400 amps, triple pole, withdraw-able, quick make/break, moulded case circuit breaker with adjustable thermal and magnetic trip devices for overload and short-circuit protection and complete with under voltage release.

2- ON/OFF indication lamps.

1- Set of electro-mechanical key interlock.

1- Anti-condensation heater with thermostat.

1- Designation label.

Outgoing circuits:

The outgoing circuit breakers panel shall as a minimum be equipped as under:

1- Sheet steel floor mounting housing complete in all respects and with anti-condensation heater, thermostat and designation label.

1- Set of bus-bars, 400 amps rating, HDHC, heat shrunk, Raychem sleeved, round edged copper bus-bars and all joints silver plated.

Triple pole moulded case circuit breakers:

LV circuit breakers shall comply with IEC 60947 and as a minimum be equipped as under:

56-Triple pole moulded case circuit breakers with adjustable trip device for overload and fixed magnetic short-circuit protection and complete in all respects and each feeder, having a designation label and "ON" indicator for following applications:

MCCB's shall comply with IEC 60947.

6- 32 amps MCCBs for motor control and anti-condensation heaters.

6- 16 amps MCCBs for suction valve actuators.

6- 16-amps MCCBs for delivery valve actuators.

1- 16-amps MCCB for manual screen.

- 2- 32 amps MCCBs for bar screens.
- 2- 32 amps MCCBs for band screens.
- 1- 16 amp MCCB for submersible pumps.
- 1- 25 amp MCCB for PLC/SCADA system.
- 1- 25 amp MCCB for battery chargers.
- 12- 16 amp MCCBs for 3 phase exhaust fans.
- 6- 32 amp MCCBs for 3 phase industrial sockets.
- 1- 16 amp MCCB for electric overhead travelling crane.
- 3- 63 amp MCCBs as spare.
- 4- 32 amp MCCBs as spare.
- 4- 25 amp MCCBs as spare.

The quantities of MCCBs specified are the minimum. The Contractor may increase the quantity according to his design

Minimum number of single pole miniature circuit breakers:

MCB's shall comply IEC 60898 and as a minimum be equipped as under:

Lot - 16 amp single pole miniature circuit breakers with designation labels for internal and external illumination of the pumping station.

12- 32 amp single pole miniature circuit breakers with designation labels for single phase, 3 pin - switch-socket - outlets.

6- 32 amp single pole miniature circuit breakers as spare.

6- 16 amp single pole miniature circuit breakers as spare.

7.4.5. Work Item No.18: Instrumentation panel

Sheet steel, floor mounting housing for following gauges and instruments complete with transmitters for monitoring with PLC.

- 4- Digital type level indicator for 2 No chain hauled raking bar screens and 2 No central flow band screens.
- 1- Digital type level indicator for suction well.
- 6- Digital type pressure gauges for pump suction branches.
- 6- Digital type pressure gauges for pump discharge branches.

1- Digital type pressure gauge for common manifold.

12- Digital type pressure gauges for 6 No sealing water duplex filters.

1- Digital type flow indicator complete with totalizer

7.4.6. Work Item No.19: 11 kV motors

6 No-Squirrel cage induction motors suitable for operation on 11 kV, 3 phase, 50 Hz supply and Work Item No 6 and each complying with following specifications.

Output of motor: Approximately 820 kW but should be 10% in excess of power required by the pump at duty point and 5% in excess at run-out condition.

Speed: Approximately 740 rpm.

Efficiency at full load: Not less than 95%

Power factor at full load: Approximately 0.85 lagging

Motor Design: Vertical type with two bearing end shields, with antifriction bearings of ball/roller type, with one cable end box of suitable size, with gland, one set of anti-humidity heater system working on station auxiliary supply of 400 V, 3 phase 50 Hz, totally enclosed, and tube cooled, winding insulation class F and maximum temperature not to exceed that permitted for class B, ambient temperature of operation 40°C and motor suitable for operation in humid and tropical climate, with protection class IP 55 according to IEC 60034. The motor shall be supplied with following accessories:

- a. Winding RTDs : 6 No
- b. Bearing RTDs : 2 No
- c. Space heater : 1 No

Motors shall be fitted with means for locking rotors to avoid damage occurring to bearings when motors are laid horizontally and to facilitate transportation in this mode

7.4.7. Work Item No.20: 11 kV/415V transformers

2 No-Three phase, all immersed transformers, naturally cooled according to IEC 60076, double wound, core type in sealed tank design with oil conservators and bi-directional flat rollers, suitable for parallel operation

and each according to K-ELECTRIC specifications. Main parameters shall be as under:

Rated load	: 250 kVA
Phases	: 3
No load voltage ratio	: 11 kV/415 V
Frequency	: 50 Hz
Off load tap changer	: $0 \pm 2.5\% \pm 5\% - 7.5\%$
Basic Impulse level (BIL)	: 75 kV
Copper temperature rise (Avg.)	: 45°C
Oil temperature rise (Max.)	: 35°C
Peak Ambient air temperature	: 50°C
Mean max. Temperature (24hr)	: 45°C
Min. temperature	: 0°C
Impedance at nominal tap	: about 5%
Efficiency	: Minimum 98.5%
Maximum short circuit duration	: 2 Sec.
Vector Group	: DY 11
Cooling	: ONAN
Place of installation	: indoor
Accessories	: 1- breather 1- dial type thermometer with trip contact

7.4.8. Work Item No.21 Exhaust fans

18 No-3 phase exhaust fans, 12 for motor room and 6 for pump room at basement of constant speed, minimum 600 mm sweep, having reverse and forward motion for operation on 415V, 3 phase, 50 Hz supply, with type bearing for noiseless operation.

ON/OFF switch and auto star/delta starter for individual fan shall be mounted on the LV distribution board. The fans shall have stove enamel finish of approved colour and shall be made to Pakistan Standard PS-1 1958. The make shall be Pak, Millat or approved equivalent.

Frames for mounting, the fans shall have stove enamel finish and shall be mounted on the walls at designated locations with appropriate sized G.I. nuts and bolts.

The fans shall be protected with G.I. mesh of sturdy design to prevent bird entry.

4 No-Single phase exhaust fans for transformer room, control room, PLC/SCADA room and battery room of constant speed and 450 mm sweep for operation on 220V, single phase, 50 Hz supply with grooved type bearings for noiseless operation.

ON/OFF switch for individual fan shall be mounted in the respective room. The fans shall have stove enamel finish of approved colour and shall be made to Pakistan standard PSI 1958. The make shall be Pak, Millat or approved equivalent.

The exhaust fans shall be louvered type.

2 No- 300 mm sweep exhaust fans suitable for operation on 220V, single phase, 50 Hz supply of Pak, Millat or any other approved make complete with ON/OFF Switch for installation in bathrooms.

7.4.9. Work Item No.22: PLC/SCADA system

Purpose

PLC shall receive inputs from 11 kV and LV protection and control and will provide outputs to annunciation control for all desired operations and will perform all logical functions.

PLC shall be constructed in modular form having provision for accepting add-on cards and shall be capable of operating without trouble in a temperature range of 0-55°C and relative humidity of 10% to 95%. All incoming cables shall terminate in the cable marshalling area and not directly on the PLC for which a separate housing shall be provided.

Power Supply Unit

Power Supply Unit shall be suitable for the specified supply voltage having protection against voltage and frequency fluctuations and harmonics. The unit shall be provided with battery backup for all volatile registers and memory locations to allow retention of data and programs for a period of not less than three months.

Inputs / Outputs

The Contractor shall determine the number of I/Os to suit operational requirements with an allowance of 25% spare capacity. LED indicators shall be provided to show status of I/Os which shall be individually isolated to prevent system transients and radio interference affecting the normal operation or decoupling shall be provided for I/O signals.

Central Processing Unit

Central Processing Unit shall operate at a speed of operation suitable for carrying out all specified duties and shall have all necessary built-in timers, relays and mathematical functions etc. The processor shall have non-volatile EPROM and a volatile RAM. Allowance shall be made for 25% spare volatile and non-volatile memory.

Programming function for the CPU shall be built into the PC. Program entry and modifications shall be possible in mnemonic language, ladder diagram or flow charts. Security arrangement shall be provided to prevent unauthorized tampering with the PLC control.

The contractor shall be responsible to provide Operating System and Application Software on separate media, Preferable on DVDs. The contractor shall train KWSB staff for installation, testing, commissioning, customization, O & M and archiving/restoration of system.

SCADA

PLC shall take inputs of 11 kV protection and control to provide outputs from annunciation and control for each motor and pump. The PLC shall monitor and control all desired operations and perform all logical functions.

A personal computer running SCADA software shall communicate with the PLC on Industrial Ethernet network and shall provide all required features of control and monitoring such as:

- a. Real time data of all variables.
- b. Trends and graphs of all desired parameters.
- c. Data logging
- d. Report and statistical analysis.
- e. Alarm management and event based programming.
- f. Advanced graphic display for real time mimic display.
- g. 8 levels of password protection.
- h. Multi users support, LNA, PSTN dialup, RAS, WAN and internet fully supported.
- i. Operator Log

A 24 inch high resolution monitor LED/LCD shall be provided on the module for displaying all logical functions.

Twelve DVDs shall be supplied additionally for storm, data and programs.

Compatible latest HP Laser printer with 6 Nos. black cartridges shall be provided.

UPS shall be provided for PC and PLC power supply only for minimum 15 minutes back up time on full load.

Protection relays shall communicate with the PLC on same data network to allow monitoring of all critical parameters such as RTD temperatures, protection and safety. PLC will send signals to annunciation panels in case of any fault.

LV I/Os shall be connected to PLC and SCADA system to monitor and control all pressures, levels, flow rates and overload relays etc.

An application Process shall record all critical parameters.

Control of process through PLC

Pre requisites

- a. All selector switches in "auto" position.
- b. All valves in "auto" position.
- c. All central flow band screens in "auto" position.

Main pumps

- a. H/O/A selector switch in "auto" position for transforming pump controls from push buttons to PLC.
- b. Selection of duty pumps for activating their ON signals.
- c. Low level to pass ON command if there is sufficient water level in suction well.
- d. If low level, pumps will not start and an alarm will be triggered.
- e. Low level setting to be segregated so that all pumps do not stop simultaneously.
- f. Starting of pumps to be segregated through a timer so that all pumps cannot be

- started simultaneously.
- g. Any other requirement of the manufacturers.
 - h. Temperature sensor of pump bearing.

Control philosophy

General

Raw water after coarse screening shall enter the screening chamber.

Pre-requisite

Selector switch is on 'auto'- mode'.

Operation of central flow band screen

Under normal conditions, PLC based adjustable timer will operate the screen three times a day. Level across the screen will be sensed by ultrasonic level sensors having three level settings.

High differential level: The output of differential level relay-1 will be fed to the PLC which in turn will give command to the screen to start at low speed. An indication of high differential level will also be given to SCADA terminal.

Very high differential level: If clogging of screen still persists causing increase in differential level, differential level relay-2 will operate and give input signal to PLC which in turn will switchover motor from low speed to high speed and an indication of very high differential level will be given to SCADA terminal.

Very, very high differential level: At very, very high differential level, relay will operate and give input command to PLC which in turn will initiate klaxon and first duty pump will stop. At the same time, a PLC timer will be initiated which after preset time intervals will stop second and third pumps if clogging continues and indication of very, very high differential level is given to SCADA.

PLC will also give command to flushing valves to actuate simultaneously with the motor. PLC will keep the "ON" command to flushing valves for about five minutes even after stopping of motor to ensure clearing of the screen.

In case of tripping of any motor PLC will give command to klaxon.

PLC interface with pumps

Main pumping sets will start through push buttons manually. However following interlocks will be provided by PLC.

- a. Duty selector switch input command will ensure that not more than four pumps can be operated at one time.
- b. PLC based adjustable timer will interlock the switching "ON" of the pumps so that pumps cannot be started simultaneously.
- c. Pump bearing lubrication/water sealing system will be over-ridden for 20 secs to allow flow- of water to develop. If after this time, flow pressure is not proved, pump

will be stopped and an alarm will be initiated.

- d. RTD inputs from windings and bearings will be fed to PLC which will continuously monitor the temperatures. In case of exceeding preset limits, an alarm will be initiated. SCADA terminal will continuously monitor and record the data.
- e. If circuit breaker trolley is in test position, its remote "ON" will be blocked.
- f. Starting of pumps will be interlocked with discharge valves both during start and stop operations.
- g. Fully open/close position of limit switches will be indicated by an indication lamp.
- h. Power fuse blow control or operation of motor protection relay will give tripping command to motor as well as trigger an alarm.
- i. Stopping of pumps will be staggered.
- j. Any other requirement of the pump manufacturer.

PLC interface with SCADA

All information available to PLC shall be transferred to PC through Industrial Ethernet such that complete monitoring of the plant can be carried out through HMI.

Split Air Conditioner

- 1 No-Supply and installation of a split type air conditioner of 1.5 ton capacity in the PLC/SCADA room.

7.4.10. Work Item No.23 cables

11 kV Cables

8.7/15 kV, 3 core, XLPE/SWA/PVC, PVC insulated triple extruded copper conductor cables for following applications (as per IEC 60502.2 and BS 6622 also meeting K-ELECTRIC specification):

2-feeder: Minimum 300 sq mm between K-ELECTRIC switch room panels and two 11 kV incoming panels in the pumping station suitable for operation of Four pumps.

6-feeder: 120 sq. mm between motor outgoing panels to respective 11 kV motors and power factor improvement capacitors.

2-feeder: 70 sq. mm between transformer outgoing panels and 250 kVA transformers.

LV Cables

600/1000 V, PVC/PVC insulated copper conductor single or multi-core power, instrument and control cables for following applications conforming to IEC 60502-1 and BS 5467.

2 feeders: 3.5 core, minimum 300 sq. mm, between transformers and transformer incoming panels.

Lot: All single and multi-core cables of required cross-sections for power instrumentation and control between all supply points and all items of plant necessary for setting to work the whole plant.

All cables shall be laid together with ECC in trenches, trays and GI/PVC pipes with all required accessories for proper installation and termination as per specifications and requirements of the work as approved by the Employer.

All 11 kV and LV cables shall be of Pioneer Cables Limited or Pakistan Cables Limited or their approved equivalent.

The Contractor shall make all assessments of the cable lengths and sizes including installation material required for completing the work as per specifications and drawings. No claims for extra payment shall be entertained by the Employer on any account.

7.4.11. Work Item No.24: Earthing system

1 Set-Complete earthing system for the pumping, station including, screens. Pipework, ancillaries and accessories etc. to be provided by two separate and distinct connections with earth in accordance with prevalent Electricity Rules of Pakistan and Code of Practice 7430 and BS 951 shall comprise of:

- a. Earth copper plates of 600 x 600 x 3 mm in individual earthing pits interconnecting earth bars/cables/standard earthing copper conductors.
- b. Earthwork / C.C work including inspection covers.
- c. Earth connecting points/jointing material.

Pump house building shall be provided with 2 No. wall mounted earth bars and earth pits independently linked to all exposed conductive metal parts. This shall include but not be limited to pump set frames, main switch and control panels, screens, crane rails, hand railing, all pipe work entering/leaving and within the building and lightning, protection system etc.

Extraneous metal parts shall be bonded as required by the IEE Regulations/local Electrical rules including building structural steel and concrete reinforcement bars.

7.4.12. Work Item No.25: Lightning protecting system

1 set-Complete lightning protection system as per Specification and latest IEC and BS standards requirements of the system comprising as a minimum:

- a. Lightning arrestor of copper rod minimum size 25mm dia., 1 m long complete with mounting base, connectors and clamps etc.
- b. Earth electrodes.

- c. Down connectors of copper 25 x 3 mm from lightning arrestor to earth electrodes.
- d. Required bonding with building structural steel and concrete reinforcement bars.

7.4.13. Work Item No.26: 110 V dc system

2 sets-110 V dc nickel cadmium pocket plate type battery systems each rated to give 100% of the entire DC load under site environmental conditions plus a 30% surplus output capacity with internal resistance lower than 0.08 ohms/C5 medium rate characteristic and comprising of:

Nickel cadmium batteries

- a. Each battery cell shall be enclosed in a transparent / translucent, shock absorbing, plastic container having a sealed cover with removable plugs.
- b. Copper connections between rows of cells and from battery to through wall bushings shall be annealed copper of adequate cross section supported on insulators. Copper rods shall be insulated by PVC sleeving or approved type of taping. Cell connectors shall be insulated by PVC covers.
- c. Each battery main copper connections shall be connected to a suitably located double fuse box having high breaking capacity, fuses suitable for battery charger/dc distribution board and should be able to discriminate clearly in case of faults. A separate fuse box for each charger shall be providing for auxiliary purposes i.e. for charging of separate cells etc. In case of parallel operation of charger outputs, suitable terminals and flexible wire connections of sufficient length shall also be provided.
- d. Cells shall be mounted on stands in single rows of single or double tiers and so arranged that bottom of the batten shall not be less than 300 mm above the floor level. Stands shall be treated with minimum two coats of leach resistant paint of approved color.
- e. Clearances provided by racks and the method of connection of banks shall ensure that each cell or group of cells can be easily removed without disturbance to other adjacent cells.

Each battery system shall have following accessories.

- a. 2 syringe hydrometer.
- b. 2 thermometers.
- c. 1 digital type cell testing voltmeter reading to 3 decimal digits.
- d. 1 plastic jug.
- e. 1 plastic tank for distilled water storage, minimum capacity 60 liters.
- f. 1 maintenance tool box.
- g. Set of auxiliary devices and auxiliary flexible cables.
- h. 6 spare cells with electrolyte.

- i. Set of instruction cards and battery record book.

Bidders are required to submit technical report, comparisons and merits / demerits of proposed Ni-Cd batteries viz-a-viz equivalent lead acid batteries particularly detailing behavioral differences under ambient conditions, maintenance facilities and spare parts requirements. Alternative cost prices may be provided with economic comparison of the two systems.

Battery Chargers

The Contractor shall ensure that general design of batteries and chargers shall be coordinated, if supply from different sources is proposed. O&M instructions labels, instruction plates and danger signals shall be sufficiently detailed as required under relevant standards. Each charger shall have following minimum provisions:

- a. DC output voltmeter.
- b. DC output ammeter.
- c. Green lamp indicating charger on duty.
- d. Red lamp indicating charger on boost charge.
- e. Under voltage relay with timer.
- f. AC supply failure relay.
- g. Battery charger failure.
- h. Earth fault relay with additional measurement instrument to detect magnitude of defect.
- i. Battery circuit supervision.
- j. Push button for checking all indication lamps.

Each alarm shall be indicated by its local indication lamp. 110 V dc common alarms shall be wired to a remote indication. Remote indication of charger failure signal shall be suppressed in case of failure of charger auxiliary supply.

Supervision relays shall initiate bypassing of semi-conductors in order to maintain voltage at DC load within specified limit.

7.4.14. Work item No 27: Light fittings and auxiliary AC supply system

Following light fittings and power supply points shall be provided complete with power supply and control cables, wires and all installation material in GI/heavy gauge PVC conduits as required for internal and external illumination of the pump house

S. No	Location	Description	Type
1	Motor and pump rooms	Metal halide light fitting Phillips type MDK-900 with 400 W MDK lamp or equivalent.	D

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2	PLC/SCADA	Fluorescent light fitting Phillips type TCS-398 M6 with 2x36 W lamp or equivalent.	A
3	Transformer and store room	Fluorescent light fitting Phillips type GKD-240 with 2x36 W lamp or equivalent.	B
4	Bathrooms and Battery Room	Fluorescent light fitting Phillips type TMW-140 with 1x36 W lamp or equivalent.	C
5	Office	Reflecta-free LED fitting Pierlite type LED 600 X 600, 35W, 4000K, white, low glare	E
6	External illumination of pump house building	LED Flood Light Pierlite type Hippo Midi 50W LED, IP 65, Die cast Aluminum	F
7	Office PLC/SCADA store and battery room	56 inch sweep ceiling fans with regulator	
8	Motor room and pump basement	Industrial plug and socket 32A, 5 pin, 3P+N+E	
9	Motor room and pump basement	2 pin + E 16 amp switch socket outlets	
10	Street light	Philips mercury light fitting SGX 186 with 1x150 W SON lamp or equivalent complete with fixing material, brackets, nuts and bolt etc. mounted outside the pump house building and GI tubular poles, minimum height 8 m	
11	Flood light for illumination of screen chambers mounted on 3 Nos. GI poles	Philips mercury flood light fitting type SNF-300, 1 x 250 W SON lamps or equivalent complete with junction box, CB. Fixing material, brackets, nuts and bolts etc. flood lights mounted on a GI tubular pole minimum height 8 m	

7.4.15. Work Item No.28: Emergency lighting

14 No Emergency lighting system to be provided in accordance with BS 5266 and BS 5499.

Lights shall be of the independent self-contained 3 hour non-maintained type with 8 watt high efficiency fluorescent lamps and prismatic diffuser, with maintenance free Ni-Cd batteries / chargers / inverter equipment, separate baseplates and plug-in luminaries with locking screws. The emergency output shall typically be 180 lumens.

Lights shall be directly connected to the respective main area lighting circuits to give operation for both total power or sub-circuit power failure and so equipped that, when the power supply is on, the batteries get charged.

All Ni-Cd batteries shall be of the high temperature type, with rated life of at least 5 years and the lights shall be warranted for 3 years from the date of commissioning.

7.4.16. Work Item No.29: Telephone system

The contractor shall provide cables, telephone junction boxes and telephone instruments of 15 lines intercom system.

Proposed cable routes and places where telephone connections are to be provided will be decided by the employer.

The telephone cables shall have minimum 30% additional pairs to future use / replacement purpose.

Cables shall be laid in underground heavy gauge PVC conduits, minimum dia. 75mm water tight cable draw=pits shall be provided at convenient locations viz at bends and entry to the building etc.

Vandal proof and weather proof distribution cabinets on C.C. pads shall be provided at appropriate locations.

7.5 Supplies and services

7.5.1 Work Item No.30: Training of employer's O&M personnel

Training programs/services for periods specified in the Specification, Volume-II.

7.5.2 Work Item No.31: Drawings

Drawings including, construction and as-built drawings shall be provided in six (06) copies as given in the Specification, Volume-II along with soft copies.

7.5.3 Work Item No.32: Operating and maintenance manuals

Operating and maintenance manuals shall be provided in six (06) copies as given in the Specification, Volume-II along with soft copies.

7.5.4 Work Item No.33: Precautionary equipment

As a minimum, the Contractor shall provide following precautionary equipment.

8 No. fire extinguishers of suitable type and capacity at approved locations.

100 m-rubber matting of black colour, 1 m wide and 6 mm thick for placing before all HT/LV panels.

10 No-regulation safety charts of approved design.

5 No- 11 kV danger signals "CROSS BONE AND SKULL" on metal sheets in standard colours provided at approved locations.

7.5.5 Work Item No.34: Submersible pumps

4 No- Submersible pumps with discharge ports of 100 mm dia. capable of delivering water at 25 meter head having minimum solids passing size upto 15 mm.

2 No- Submersible Pumps with discharge port of required dia. and capable of delivering 20 l/s (1730 m³/day) at 25m head having minimum solid passing size upto 15 mm.

The requirements and specification of each pump and motor of both sizes of pumps shall be:

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Pump:

- Housing : grey cast iron
- Multi-vane impeller : stainless steel
- Nuts, bolts, screws and washer set : stainless steel

Motor:

Motor design	:	Submersible and directly coupled with pump
Power supply	:	400 V, 3 phase and 50 Hz
Rated power	:	as required
Speed	:	2900 rpm
Start	:	star / delta
PVC/PVC insulated cable	:	30 meter long
Type of shaft seal	:	mechanical
Bearing types	:	angular and deep grooved ball bearing
Insulation	:	Class F
Protection	:	IP 68
Motor shaft	:	stainless steel
O-rings	:	nitrite rubber
Motor jacket	:	stainless steel

7.5.6 Work Item No. 35: Security system

Pumping Station is a sensitive area and unwanted / undesired movements are required to be monitored. Therefore, a security system is required, comprising CCTV cameras, recording system, display units and other affiliated material / equipments.

The Station perimeter and inside building is required to be monitored on 24/7 basis with Digital CCTV cameras having Infra-red & motion detection facility for Day/Night recording. A separate storage device with minimum 30 days recording backup capacity is to be provided. The outdoor camera should have IP65 protection housing.

Contractor will also propose archiving system for CCTV recordings with all required hardware/software.

Minimum requirements shall be as under:

Item #	Description	Qty.
1	Digital CCTV Camera Max. Video Resolution (Pixel) 1,280 X 960 True Day / Night Power Source (PoE +) **All outdoor cameras will have speed dome and audio with support codes and housed in IP65 box.	8
2	Recording System (NVR)	1
3	LCD 21"	2
4	PTZ Controller	1
5	Providing, Installing and fixing at any height CCTV Cameras with cables, connectors and power supply, including poles complete in all respect.	1

7.5.7 Work item No. 36 Lighting arrangement on boundary wall

Perimeter lighting to illuminate the boundary wall approx. 1200 meters and its surroundings shall be included. Narrow beam floodlights with high pressure Sodium lamps be used.

Design calculation shall be submitted for approval of Engineer.

7.5.8 Work Item No.37: Equipment spare parts

Priced lists of recommended spare parts for five years as provided in Clause 1.24 of the Specification, Volume-II.

The spare parts cost shall not be included in the total Tender Cost but given separately and will be given due weightage in the evaluation of the Tender. Separate order for supply shall be placed by the Employer on the basis of approved items of spare parts and charged to the provisional sum.

Prices of spare parts given in Annexure-B may also be included in the recommended

list.

7.5.9 Work Item No.38: Special tools and test equipment

Priced list of tools and test equipment as provided in Clause 1.25 of the Specification, Volume-II.

The cost of tools and test equipment shall not be included in the total Tender Cost but given separately and will be given due weightage while evaluating the Tender. Separate order for supply shall be given by the Employer on the basis of approved items and charged to the provisional sum.

Prices of tools given in Annexure-c may also be included in the recommended list.

7.5.10 Provisional Sums

Payment work for Items 37, 38 and unforeseen will be made against works and services of Rs. 35,000,000 (Rupees Thirty Five Million only)