



"Mei Herzeliya" Water Corporation

Herzeliya Wastewater Treatment Plant

TENDER DOCUMENTS

Document C: Particular Specifications For Blowers

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CHAPTER 16: Supply and supervision of erection of electro-mechanical equipment

16.0 Preliminary

16.0.01 Description of Work

The works to be carried out according to this specification consist of the supply and supervision of erection of blowers to be used in: 'Herzeliya' Wastewater treatment plant.

It is emphasize that the equipment shall be supplied by manufacturers that has at least five (5) years of continuous successful experience in manufacture of the equipment in at least three (3) Wastewater Treatment Plants, or similar facilities, under conditions similar to those expected in the works.

All the equipment specified shall be products of manufacturers regularly engaged in the production of such equipment and are represented in Israel by a technical representative.

Like items of materials/equipment shall be the end product of a single manufacturer, to the extent possible, in order to provide standardization for appearance, operation, maintenance, spare parts, and manufacturer's service.

The Contractor shall have the sole responsibility for the proper functioning of the equipment as furnished.

The Contractor shall be responsible for fitting the equipment, and the equipment pipework to the external pipework. Any adjustment needed to connect the different types of equipment or to connect the equipment to external pipework and/or air pipes shall be part of the offer. No additional payment shall be given for adjustment of the equipment.

16.0.02 Extent of Work & Related Instructions

This tender encompasses the supply of electro-mechanical equipment and specified control and instrumentation equipment (including, but not limited to, manufacture, testing, and delivery to site), the supervision of erection of such equipment.

“Engineer” or “Engineer's Representative” are the engineers who are employed by Owner.

Within the process extents of supply for each type of equipment, any and all electro-mechanical equipment necessary to provide the complete item or system specified in that type of equipment, safe and completely fit and ready to operate, in complete compliance with all local (or other) codes and regulations, and capable of meeting, as efficiently as possible, the performance requirements for that type of equipment is to be considered an integral part of the requirements of the contract, even if such necessary equipment is not specifically listed in these Specifications or in the Preliminary Drawings. Such necessary equipment shall include, but not be limited to, all motors and drives, instrumentation, safety equipment, operational and process control equipment.

The Supplier will be solely responsible for the determination and designation of those areas (in the areas for which are offering equipment) that are to be designated as potentially explosive or otherwise dangerous, and all equipment supplied for these areas (whether under this contract or other contracts) shall be suitable to such determination and designation. All such determinations and designations shall be submitted by the suppliers together with their offers. As part of his responsibility under this clause to propose additions and/or changes, the Sub-Contractor shall include with his offer a list clearly specifying the degree and nature of protection necessary for all equipment to be supplied for use in these areas – whether such equipment is to be supplied by him or by another, and regardless of whether this equipment is specified in these Documents or is proposed (as an addition and/or change) by the suppliers, as per his responsibilities under this Clause.

All equipment supplied under this Contract shall include testing and delivery to site.

Unless specified otherwise, a warranty period of no less than 18,000 hours of operation shall be granted for all the equipment supplied under this contract. The period of warranty shall start upon first successful operation of the equipment. The contractor shall be responsible for the maintenance of the equipment before the installation.

The Supplier shall specify under a separate list (not to be included in the main offer) the spare parts and the quantities thereof that he considers necessary due to wear and tear under normal operating conditions during two years or 10,000 hours of operation. Prices for all listed parts shall be included, such prices to be valid and binding for all orders placed by the Employer at the time of the written acceptance of the offer and for ninety (90) days thereafter.

16.0.03 Standards and Standard Specification

Local Standards and other standards, local or foreign, referred to in this Contract, whether or not attached to the Contract, shall be deemed to be part of the Contract. In the case of a contradiction or discrepancy between any standard and any requirement of the Specification, the latter shall apply and the standard concerned shall be considered amended by the Specification. Where no date or number of edition follows the title of a standard, the latest valid edition thereof shall apply including all amendments and revisions made up to the date of its application. Where a standard is referred to in the Specification, other standards will be acceptable if it is proved to the Engineer's satisfaction that the work done or material supplied under such other standards will be at least equal to or better than those done or supplied under the standard originally referred to in the Specification.

16.0.04 Climatic Conditions

Unless more severe conditions are specified elsewhere, all Plant whether installed indoors or outdoors shall be capable of reliable operation during its lifetime in the following climatic conditions.

Parameter	Winter	Summer	Comments
Temperature	2-17°C	21-40°C	
Relative Humidity	50-85%		
Rainfall	500 – 700 mm/annum		

16.0.05 Drawings

16.0.05.1 Preliminary Drawings:

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16.0.05.2 Tender Drawings:

The Tenders shall be accompanied by a full description, submitted in triplicate, of the proposed units and accessories. This descriptive material shall include typical drawings, performance diagrams, characteristic curves and schedules of materials of construction, noting the standard specifications with which these materials comply, all in sufficient detail to indicate clearly the size and position of the individual parts of the Plant, provided that any omission of details from the Tender Drawings shall not relieve the Contractor from any obligation under this Contract. Figures shall be used in preference to scaled dimensions and large scale drawings in preference to small scale drawings.

The limits of work included in the supply shall conform to requirements of this Specification and shall be clearly shown on the Drawings. Where work is shown which is not intended for inclusion it shall be clearly marked "not included in the supply".

16.0.05.3 Working Drawings and Details - Scope:

The Contractor shall, within two (2) weeks after receiving approval for the equipment, submit for the Engineer's approval six copies of the following working drawings and details. All drawings shall be scaled drawings:

- a) All general arrangements and detail drawings and sectional views, which shall be fully dimensioned and show in detail plant and ancillary equipment to be supplied under the Contract.
- b) Dimensioned detailed erection drawings of each item of the plant including, where applicable, drawings showing the recommended foundations, weights of the plant, kinds of materials and finishes.
- c) Working drawings for equipment requiring electrical and/or mechanical connections showing the units of equipment in the proposed position for installation and the details of attachments and connections required, with locations referred to each other and to the structure.

- d) Dimensioned detailed working drawings of all pipe work, showing exact locations and elevations of all pipes, joints, fittings, specials and valves and type and locations, designs and details of hangers, pipe supports, cleanouts, tie-downs, thrust blocks, etc.
- e) Diagrams of connections for each type of electrical equipment include electric power, control and lighting installation together with a comprehensive wiring diagram showing all connections between the various items of the equipment. The terminal lettering or numbering shall correspond to the terminal marking to be used on the equipment.

The comprehensive wiring diagrams shall include one-line diagrams, control diagrams and detailed installation (layout) plans (shown in scale on the equipment erection drawings) from the System (or other appropriate) Control Panel to all motors, control equipment and instrumentation.

- f) Dimensioned detailed working drawings of electrical switchboards, showing construction, component arrangements, wiring and front elevations. On wiring diagrams, all terminals shall be marked with the marking corresponding to that used on the equipment.
- g) All detail drawings of ducts, openings, bolt holes and all other works which have to be incorporated in the Civil Engineering works shall be prepared by the Contractor and shall conform to the Civil Engineering drawings.
- h) Permanent and temporary loads at points of concentration, the stresses in structures due to temporary loads, the size and class of materials of temporary members and bracing installed or placed to minimize excessive stresses in the completed structures and such computations to show that the temporary rigging equipment will not damage or injure any portion of the complete structure.

Working drawings shall be numbered consecutively and each drawing shall be dated and shall contain:

- The name of this project, and the Contract Number.
- The descriptive names of equipment or materials covered by the drawing.
- The locations or points at which the materials or equipment are to be installed in the work.

16.0.05.4 Working Drawings and Details - Submittal:

In submitting working drawings for approval, all associated drawings relating to a complete assembly of various parts necessary for a unit shall be submitted only when the assembly of drawings is complete, so that they may be checked in relation to the assembly proposed. Where errors, deviations and/or omissions are discovered later, they shall be made good by the Contractor irrespective of any approval by the Engineer.

With submittal, the Contractor shall notify the Engineer of all departures from the Contract Drawings and Specifications; otherwise approval of such submittals will not constitute approval of the departure. Approval of a working drawing will constitute approval of the subject matter thereof only and not of any other structure, material or apparatus shown or indicated thereon. Materials or equipment shall not be ordered nor shall any work be done by the Contractor before the materials, the equipment and the working drawings as herein required have been approved by the Engineer.

All items of electrical equipment constituting an operating system and any mechanical units involved therein or necessary for the functioning of such system shall be submitted at the same time and shall include approved clear diagrams showing circuit functioning, and necessary details for field construction.

Working drawings prepared by subcontractors and manufacturers shall be checked for accuracy and contract requirements by the Contractor before being forwarded to the Engineer. A note shall appear on the working drawings indicating that the Contractor has made this check. Working drawings not so checked and noted will be returned to the Contractor without further examination.

16.0.05.5 Working Drawings and Details - Approval:

The working drawings submitted by the Contractor shall be checked by the Engineer, who will within 30 days from their submittal either approve the drawings or demand such changes therein as he may deem necessary, and in the latter case the Contractor shall amend the drawings and re-submit them for approval within 15 days. Should the Engineer fail to approve, return for amendments, or otherwise comment on the drawings within 30 days from their being submitted they shall be deemed to have been approved by the Engineer.

When a working drawing is satisfactory to the Engineer, the prints will be marked "Approved" by him, will be dated and one copy thereof will be returned to the Contractor. The Contractor shall then insert the date of approval on the tracing and furnish the Engineer with six prints of the working drawings as approved and one reproducible transparent copy of each.

If required by the Engineer, the Contractor shall supply additional copies of the drawings as may reasonably be required for the purpose of Contract.

After approval of the Contractor's Working Drawings, the Engineer will incorporate in the civil works drawings all details and dimensions pertaining to the installation of the Plant.

The Contractor shall check these drawings for accuracy and correctness and shall return one copy to the Engineer marked "checked and agreeing with the requirements of the installation of the Plant". If the Contractor neglects this duty or delays the production of his drawings or amended drawings or detailed instructions, or if errors are made in the building work as a result of incorrect or incomplete information supplied by the Contractor, whether on the drawings or otherwise, he shall be charged the whole or part of the cost of any resulting extra work carried out in altering work already erected so as to meet the requirements, save in the case where the Engineer in writing shall waive such a charge.

The notice of the Engineer's approval of any drawings will only signify his general approval of the design and shall not make him liable for any errors of the Contractor in detail or lack of strength or efficiency of any part.

16.0.05.6 As-made Drawings:

After the work has been completed, the Contractor shall furnish as-made drawings prepared during construction, showing the Plant as erected and other work done, together with all other information that may either be required or be useful for the operation and maintenance of the Plant in the future.

16.0.06 Packing, Marketing, Delivery

16.0.06.1 Packing:

After testing and approval by the Engineer and prior to dispatch from the Contractor's works, the equipment shall be thoroughly protected against corrosion and incidental damage, including the effects of vermin, strong sunlight, high temperatures and humid and salty atmosphere or sea spray.

All items of plant intended to be painted shall receive the treatment specified in Clause 16.0.11 and all unpainted parts liable to corrosion (with the exception of electrical equipment) shall be heavily coated with a mixture of white lead and tallow (free from acid) or other approved protective substance.

In addition, all electrical equipment shall be suitably protected against corrosion and incidental damage to the satisfaction of the Engineer. Temporary leads shall be fitted to electrical equipment to enable anti-condensation heaters to be energized when the Plant and Equipment are in store.

The Equipment shall be packed to withstand rough handling in transit, and packages shall be suitable for export to and storage in the tropics including possible delays on exposed quaysides. The Contractor shall be held responsible for the Plant and Equipment being packed so that it reaches its destination intact and undamaged. The Contractor shall provide and include in the Contract Price the cost of all necessary packing, cases and crates properly strengthened by battens (which shall be considered as non-returnable), material (to include but not limited to the use of polythene or similar waterproof wrappings, silica, etc., wherever necessary) hoop iron banding and labor. Packages containing dangerous goods shall be packed and marked in accordance with any statutory rules and order applicable.

16.0.06.2 Marking:

All crates and packages shall be correctly and adequately marked as follows:

- a) Name of the Project
- b) Designation of Plant
- c) Item No.

16.0.06.3 Delivery:

The Contractor shall keep the Engineer fully informed of the state of deliveries, and shall forward copies of all shipping documents by air mail to the office of the Engineer on Site, giving ship, crate numbers and contents of each crate. In any case the Contractor shall be fully responsible for the safe delivery of the Plant until it is handed over to the contractor in charge of its erection.

16.0.07 Training of Employer's Staff

If so required in the Particular Specification and for the period stated therein, the suppliers shall train the operators to take over the running, but shall not be required to provide consumable materials.

The Supplier will provide a competent engineer(s) and/or technician(s) thoroughly familiar with the operation and maintenance of the equipment, to supervise the running-in (start-up) of all plant supplied, and, at the same time, to train the owner's on site staff to take over the running of such plant and in the operation and maintenance of the items of plant and installations so that at the conclusion of the running in operations the staff can be entrusted with the operation and maintenance of the plant and installations.

The engineer(s) and/or technician(s) provided shall be thoroughly familiar with the operation and maintenance of the Plant above, and shall be competent to resolve process questions, problems and procedures relating to Plant supplied. The training provided to the staff shall be such as to endure that, at the conclusion of the running in period; the staff can be entrusted with the operation and maintenance of the plant and related works.

The duration of the running in period, for which the above engineer(s) and/or technicians shall be provided, shall be three (3) consecutive working days. For all works executed under this Contract, the running in period shall begin immediately after the taking over of said work. The decision as to whether the running in period has been successfully concluded shall be the Engineer's alone, and his decision will be final.

The price of the above services shall be included in the price of the equipment for which the services are provided, and no additional payment shall be made to the supplier for the provision of such services.

16.0.08 Supervision of Erection

The services to be provided at the supplier under this item shall include:

1. Provision of detailed erection instructions, including all relevant plans and sketches, with each item of equipment supplied.
2. Inspection by qualified representatives of the Equipment Manufacturer of each item of equipment after its erection has been completed and provision for each such item of certificates (from the equipment manufacturer) stating that the erection has been completed to the satisfaction of the equipment manufacturer and that the equipment may be put into operation. Should the equipment manufacturer's representative take exception to or find fault with the erection, he shall clearly state in writing all required corrections, additions and any other work required to complete the erection to his satisfaction.
3. The equipment manufacturer's representative shall be a direct employee of the manufacturer with appropriate qualifications. Local agents or representatives of the manufacturer shall not be approved. The manufacturer representative shall inspect the installation of the equipment and the startup for a period of at least seven (7) working days.

16.0.09 Electric Motors

All motors supplied under this Contract shall conform to the provisions of this Clause 16.0.09

Requirements:

1. Output, service factor, speed, direction of rotation, etc. shall be as per Particular Specification.
2. All motors in dry installation shall be totally enclosed fan cooled (TEFC), with minimum degree of protection IP54.
3. Motors shall be class F insulated, and designed for 40°C ambient temperature.
4. All motors shall be three-phase squirrel cage type.
5. Motor performance shall be according to IEC publication no. 34. Motor dimensions shall be according to IEC publication no. 72-1.
6. Motors with a nameplate rating of 10 HP and higher, and all motors employing a variable frequency drive, (irrespective on the power) shall be equipped with to temperature sensor protector type thermistor or klicson.

7. Electric motors for operating in ambient temperature of 45°C, and continues output equal to nominal output times the service factor, including rated operating thrusts and bearing cooling conditions, the temperature rise shall be at least 5°C lower than those permitted at an ambient temperature of 40°C by I.E.C. recommendations publication No. 34 or the latest NEMA MG1 - 12.42, 2a for an ambient temperature of 45°C.
8. All electric motors shall have 1.15 service factors.
9. The power of each electric motor, as specified on the nameplate, shall be at least 10% higher, then the power required by the load, (at full load).
10. Motors Voltage: 3 Phase, 400/230 ±10% four wire, 50 cycles ±5%.
11. Unless more severe conditions are specified elsewhere, all Plant whether installed indoors or outdoors shall be capable of reliable operation during its lifetime in the following climatic conditions that were given in clause 16.0.04

Enclosure and Cooling

The enclosure shall be suitable to the motor's intended location and operation, and shall apply to the types specified below:

Installation	Ingress Protection Code	Cooling		
Submersible	IP68			
Dry – indoor	IP55	Totally Enclosed	Fan Cooled	
Dry – outdoor	IP67	Totally Enclosed	Fan Cooled	

Finish

Tropical - rust protection required.

Insulation

Tropical - moisture and fungus proof

Temperature Detectors

Embedded temperature detectors shall be required for motors larger than 10 HP - thermistor type sensors required in each phase. Two sets shall be required for motors of 250 HP or larger. Terminals to be brought out to a special terminal box marked "Temperature Detector".

Motor (HP)	Size	PT100 sensor	Thermistor	Klicson Detector	Bearings PT 100 sensor
10-200		--	1 set		
201-500		--	2 set		
> 500		6			2
Submersible				1	

Heater

Motors greater than 70HP shall include a heater - 230 Volts - for keeping motor dry in case of relatively high wet conditions. Terminals shall be brought out to a separate terminal box marked "Heater". Voltage and wattage to be marked on a nameplate affixed to terminal box.

Motor Winding Terminal Box

Dust tight and splash proof. Motor leads to terminals shall be protected by non-hygroscopic, heat resistant insulating sleeves. For weather protected enclosures, design of box shall be such as to afford protection against penetration of rain even if cover is not tightened (IP55).

Starting Capabilities

Starting capabilities - all motors, irrespective of stated starting conditions, shall be capable of starting direct on line with full voltage at motor terminals.

Test Report

(For motors larger than 100 HP) or as required in Particular Specification.

- (a) Standard test for line type motors.
- (b) Certified tests for all non-line types.
- (c) Tests to include:
 1. No load current and losses at 120%, 110%, 100%, 90% of nominal voltage.
 2. Locked rotor current and losses
 3. Resistance of windings
 4. High potential test
 5. Insulation resistance test

6. Vibration test
7. Speed-torque curve
8. Air gap
9. Heater resistance
10. Any other tests of horizontal and vertical motors if so required in the Specification.

Nameplates

(a) Marking of the following information is required:

- Model
- Serial No.
- Year of manufacture
- Nominal output
- Service factor
- R.P.M.
- Nominal voltage
- Frequency
- Phases
- Nominal current
- Power factor at nominal load
- Code letters as per NEMA
- Insulation class
- Protection

(b) The following marking is desirable but optional:

- Locked rotor current
- Weight
- Standard

Packing and Transport

As per Specifications

Information

(a) The following information shall be submitted with the contract:

1. Output of motor
2. Service factor
3. Motor efficiency and power factor at 115%, 100%, 75% and 50% of nominal output.

4. Kind and class of insulation
5. Slip at nominal output
6. Locked rotor current and power factor
7. Outline dimension drawing and cross-section
8. Weight

(b) The following information shall be submitted upon receipt of order, or in accordance with the Time Schedule.

1. Stator winding, heater resistance and temperature detector connections including particulars.
2. Torque speed and current speed curves
3. Noise level
4. Vibration amplitude
5. Maintenance and operating instructions in triplicate.

(c) See Sub-clause 4.00.9 on horizontal, vertical and submerged motors for further specific data required.

Horizontal Motors

(a) Bearings

Self cooled anti-friction bearings desirable. Oil lubricated bearings to be fitted with sight glass level indicators. Grease lubricated bearings to be fitted with device for automatic removal of excess grease.

Separate quotation, if so required, for bearing thermostats, adjustable approx. 50-120°C with change over contact 1A, 380, P.F.O.2.

(b) Shaft Coupling

As per Particular Specifications.

(c) Construction

Horizontal for mounting on a horizontal base. Motor and pump to be mounted on a common frame. Motor to be provided with holes for locating dowels. Desirable - openings with removable covers for purpose of checking air gap. Separate quotation required for suitable feeder gauges.

(d) Additional Information Required upon Receipt of Order

- (i) Axial displacement and rise of driving end of shaft in relation to foundation and variation of air gap length due to changes in ambient temperature and heating up from ambient to full load working condition.
- (ii) Bearings-Type; end play; maximum external axial force permitted. Type of lubrication and intervals for lubrication. In case of roller bearings, type numbers to be given. Bearing temperature rise. Insulated bearing if recommended.
- (iii) Axial force (for sleeve bearings) - maximum force which may be applied by rotor (magnetic pull) to driven machine with rotor at any position made possible by endplay.
- (iv) Maximum transient torque considering re-closing at unfavorable moment (electrically).
- (v) Maximum runaway speed permitted (if driven by pump).

Vertical Solid Shaft Motors - Addenda

(a) Shaft, Bearings, Coupling

Solid shaft, rolling bearings. If spherical roller thrust bearings are used, springs shall be fitted below them, so that an accidental uprise of the motor half coupling by 1 mm shall cause no damage.

Bearings shall be air-cooled.

Care shall be taken against oil leakage to the interior of the motor.

Statistical L-10 life of the bearings shall not be less than 30,000 hours. Oil level indicators shall be well protected mechanically.

With 24-hour operation, the bearings shall require no more attention than once per month.

The type of coupling and the necessary plays shall be agreed upon between the motor and pump manufacturers.

The shaft end shall be suitable for mounting of an elastic coupling.

The coupling shall be secured by a nut at the end of the shaft.

Motor coupling requirements - as per Particular Specification.

(b) The following extras shall be quoted, if required:

Adjustable temperature control switch with calibrated scale (lowest setting not over 60°C) fitted to thrust bearing. Change over contact rated 2A, 380V, A.C.

- (i) Plugged opening for insertion of thermometer in oil well of thrust bearing.
- (ii) Temperature control switch in guide bearing (as for (i))
- (iii) Plugged opening for insertion of thermometer in oil well of guide bearing.
- (iv) Suitable openings for insertion of feeler gages for measuring the air gap, as well as suitable feeler gages.
- (v) Insulated bearings if recommended by the motor manufacturer.

(c) Test Reports

- (i) A no load run for 3 hours shall be included in the absence of a load test. The temperature rise of the bearing oil, core, air inlet and outlet shall be noted.
- (ii) Longitudinal play of motor.

(d) Name Plate Data

The following shall be marked on the same plate as the general data or on a separate plate:

- (i) Bearing designations
- (ii) Recommended viscosity and type of oil or grease
- (iii) Quantity of oil in each bearing
- (iv) Lubrication instructions

(e) Information to be supplied upon Receipt of Order

- (i) Hooking height
- (ii) Type of thrust and guide bearings
- (iii) In case of use of spherical roller thrust bearings, approximate upward force applied by springs below bearings.

Submersible Motors

Submersible motors shall be of the squirrel cage type. Submersible pumps shall employ sealing rings encased in an oil-filled housing.

Submersible motors shall be equipped with:

- 10-meter-long integrally sealed cables for power and control, as specified below.
- Thermal windings over heat protector, N.C. contact, automatic reset klicson type.
- electrical winding heater to prevent moisture
- An electrode to detect the presence of water in the oil filled housing in which the sealing rings are encased.

Sealed cables shall consist of the following wires:

- 6 conductors for 3 windings
- 1 conductor for earthing connection
- 2 conductors for thermal over-heat protector
- 2 conductors for winding heater
- 1 conductor for the electrode, detecting water in oil.

All conductors shall be permanently marked.

16.0.10 System Control Panels

Some of the electrical and electro-mechanical equipment to be supplied under this contract will be operated and controlled from the plant's Central Control Panel (CCP), which will be located in the plant's Central Building. The CCP will be composed of a Central Programmable Logic Controller (CPLC), a Central Motor Control Center (CMCC), and a Central Computer. The supply and erection of the CCP is part of the electrical work Tender (not part of this Tender).

Some of the electrical and electro-mechanical equipment to be supplied under this Contract will be operated and controlled by System Control Panels (SCP's). These SCP's will be located, as per drawings, in local electrical rooms, near the equipment they operate and control. The supply of these SCP's is part of the Works under this Contract.

An Individual SCP shall be supplied for each machine (i.e. Decanters, GBT, Bar screens etc.). A common SCP for several machines shall not be allowed.

SCP's shall comply with Israeli and European Electric Code regulations.

The electrical connections between each SCP and its associated motors and instrumentation and between each SCP and the CCP is part of the electrical works.

Each SCP will consist of a System Programmable Logic Controller (SPLC) and System Motor Control Center (SMCC), and both of these components are specified in detail below. The design and construction of all System (and other) Control Panels shall be reviewed, approved and signed by a qualified electrical engineer. The engineer shall have at least 5 years experience in the design of similar control panels built, and the qualifications of the engineer shall be subject to the review and approval of the Owner. The engineer's signature shall certify that the SCP is in compliance with all relevant codes and regulations and that the design and equipment used conform to the best current engineering practice.

The supply of all System (and other) Control Panels shall include their placement in one piece (completely wired and connected) in the location specified in the Drawings and/or by the Engineer.

The operation and control logic for all Plant to be supplied under this Contract is specified in appropriate sub-clauses below.

Unless otherwise specified, SCP's shall receive and transmit, for all the motors under their operation and control, the following discrete input (DI) signals, hereinafter called "motor status signals":

- Motor in operation
- Overload failure of motor
- Control of motor in "auto" or in "Manuel" selector switch setting
- Soft starter failure (for motors over 10 HP)
- VFD failure for motors running with variable speed control.

- High temperature failure (for motors over 10 HP)
- Infiltration of water into oil-filled enclosure (for submersible motors)
- All other signals necessary for the proper and safe operation and control of associated equipment

Motor status signals for CCP motors will be transmitted to the CPLC directly from the CMCC. Motor status signals for SCP motors shall, be transmitted from the SPLC to the plant's Central Computer.

All SCP's shall be linked to the plant's CPLC by a dry contact. When closed, the dry contact shall activate a System Failure Alarm at the CMCC Control Desk. The criteria defining when a System is in failure are delineated in appropriate sub-clauses below.

Unless specified otherwise, and except for motors not connected to either the CPLC or an SPLC, it shall be possible to start or stop any motor - overriding its normal operation program - from the Central Computer. For all such motors, and regardless of whether the motor is connected to the CPLC or an SPLC, it shall be possible from the Central Computer to change the set points or parameters of the program logic governing the operation and control of any motor. Changes to program logic (that is, the ladder diagrams themselves) shall be possible, but these shall be executed locally via an IBM PC - compatible computer. For this reason, extensive documentation for all SPLC's supplied has been specified below.

It shall be possible from the plant's Central Computer to activate the Auto Start and Auto Stop sequences for any SCP. SCP's supplied shall be suitable for this purpose. Prior to the activation of any Auto Start sequence from the plant's Central Computer, the SCP shall sound a ten-second-long audio warning horn, such alarm to be silenced automatically upon the actual start of the sequence.

Unless directly specified otherwise, all measurements transmitted to SCP's from measuring devices and other instrumentation and all other inputs (including motor status signals, selector switch settings, position indications from power-actuated valves, etc.) shall be transmitted from the SPLC to the plant's Central Computer. All SCP's supplied shall be suitable for this purpose.

Control panels and switchgears shall be metal or fiber reinforced polyester, free-standing cabinets with minimum degree of protection IP55 (NEMA 4). The panels shall be designed for 35 KA RMS short circuit current. All cable entries shall be made from the bottom. All panels shall be equipped with a lockable main circuit breaker or main disconnecting switch, operated from the front door. All circuits shall be protected by molded case circuit breakers or miniature circuit breakers. The use of fuses shall not be allowed.

All electrical equipment shall be protected against lightening storms and voltage sharp spikes

Motor starters shall include temperature compensated, differential overload protection (as a separate unit, or combined with the circuit breaker). Motors up to 7.5 kW shall be equipped with a direct on line starter (DOL). Motors of 10 kW and above shall have reduced voltage, soft starter or star-delta starter.

All control devices shall be water-, oil-, and dust-tight.

All electrical parts in the control panel shall be protected against highly corrosive atmosphere

Pilot lights shall be of the multi-LED type, combined with individual transformer (if required).

All of the equipment shall be "finger-proof" according to IP20 (NEMA 1), to prevent the accidental touch of current-carrying parts.

Each MCC shall include a voltmeter and phase switch

Electrical Power and Control Panels

A. GENERAL

All electrical panels shall be manufactured and meets the requirements of the code: T.T.A. (type tested assembly) – form 3B.

The BUS BARS shall be copper made and tin coated

B. ELECTRICAL PANELS DESCRIPTION

The M.C.C. panels shall be metallic enclosures, floor mounted IP55 protected, with 25% spare room, epoxy painted.

The panel shall consist of two compartments as described below.

COMPARTMENT NO. 1

This field shall contain:

- Main switch disconnected
- Voltmeter, phase selector switch and C.B. protector
- Complete starters for the electric motors
- Bus bars

COMPARTMENT NO. 2

The field shall contain:

- variable frequency drives (V.F.D.)
- fans for air exchange

B1. MOTOR STARTERS DESCRIPTION

B1.1. DIRECT TO LINE STARTER (D.T.L.)

The D.T.L. starter shall consist of:

- Motor protector type "P.K.Z.M./ MOELLER" or approved equal, for motors up to 10kw.
- Circuit breaker type "NZM/ MOELIER" or approved equal for motors larger than 10kw.
- Contactor 25% larger than the motor in AC3, operating conditions, type SCHNEIDER ELECTRIC..
- Run, fault, thermistor, klicson non return valve, etc signal lights.
- Manual – 0- auto selector switch.
- Control devices (relays, timers, etc).
- Power supply units.
- Miniature circuit breakers for control protection.

B1.2. VARIABLE SPEED MOTOR STARTER

The starter shall consist of:

- All components and items as described for the D.T.L. starter.
- Variable frequency drive 15% larger than the power of the motor in heavy duty operating conditions, type vaccon or ABB/ACS 800 or approved equal.

B1.3 SOFT STARTER

The starter shall consist of:

All components and items as described for the D.T.L. starter.

Electronic – digital soft starter, 15% larger than motor, in heavy duty operating conditions, type – solcon rvsdn or approved equal.

B2. PROGRAMMABLE LOGIC CONTROLLER (P.L.C.)

The P.L.C. shall be mounted and wired in the control cabinet.

The P.L.C. shall be equipped with all the necessary hardware and software for control and operation of the all system including the peripheral equipment.

The P.L.C. shall include the programming software, drivers, protocols, and all other software necessary, for system completion.

The P.L.C. shall include communication ports as listed below:

- Ethernet TCP-IP port for communication with the plant net.
- Profibus D.P. port for communication with local items (such as V.F.D'.S etc)
- Communication port for local programming.

The P.L.C. shall include 25% spare I/O.

The P.L.C. shall be one of the following

Types:

SIEMENS/S7-315-2PN/DP

GE/RXI-315

Modicon/quantum-140cpu43412A/16K

AB/slc-500-505/32K

Mitsubishi/system Q02H

B.3 VARIABLE FREQUENCY DRIVE UNITS (V.F.D.)

Unless specifically mentioned, all motors shall be supplied with V.F.D.

The power size of the V.F.D. shall be 15% larger than the power size of the motor, in heavy duty operating conditions

The V.F.D shall be rotation, for electric motor 400VAC \pm 10%, 3PH, 50Hz.

The V.F.D. shall include:

- L.C.D. remote panel for data display and parameters set up, to be mounted on the front of the panel.
- Special preparation in order to immunize it against the extremely corrosive atmosphere, (double layer lacquer coating of the electronic cards, tin coating of the electronic contacts, etc)
- Profibus D.P. communication port with protocol.

- Auxiliary contacts.
- IP54 protected original enclosure.
- 4-20M.A. analog output and input. (isolated)
- The VFD shall be provided with standard RFI and EMC filters comply with the IEC standards for harmonic voltage distortion in the grid.
- Suitable to operate in heavy duty conditions.
- Communication port Ethernet/tcp-ip.
- The V.F.D. shall be type vacoon or ABB/ACS800 or approved equal.

B.4 Digital, Electronic Soft Starter

Listed below are the main characteristics of the electronic soft starters:

- Starting and running motors continuously without support of bypass contactor.
- Sized 15% more than the power size, of the motor in operations conditions: "without bypass contactor".
- Variable soft start time and soft stop time.
- Variable soft start torque and soft stop torque.
- LCD panel for parameters set up programming and unit data display.
- Motor protections.
- Voltage free, change over auxiliary contacts (Run, Start, by pass contactor).
- Isolated 4-20mA analog output for motor current monitoring.
- 50 degrees centigrade operation conditions.
- Special treatment for operation in extreme corrosive atmosphere (double layer lacquer coat, etc.).
- The soft starter shall be type RVS-DN SOLCON make or approved equal.

B5. Main Switch disconnecter

- 25% larger than the whole current consumption of the panel
- Equipped with a clutched, lockable front mounted operating handle
- Including auxiliary contacts
- Manufactured by manufacturers comparable to NZM Moeller, or Schneider Electric.

B6. Programmable logic controller (PLC)

Each MCC of each machine shall be equipped with a PLC.

The PLC shall include all necessary hardware and software to operate and control the whole machine and its peripheral system.

The PLC shall interface to the starters and all other equipment of the machine.

The interface to VFDs shall be one of the two options (The decision by the engineer):

- a) Analog input and analog output
- b) Profibus D.P. com port

The PLC shall include all necessary software to operate the machine and to communicate with the local touch screen and to connect to the net into the WWTP for interface with the HMI in the control room.

The PLC shall be equipped with the communication ports as listed hereafter:

- Ethernet TCP/IP, to communicate through the net with other PLCs and HMI
- Communication port for local programming by PC

The PLC shall include 30% spare I/O of all kinds.

The PLC shall be one of the following models:

- 1) Modicon 340
- 2) Siemens S7-300

B7. Local Touch Screen

The local control panel shall include a 10" color, graphical touch screen. The touch screen shall be an industrial heavy duty type and suitable to operate in an extreme corrosive atmosphere. The touch screen for the Bar Screens shall be intrinsically safe

B8. Local Control Panel

Each machine shall be supplied with a local control panel. The local control panel shall be 60x60x30 cm, S.S. 316L, wall mounted, and with IP 65 ingress protection degree.

B9. Extreme corrosive atmosphere protection

All vulnerable electronic components (electronic cords etc.) shall have a strengthened corrosive atmosphere prevailing in the plant. The protection shall include:

- Tin coated electronic contacts
- Additional special coating layer for all electronic cords
- All other necessary treatment for preparing the equipment to be able to operate under corrosive conditions.

16.0.11 Protective coatings, linings & paintwork

Unless otherwise specified, the protective coatings, linings and paintwork described in this Clause shall be applied, as directed in this and other Sub-clauses of this Specification, to all metallic items supplied in this Contract.

All equipment supplied and delivered to Site under this Contract shall be inspected by the Engineer, and any equipment found to have defective or damaged coatings, linings or paintwork shall be repaired or replaced (as per the decision of the Engineer) by the Contractor. Repairs shall be affected as directed below.

The Contractor may suggest equivalent alternate materials to those specified in this Contract, but prior approval by the Engineer shall be required in all cases. If the applied coating, lining or paintwork is not as specified or approved, the Contractor shall be required, at his expense, to remove it (to the satisfaction of the Engineer) and to replace it with a coating, lining or paint meeting the requirements of this Specification.

Documentation attesting to the application of the coatings, linings and paint work as per the requirements of this section shall be furnished with all items supplied under this Contract. Supply Contractors shall be responsible for providing this documentation to the Engineer for his review. No equipment shall be shipped from its place of manufacture without the explicit approval of the Engineer of the documentation submitted; general approval of the equipment by the Engineer shall not be understood as including approval of the coatings, linings and paintwork documentation unless an explicit statement to this effect is made in the letter of general approval.

16.0.11.1 Surface Preparation

The surface preparation described in this section shall be applied to all metallic items supplied in this Contract, unless an instruction to the contrary is expressly stated.

The surfaces of all items to be painted or coated shall first be thoroughly cleaned of all rust, burrs, chips, dirt, oil, grease, dust, sand, and all other contaminants. No paint or

coating shall be applied to a wet, rusty or unclean surface. Meticulous surface preparation is critical to the successful application of any paint or coating, and such preparation shall not be compromised in any way.

Surfaces shall be washed and cleaned; a mechanical steel brush shall, if necessary, be used. Oil and grease remnants shall be cleaned with benzene - based or other solvents. Next, the surface shall be sand-blasted, as per Swedish Specification SIS 05 5900 S.A. 2 or SSPC No. SP10-63-T, to "near white metal".

The application of the first layer of coating, lining or paint shall be no more than 1 hour after the surface has been sandblasted.

16.0.12 After Sales Service, Instruction, Manuals, Etc.

16.0.12.1 After Sales Service:

The Contractor shall provide together with his proposal full details of the facilities which he will afford the Employer for after sales service in the supply or replacement of components and skilled maintenance services at Site at any time in the future, covering all Plant included in the Contract. After sales service shall be available for all Plant supplied under this Contract.

The Contractor's attention is drawn to the fact that availability and extent of such after sales service will be one of the decisive considerations in awarding the Contract.

16.0.12.2 Spares:

The Contractor shall furnish separate schedules of items of spares for all Plant subject to normal wear and tear or easy breakage in transit, installation and maintenance, including spares for electrical equipment. The composition of items and their respective quantities, unless detailed in this Specification, should be sufficient for a maintenance period of two years or 10,000 hours of operation, whichever is decisive under prevailing climatic and operational conditions.

16.0.12.3 Workshop Equipment:

If any special, non-standard tools are required for erection, dismantling, maintenance and repairs of the items supplied under the Contract, two complete sets of such tools shall be provided with the supply. The tools shall be high quality, plated and mounted in suitable tools kits.

The Contractor shall furnish full lists of such special appliances and tools with his Tender.

The cost of the above appliances and tools shall be included in the supply of the various items of plant and shall not be paid for separately.

16.0.12.4 Instruction Manuals

The Contract shall include the provision of six complete bound sets of instruction manuals which shall cover the erection, commissioning, testing, maintenance and operation of the Plant in its entirety. The greatest importance is attached to completeness and clarity of presentations. In the event of the Engineer rejecting all or part of the instruction manuals or drawings, the Contractor shall amend them to meet the Engineer's requirements.

Each manual shall contain the following chapters:

- Description of each item of equipment.
- Erection and dismantling instructions.
- Operating instructions.
- Running maintenance instructions.
- Fault tracing instructions.
- Miscellaneous data, information and instructions.
- Spare parts lists and ordering procedure.

The greatest importance is attached to completeness and clarity of presentations. It should be emphasized that a collection of standard pamphlets of a general nature, unaccompanied by drawings and descriptive matter relating to the Plant as installed, will not be acceptable. In particular, information supplied by Sub-contractors must be co-ordinate into the comprehensive manual. Cross referencing of descriptive matter, drawings and spare parts lists must be complete.

The instruction manuals shall describe the installation as a whole and give a step by step procedure for any operation likely to be carried out during the life of the Plant including erection, commissioning, testing, operation, maintenance, dismantling and repair.

Maintenance instructions shall include charts showing lubrication, checking, testing and replacement procedures to be carried out daily, weekly, monthly and at longer intervals to ensure trouble-free operation. Where applicable, fault location charts shall be included to facilitate finding the cause of mal-operation or breakdown.

Separate sections of the manuals shall be devoted to each size and type of equipment. They shall contain detailed descriptions of its construction and operation and shall include all relevant pamphlets and a list of spare parts with procedure for ordering spares. Electrical equipment shall be described in operation step by step, giving the complete sequence of operation. The detailed sections of the manuals, if necessary, shall contain further maintenance instructions and fault location charts.

16.0.13 Particular specifications

16.0.13.1 General

Currently, four (4) three-lobe blowers are installed. Two (2) blowers supply air to the aeration tanks, one (1) blower supplies air to the filtration system and to the grit trap, and one (1) blower serves as backup. The capacity of each blower is 5,500 Nm³/hr @ 700 mbar. The blowers are connected to a common discharge manifold, and the air is distributed to the aeration tanks via a single pipe that is branched after each aeration tank.

Three (3) blowers shall be supplied, two (2) on duty (NM210-AT1, NM211-AT2) and one (1) as backup (NM212-AT3).

16.0.14 Scope of supply

The blowers shall be supplied as complete units, fitted to indoor installation, and shall include all equipment items, instrumentation, pipework accessories, electric equipment items, that are necessary for the proper functioning of the blowers.

The contractor shall include in his offer any device that is needed to protect the blowers from failures of the electric power supply.

The contractor shall include in his offer any adjustment that is needed for proper communication between the local controllers to the main controller of the WWTP.

The scope of supply of the blowers shall consist of, but not limited to:

- Three (3) blowers, including local control panel (LCP) for each blower.
- One (1) System Control Panel (SCP).
- Oil lubricating system (if needed) for each blower.
- Couplings.
- Base Plate for each blower.
- Electric motor for each blower.
- Inlet filter/silencer for each blower.
- Discharge expansion joint for each blower.
- Discharge cone for each blower.
- Blow-off valve for each blower.
- Check valve for each blower.
- Isolation valve for each blower.

- Instrumentation: as specified in sub-clause 16.0.30.

16.0.15 Design Operating Data

The blowers operating data shall be as following (data are given for a single blower):

Parameter	Flow rate (*Nm ³ /hr)	Pressure (mbar)
Blower full Capacity	7,000	800
Most frequent flow rate	5,600	750
Maximum flow rate	7,000	750
Minimum flow rate	3,150	750

* Normal conditions: barometer and inlet pressure of 1 atm, inlet air temperature of 20°C and relative humidity of 36%.

The blowers shall be designed so that the highest efficiency is obtained for the most frequent working point (5,600 Nm³/h at 750 mbar)

The blowers and motors shall be capable of operating under all meteorological and climatologically conditions at the plant (regarding air temperature, relative humidity, barometric pressure etc.),

General parameters:

Parameter	Units	Value
Site elevation	m above sea level	30
Inlet air temperature	°C	2-40
Inlet air relative humidity	%	5-85
Water level in aeration tank	m	6
Effective water level above diffusers	m	5.7
System pressure	Bar absolute	1.814
Maximum allowed noise (indoor)	dBA	75

The design system pressure above shall be understood as a minimum requirement.

Blowers shall not surge or exceed the nameplate motor rating at any of the above conditions. The blower shall have a surge pressure slightly higher than the maximum system pressure under minimum airflow conditions. Calculations attesting to the sufficiency of the blower/motor in this regard shall be included by the Contractor with his offer.

16.0.16 Power consumption

The bidder shall fill the data regarding the power consumption of the blowers in the "Schedule of Particulars and Guarantees" (see chapter 17 below).

The following data shall be given:

1. Wire power consumption (kW)
2. Shaft power consumption (kW)
3. Motor rotational speed (rpm)
4. Blower rotational speed (rpm)

Wire power is determined as the actual electric power consumed by the motor. The Wire power shall include the power of all electro mechanical parts of the motor and the blower and all the support systems. The wire power shall be measured on the electric panel that supplies power to the motor.

Shaft power is determined as the power that is measured at the shaft of the blower.

Each of the above data shall be given for the following capacities:

1. Full capacity (max. flow rate at max. pressure)
2. 100% (max. flow rate at working pressure)
3. 80%
4. 60%
5. Minimum

The data shall be given for:

1. Normal conditions (20°C, 1 atm, 36%)
2. Frequent conditions (30°C, 1 atm, 80%)
3. Worst case conditions (40°C, 1 atm, 85%)

16.0.17 Control method

The control system (both hardware and software) for the blowers (including the system control panels (SCP)) which will send and receive information to and from Plant Central Panel (CCP), shall be included in the supply of the blowers. Three (3) local control panels (LCP) shall be supplied (one (1) for each blower), and one (1) SCP shall be supplied to control all the blowers.

All the blowers shall be connected to a common discharge manifold. Three air pipes shall be branched from the manifold, one for each aeration tank.

The control system shall be based on maintaining a programmed pressure in the system (desired system pressure to be programmed and adjustable at the SCP) System pressure shall be measured by a pressure transmitter (included in the supply of the blowers) erected in the blowers' Common Discharge Manifold. The pressure transmitter shall send a 4-20 mA signal to the SCP which shall then automatically control one, two or three of the blowers.

The pressure of the system will change (resulting, as explained above, in the SCP-initiated control of the blower(s)'s delivered air flow rate to restore the system to the programmed system pressure) based on the position indication of the automatic control valves erected in the main air supply pipes to all three aeration tanks. The automatic control valves shall be controlled by the plant's Central Programmable Logic Controller (CPLC) based on 4-20 mA dissolved oxygen concentration signals received from two DO meters per tank. Simultaneous operation of the blowers shall be possible without special requirements.

The condition of blowers running in parallel with different air flow rate settings must be met and the safety margin between discharge pressure and surge pressure must be maintained at the same value for each unit operating in parallel.

One of the existing three-lobe blowers shall serve as a backup to the other blowers. This blower shall be shown on the SCP that shall control all the blowers. The supplier shall be responsible to connect the existing blower to the control system and to ensure its ability to operate as a backup blower to the blowers. All the adjustment that may be required shall be part of the offer.

Starting or stopping any individual blower must be possible without altering the air flow rate of the plant.

A surge control system shall be installed and designed to detect the incidence of pneumatic surge and protect the blowers accordingly. The blower's surge limit shall be no greater than 40% of the maximum air flow rate capacity, thus allowing a 5% capacity margin below the minimum turndown capacity (45%) and the onset of surge.

16.0.18 Oil Lubricating System

A complete oil lubricating system shall be provided with each blower. The system shall be capable of supplying clean oil at a suitable pressure and temperature to lubricate the speed increasing gears and bearings. All components of the lubricating system shall be installed integral with the blower base plate and arranged to permit ease of accessibility for operation, maintenance, inspection and cleaning.

The oil lubrication system shall consist of a reservoir in the base, two positive displacement pumps with strainers, an oil-to-water heat exchanger, one oil filter and miscellaneous appurtenances. A pressure gauge, thermometer, adjustable high and low temperature switches and adjustable high and low oil pressure switches shall be installed on each oil lubricating system.

The oil reservoir shall be integrated in the base and the interior of the reservoir shall be descaled and rustproofed by the application of a permanent coating of the Manufacturer's standard. The equipment attached to the top of the reservoir shall be mounted by means of pads. All cover openings shall be gasketed. The reservoir shall be equipped with a suitably sized vent and breather filter and have a minimum working capacity of 3-min retention time based on normal flow.

One main motor or gearbox shaft-driven primary oil pump shall be provided and, in addition, one electric motor-driven oil pump shall be provided to act as standby. Each of the pumps shall be of adequate capacity to supply lubrication for the blower/gearbox when operating and during start/stop. The electric motor driven oil pump will operate at start/stop of blower and at low oil pressure, activated by the control system located in the local panel.

The oil filter shall be of the full flow, replaceable cartridge type, single or duplex filter, suitable for at least two years of undisturbed operation, capable of removing particles over 10 microns with a clean oil filter pressure drop not to exceed 0.35 bar at design temperature and flow. Filter cases shall be suitable for operation at a pressure not less than the relief valve setting. A visual gauge shall indicate when a filter is dirty and requires changing.

Strainers shall be manually cleaned and equipped with a magnetic trap. Design and installation shall permit ready access for cleaning.

An oil cooler for each compressor shall be furnished and may be of the water-to-oil type, mounted on each blower skid. The cooler shall be capable of maintaining the required cooling rate at all ambient temperatures. Each cooler shall be rated to dissipate the total emitted joule from the blower/gearbox. The cooler shall be furnished with a cooling-water, flow control valve and an on-off water solenoid valve.

If cooling water is needed it will be drawn from a hydrant, such hydrant to be included under the Civil Engineering Contract, not this Contract. The water piping from the hydrant up to (but not including) the above-mentioned water solenoid valve will also be supplied and erected under the Civil Engineering Contract.

The blower manufacturer's standard provisions for oil heating shall be provided to heat the oil if the temperature in the blower room goes below 6°C. The heater must be designed to heat lightweight oils with no more than 15 W per square inch. The heater and thermostat shall be mounted on the oil reservoir with the contactor located in the local control panel. The blower shall not start unless the oil is above 10°C. A low oil temperature warning light shall be provided on each local control panel.

16.0.19 Couplings

Flexible, forged steel spacer couplings, double disc type, or approved equal, shall be furnished for connecting the blower and motor. Couplings shall be of the proper size to transmit the power required to drive the blower under all conditions of operation with a service factor of minimum 1.5. Coupling and spacer shall be dynamically balanced to tolerance suitable for maximum continuous speed of quality class 6.3 ISO 1940.

The coupling shall be of the dry type and shall be designed for long periods of continuous operation. The coupling design shall absorb inaccuracies of alignment and permit axial adjustment. The coupling shall ensure that the motor shaft does not exert a thrust on the blower bearing. Coupling construction shall be such that either shaft of the unit may be removed without disturbing adjustment of the other. An approved steel guard shall be provided and installed over the coupling.

Each compressor and motor, coupled together, shall be mounted on common steel base, properly braced to form a rigid support for the entire unit.

16.0.20 Base Plates and Mountings

Each blower unit shall be furnished with a base plate of adequate size to support the equipment items specified in this Sub-clause. The base plate shall be constructed of fabricated steel, provided with lifting lugs and shall be of sufficient rigidity to permit lifting (using a four-point lift), with all equipment mounted, without distortion or other damage to the base plate or to component parts of the machinery. The base plate shall contain the oil reservoir. The base plate shall be mounted on machine mounts suitable to absorb the weight and vibration of the blower assembly without undue stress or distortion.

16.0.21 Blower Tests

(a) The factory test outlined in (b) below shall be conducted on one of the actual blowers to be supplied (unit to be selected at random by the Owner) All costs of the test shall be borne by the Contractor (including but not limited to travel, lodging and board expenses for one representative of the Owner to be present as a witness for the duration of the test)

(b) The blower shall be factory tested over its entire performance range to prove compliance with these specifications and with the Contractor's entries in the Schedule of Particulars and Guarantees. The tests shall include determination of the surge limit and verification of the blowers' performance curves (as regards capacity, pressure and kW

inputs) Particular emphasis will be placed on the wire efficiency of the blowers at the 100%, 80%, 60% and minimal capacity airflow rates, as entered in the Schedule of Particulars and Guarantees.

(c) The Owner reserves the right to require the performance of the test outlined in (b) above before the acceptance of any offer. In this case, the blower tested need not be one of the actual blowers to be supplied (but should be identical or same) In the event a pre-offer-acceptance test is conducted, and if the Contractor's offer is later accepted, the pre-offer-acceptance test will be of the test required in (b) above. The Contractor shall bear all costs of the pre-offer-acceptance test, as above, regardless of whether the blower passes the test or not, and regardless of whether the Contractor's offer is accepted or not.

(d) The following penalties shall be imposed on the Contractor in the event the tested blower does not satisfy the guaranteed wire efficiency entered by the Contractor in the Schedule of Particulars and Guarantees. These penalties shall in no way be considered as a waiver on the part of the Owner to materialize any of his rights under the Contract, either with respect to acceptance of the equipment or with respect to any other claim of the Owner's due to the Contractor's failure to comply with any of the conditions of the Contract or to fulfill his assigned responsibilities. These penalties shall only apply in the event the Contractor's offer for this Part is accepted.

- At the 100% capacity air flow rate, if the actual wire power consumption is found to be above the guaranteed value in the Schedule of Particulars and Guarantees, the penalty on the Contractor shall be calculated at a rate of ½% of the sum entered in the respective Sub-clause (in the Bill of Materials) for each 1% of negative deviation.
- At the 80% capacity air flow rate, if the actual power consumption is found to be above the guaranteed value in the Schedule of Particulars and Guarantees, the penalty on the Contractor shall be calculated at a rate of ½% of the sum entered in the respective Sub-clause (in the Bill of Materials) for each 1% of negative deviation.
- At the 60% capacity air flow rate, if the actual wire power consumption is found to be above the guaranteed value in the Schedule of Particulars and Guarantees, the penalty on the Contractor shall be calculated at a rate of ½% of the sum entered in the respective Sub-clause (in the Bill of Materials) for each 1% of negative deviation.

- At the 45% capacity air flow rate, if the actual wire power consumption is found to be above the guaranteed value in the Schedule of Particulars and Guarantees, the penalty on the Contractor shall be calculated at a rate of ½% of the sum entered in the respective Sub-clause (in the Bill of Materials) for each 1% of negative deviation.
- All of the above penalties shall be cumulative.

16.0.22 Electric Motors

Each blower shall be provided with a horizontal, constant speed, or vertical variable speed, squirrel cage induction motor. The motor kW-power shall be equal to or in excess of the maximum normal load that will be imposed at any point in the operating range of the design conditions specified.

All motors shall be in accordance with Clause 16.0.09 and, in addition, with the requirements of this Sub-clause 16.0.22.

The motors shall be manufactured according to standard ISO 2373, vibration specification "R". This also applies to fully loaded motors.

The motors shall be of "NEMA Premium®" Efficiency.

For shaft heights above 400 mm, the maximum RMS-value of the vibration velocity shall be 2.8 mm/s.

Unless otherwise specified, the motors shall be balanced according to the "Half Key Convention".

The motors shall be equipped with a fan for low noise level. Maximum sound pressure, according to ISO 3744, shall be max 75 dB(A) at a distance of 1 meter. When using a silencer hood covering the whole compressor unit, the motor fan shall provide the necessary amount of cooling air when working against an external pressure of 60-80 Pa.

Each motor shall have a nameplate which shall provide the following: type, frame, insulation, class, kW, full load current, RPM, temperature rise, Manufacturer's name and serial number, model, voltages, locked rotor KVA code, bearing numbers, lubrication instructions and a connection diagram.

The motors shall be protected for normal shipment and unheated indoor storage.

16.0.23 Inlet Filter/Silencer

Each blower shall be equipped with an inlet filter/silencer mounted directly on the inlet of the blower via a flexible connector. Such mounting is for the purpose of reducing the pressure drop across the inlet appurtenances and of minimizing noise from the pipes. The filter/silencer housing shall consist of steel plate and acoustical sound-deadening material on the inside.

The inlet filter shall be capable of removing 95 percent of all particles 10 microns and larger and 90 percent of all particles 1 micron and larger.

The filter elements shall be on a flat, vertical mounting frame, secured by hold-down clips. These hold-down clips shall facilitate easy removal and replacement of elements. Suitable gasket material shall be permanently affixed to the mounting frame to prevent bypass of air around filters. The filters shall be sized for a normal face velocity of 3.0 m/sec. at peak air flow, with a final pressure drop of 30 mm water column (w.c.) across the element.

The integral inlet silencer shall consist of a lamella, mounted internally in the filter/silencer between the filter elements and compressor inlet, suitably wrapped with sound absorbing material. Lamella internals shall serve to reduce the noise level from blower inlet via the sound absorbing material. Maximum pressure drop of the inlet filter/silencer unit with dirty filter elements shall be 60 mm water column.

16.0.24 Discharge Flex Connector

Each blower shall be provided with a discharge expansion joint. The expansion joint shall alleviate stress caused by thermal expansion and contraction in the piping system and the vibration imposed on the piping by the blowers. The expansion joints shall be capable of withstanding the pressure under all operating conditions and a temperature range from 0 to 200° C.

16.0.25 Discharge Cone

Each compressor shall be supplied with a discharge cone to increase the discharge from the compressor outlet to the discharge pipe, thus reducing the air velocity to a maximum of 20 m/sec. The length of the discharge cone shall be aerodynamically designed in order to recover dynamic pressure head and minimize discharge turbulence. The discharge cone

shall be constructed of galvanized steel plate, with flanges, and be equipped with a stud for a possible measuring device.

16.0.26 Blow-off (Bypass) Valve

Each blower shall be provided with a blow-off valve to allow unloaded start-up and stop. The valve shall be a wafer type butterfly valve, for air service. The valve operator shall be motorized, equipped with open/closed limit switches, and shall be suitable for air service at 200°C operating temperature. Open close modulating operation of the valve shall be based on remote contact closures from the blower control panel while in automatic mode of operation. Opening or closing shall be controlled by the open-close pushbuttons while in the manual mode of operation. Controls for the valve shall be mounted in each local blower control panel with indicating lights to indicate fully open or closed.

The blow-off valve shall open quickly when the blower is shut off and shall close slowly (in controlled increments) when the blower is turned on.

A blow-off silencer shall be provided for each blower and mounted on the discharge bypass line. The blow-off valve silencer shall be constructed of carbon steel and contain sound absorption material encased in an outer shell. The silencer shall have one flange inlet connection for bolting onto the end of the bypass line.

16.0.27 Check Valves

Each blower shall be provided with a discharge check valve. Check valves shall be of the dual flat plate type with center hinge and spring closure, and shall have a cast iron body and aluminum/bronze plates, stainless steel hinge pin and springs, and silicone or Viton seals. The valves shall have flat surfaces with resilient seat facing on the body. The two plates shall be independently supported on the hinge pin and have separate closure springs.

Valves shall be wafer body type and valve ends shall be plain faced for bolting between flanges. Valves shall handle the blower rated discharge flow with a headloss not to exceed 100 mm w.c. and shall be rated for temperatures up to 140°C.

16.0.28 Isolation Valves

Each blower shall be equipped with a discharge isolation valve.

The valve shall be of the butterfly type, designed with a body suitable for bolting between flanges and a stainless steel seat ring. The valve disc shall be eccentrically mounted on the shaft, and the shaft centerline shall be off-centered with the body centerline.

The elastomeric seal shall be seated in a recess along the periphery of the disc and shall be fixed by a metal retaining ring bolted to the disc. The shaft shall be mounted in bronze bushings, sealed by O-rings.

Valve to include descriptive placard (enameled or synthetic material) with attachment plates and screws. Valve shall be equipped with handwheel operation.

Valves shall be rated for temperatures up to 140°C.

16.0.29 Manifold and Related Pipework

The supply of the blowers shall include the supply of a 14"/24" diameter Discharge Manifold and all related pipework and fittings from the blowers to the Manifold and from the Manifold to the 24"-diameter common discharge pipeline at a flanged connection point ½ meter outside the external wall of the Blowers Building (as per Drawings) At this connection point, the pipeline will be connected to a discharge pipeline to be supplied and erected under the Civil Engineering Contract (not this Contract) All exposed pipework and fittings shall be suitably insulated to protect plant operations personnel. Also included in the supply of the blowers shall be the pipework for the blow-off valve and silencer (extending through the external wall of the building) and instrumentation pipe accessories.

16.0.30 Instrumentation

All instrumentation necessary for the operation of the blowers as described herein shall be supplied by the Contractor. All instrumentation shall satisfy the requirements of Sub Clause **שגיאה! מקור ההפניה לא נמצא.** below. References to the plant's CPLC or an SPLC shall be understood as referring, in the case of the blowers' instrumentation, to the blowers' local control panels described in detail below.

Instrumentation shall include, as a minimum (for each blower):

- a. Inlet Air Filter Differential Pressure Gauge (visual)
- b. Inlet Air High Temperature Switch to shut off blower when pressure rise in inlet due to recirculated air is detected)

- c. Surge Indicator Switch (surge monitor) (to shut off blower when pressure drop characteristic of surge is detected)
- d. Oil High Temperature Switch
- e. Oil Temperature Gauge (visual)
- f. Oil Low Pressure Switch
- g. Oil Pressure Gauge (visual)
- h. Oil Filter Differential Pressure Indicator (visual)
- i. Self-Acting Thermostatic Water Valve for Water-Cooled Oil Cooler if used
- j. Inlet AirFlow Rate Control Mechanism Position Transmitter, 4-20mA (either from inlet vanes or inlet throttling valve)
- k. Pressure Transmitter for erection in the common Discharge Manifold. 4-20 mA signals to be used by SCP to regulate blower air flow rates to keep constant system pressure.
- l. Frequency converter for each blower. Each converter shall be suitable for the size and capacity of blowers and will be approved by the engineer.

16.0.31 Control Panels

Three (3) local control panels (one (1) for each blower) and one (1) system control panel (SCP) shall be supplied. All The control panels will send and receive information to and from the CCP. All the control panels shall be the blower manufacturer's own original control panels.

Control panels shall comply with clause 16.0.10 and with this sub-clause 16.0.31

The supply and erection of the electrical and control cabling between the LCP's and the blowers, between the LCP's and the SCP, and between the LCP's/SCP and the plant's Central Control Panel shall be effected under the Erection Contract (not this Contract) The Contractor under this Part shall, however, supply the Erection Contractor with complete and explicit wiring cable list and terminal connection diagrams and other diagrams and drawings and shall supervise the electrical works to be undertaken by said Erection Contractor. All wiring within the LCP's and SCP shall be executed by the Contractor under this Part.

All signals (discrete or analog), alarms, alerts, switches, etc., received at any of the LCP's or at the SCP shall be transmitted to the plant's Central Control Panel via discrete or analog outputs from the SCP. The LCP's and the SCP provided shall be suitable for this

purpose. The AO/DO from the LCP's/SCP shall include the following for EACH of the blowers:

- * Motor status signals (on, off, failure) for each of the blowers and for all auxiliary motors.
- * Selector switch setting for all motors
- * High temperature failure
- * Surge alarm
- * Inlet air high temperature alarm
- * Low oil pressure alarm
- * Air flow rate (m³/h) for each blower
- * Position indication of inlet air flow rate control mechanism (inlet vanes or throttling valve)
- * Pressure in common discharge manifold

Local Control Panels

Each blower shall be furnished with a separate local control panel. Each LCP shall include all controls to start, stop and operate the blower, provide detection of malfunctions and shut down the blower should malfunctions occur. The LCP shall incorporate all features required for proper operation of the blowers. Control philosophy shall be fail-safe operation, i.e., all controls and instruments shall fail in an alarm situation. The controls shall be designed so that the blower cannot operate unless the controls are energized, nor can it operate with any defective or failed controls. The controls shall be housed in a panel to be mounted on the blower skid.

The local control panel shall consist of the following:

Low voltage system - with main switch and motor-overload relays for auxiliary equipment such as blow-off valve, variable diffuser, and inlet vanes or inlet throttling valves, and all other blower motors with the exception of the main blower drive motors. Further, with thermistor relay (trip) to connect to the drive motor's temperature sensors, and relay for control of drive motor's main switch, with wiring to:

Control system - with automatic programmable logic controller with current overload-circuit to limit power consumption of the blower, and all necessary control circuits for oil pressure, oil temperature, surge limit, and recirculation. Blower airflow rate to be adjusted

automatically and continuously based on instructions from the SCP. LCP shall include color 7" touch screen for operation and data.

Front panel - with necessary finger-touch pad with symbols and LED flush lamps for function indication, in solid and dirt-resistant diaphragm technique, with position indicator for inlet air flow rate control mechanism, with hour counter, ammeter, and emergency stop. Front panel shall include local – stop – remote control switch. Local from touch screen, remote from SCP.

Low voltage and control systems mounted in a steel panel, IP54, and internally wired.

Terminal strip for external wiring.

Power supply: 3 X 230/400 V, 50 Hz, O-earth, 16 A.

System Control Panel (SCP)

A programmable controller-based sequencing panel shall be provided for starting and stopping compressors automatically and to control the blowers (infinite variation across operating range) and thereby provide discharge air header pressure control.

The sequencing system shall provide discharge header pressure with any or all of the blowers in service. The discharge pressure set point shall be adjustable over a certain range. The remote set point input shall be a 4-20 mA DC signal corresponding to the control range.

The panel front shall have a selector switch for each blower; rotation of the blowers shall be automatic (per start command but not less frequently than once per day) The local set point adjustment knob and the switch for local or remote control shall also be located on the panel door.

The SCP shall have status lights as follows, for each blower:

1. Blower in remote
2. Blower
3. Blower alarm

The master sequence controller, via the internal programmable controller, shall receive the main air header pressure 4-20 mA signal that calls for more or less air. The controller shall bring on-and-off line and increase/decrease on-line blower capacity based on the

Manufacturer's standard control logic. The result shall be gradual increase/decrease of air throughout the entire capacity range of the blowers online. In event of blower failure, the next blower in the pre-selected start sequence shall come online.

The SCP shall include communication outputs as follows: MODBAS AS 485, MODBAS over TCP/IP.

Communication between LCP and SCP shall be MODBAS AS 485.

All information from SCP and LCP shall be transferred to the plants' central control panel via MODBAS over TCP/IP.

Plants' control shall be able to operate and define set points for each blower and/or all 4 blowers.

16.0.31.1 Surface Preparation and Shop Painting

All surfaces shall be prepared, shop primed and shop finish painted with two coats of Manufacturer's standard paint system as part of the work under this Section. Machine surfaces that are not painted shall be protected by coating with a corrosive-protective compound.

16.0.31.2 Tools and Spare Parts

Special tools shall be furnished with the equipment. All such tools shall be furnished in a suitable wooden or steel tool chest complete with lock and duplicate keys. A list of the special tools to be supplied shall be furnished by the Contractor together with his offer. A list of the spare parts required for the blowers shall be furnished together with the offer.

16.0.32 Supervision of Blowers Erection

The Supervision of Erection under this clause - 16.0.32 will follow the demands detailed on clause 16.0.08.

Quality Assurance

For each of the Sub-clauses under this Clause 16.0.32 , the Supplier shall supply proof that the individual authorized by the Supplier/Manufacturer to supervise the (mechanical and electrical) erection of the equipment described above has supervised the successful erection of at least (3) similar systems in the past five (5) years. Absent such proof, the Supplier shall be required to provide the services of a qualified employee of the manufacturer (authorizing the Supplier's representation or agency) to supervise the

erection activities. Such employee shall have supervised the successful erection of at least three (3) similar systems in the past five (5) years.

CHAPTER 17: Schedule of Particular & Guarantees

17.1 Preamble

The Tenderer shall supply the information requested in the Schedule of Particulars and Guarantees by writing in the spaces provided. Should the space be insufficient, additional pages may be added by the Tenderer, which shall be attached to the Forms contained in the Schedule.

A digital copy of Schedule of the Particulars and Guarantees table with the information requested shall be enclosed.

Catalogues and other pertinent literature, as well as performance curves, etc., called for in the Schedule of Particulars and Guarantees shall be enclosed with the Tender Documents submitted by the Tenderer.

The Guarantees called for in respect of certain equipment shall be given separately for each item, and shall bear the Tenderer's signature.

The Tenderer should carefully read the General and Particular Specifications, so as to become thoroughly familiar with his duties and obligations in respect to each item of work, the specifications and requirements of each work item, the methods of measurements, and the details concerning what the unit rates include.

The Tenderer shall duly sign each page of the Schedule of Particulars and Guarantees, and Schedule of Deviations (if any) if a Schedule of Deviations is submitted; a signed note to this effect shall be entered in the Schedule of Particulars and Guarantees.

17.2 Schedule of Particular & Guarantees

General

Description	Minimum Requirement	Supplier's offer
Manufacturer's Name:		
Model:		
Type:		
Method of Air Flow Rate Control:		
Surge Limit, expressed as a percent of blower air flow rate capacity:		
Blower Casing Material:		
Gears Material:		
Rotors Material:		
Shafts Material:		
Shaft Seals – Type:		
Local Control Panels - Manufacturer		
Main Control Panel - Manufacturer		

Electrical Motor:

Manufacturer's Name:		
RPM:		
Rated Power (Kw):		
Type / Model:		
Frame Size:		
Service Factor:		
Power Factor at Full Load:		
Motor IP Protection Rating:		
Current: Nominal Current (Amp.):		
Locked Rotor Current (Amp.):		
Insulation Class:		
Temperature Rise at Full Load (°C)		
Net Weight of Motor (kg)		

Guaranteed Performances

The Manufacturer shall fill in the following tables the expected flow rates, pressures, power and rotation velocities of both the motor and the blower. The manufacturer shall state the tolerance for the guaranteed values:

Description	Minimum Requirement	Supplier's offer
Tolerance for pressure, %	0	
Tolerance for Flow rate, %	0	
Tolerance for Power, %	5	

Power consumption at normal conditions (20°C, 1 atm, 36% RH)

Pressure for full capacity is 800 mbar. Pressure of other working points is 750 mbar.

	Flow rate m ³ /h	Shaft power kW	Wire power kW	Blower RPM	Motor RPM
Full capacity (800 mbar)	7,000				
100%	7,000				
80% Capacity	5,600				
60% Capacity	4,200				
Minimum Capacity					

Power consumption at frequent conditions (30°C, 1 atm, 80% RH)

Pressure for full capacity is 800 mbar. Pressure of other working points is 750 mbar.

	Flow rate m ³ /h	Shaft power kW	Wire power kW	Blower RPM	Motor RPM
Full capacity (800 mbar)					
100%					
80% Capacity					
60% Capacity					
Minimum Capacity					

Power consumption at worst case conditions (40°C, 1 atm, 85% RH)

Pressure for full capacity is 800 mbar. Pressure of other working points is 750 mbar.

	Flow rate m ³ /h	Shaft power kW	Wire power kW	Blower RPM	Motor RPM
Full capacity (800 mbar)					
100%					
80% Capacity					
60% Capacity					
Minimum Capacity					

Time for Delivery

Description	Minimum Requirement	Supplier's offer
Delivery Time for All Equipment , months		