SECTION 5A-Subsection 9: Electrical Works

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9 ELECTRICAL WORKS

9.1 General

In the following are outlined the minimum requirements for the Electrical Works for Mechanical Biological Treatment Facility.

9.1.1 System of Units

All measurements must be in accordance with the International Systems of Units (SI), with the exception of temperature, which will be expressed in degrees Celsius.

9.1.2 Design Temperature – ambient conditions

Altitude

The altitude of the works is approx. 850 – 870 masl (meters above sea level)

Ambient temperature – design temperature

All items of goods shall be designed for an ambient temperature of 0^0 C to 40^0 C.

The Contractor shall in this design account for the temperature rise deriving from installed equipment and from solar radiation in such a way that the rated performance and stability of the plant is guaranteed under the prevailing climatic conditions.

Attention shall be given to the design of panels.

The maximum temperature inside the panels should not exceed 30°C or the maximum temperature for any electrical part in the panel.

Average humidity

On average, December is the most humid.

On average, July is the least humid month.

The average annual percentage of humidity is: 57.0%

9.1.3 Degree of Protection

All terminal boxes, cabinets, lighting fixtures, etc. shall have degrees of protection by enclosure, as follows:

Protection	Panels	Terminal	Lighting	Interior	Cable	Combinet	Other	Local	Outdoor
		Box		Socket	gland	box	material	Control	Lighting
								Box	Local
									Panel
Indoor	IP54	IP54	IP40	IP40	IP65	IP54	IP41	IP65	IP54
Outdoor	IP65	IP65	IP65	IP65	IP65	IP65	IP65	IP65	IP65

Other requirements are as specified in the relevant chapters.

9.1.4 Condensation

All enclosures shall be designed to avoid condensation with provision for ventilation and drainage as appropriate. Openings for ventilation and drainage must not give access to vermin.

All surface mounted boards will have IP65 gland, there will not be inlet with brush or sponge.

All MCC panels will be air conditioned such that room temperature does not exceed 30°C. Calculation for air conditioning will be submitted for approval.

Main Distribution and all MCC panel rooms will be airconditioned by air handling unit.

Ventilating blower system will be used in Diesel Generator room.

9.1.5 Voltages

Electricity available in Turkey is A.C., 230 V \pm 5% single phase, 50 Hz and 230 V/400 V \pm 5% three phases, 50 Hz \pm 2 Hz .The power factor of the facility shall be 0.99. The voltage drop from transformer to any consuming equipment must not exceed 5 %.

Supply voltage from energy suply point to the final loads will be maximum 5%

Simultaneous operating coefficient factor will be decided based on the operation and system.

9.1.6 Marking

Each item of equipment shall be provided with a rating plate giving the type and serial number together with its ratings and service conditions. Labels and nameplates shall be provided as necessary to clearly identify the function and circuit designation of equipment. The supply voltage shall also be written on the rating plate. All panels, switches, boxes, cables, motors etc. shall be labelled.

All rating plates, nameplates, labels and wiring plates shall be of non-corrodible material Plastic or metal material shall be provided, not label in paper). Inscriptions shall be clearly legible from the operating distance and shall be in Turkish and English throughout. Notices indicating danger to personnel shall be in Turkish. Details and locations of all such plates, labels, etc. shall be subject to the Engineer's approval.

Labeling will be made in board and equipment side in all cables.

- Cable label exterior sheath will be made of PP isolation raw material, HB flammability class will be UL 94, operational temperature range is between -40/+80°C. Length should be minimum 30 mm and width should be 10 mm.
- Label within sheath: Resistant against slight solvent, resistant against UV lights within temperature range between -18°C and 90°C, it will not fade under sunlight, made of plastic alloy with thermal printed and should be resistant against water.

9.2 Scope of Works

9.2.1 Works to be carried out by the Contractor

The scope of electrical works to be covered in this contract includes, but is not limited to, the following main items:

- A complete design of all electrical & control system.
- High voltage switchgear, step-down transformers, metering system, power supply cables for both high and low voltage.
- A complete electrical installation including transformers, UPS's, distribution panels, MCC's, control panels, PLC's, cable trays and building installations

- Electrical consumption shall be provided for each panelduring Tender Stage.
- Required number and type of energy analysers to be used during the Defects Notification Period. The Contractor shall design, supply, install, test & commission of these energy analysers. The type, number and specifications shall be subject to the Engineer's approval. These values will be communicated to SCADA.
- A complete indoor and outdoor lighting system and outdoor socket outlets stations, data and communication system.
- SCADA system shall be used for complete monitoring & operation procedures.
- A complete computer based control and monitoring system together with necessary software shall be provided. All electrical and electronic equipment used in the MBT Facility (even if they are packaged units) shall be controlled and monitored with SCADA .All parameters of the used equipment shall be transmit to tag of SCADA software as Input.
- Automatic power compensation systemshall be provided. This system shall be equipped according to Internationalstandards of harmonic distortion (% THD) in accordance with the IEEE 519-2014.
- Lightning protection systems and installation inclusive protective earthing and equipotential bonding.
- A complete instrumentation system.
- A complete uninterruptible power supply system (UPS) for the control and monitoring system and the instrumentation(Seperate UPS units shall be introduced for each relevant unit),
- An emergency lighting system in all rooms
- Diesel generator set
- Supply of electricalspare parts
- Supply of special tools
- All approvals (design, connections, earthing etc.) and negotiations with local authorities (electricity supply company)

9.3 Standards

The Contract shall be executed in compliance with the directives, norms and standards listed in General Section, listed below and elsewhere in the present description.

Standard No	Date of Issue	Subject	International Standard
TS 267	20.03.1998	Power transformers-Section 1 General	IEC 60076-1
TS 10901	17.04.1998	Power transformers-Section 2 Temp. Increase	EN 60076-2
TS 10902	02.03.2004	Power transformers-Section 3 Insulation tests	EN 60076-3
TS 3791	07.09.1982	Implementation rules for power transformers	IEC 606,214,542
TS 3989	15.12.1998	Insulation Liquids- At power frequency be pierced voltage test	IEC 60156

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Standard No	Date of Issue	Subject	International Standard
TS 623	07.03.2002	Mineral insulation oils	IEC 60296
TS 7451	26.09.1989	Power transformers-Dry type	
TS IEC 60905	13.10.1998	Loading guide for dry type power transformers	IEC 60905
TS EN 61330	30.01.2001	HV-LV Prefabricated transformers and distribution centres	EN 61330
TS 8711	29.01.1991	Noise level determination for transformers and Reactors	
TS 7032	03.05.1998	Terms and descriptions for electrotechnics, Measurement transformers	
TS 620	16.03.2004	Measurement transformers-Section 1 Current transformers	EN 60044-1
TS 718	26.04.2004	Measurement transformers-Section 2 Voltage transformers	EN 60044-2
TS 997	08.09.1983	Concrete posts	
TS 9612	19.02.2002	Air cable conductors	EN 50183
TS EN 50182	13.01.2003	Air cable conductors, Round wired same centred knitted conductors	EN 50182
TS 9756, 57	24.02.2004	Cables, Thermoplastic insulated	HD 21-1 S4.
TS 3067	23.03.1978	3 phase inductance motors	
TS 4239	24.04.1984	Mono phase inductance motors	
TS 5590	16.04.1997	Electrical measurement devices and accessories	EN 60051-2
TS 5592	16.04.1997	Electrical measurement devices and accessories- frequency meter	EN 60051-4
TS 5594	16.04.1997	Electrical measurement devices and accessories- phase meter, power factor and synchronization meter	EN 60051-5
TS 461	08.12.1998	Meters- for Alternative current (0.5 1 and 2 classes	EN 60521
TS 5018	09.01.1996	Circuit breakers, prevention of excess current at houses or similar installations	EN 60898
TS 3367	22.04.2004	Low voltage switches and control units	EN 60439-1
TS 1472	04.04.1997	Switches- for electrical equipments Section 1 General rules	EN 61058-1
TS 1058	11.11.1997	Low voltage switching and control apparatus Section 2 Circuit breakers	EN60947-2

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Standard No	Date of Issue	Subject	International Standard
TS EN 60947-3	08.04.2004	Low voltage switching and control regularity Section 3 Switches, breakers, melding wire fuses incorporated units	EN 60947-3
TS 4915	18.01.2005	Switches, for stationary electrical installations like houses or similar places	EN 60669-1
TS EN 60947-4- 1	06.10.1998	Low voltage switching and control apparatus Section 4 Contactors and Motor starters	EN 60947-1
TS 8697	17.03.1998	Lighting armatures Section 1 General rules and tests	EN60947-4-1
TS 8698	01.04.1996	Lighting armatures Section 2 Special rules	EN 60598-2-1
TS 8699	14.05.1998	Lighting armatures Section 1 General rules and tests	EN60598-3
TS 8700	15.05.1998	Lighting armatures for lighting roads and streets	EN 60598-2-3
TS 914	06.11.2001	Hot dip galvanising for iron and steel construction materials	EN ISO 1461
TS EN 62271- 100	26.04.2004	High voltage switches. Section 100 High voltage alternative current breakers	EN 62271-100
TS 2	31.01.2002	Copper wire. Hard lengthen for electrical uses	
TS 3	29.04.1994	Copper conductors, knitted, for air cables	
TS 2042	18.04.1988	Internal-external support isolators for more than 1000 volts	IEC 273
TS EN 60383-1	15.12.1998	Support isolators for air cables, of more than 1000 volts	EN 60383-1
TS EN 60383-2	05.01.1999	Chain isolators for more than 1000 volts	EN 60383-2
TS 464	27.09.1997	Surge arresters	EN 60099-1
TS EN 30391-1	22.04.2004	Condensers	EN 60931-1

9.3.1 Regulations

- Regulation on Designing of Electrical energy installations
- Regulation on electrical high current installations
- Regulation on internal electrical installations
- Regulation on electrical earthing installations

9.3.2 Technical Specifications of TEDAS

- TEDAS-MYD-96-017 Technical specifications for medium voltage breakers
- TEDAS-MYD-96-019 Technical specifications for medium voltage metal oxide surge arresters

- TEDAS-MYD-96-014 Technical specifications for knitted aluminium and steel based aluminium knitted conductors.
- TEDAS-MYD-96-018.A Technical specifications for Insulated Energy cables made from crosswire polyethylene (XLPE)
- TEDAS-MYD-99-033.A Technical specifications for medium voltage cable head
- TEDAS-MYD-95-007.C IEC62271-200, IEC 62271-100, IEC 62271-102, IEC 60265-1, IEC 60694, IEC 60281-1, IEC 60044-1, IEC 60044-8, IEC 60044-2, IEC 60529, IEC 60255Technical specifications for air insulated, medium voltage, metal clad modular cells
- TEDAS-MYD-95-012.B/TEDAŞ-MLZ/99-031.B.Technical specifications for distribution power transformers
- TEDAS-MYD-2003-006 Technical specifications for metal enclosed low voltage distribution panels
- TEDAS-MYD-96-015 Technical specifications for 0.6/1 kV thermoplastic or thermosetting insulated energy cables.

EUB.02 External type fused earthing breaker

EUB.03 Surge Arresters.

EUB.04 Steel aluminium swallow conductor

EUB.05 Medium voltage cables

EUB.06 Medium voltage cable header

EUB.08 Metal clad medium voltage modular cells

EUB.09 Power distribution transformer

EUB.10 Transformer low voltage panel

EUB.11 Compensation panel

EUB.12 MCC panels

EUB.14 0.6/1 kV YVV (NYY) power, control and signal cables

9.4 Hazardous Area Classification and Ex-proof Equipment

All explosion and fire hazards shall be identified and hazardous areas shall be defined in accordance with international standards by process and electrical engineers of the Contractor in coordination. The plant and equipment specified for such areas shall be limited as to type and construction by the area classification. Test certificates shall be furnished for all plant and equipment that constitutes a hazard. Such certificates shall be in accordance with the relevant standards stated at the end of this item of the Employer's Requirements.

Whenever on the site an explosion & fire hazard exists, adequate instructions should be given to all personnel working in the area and notices shall be displayed to warn all third parties of the danger. Such notices should also advise on precautions to be taken. The Process Engineer is responsible to issue for each unit a list, showing the data and characteristics of the flammable substances (if any) handled in that unit.

No junction boxes are allowed at hazardous areas. If necessary, Engineer's approval is required.

Proper electrical equipment and instruments shall be used for the hazardous (Classified) areas (Exd, Exi and intrinsically safe panel barriers, etc.)

Electrical and control system equipment and materials for installation in hazardous areas shall be labelled according to IEC markings, listed, certified, accepted or otherwise determined to be safe by nationally or internationally recognized testing authorities.

Ex (Explosion)-proof and/or intrinsically safe equipment shall be used at flammable gas and/or flammable gas leakage hazard areas according to the related standards (CH4 or any others).

Contractor shall follow the regulations and/or rules about the Hazardous Area Classification according to the following standards/directives and shall design/provide Hazardous Area Classification Lists and Drawings, where hazardous risks may arise for flammable gas/vapours, atmospheres:

- EN 60079-10, IEC 79-10: Electrical Apparatus for Explosive Gas Atmospheres.
- CEI 31-35 and 31-35/A: Electrical Apparatus for Explosive gas atmospheres Guides for classification of hazardous areas.
- ATEX 95 *equipment* directive 94/9/EC, Equipment and protective systems intended for use in potentially explosive atmospheres
- ATEX 137 *workplace* directive 99/92/EC, Minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres

9.5 High Voltage Switchgear and Transformer Stations

9.5.1 General

High voltage switchgear and transformer stations shall be designed for safe, reliable and maintenance free operation under the environmental conditions at the sites.

Transformer rooms, medium voltage cubicle rooms, generator rooms and, all panel boards, will have steel sheet door(it will not be usedaluminum, approval will be taken from electrical authority, they will be accordingly with TEDAŞ type MOD type electrical rooms standards. It will have minimum 2000 mm width and 3500 mm height.

The design and specifications for transformer stations shall be approved by local electricity authorities.

Mains supply voltage from local energy suppliers for plant, main inlet, current/voltage transformer ratios should strictly be considered in selection of transformer and medium voltage cubicles.

The supplying energy for the MBT Facility, the obtaining energy permission, the depositing all the legal fees, the supply installation of the energy power transmission line (XLPE MV cable), the connections to end pole will be foreseen at the border of the MBT Facility.

The MV energy supply point will be clarified by the Turkish Electricity Distribution Company and theContractor shall prepare all the application drawings and procedures and after that Legal Proceduresshould be followed. The MV energy supply point might not be at the border of the plant and that depends on the demanded – asked electrical power.

The equipment is located at the Facility property and is supplied under this Contract and is owned by the Employer. Nevertheless it shall be possible for skilled representatives from the power supply company to get unlimited access to the transformer installations.

The components of the stations shall be a standard construction provided with standard equipment and delivered ready for easy connection and reliable and safe operation.

The stations shall consist of:

- High voltage section with power circuit breakers, earthing connectors, over voltage protection equipment, volt and ampere measuring transformers,
- Transformer section with power transformer(s),
- Low voltage section,
- Earthing system.

Power transformers shall be constructed for installation on a concrete foundation. The latter shall be constructed with an internal collecting pit for insulating fluid (oil) from the transformer. The pit shall be filled with stones of suitable size. The pit shall have sufficient capacity to contain all the insulating fluid of the transformer.

The layout of the station shall allow for easy access to equipment inside the station. Further, easy replacement shall be allowed, in particular replacement of the transformers.

Protection equipment, control switches and indicating instruments for the high voltage switchgear and transformer station shall be installed in a dedicated control panel. Connectors at all panels shall be numbered.

The high voltage equipment shall be rated for continuous operation with maximum load of the distribution transformers and the present fault level as calculated by the Contractor.

All materials shall be "ready made" and prepared for easy site installation with a minimum of work required onsite.

All components shall be manufactured from a modified, cross-linked, polyolefin-based, heat shrinkable product manufactured from a semi-rigid compound. The dimensions of the product shall reduce a predetermined size upon application of heat in excess of 125°C.

The materials shall have the following properties:

- A tensile strength of 170 kg/cm², the ultimate elongation shall not be less than 350 percent and the high temperature ultimate elongation shall not be less than 400 percent. After subjection to thermal ageing at 150+2°C for 168 hours, the tensile strength shall not be less than 140 kg/cm² and the ultimate elongation shall not be less than 300 percent. The tests shall be in accordance with BS 2782.
- The electric strength of the material shall not be less than120 kV/cm.
- The material shall have a continuous operating temperature of 120°C.
- The material shall have water absorption of less than 0.1 percent in accordance with the test requirements of BS 2782.
- All parts which are required to be resistant to ingress of moisture shall be coated with an adhesive which will operate satisfactorily under the conditions of direct sunlight, temperature and humidity and in particular, shall exhibit the following properties.
- The adhesive shall have a viscosity of 250 ± 40 poise at 160°C when tested in accordance with ASTM D 1084 Method B, Shear 5, or P.
- The adhesive shall have a softening point of 120 ± 10°C when tested in accordance with ASTM E 28.

- The adhesive shall have a peel strength to PVC of 13 kg/25 mm width when tested on a rotating mandrel.
- The adhesive shall have a shear strength of not less than 35 kg/cm at 23 + 2°C on aluminium/aluminium after heating at 150°C for 20 minutes.

9.5.2 Power circuit breakers and disconnectors

HV switchgear unit should be same, as followed table.Tenderer should take the required information (voltage and current, minimum and maximum peak values of voltage and current) from local electricityauthority during Tender Stage.

MV cubicles shall be metal clad type with 1 feeder inlet (depend on the National Electric Company's approval), sectioning, transformer outlets and measuring systems.

Medium voltage cubicle structure will have following type. Transformation ratios and classifications for current/voltage transformer will be confirmed by Local Electricity Supplier.

If CHP (if any) unit is connected to HV line, the Contractor shall provide additional switchgear for CHP unit. HV switchgear unit shall be communicated with SCADA system via Ethernet for energy consumption.

There will be power analyzer / protection relay with Ethernet/bus Communication in medium voltage cubicles. It will communicate with SCADA systemviaEthernet.

Inlet cubicle	Measurement cubicle	Transformer outlet 1 cubicle	Transformer outlet 2 cubicle	Transformer outlet 3 cubicle

Power circuit breakers and disconnectors shall be three-pole types, and metal-clad draw out SF6 GAS / Vacuum circuit breaker system. Circuit breakers shall be foreseen for inlet and transformer outlets. Protection relay shall be considered for each MV cubicle with circuit breaker.

Load disconnectors shall have characteristics commensurate with the circuit they supply and a load break capacity in excess of the total load of the circuit they supply.

Power circuit breakers rated switching capacity shall be at least equal to the total load of the circuit they supply. Power circuit breakers shall be provided with adjustable instantaneous short circuit and overload trips relays to allow for changes in the site load, and to allow for plant expansion. The prospective fault level must not be higher than the breaker capacity, and the time/current tripping characteristics shall be chosen and set with due regard to the equipment performance and circuit data, and to assure discrimination between series connected power circuit breakers. The power circuit breaker closest to a fault shall clear the fault. If it fails the upstream power circuit breaker shall clear the fault.

Power circuit breakers shall be fitted with a protection system to comprise the following facilities:

- Single phase failure trip
- Earth fault trip
- Thermal overload trip
- Short circuit trip

Construction in accordance with:	IEC 60265 and 60420
Fuses:	HRC fuses to IEC 60282-1
Transformer stations	
On and off switching:	Independent of operation speed, snap action.
Manual Opening:	Manual by means of an operating handle.
Automatic opening:	Energy storing trip mechanism for automatic opening after HRC fuses have operated.

The power circuit breakers shall comply with IEC 60265 and 60420.

All power circuit breakers shall be automatically controlled from the protection equipment (gas alarm, high temperature alarm, overcurrent, short circuit and I²t thermo).

All power circuit breakers shall be fitted with an operator handle enabling manual switching.

All cables shall be connected through terminals. Terminals shall be suitable for the dimension of the cables and conductor material used.

All available signals shall be provided for SCADA and wired to the PLC for remote control and monitoring.

9.5.3 Transformers

Transformer inlet will be confirmed from Local Electricity Supplier.

Transformer will be dry type or oil immersed type, will have MV and LV copper winding, minimum 5 stageon load automatic tap changer, forced fan, andwill have heat control probe.

All material used for manufacturing transformers, will be chosen as appropriate for its use and purpose in structure, first class quality, robust, and will have excellent physical and electrical features.

Design and manufacturing of transformers, will be accomplished by the latest technical applications and with the best workmanship and safety factors will be taken into consideration thoroughly for the whole job.

The power transformers shall be three-phase transformers with voltage level 36/0,4 kV (thisvalue shall be approved by Local electricity authorities) suitable rated for continuous load of the Facility under worst climatic site conditions. The capacity is divided into two transformers including 1 spare in same capacity. The Contractor has to specify the capacity based on the detailed design.

The capacity will be calculated as demand power and divided in two transformers. There will be two transformers with equal power where both will be operated in parallel. Third one having same capacity will be kept in spare. Spare one will be able to be put into operation when one of both is in failure.

The design and specifications shall be approved by local electricity authorities.

Transformer losses (no-load and load losses) shall be designed to a value according to IEC-60076 or Ecodesign directive.EN 50588-1:2015; EU No 548/2014

The impedance voltage Uk (%) will have a valuebetween 4-6 %.

The transformer rating under standard conditions shall be in accordance with IEC-60076.

There will be plug in connection type on the transformer MV bushings.

The three phase transformer windings shall be connected in a delta-star formation with group 4 phase displacement, high voltage to low voltage vector group reference Dyn 11. The star point of the low voltage winding shall be brought out through the tank and suitably terminated for solid earthing.

Winding insulation shall be to Class 'A'. The temperature rise shall be limited to the maximum operating temperature for Class 'A' materials as defined in IEC 60076 de-rated for the climatic conditions.

The high voltage windings shall be provided with tapping from +5% to -5% in $2\frac{1}{2}\%$ stages with constant flux voltage variation as defined in IEC 60076.

On load tap changershall be preffered. Tap selection shall be by means of a five position (or more depend on the area to be applied) externally operated automatic control on load tapping switch. Last decision should be taken with the Engineer as well as Local Electrical Company.

The winding design and construction shall provide adequately designed and located coolant flow ducts so that possible hot spots are eliminated. Windings shall be braced to withstand dynamic stresses due to short circuit conditions. Full details shall be provided of the arrangements for taking up or eliminating coil shrinkage during service. The core and winding shall be designed so that the loss is minimum but the ratio of copper loss to iron loss shall be in accordance with an economic design and the manufacturer shall state the ratio used.

The complete transformer arranged for service shall be capable of withstanding an impulse voltage on the primary windings in accordance with IEC 60076-3.

Cooling will be made by forced blower, which is coupled to transformer in transformers of which power is greater than 800 kVA. (AF type). MV winding will be coated with epoxy resin under vacuum and LV winding will be coated with cast resin.

Transformer shall provide as followed regulations and standards;

Standards;

Acc to EC 60076-11 Climatic C2, Environment E2, Fire BehaviourF1

- HD 464 S1
- HD 538.1 S1
- EN 60726
- VDE 0532
- ANSI C57.12.01

Temperature control will be made in low voltage winding by PT100/PTC and will put forced fan into operation at set value and will be able to switch off transformer if temperature continues.

Oil-immersed type transformers (Hermetically):

Transformers shall be constructed in accordance with IEC 60076 and be of the naturally air-cooled (ONAN) oil filled type and meet or exceed the requirements of IEC 60076. They shall be suitable for outdoor installation(hermetically) and provided with a first filling of mineral oil to comply with BS 148 Grade B30 or similar (VDE 0370, ANSI C59-2 and TS-623). The transformer shall be mounted over an oil pit. The pit shall have capacity to consume the entire amount of oil in the transformer. The pit shall be filled with stones that in shape and size are suitable for the purpose of preventing fire in the spilled oil.

All terminals shall be brought out through oil tight insulating bushings to facilitate cable testing without the necessity to disconnect the cables. Bushings shall be made of porcelain.

All windings, winding terminals and connections shall be fully immersed in oil under all operating conditions. All materials shall be suitable for this duty and not subject to deterioration.

All joints shall be arranged so that they may be tightened externally.

All transformer tanks, tubes and all steelwork shall be shot blasted internally and externally before painting and a rust inhibiting paint shall be applied to both external and internal surfaces before applying a final finish. The exterior shall be given an additional coat on site of a durable oil and weather resisting paint to BS 4800 to the shade to be specified by the Engineer.

Each transformer shall be provided with the following facilities:

- Thermometer for oil temperature with alarm and trip function,
- Buchholz relay with trip function,
- Oil level gauge, clearly visible from ground level,
- Large identity labels shall be affixed to each transformer identifying their high voltage circuit feeder switchgear,
- High voltage and low voltage power circuit cable termination to suit the specified power circuit cables,
- Drain valve.

9.5.3.1 Dry type transformers:

- Three-phase, two coil
- Dry type that has epoxy resin covered coils
- Indoor
- Protection level IP31
- Voltage adjusted at idle

It will be 34.5 kV/0.4 kV voltage level in accordance with the facility energy input. (As per Local Energy Supplier's Instructions.).

Unless it is stated otherwise in this specification and appendices, transformers will be manufactured and tested according to Turkish Standards (TS) and International Electrotechnical Commission (IEC) standards latest versions given below:

TEDAŞ-MLZ/99-031.B

TS EN 60076-11	
TS IEC 60905	
TS 7451/IEC 60726	: Dry type transformers
TS IEC 60905	: Loading rules for Dry type transformers
TS 267/IEC 76	: Power transformers
HD 464 S1/A2	: Dry type transformers
HD 464 S1	: Dry type transformers

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HD 538

: Three phase dry type distribution transformers

ISO 9001

9.5.3.2 Testing and commissioning

Power transformers shall be routine tested at the manufacturer's works in accordance with BS EN 60076

The Engineer will require witnessing the following tests:

- Measurement of winding resistance.
- Ratio, polarity and phase relationship.
- Impedance voltage.
- Load losses.
- No-load losses and no-load current.
- Insulation resistance.
- Induced over-voltage withstand.
- Separate source voltage withstand.
- Temperature rise test which could be provided as type test.
- Transformer vector group test.
- Routine tests which are held in the factory without witnessing, which should be sumbmitted to the client.

Further witness tests shall also be carried out in accordance with the following:

- Impulse voltage withstand. If the manufacturer can provide evidence covering impulse voltage withstand tests for transformers of similar type and design, Type Test certificates will be acceptable.
- Temperature rise. If the manufacturer can provide evidence covering temperature rise tests for transformers of similar type and design, Type Test certificates will be acceptable.
- Prior to dispatch to site the Contractor shall pass to the Engineer or its representative, in triplicate, copies of the all test certificates for approval.

9.5.4 Instruments&Power Analyzers

The measuring transformers shall at least include load for the following instruments, all within Class 1.

There will be Multifunction Power Analyzer with minimum 2 Port Ethernet Communication at outlet of all transformer, generator and CHP units. There will be current, voltage, active/capacitive/reactive power, cosF, frequency in power analyzer, it will be able to create alarm, IEC/ANSI power accuracy class will be 0,2 there will be 4 digital input/ 2 digital output, it will be able to report in EN 50160 standard, it will have IEC 61000- 4-30 class A or Class S, All these data will be communicated to SCADA.The meter supports TCP/IP, HTTP, SNTP, SNMP, SMTP and FTP protocols and can communicate at data speeds up to 100 Mbps through its Ethernet communications port. The meter supports a single IP address between two 10/100Base-T Ethernet ports.

Instrument current transformers for protection equipment shall be installed.

Current transformers shall be of the wound primary or bar primary type according to the ratio required. Current transformers shall be suitably rated and designed to carry out appropriate metering and protection functions as indicated.

The rated load of current transformers shall not be less than the sum of loads of all relays, instruments and related loads. The current transformers shall have a continuous thermal current capacity in accordance with the current capacity of the relevant switchgear, and a short circuit capacity of the plant.

All available signals shall be provided for telemetry and wired to the PLC for remote control and monitoring.

9.5.5 Earthing system

The systems shall be designed according to below list;

Transformer/generator/C	Board,	PLC	Lightning	Rod	Operation	CHP grounding
HP operation grounding	Grounding		Conductor		Grounding	
≤3 ohm	≤ 1 ohm		\leq 5 ohm		≤3 ohm	≤3 ohm

The avarage of all earth network shall be provided with an earthing system less than 1 ohm.

The earthing system shall be constructed of earth rods driven into the ground beneath, or as close as practicable to the foundation of the transformers. An additional earthing connection between the earthing rods may be installed in as a ring electrode if needed. When strips are used, they may be buried beneath the foundation or laid in trenches at least at 1.5 m depth.

The rod electrodes shall be depth electrodes of copper with low carbon steel core not less than 1,5 meter

length and 20 mm in diameter in all earthing system.

Galvanize strip 30x3,5 mm will be used for building earthing system. The galvanize strip shall be connected other buildings minimum by 50 mm² stranded copperwire.

Galvanize strips will surround structure and will be contacted with 50 mm² stranded copper cable by Cadweld welding and will be connected with equipotential busbar.

All connections except foundation structure strip connection will be contacted with each other by Cadweld welding.

Structural earthing will be built for all structures and buildings and will be extended such their ending will be 3 m above completed ground level.

50 mm² bare stranded copper cable or equivalent galvanized strip conductor will be laid inside trays and will be contacted with grounding inside tray and plant.

The strip electrodes shall be of bare copper with conductor size not less than 20 x 4 mm.

The earthing system for each transformer station shall be interconnected with the common equipotential bonding bar (CEBB) for the Site. This interconnection shall be made of a copper strip or wire with cross section not less than 50 mm².

The earthing system shall be provided with testing joints mounted in a separate earthing cubicle. Testing joints shall be provided for each earth rod and for the connection point to the earth for the plant.

All joints and connections in the earthing system shall be carefully designed to ensure that they produce a non-relaxing joint. Welded, bolted or clamped connections are permitted.

All earth conductors shall be marked green-yellow.

9.6 Diesel Generating Set

9.6.1 General

The diesel generating set shall provide power in case of a grid failure; i.e. its power output shall be designed as a stand by set. As grid failures may occur frequently for the long duration, the set shall be capable of supplying its rated power continuously. The Contractor shall take all permission about diesel generating set from the related authority. The generator shall include power meter and this power meter shall be communicated with SCADA.

Generator will strictly be positioned inside building. Isolation cabinet or sound absorption cassettes will be used to prevent the high sound as per ER.

Generator will be selected such that it will be prime power. Additional 10% power will be added to total load in calculation for primepower.

Generator set shall be able to be operated automatically and manually.

The power rating for the generating set shall be selected to ensure that the generating set is not more than 90% loaded when all specified equipment (refer below) are operating at the same time at maximum capacity at the given power factor and at site conditions.

Rating and performance shall be in accordance with the ISO, at site conditions.

In the event that generator need is greater than 1000 kVA, generators which have power which will be able to maintain 10% additional power of total need and which have synchronization system within each other will be used. For example, 2 Nos 630 kVA synchronized board is necessary for 1250 kVA power requirement. If there is CHP unit in synchronization plant and if it supplies same line, it will also maintain network/common busbar synchronization. Generator set shallbe equipped with originally synchronization circuit breaker motorized with 4 poles. Generator set shall be separate synchronization panel.

Rating: Continuous running at variable load for duration of an emergency situation

Voltage reg.: +/- 5%

Governing: Electronic type/Class A 1

Load Acc.: 60 % in one single step and sufficient to run as specified in this section/clause

The prime mover and the alternator shall be factory mounted on a common steel chassis frame with built-in anti vibration system.

A flexible coupling shall be provided between the alternator and the engine. All piping and electrical connections shall be flexible to prevent damage by movement of the gen. set.

A local authorised representation in Turkey shall be able to provide service and maintenance. Name, address and a list of service and references shall be provided for the local representation.

9.6.2 Prime mover

The prime mover shall be a 4-stroke multi-cylinder (preferably a 6-cylinder engine), direct injection industrial standard diesel type according to ISO 8528.

The engine shall be suited for the purpose and shall have a proven record of long life operation with a minimum of maintenance.

The following details shall be incorporated:

9.6.2.1 Fuel System

The fuel system shall at least include the following:

There will be fuel tank below generator which will be sufficient for operation of generator for 8 hours under 100% load and also there will be separate fuel tank which will be sufficient for operation of generator for 24 hours under 100% load. Fuel tank will be positioned outdoors and will be manufactured from material which is suitable for outdoor. Concrete base will be built under fuel tank and Cantilever will be made of metal accessory for protecting against snow and rain for protecting against weather conditions. Wire fence will be constructed with 1 m distance with each point of fuel tank such that its height will exceed 1 meter over fuel tank.

- Fuel storage tank with a capacity for 24 hours continuous operation.
- Reservoir for the fuel storage tank to prevent oil spillage to the surroundings in case of leakage
- Pipe near the road for filling the tank (provided with a padlockable lid and ideal access)
- Level indication on fuel storage tank (accuracy +/-50 litres)
- Local fuel tank incorporated in the frame, with a capacity for 8 hours continuous operation
- Drip tray under the sump to collect oil spillage
- Fuel oil booster pump (electrically driven)
- Fuel oil filters for the duplex type. Filter elements of paper and of the disposal type
- Injection pumps
- Injection valves
- Fuel water separator
- Piping, valves and fittings
- Dual flexible fuel lines.

9.6.2.2 Fuel Specification

The diesel engine shall operate on high speed (HSD) diesel fuel.

9.6.2.3 Combustion Air

The combustion air system shall include but not be limited to the following:

- Dry element air filters
- Service indicator (restriction indicator)

• All necessary air ducting between filter and engine.

9.6.2.4 Lubrication System

The lubrication system shall at least include the following:

- Lubrication oil pump (forced driven)
- Hand operated pump for emptying engine oil
- Lubrication oil tank (only if a dry sump is used)
- Lubrication oil filter of the duplex type with replaceable filter elements and by pass function
- Facility for pressure gauge and low voltage switch
- Piping, valves and fittings.

The filters shall be mounted in accessible locations enabling easy changing of filter elements without the necessity of disconnecting piping or other engine equipment.

9.6.2.5 Exhaust System

The exhaust system shall include but not be limited to the following:

There will be filtered, flexible air outlet canal structure with damper for generator air outlet.

Air inlet will be 2-fold of exhaust air area.

Minimum distance between generator and the side walls will be 1,5 meters.

The exhaust system shall include but not be limited to the following:

- Expansion joints
- All necessary exhaust system piping inclusive hangers
- Exhaust pipe.

Exhaust silencer shall be of welded construction designed for outside mounting. Pressure drop through the silencer shall not exceed the engine manufacturer's recommendations. The exterior of the silencer shall be treated to resist rust.

Exhaust silencer shall be of welded construction designed for outside mounting. Pressure drop through the silencer shall not exceed the engine manufacturer's recommendations. The exterior of the silencer shall be treated to resist rust.

The exhaust pipes shall be properly insulated in accordance with the recommendations of the engine manufacturer.

On leaving the engine room, the exhaust pipe shall pass through a weather proof flange. The piping shall have as few bends as possible.

The exhaust system shall be designed to reduce the heat transmission inside the room as much as possible.

9.6.2.6 Starting System

Batteries (maintenance free, lead type) for starting shall be included. The battery shall have a capacity sufficient for at least 10 abortive start attempts, each of 10 sec. duration, without recharging.

The engine shall be equipped with an alternator and voltage regulator for re-charging batteries when running as well as a static charger with manual boost charging function. The static battery charger shall be built-in in the DGP.

It shall be possible to start the engine from any crank position.

9.6.2.7 Cooling System

The cooling system shall include but not be limited to:

- Radiator cooler
- Cooling water pump for circulation of water through diesel engine and radiator cooler, engine driven
- Cooling thermostatic valve, designed to fail open to radiator circuit
- Expansion tank
- Facility for temperature gauge and high temperature switch
- All necessary piping, valves, vents, drains, etc.

9.6.2.8 Speed Control

An adjustable droop governor shall be provided complete for the diesel engine and shall be of the electronic/hydraulic type. The governor shall be capable of maintaining the frequency within the limits set in ISO 8528 for standard types.

9.6.3 Alternator

The alternator shall be of the flange mounted, brushless, self-exciting, self-regulating standard type.

Alternator enclosure shall as a minimum be IP22.

Both ends of the generator main leads shall be brought to a terminal box and star connected.

The alternator shall be able to sustain unbalanced loads up to 20% without affecting the voltage regulation.

The insulation of alternator and exciter windings shall be class H, and the manufacturer shall guarantee that the insulation is suited for use in tropical climate. Alternatively a special varnish shall be applied to achieve the required guarantee.

The alternator shall be capable of producing short circuit currents of 3-5 times I_N , enabling the protection devices in the panels to function.

9.6.3.1 Automatic Voltage Regulator

An automatic voltage regulator of the static type capable of maintaining the voltage within the limits set in ISO for best grade of voltage regulation shall be incorporated.

The system shall incorporate a low speed protection, that decreases the excitation current in case of the alternator being operated at a speed lower than nominal. The system shall provide full security for the excitation system against overload.

9.6.3.2 Arrangement of the Diesel Generator Set

The diesel generator set shall be installed in the generator room on a solid concrete block. The concrete block shall be isolated from other building works by provision of flexible expansion joints, in order to isolate seismic motor vibrations from spreading to building structures producing cracks.

Generator company will give certificate. Noise reduction measures shall be included in order to reach not more than 85 dB (A) in 1 metre from the generator room. The measures shall include air intakes provided with noise reducing baffles and heavy-duty isolation of the entrance door to the generator room. Refer the civil works specification for further information.

The Contractor shall include installations (if necessary), such as forced ventilation of the generator room, in order to reduce the indoor temperature rise to an acceptable degree recommended by the equipment supplier, when the diesel generator set is in operation. Heat reduction measures must not reduce noise reduction precautions.

All equipment located outside shall be provided with sun cover in order to be protected against direct sun radiation.

Synchronization of CHP units and diesel generators in case of power blackouts and brownouts. Diesel generator should be selected for the emergency loads as per technical spects mentioned in ER. These loads should be firstly operated by Diesel genset. Afterwards CHP gensets shall synchronize with diesel gensets and emergency loads shall be taken over by CHP gensets. Hence, diesel genset power rating shall correspond to all the emergency loads.

9.7 Assemblies (Panels)

In the following low-voltage switchgear and control gear assemblies, panels, switchgears, switchboards, cubicles, control gears etc. are referred to as assemblies.

9.7.1 General requirements

Assemblies shall comply with:

- EN 60439, Low-voltage switchgear and control gear assemblies.
- EN 60204-1, Electrical Equipment on Machinery.

Assemblies shall provide minimum of 20% spare space for future use after installation is completed and when handing over. The spare space shall be provided as coherent space in whole and empty subsections.

Building installation such as illumination, socket outlets, electrical heaters etc. shall be energised from assemblies intended solely for building services.

Steel construction table shall be foreseen under the LV panels if necessary.

Especially all LV rooms shall be designed as raised floor. Height shall be at least 1000 mm.Raised floor material sizeshall be minimum 600x600mm, Raised floor material shall be TE-EN312 standards requirement. Material shall be anti-staticresistant to 40kV. Material shall be minimum 90 min fire proof.

There must be at least 1-meter free distance between the back of the panel and the wall. There must be

at least 2 meters free distance between the front of the panel and the wall.

The Contractor shall provide a drainage pit and a drainage pump under each panel room.

9.7.2 Construction

Assembly enclosures are to be fabricated from best quality of electro-galvanised mild sheet steel and cold rolled sections bolted together. All steel parts shall be treated effectively against corrosion after manufacturing. The treatment shall include sand blasting, anti-grease, primer and coating. Paint must be sprayed and kiln-dried.

Assemblies shall be constructed so that normal maintenance may be carried out from the front. All cubicles shall be fitted with doors at the front to access to control wiring and equipment. Front doors and covers shall be hinged and lockable with a common key for each section. Assembly enclosures shall provide a minimum protection of IP54, dust and vermin-proof.

The construction shall comply with EN 60439-1 and especially:

- Main switchgear and main EDG switchgear Form-4b
- MCCs Form-3b
- Lighting, small power and other distribution boards Form-2b

They will be so constructed as to withstand all forces likely to be produced upon them during transportation, erection, operation, and short-circuit conditions.

Each compartment shall be isolated from the nearby compartment by metallic barriers.

Assembly design is to be of a modular type allowing the assembly to be broken down into sections for ease of transportation and installation. The preferred module size adopted is 600x600 mm. Height of assemblies must not exceed 2100 mm measured from finished floor level to the highest point of the assembly. Isolator handles, control switches, push buttons, indicator lamps and instrumentation shall not be less than 300 mm and not more than 1,900 mm above finished floor level. Width for terminal compartment will be minimum 400mm in MCC boards and 800 mm in PLC boards. All cable inlet and outlet for board will be made through IP 65 gland.

Solid barriers shall be provided to segregate each load compartment from other compartments and the busbar chamber, to prevent objects falling into lower live compartments, and to restrict fault travel to other compartments.

The finish colour for assemblies shall be the manufacturers standard unless specified in the particular specification.

Assemblies shall be regular shaped and rectangular, and where possible designed and constructed for floor mounting over cable trenches.

Minor assemblies may be designed and constructed for wall installation. All cables must enter or exit assemblies through a glanding plate provided with the appropriate sizes and types of cable glands (bushings) from the bottom side of the assembly.

Reference is to be made to service conditions above for the rating of components and equipment to be installed in assemblies. Further equipment ratings shown on components and equipment must show the values applicable for the ambient conditions.

9.7.3 General electrical requirements

Assemblies shall be rated for operation on a 400 V AC, 3 phase,TN-C-S earthing system, 50 Hz supply. Control voltages shall be 230 V ACand 24 V DC. The size of the 24 VDCSupply unit is to be based upon actual consumers connected plus future expansions of the plant.

All components shall function properly within a supply tolerance of -10 % to +10 % on the 400/230 V and -2,5 % to +2,5 % on the 50 Hz frequency.

Signals to and from passive instrumentation shall be for analogue 4-20 mA, active or analyser instrumentation communication system should be for Ethernet (TCP/IP) / analogue 4-20 mA, and for digital signals 24 V DC.All component installed in assemblies shall be CE-labelled, and must be capable

of withstanding the dynamic and thermal stresses, without detriment, resulting from the prospective fault current. The colour of the electrical panels shall be as RAL 7035.

The system of tripping devices for the circuit breakers shall be designed and set to ensure full selectivity. E.g. short-circuit in any circuit shall be cut off by the breaker that is closest to the short.

The branch circuits shall be protected by means of circuit breakers. Fuses may not be used.

Relays shall have indication of status (on/off) by signal lights (LED) or by a mechanical arrangement. Relays shall have a test button. The relays shall be connected via a standard 11-pole circular socket mounted on DIN-rails.

Pilot and indication lamps shall be of the LED type and provided with a common lamp test facility.

9.7.4 Access

All apparatus, equipment and components within assemblies must be so arranged that they can easily be identified and worked on, and, as necessary, removed for repair and maintenance. Sensitive equipment must not be installed on covers, doors or hinged assemblies. It is a requirement of this specification that any piece of equipment shall be removable without disturbance to any other piece of equipment.

9.7.5 Internal wiring

All wiring within assemblies must be supported in trunkings appropriate during construction. Component terminals must never take the weight of wires. All supports for wiring must be either screwed or stud welded. Adhesive type supports are expressly forbidden.

All wires shall have stranded copper conductors. The minimum conductor size shall be 0,75 mm² (except

original connector cable). The maximum size for door mounted equipment shall be 2.5 mm².

Wiring at different voltages and AC and DC must be segregated in accordance with IEC 60364.

Wiring shall not be less than 300/500 volt grade with an insulation temperature withstand of not less than 70° C. Wiring is to be sized according to the prospective fault current level and duration in reference to current rating. Joints between components in wiring will not be permitted.

9.7.6 Terminations

All terminals and terminal blocks must have each termination numbered. Connectors at all panels shall be numbered. Power supply terminals are to be identified with colours and/or numbers corresponding to phase designations. Depending on the type of terminal, cable lugs shall be attached to wires or cores; however, the use of "C" or "Jaw" type lugs is expressly forbidden.

9.7.7 Earthing

All normal non-current carrying metal work of an assembly must be bonded to the earth connection point within the enclosure. All doors, covers or assemblies must be permanently connected. All earth conductors must be single core multiple stranded and PVC insulated for mechanical protection, coloured green/yellow spiral striped.

9.7.8 Transient and surge protection equipment

Transient and surge protection equipment shall be connected to the main incoming power supply cables and medium voltage power consumers like motors and transformers, if any. The equipment shall be placed in its own section of the assembly and located as near as possible to the consumer. Each phases and the neutral shall be provided with overvoltage/transient protection devices. Status (available/defect) of the transient protection equipment is to be signalled to the PLC.

Requirements for transient protection equipment are listed in a separate chapter.

It will be used for type 1 power inlet in Main distribution boards, type 2C in MCC boards and type 3D power inlets for PLC board. Suitable surge arrester will be used in outdoor equipment boards accordingly with usage objective.

PLC analog cards will have galvanic isolation. Analog signals which are delivered and received from and to exproof areas will be protected by serial surge arrester when there is equipment.

9.7.9 Busbars

Assemblies shall be equipped with separate earthing and neutral busbar.

Busbars shall be of hard drawn electrolytic copper.

Ends and joints must be protected against corrosion. The buses shall be painted and supported on flameretardant, track-resistant and nonhygroscopic insulators strong enough to withstand the stresses caused by magnetic forces when faults occur.

Busbars must be sized for the prospective fault current level and duration. Due regard shall be given to the method of supporting, regarding current withstand and thermal/mechanical stresses. The busbars shall have a continuous current rating in accordance with IEC 298 standard of temperature rise.

The dimensions of the busbar copper work shall be of one size throughout the complete assembly and the busbars shall be the same rating as the incoming supply switch.

Busbars shall be enclosed in a separate chamber and shall be continuous over each shipping section.

Riser bars shall be of the same construction and be fault rated to the same level as the main busbars.

Easy access shall be available to the busbars for future connections.

Circuit connections to the ground bus shall be made so that it is not necessary to open circuit the ground bus to remove any connection made to the ground bus.

Connections between transformers in 1000 kVA or greater and main TR circuit breaker inside the Main

Distribution Panel shall be with isolated busbar. Copper busbars shall be used.

9.7.10 Assembly ventilation

All sections that contain equipment susceptible to heat that may be generated in normal operation shall be fitted with forced air-cooling.

Filters shall be provided to maintain the integrity of the dust and moisture protection rating of the assembly. Fans shall be thermostatically controlled and automatically switched on, on rising temperature level in the section.

Indication of fan failure or section over temperature shall be included on the section door and signalled to the PLC.

9.7.11 Circuit breakers (CBs)

Circuit breakers (CBs)for supply of final sub-circuits to equipment shall be in accordance with EN 60947, type 2, and have a rated switching capacity at least equal to the total load of the circuit they

supply. CBs greater than 800 A shall be draw-out type and CBs greater than 630A shall be air circuit breaker.

Miniature circuit breakers (MCB) shall be provided with fixed instantaneous short circuit and overload trips, and be of the single, double or triple pole type as required. The prospective fault level must not be higher than the breaker capacity, and the time/current tripping characteristics shall be chosen with due regard to the equipment performance and circuit data, and to assure discrimination between the miniature circuit breaker and the moulded case circuit breaker. The choice of miniature circuit breaker shall ensure basic protection against indirect contact when used on a circuit with earthed equipotential bonding.

Inlet circuit breakers shall be 4-poles and motorized in MDP and have residual current protection.

Automatic transfer switching shall be applied inside the MDP.

1 pcs emergency stop button shall be placed inside the LV panel room and it is capable of cutting the energy off entirely.

9.7.12 Earth leakage circuit breakers

Earth leakage circuit breakers (ELCB) for supply of final sub-circuits shall generally comply with the sub-section above.

Earth leakage protection shall be adopted in every branch circuit with socket outlets. Earth leakage

protectionshall be 30 mA in plugs and 300 mA in panel power supply. MCC main circuit breaker inlets

shall be 4 poled and there shall be 300 mA residual current.

There will be residual circuit breaker which can be mounted over thermal/magnetic circuit breaker upto 800 A. There will be separate residual current circuit breaker and toroid current transformer for circuit breakers greater than 800 A. Time delay can be adjustable up to 4,5 seconds.

Diesel Generator and CHP circuit breaker will be 4 poled and there will be residual current circuit breaker.

30 mA-30A toroid current transformer Residual current circuit breaker with 0-4,5 seconds delay will be installed at transformer outlet circuit breaker, generator outlet circuit breaker, CHP outlet circuit breaker, MCC main inlet circuit breaker.

Serial residual current circuit breaker will be used in secondary board main inlet circuit breaker, outdoor lighting board inlet circuit breaker.

9.7.13 Isolating switches

Isolating switches shall be adopted as bus-coupling switches and as incoming breakers in down stream assemblies if they are protected by a source circuit breaker.

Isolation switches must be four pole and have characteristics commensurate with the assembly duty, and as a minimum be rated at a voltage of 500 V and of a load break capacity in excess of the total load of the assembly.

The switch is to generally comply with EN 60947 and be provided with an operating handle, interlocked with the compartment door, lockable in the on and off positions.

Excluding connection between frequency converter(outlet) and motor.

There will be lockable isolation switch with extension lever up to cover at panelside for all motor power supply. Position of isolation switch will be delivered to PLC. Panel cover will not be opened before bringing Isolation switch to OFF (0) position and without switching off compartment where isolation switch supplies power.

There will be isolation switch for actuators (motorized triphase valves).

9.7.14 Motor controllers

Each electric motor must have its associated control and protection equipment located within compartments of the assembly complying to form 3b. All motor control gear must be in accordance with EN 60947.

Motor controllers are to be designed in accordance with the manufacturers' recommendations for the motor type, characteristics, size and duty. Facilities for padlocking in on/off positions are to be provided as well as extended operating handle for front of assembly operation.

Contactors and relays must be chosen to ensure that under normal operation the contact's life will exceed 5 years, and that, irrespective of actual usage, all motors starters are to have a category of frequent duty.

Two auxiliary contacts shall be provided for signalling. Single phase failure shall be incorporated on all phases with a sensitivity not exceeding the values stated in EN 60947.

Contactors for motor starters are to comply with IEC 158 and be arranged as necessary for direct-online, with the choice of contactor ensuring that the full-load current is not at the contactors capacity (25% spare capacity is to be assured). Contactors shall be of the no volt release type. Two auxiliary contacts are to be provided for signalling.

Concerning the starting method / control of a motor the following general rule will be followed:

- motors with installed power≤ 5kW will be operated with direct on-line starting method,
- motors with installed power 5<P<15kW will be operated with star-delta starting method,
- motors with installed power ≥ 15 kW will be driven by soft starter
- and some other motors which must change theri operational values, depended on their function - process (such as if we need to change flow, speed, frequency, etc)will be driven by frequency converter.

Motor starters shall include the following:

- Motor circuit breaker, suitably rated moulded case circuit breaker, with short circuit protection.
- Suitably rated miniature circuit breaker for the control circuit.
- Contactor suitably rated for direct on line start.
- Adjustable thermal overload protection
- Complete control circuit.
- Set of main and auxiliary terminals and a 15% spare capacity.
- Door mounted:
 - Indicating lamps for:
 - Common fault
 - running

- emergency stop activated (if applicable)
- Selector switch for hand-off-automatic (HOA) control In position:
 - Hand: The operator controls operation of the motor by means of start/stop push buttons. The automatic control system is bypassed.
 - Off: The motor is switched off and inoperative. The automatic control system is bypassed.
 - Automatic (Auto): The motor is controlled by the automatic control system, i.e. the PLC. The start/stop push buttons are inoperative.
- Push buttons for:
 - LED type start/stop
 - common fault reset
- Auxiliary contacts for remote monitoring.

All available signals shall be provided for telemetry and wired to the PLC for remote control and monitoring.

Circuits for manual operation shall be hardwired to ensure operation of the plant if the automatic control system fails.

Every safety and protection device for the motor e.g., thermistor switch imbedded in motor windings etc., shall be hardwired into the motor control circuit to ensure immediately disconnection of the motor in the event of a failure. **Important**: The control circuit shall be designed such that a tripped motor cannot re-start automatically, but only after the <u>fault has been cleared and after reset by hand via a door mounted push button</u>.

All available signals shall be provided for communication to the PLC for remote control and monitoring.

Pump thermal circuit breaker and water leakage signals which were supplied from manufacturer for pumps (common or separately depending on property of equipment) will be communicated to PLC too. Soft starters

(1) Introduction

This specification guide describes the required performance, functional specification, fabrication details and installation of a microprocessor controlled low voltage Softstarter, used for stepless start and stop as well as protecting of standard AC squirrel cage induction motors.

It should have internal bypass contactor, triphase controlled moment control system and minimum IP 20 protection class.

(2) Codes and Standards

The softstarter shall be designed, built and tested according to the latest editions of applicable IEC standards, i.e EN60947-4-2.

(3) Main Features

The softstarter shall contain at least the features, functions and adjustments described below, in order to provide the motor and application with sufficient protection, and start and stop the motor in a precise and controlled manner.

(4) Acceleration Control with built-in "Torque Control" Option

Acceleration Controlshall be fully adjustable in programming to match any application. As a minimum, the softstarter shall come complete with the following setting possibilities.

Ramp Type For Start: For the start ramp, it shall be possible to select between voltage ramp and torque control.

Initial Voltage: Initial voltage output shall be adjustable between 30-70% of the nominal voltage. The end voltage shall be set at the same time having the range of 20 to 60%

Current Limit: Current Limit shall be adjustable between 150% and 700% of the softstarters rated full load current.

Torque Control: Torque control feature shall be based on closed-loop principle with self-adjusting output to thyristors. The self-adjustment in the closed-loop shall be in relation to an actual and ideal load characteristic, where the ideal torque is set up using the softstarter parameters. The objective of the torque control feature shall be to obtain smoothest possible start-ramp where output torque curve closely follows the load curve in a near-linear manner.

Ramp Time For Start: The time between Initial and Full output voltage shall be adjustable between 1 and 30 seconds

Kick Start: The starter shall include a Kick Start feature. The Kick Start voltage level shall be adjustable between 30-100% of nominal voltage, and the kick time should automatically be adjustable between 0.3 and 1.0 seconds

(5) Deceleration Control with built-in "Torque Control" option

Deceleration Control shall be built in and be selectable with the following adjustments, all of which shall be completely independent of any acceleration setting.

Ramp Type for stop: For the stop ramp, it shall be possible to select between a voltage ramp and torque control.

Ramp Time for Stop: The deceleration time shall adjustable from 0-30 seconds to allow controlled deceleration and soft stop of the motor.

End Voltage Level: End voltage level shall be adjustable from 20-60% of line voltage. The end voltage shall be set simultaneously as the initial voltage (at start).

Torque Control: Torque control feature shall be based on closed-loop principle with self-adjusting output to thyristors. The self-adjustment in the closed-loop shall be in relation to an actual and ideal load characteristic, where the ideal torque is set up using the soft starter parameters. The objective of the torque control feature shall be to obtain smoothest possible stop-ramp for pumps where output torque curve closely follows the load curve in order to prevent pressure surges and water hammering.

(6) Motor and Load Protection

Motor and Load Protection shall be integrated with the soft starter and all the protection functions shall under no circumstances be disconnected or disabled when the integrated by-pass contactors are used.

All the different protection functions shall be selectable individually and all be switched off as default except for the Motor Overload Protection. In order to protect both the load and motor the Soft starter shall be provided with the following functions:

Motor Overload Protection: Thisprotection shall be possible to turn on and off. When active, (On) it shall be possible to select between some predefined standard overload trip curves. The trip curves shall be selectable between the following tripping classes - Class 10A, 10, 20 and 30. The overload protection

shall be based on a thermal register retained in memory until the motor is completely cooled down (no risk of re-starting the motor).

Motor Underload Protection: This protection shall be possible to turn on and off. When active (On) it shall be possible to set between 0,2 - 1,0 times the set rated current value.

Locked Rotor Protection: ThisLocked Rotor Protection shall be possible to turn on and off. When active (On) it shall be possible to set between 0,5 - 7 times the set Ie value.

Manual or Automatic Reset: For the three different protections above it shall in be possible to select between manual reset and automatic reset in unattended remote applications. The factory default shall be manual reset.

Thermal Memory: The over load protection shallnot lose track on the motor temperature if the control supply voltage is lost or shut down, or the motor is stopped. Upon reapplication of power within two hours, the microprocessor shall be updated as to the motor temperature and adjusted for real time cooling while the power was off.

Thermal Capacity Reset Level: If the Motor Overload Protection is tripping, the softstarter shall not allow a restart (reset) until the motor has cooled down to 60% of its total thermal capacity.

Phase Reversal: The soft starter shall be totally insensitive for Phase Reversal and shall be able to start in all various combination of incoming phase orders.

(7) Softstarter Protection

Soft starter protectionshall be provided to maintain reliability of both the driven equipment and the electrical components, with the following features:

Soft starter Overload Protection shall be built-in and protect the Thyristors (SCRs) from exceeding the maximum load capacity.

(8) Fault Detection

In order to protect both starting equipment and the load, the soft starter shall be provided with the fault detections below. All fault detections and signals shall be standard and not possible to disable or disconnect. When a fault occurs it shall be indicated directly on the soft starter what type of fault it is. At least the following fault indications shall be available.

Soft starter Over Temperature Fault shall be built-in and protect the Thyristors (SCRs) from excessive heat in the enclosure or heat sink. The temperature shall be measured direct on the Soft starters heatsink with an internal temperature sensor.

Phase-Loss detection shall be standard and it shall shut down the soft starter if there is no current detected in any of the three phases.

Shunt Fault shall detect if there is a current flow through when stopped, from having a shorted thyristors (SCR) or a by-pass contact(s) closed.

Bad network quality detection shall be standard and indicate if the main supply network contains of excessive disturbances.

Current lost detection shall detect and stop the soft starter if the operational current is lost in one or several of the three phases.

Low control supply voltage shall stop the soft starter in case of interruption of the control supply to secure a safe stop of the soft starter.

High Current Protection: The soft starter shall be equipped with a fixed high current protection, tripping if the current reaches above 8 times the set rated current and when lasting longer than 200ms.

Communication fault. In the event of a communications failure the soft starter shall give indication of the failure and revert to the off position, only active when serial communication is used.

(9) Inputs

The soft starter shall be equipped with three digital inputs, Start, Stop and Reset. Inputsshall are provided for the control and operation of the soft starter and they shall have a common 24VDC internal source for the control.

The digital inputs for start and stop shall be self holding circuits, allow controlling of the soft starter without the need of an external relay..

(10) Outputs

The soft starter unit shall have a minimum of three (3) signal relays. The function of the relays shall be,

Run (NO – normally open),T.O.R indicating feeding the motor with 100& voltage (NO – normally open)Event (No and NC – normally open and normally closed)

(11) Analog Input and Output

The soft starter shall be equipped with a minimum of one (1) analog output and one (1) analog input signal using 4 - 20mA. It shall be pre-programmed so 20mA is representing 1,2 times the set Ie value.

(12) Operator Interface HMI

The starter shall be operated with a LCD display presenting all data and information using a language neutral icons and figures. All numbers shall be presented using four positions, seven segments.

The use of binary, hexagonal code, or any other code is not acceptable and currents and measurements shall be presented as either exact values or as a percentage of the maximum value.

Adjustments shall be made by a digital four push button keypad. No binary coded dipswitches shall be used for programming or function selection.

The HMI shall be possible to lock to prevent unauthorised changes to the programming.

Data should always be presented with as the actual value, and the unit of the data (i.e. V, A or % etc).

Data entered and selections made to the Soft starter using the display and keypad shall be stored in case of a power loss.

LED Indicators using long life LEDs shall provide additional quick annunciation of; **Green LED marked Run** – Flashing when given a start command during ramping and steady when they reached top of ramp, when feeding the motor with 100% voltage.

Red LED marked Fault – Steady when the soft starter sees and trips on any faults

(13) Metering

Meteringfunctions shall be provided through the Numeric Displayfor indicating the following;

Maximum RMS Output Current showing the highest current of the phases. Indicating range to be 0.0 – 9999 amps

Output Voltage shall be possible to read in terms of % of the rated full voltage, in the rage of 0 - 100%. But also as an exact value in the range of 0 - 999V.

Power factor shall be possible to read as a $\cos \emptyset$ value.

Real time clock: A real time cock shall be available, in order to see when different events have occurred.

(14) Serial Communication

A neutral Serial, RS485, TCP/IP Communications shall be built-in as a standard feature. The product shall be designed to, benefitting on the flexible design concept.

The soft starter shall have at least 255 different address options, in order to find each individual soft starter in the communication system.

(15) Design Specifications

The soft starter shall be controlled completely through solid state design algorithms. The soft starter shall be controlling the current in three of the three phases, using three anti-parallel Thyristors (SCRs) in each controlled phase. The soft starters shall be designed to the following specifications:

(16) Power Ratings

Rated Supply Voltage (Ue): 208 to 600V, -15% to +10%, 3 phase 50/60Hz \pm 5%

Output voltage: Reduced voltage two phase AC derived from phase-angle fired inverse-parallel thyristors, ramped to full voltage.

Output Capacity: The starting capacity shall allow the use of a class 10 over load relay up to 500% of the rated current.

Control Supply Voltage (Us): Wide voltage range, 100-250VAC -15% to +10% for 50/60Hz \pm 5%, shall be standard on each softstarter.

(17) Thyristors (SCR Devices)

PIV Ratings: (a)230-600V 1600V Minimum

Protection: RC-snubber network protection circuits shall be provided for softstarter sizes designed for rated current of 200A and more, to avoid possible component damage.

(18) Ambient Conditions

The soft starter shall be capable of withstanding the following environmental conditions during operation and may not cause any electrical/ mechanical damage or degradation of performance.

- **Temperature:** As a standard of soft starter design quality, the starter shall be documented to show that the open chassis design has been tested for $-25 60^{\circ}$ C operation with de-rating above 40° C.
- Altitude: 4000m maximum with de-rating above 1000m.
- **Thermal:** The soft starter shall be equipped with a heat sink temperature switch designed to protect the thyristors (SCRs) from over temperature.

(19) Mechanical Construction

The soft starter shall be housed in a plastic material and termination points provided to accommodate the required incoming cables for the line and load connections.

The soft starter shall be ventilated with fan cooling when necessary. The fans shall be temperature regulated and automatically switch on during soft start and soft stop (if used) and in between only when cooling is necessary. This in order to reduce energy consumption and noise level of the Soft starter as well as increasing the life length of the fans.

All Soft starters shall be equipped with integrated by-pass contacts or contactor(s) as standard. This design shall reduce the power losses during continues run to allow enclosing the soft starter without using any forces cooling.

The sensitive parts on the electronics, the printed circuit board assembly, shall be protected from harsh environments using protective coating.

(20) Quality Requirements

The vendor shall be certified to ISO 9001 (quality certification) and ISO 14001 (environmental certification).

The produced soft starter shall be functionally tested operating a motor, prior shipment to assure proper operation per specification.

Subassemblies shall be inspected and/or tested for conformance to vendors engineering and quality assurance specifications.

Each soft starters shall be marked with an unique serial number to secure tractability. The marking shall be possible to read after installation.

Bypass relay and contactor.

(21) Documentation and Marking

Units shall be shipped with a complete set of documentation to include the following items:

- It shall provide Complete schematics and wiring diagrams and dimensional drawings
- Main product catalogues

The soft starter unit shall be clearly marked with information regarding current and voltage ratings at the front of the soft starter. Vital information at the side of the soft starter is not accepted, as the surrounding components and/or enclosure easily can cover this information.

9.7.15 Frequency converter motor controllers

In addition to the required standard motor starter fitting-out mentioned above, frequency converter motor starters shall be performed according to the following.

All frequency inverters shall be selected heavy-dutytype. All panels shall be designed to isolation

contactor before than frequency inverters. All frequency inverters communicate PLC by the Ethernet protocols.

Earth leakage protection shall be incorporated either using electronic relays or by adding residual current protection to the motor circuit breaker. The earth leakage protection shall in either cases trip the motor circuit breaker instantaneously in the event of an insulation fault in the motor circuitry, ensuring that the system-to-frame voltage will not exceed 50 V AC and will be cleared within 5 sec, as required pursuant to IEC 60364. Attention is drawn to the fact that the earth leakage protection must be of a type, which is capable of functioning with frequency converters.

It shall be heavy duty type. fk series shall be provided if it'll be used for pumps.

If the frequency converters employed are incorporated with overload protection the latter may be utilised for motor overload protection in lieu of thermistor protection relays. It will be used in the event that motor system maintains this requirement. (except thermal protection and water leakage signals which provided from manufacturer).
Each frequency converter shall be clearly labelled with the number of the motor/pump, which it is serving. The frequency converter shall be placed so its internal control panel is placed approximately 1600 mm above finished floor level. If installed inside an assembly provision shall be made for adequate ventilation.

When the panel hand-off-automatic (HOA) selector switch is in position (signal also to PLC):

- Hand: The operator controls operation of the motor from the front of the frequency converter. The automatic control system is bypassed.
- Off: The motor is switched off and inoperative. The automatic control system is bypassed.
- Automatic (Auto): The motor is controlled by the automatic control system.

The start/stop push buttons, the required specification for a standard motor controller shall not to be employed. Manual control shall be performed from the front of each frequency converter where the operator shall be capable of starting/stopping and turning up and down the pump revolutions.

Each frequency converter shall be configured to display the following current values on request:

- Ampere [A]
- Power factor (0-1)
- True power [kW]
- Apparent power [kVA]
- Revolutions per minute [RPM]

Frequency converters shall comply with:

- EN 60439, Low-voltage switchgear and control gear assemblies.
- IEC 60664, Insulation co-ordination for equipment within low-voltage systems.
- EN 50082-1, Electromagnetic compatibility (EMC) genetic immunity standard part 1: Industrial environment.

Frequency converters shall be 3 phase - 400 V grade, equipped with EMC-filter, fully enclosed to a degree Frequency converters to be used inside panel will have minimum IP41 and ones to be used directly in outdoors will have minimum IP65 protection class,fitted with self-cooling fans venting through filters, capable of 100 % continuous RMS load up to 50 °C, at least 110 % overload for 60 seconds and capable of providing constant torque when high start torque required. All electronic parts shall be varnished against adverse effects of wastewater environment or equally protected.

Frequency converters shall be micro processor based, fully configurable and fitted with an internal multilingual alphanumeric control panel with keypad-display for user interface for monitoring, adjusting parameters, manual control and configuration of the converter. Frequency converters shall come with an extensive library of pre-programmed application macros to allow rapid configuration of its in and outputs.

Control panel of F/C's are capable of placing onto the relevant compartment on MCC panel.

Frequency converters shall have the following configurable in and outputs:

- Two analogue (4-20 mA) inputs.
- Two analogue (4-20 mA) outputs.
- Six digital inputs.

• At least two digital outputs.

All available signals shall be provided for telemetry and wired to the PLC for remote control and monitoring.

9.7.16 Motor valve controllers

Motor starter for motor valves shall include the following:

There will be two port ethernet/BUS communication in actuator systems. Motor circuit breaker, suitably rated miniature circuit breaker with overcurrent protection.

- Suitably rated miniature circuit breaker for the control circuit.
- Complete power and control circuit inside the actuator.
- Door mounted:
 - Indicating lamps for fully opened, fully closed, malfunction. The following colours are to be applied:
 - Valve fully opened "Green"
 - Valve fully closed "Yellow"
 - Valve malfunction "Red"
 - Selector switch for hand-off-automatic (HOA) control. In position:
 - Hand: The operator controls operation of the motor by means of open/close switch buttons. The automatic control system is bypassed.
 - Off: The motor is switched off and inoperative. The automatic control system is bypassed.
 - Automatic (Auto): The motor is controlled by the automatic control system. The open/close switch is inoperative.
 - Open/close switch.

Actuators should have internal power and control units,

All available signals shall be provided via etherhet/BUS communication to the PLC for remote control and monitoring.

9.7.17 Control panels for local functions

The cabinet shall be equipped with protection/general differential and thermal switches for power supply, sensors and each element liable to overvoltage.

The contractor shall supply detailed electric schemes with the composition of the cabinet.

Local functions can be designed as stand-alone units with possibility of local manual operation.

Outdoor local control panels will have IP 65 protection and double cover and capped. First over will be UV film coated or will have filtered glass and there will be control buttons or switches over 2nd cover. It will be designed such that dust or liquid will not enter through 2nd cover. Emergency button will be present at right hand side over 1st cover.

The panel shall automatically control the operation of the installations. "Auto-O-Manuel" selectors shall be available locally.

There will be load disconnector (except motors with frequency converter) IP65 LED illuminated start/running (green) and stop/failure(red) integrate push buttons, IP65 lockable mushroom emergency button(labelled) over local box.

The material of local control panel shall be preferred as hot dip galvanized material, stainless steel material at least AISI 304 qualityor thermoplastic material. Supports of the panel shall be made as hot dip galvanized or stainless steel (heavy duty type).

Monitoring of the motors running and faults shall be included in the control and monitoring system.

9.7.17.1 Local Pad-lockable Stop Switch:

A local stop switch shall be installed adjacent to each machine (motor). The stop position shall be padlockable, and it shall be impossible to start the machine when locked. The switch shall be capable of disconnecting the full load current. For motors with a nominal current above 180 A, the safety switch facility shall be provided by means of the motor circuit breaker.

The switch shall include the following positions/functions:

- **O** : Stop, pad-lockable, power supply is cut-off
- **I** : Automatic, control from panel.

The switch shall be installed in the power circuit for the motor and all phases shall be disconnected in the OFF position.

Status of each safety switch shall be signalled to the PLC as well as SCADA.

9.7.17.2 Emergency Stops:

In general emergency stop for emergency shutdown is mandatory for any machinery, which can expose personnel to risk of injury during normal operation.

Emergency stop button is present in local control box for each motor and they will stop relevant motor.

Emergency stop which will be operated with Category 4 24 VDC emergency safety relay will be placed for groups belonging to those areas. It will not reset from SCADA or PLC. Operator will reset manually from board cover when emergency disappears. Emergency stop relay will switch off all control voltages for relevant group. Emergency stop which is present in PLC board cover, will switch off all control voltages for relevant MCC. There will be group emergency stop areas warning light/emergency stop reset illuminated pushbutton in board covers. When emergency stop button is pressed it will enable audible and visual warning which is present in PLC board.

Emergency stop push buttons are required adjacent to every pump (except drain/sump pumps), motor valves and valve actuators and at aerated tanks for stop of the blowers.

Emergency stop shall be housed in tough high visibility yellow enclosures with red mushroom button which stand out well amongst other equipment and must be clearly labelled: "EMERGENCY STOP" (note the text shall be in Turkish and English). The button shall stay in off position when activated and can only be brought back to normal position, when reset.

Every emergency stop circuit shall be hardwired into the motor control circuit to ensure immediately disconnection of the motor in every mode of control. **Important**: The motor control circuit shall be designed such that a tripped motor will not restart automatically when the emergency stop is reset. A stopped motor can only re-enter service when the emergency button has been reset and <u>after reset by hand via a door mounted push button in the motor panel.</u>

Status of each emergency push button shall be signalled to the PLC as well as SCADA.

9.7.18 Labelling and marking

Text on labels shall be in the Turkish and English languages. Other languages will not be accepted.

All marking shall comply with the documentation for the assembly e.g. circuit diagrams and wiring diagram etc.

Each assembly shall be provided with a label displaying the assembly's identification number, and describing the function of the assembly. The height of text applied shall be minimum 10 mm.

Labels identifying each front of assembly mounted devices e.g. ammeter, selector switches, push buttons, lamps, etc., shall be provided on the face of the assembly. Labels identifying and denoting the function of apparatus and group of equipment located behind doors e.g. motor controller etc., must be placed on the respective front door. The height of text applied shall be 4-5 mm.

All labels shall be with black engraved letters on white background. Only uppercase letters may be used.

Assemblies shall be fitted with a warning label, warning against electric shock. The warning label shall be engraved to give black letters on a yellow background, and be preceded by the lightning flash symbol.

Labels shall be fixed with countersunk chromium plated or stainless steel screws. <u>Self-adhesive labels</u> will not be accepted.

Internal labels designating components shall be fixed to non-removable equipment. Internal labels must be visible and must not be obscured by assembly wiring, etc.

Labels on the face of assemblies shall be so placed that levers in any position do not cover them.

Each and every component or piece of equipment within assemblies must be tagged with an independent reference number. Marking shall be executed by adhesive marks of plastic impregnated tissue.

Each internal wire shall be identified pursuant to circuit diagrams by means of ring type plastic makers at both ends, placed on the wire before termination.

Terminals for connection of power cables shall be marked with phase nomination and group number. Terminals for connection of control and instrument cables shall be numbered.

9.8 Electrical Installations

9.8.1 Lighting

Lighting shall be installed in all rooms of the plant as follows. Lighting outside shall be installed along roads, on structures, at the gateways. Lighting outside shall provide a light level sufficient for safe orientation (average 15 lux). Lighting outside shall also include spotlights near installations that require regular maintenance or supervision such as bridges, screens, tanks etc..

Led type lamps as well as fixtures shall be preferred as indoor and outdoor applications.

LED type luminaries to be used indoors will have fabrication LED press, polycarbon housing and polycarbon glass. Its driver will have PFC fixed current, short circuit and over load protection, Aluminum board, operational voltage will be 220-240 VAC, 50-60 Hz, operational temperature will be -30+80 degrees, efficiency will be 92%, operational lifetime will be 60.000 hours, light flux will be minimum 3800lumen, color heat will be minimum 6000 K and power will be minimum 30 watt. It will have property which will allow mounting emergency kit.

The following average light intensities shall be obtained, the variations not exceeding 25%:

Control room:

Working areas and tunnels:	300 lux
Office:	400 lux
Other rooms:	150 lux
Gangways and ladders:	To such extent that the safe passage is assured

The Contractor shall, if required, present a protocol of measurements to the Engineer.

All luminaries shall be delivered and installed complete with lamps, ballasts, power factor correcting equipment, starters, etc.

The power factor shall be as minimum 0.9.

Luminaries for the control room, offices etc. shall be of the decorative type designed to be used with computer monitors. Protection class IP40.

Other luminaries for the administration building shall be a type suitable for the specific use. Luminaries in the working areas of the plant shall be the industrial type and as a minimum be in protection class IP 65.

When luminaries are to be installed in rooms with a suspended ceiling they shall be suspended from the slab. No weight shall be applied to the ceiling structure.

The following luminary types shall be provided for all locations, except working areas where luminaries with sodium or mercury lamps may be used.

Each luminary shall be connected through a connection box.

Lighting in each room shall be controlled by means of manual switches placed at each door in the respective room.

All luminaries and associated gear shall be earthed.

In no cases shall a flexible cable be used for connection of more than one luminary.

All cables to be used in lighting installation shall be PVC-insulated copper cables with a minimum cross sectional area of 1.5 mm².

Cables for connection of the fluorescent luminaries to the fixed installation shall be flexible cables with a minimum cross sectional area of 0.75 mm^2 .

9.8.2 Outdoor lighting equipment

The outdoor lighting system shall be provided with all equipment necessary including poles, fixtures, cables, foundations etc.

LED luminary, Aluminum injection housing, tempered glass driver will have PFC constant current, short circuit and overload protection, aluminum card, operational voltage 220 V-240 VAC, 50-60 Hz Operational temperature -30 +70 degrees, efficiency will be 92% operational life time will be 60.000 hours, light flux will be 31250 lumen, color heat will be minimum 6000 K and minimum 250 watt. Product will have TS8799 EN 60598-2-3 product certificate.

Minimum 2 Pieces RGB type wallwasher LED luminary (with color to be determined by administration will be placed in all direction for decorative illumination at outside of administrative building.

Lighting pole to be used will have minimum 9 meter height, back protection, it will have 100 W LED projector. If pole in 14 mt or higher will be used, Control and fuse panel for projectors will be present at bottom of pole inside double covered IP65 board which is mounted over steel sheet stand. It will have

ladder, hexagon platform and at least 250 W LED projector. Type 2 surge arrester will be used in energy inlet and each projector will be controlled by separate control selector.

All projectors will be able to be operated by photocell and time clock control. Safety factor for poles will be minimum 1,5, wind load will be 130 km/h, it will be S235JR alloyed, galvanize coated and will be accordingly with EN ISO 1461.

Each lighting pole shall be provided with terminals and fuses housed inside the pole.

Fixtures shall be made of weather resistant material. Changing of bulbs shall be easy and not involve special tools. The protection class shall IP55 or higher.

Galvanized steel polygonal lighting poles, pole-mounted lighting fixtures and grounding cables shall be included in road and environment lighting. Road lighting shall have photocell and manual selections to switch on.

Lighting test shall be made on site after installation. Average 15 lux lighting intensity shall be provided.

Fence lighting along the border shall also be foreseen to keep the security.

9.8.3 Emergency lighting

Emergency lighting shall be provided for all the rooms. 20% of the normal lighting fixtures should have emergency lighting kits.

Escape from the building together with illumination levels & exit signs shall be provided. This system shall be foreseen for all buildings.

The emergency lighting shall automatically switch ON when the normal power supply fails. The emergency units shall be supplied from a battery unit that can provide light in a minimum of 1 hour.

The units shall be complete units provided with housing (IP54), fluorescent light (18W), battery, charger, indication of battery OK etc.

Recharging of the battery shall be automatic.

9.8.4 Socket outlet stations

Socket outlet stations shall be provided for power supply of maintenance equipment such as welding units, power tools and hand held lamps and for the places such as Bio-P tanks, aeration tanks, RAS station, outlet station, etc

Socket outlet stations shall be provided for indoor and outdoor locations as follows;

At least 1 pcs station for indoor industrial type rooms and 1 pcs outdoor for each 30 mt.

The socket outlets shall be installed in a socket outlet station, a box made of glass-reinforced polyester. The box shall be in protection class IP65.

The stations shall comprise the following socket outlets, each supplied from its own circuit breaker and ELCB:

- one 230V
- one 230V, CEE type
- one 400V, CEE type.

230V socket outlets for supply of household appliances and similar equipment shall be provided in all buildings and rooms of the plant.

The number of 230V socket outlets shall be based on the area of each room and each socket outlet shall cover no more than 7 m^2 , hence a room off 16 m^2 shall be provided with 3 socket outlets.

400V socket outlets shall be installed where required due location of machinery, maintenance procedures etc.

The socket outlets shall be equally distributed in the rooms.

230V AC socket outlets, the socket outlets shall have active earthing contact. When a plug is not inserted, the plug holes shall be covered by a lid.

230V socket outlets shall be 13A CEE-types, according to BS 1363.

400V AC socket outlets, the socket outlets shall have active earthing contact. When a plug is not inserted, the plug hole shall be covered by a lid. If the plug is pulled out when loaded, arching shall be extinguished inside the unit and confined in the enclosure.

Each socket outlet shall be combined with a load switch and leakage current relay.

400V socket outlets shall be according to CEE and 25 A.

9.8.5 Uninterruptible power supply (UPS)

A UPS system shall be provided for the whole control and monitoring system and the instrumentation at the Facility, which is double conversion on-line type. It shall include automatic transfer switch, manual maintenance bypass switch. Design shall be based on microprocessor/DSP controlled "pulse width modulation" technique.

The UPS system for the Facility shall ensure the operation of the control and monitoring system and protect the system from losing data in case of a power cut. UPS shall have a means of on-line test procedure to test battery condition and battery management system to ensure 10 years of battery life time.

Administrative building	CCTV	/PLC boards	SCADA	Fire System	Phone/ Data (Ethernet/fiber converter) system
20 kva, 3 phases	3 kva	DC_UPS	3 kva (2 piece, parallel)	3 kva	3 kva
3 hours	1 hour	1 hour	1 hour	1 hour	1 hour
It will supply all administrative building, if CCTV, fire, phone, data system is located in administrative	It will be used if it is in separate location from administrative building	It will be located in interior covers of boards	It will be rack type UPS	It will be used if it is in separate location from administrative building	It will be used if it is in separate location from administrative building

building, they

will be supplied from this UPS

All equipment necessary for operation of the control and monitoring system shall be fed from the UPS system including the following:

- The operator station including all connected equipment
- The maintenance station including all connected equipment
- The PLC's
- The Server System,
- The communication network
- The instrumentation.
- The fire detection system

The UPS system for the Facility shall fulfil the following requirements:

- Efficiency AC/AC: min 90%
- Overload, 1 min.: 150%
- Disturbance: <10%
- Power factor: >0.9
- EMC: VDE 871-B/0875-E
- Acoustical noise: max. 55dBA.

It shall include indication of:

- Power source (grid or battery)
- Charging
- Battery OK
- Inverter OK
- Charger OK
- Grid OK
- Static Bypass
- Manual Bypass.

9.8.6 Earthing system and equipotential bonding

A four-conductor earthing system (TN-C-S) pursuant to IEC 60364 with commonprotective conductor (PE) and neutral (N) conductor shall be established from the power transformer(s) and throughout the new installations to be established, till the entrance of every building.

Part of the system uses a combined PEN conductor, which is at some point split up into separate PE and N lines. The combined PEN conductor typically occurs between the substation and the entry point into the building, and earth and neutral are separated in the service head.

The above configurationshall be approved by the electricity company.

A common equipotential bonding bar (CEBB) shall be installed connecting:

- Power transformer low voltage (LV) earthing points.
- Facility protective conductor system (PE).
- Building reinforcement.
- Facility cross-bonding system.
- Earthing system for external lightning protection system.
- Lightning and overvoltage arresters.

Foundation earth shall be firstly applied to the reinforcement of buildings / units via galvanized steel strip in 30x3,5 mm. Afterwards second circle shall be created around the buildings / units via copper conductors in at least 70 mm² in a way that distance between galvanized strips and copper conductors will be around 1 meter. Both circles shall be connected each other from each corner via copper conductors in at least 70 mm².

Every building / unit shall be connected to other building / unit from at least 2 points via copper conductors in at least 50 mm² by using equipotential bars.

The common equipotential bonding bar shall be made of copper and have a cross sectional area such that it can act as the circuit protective conductor on each item of the plant and equipment connected to it. The bar shall be clearly labelled to identify its purpose and bolted firmly to the building wall mounted on 50 mm distance pieces. Cable termination shall be made with compression-type cable lugs bolted to the bar.

An equipotential zone shall be created throughout all installations encompassing all metal structures. Extraneous metalwork, building reinforcement, metal supporting structures and machinery equipment i.e. pipes, conduits, pumps, motors etc. shall be cross-bonded and connected to the common equipotential bonding bar.

An earthing system for power transformers shall be established as specified in this specification.

The earth resistance of the earthing system shall be as low as practicable but shall in any event be such that the electrical resistance between the common equipotential bonding bar and the general mass of one earth group shall not exceed 5 ohm when any one group of electrodes is disconnected. Connections to copperweld ground rods will be made by the Cadweld process.

Distance between 2 different earth groups shall be at least 20 m. Electrodes of earth socket shall be buried with the superior part at the minimal depth of 0.8 m.

Every construction shall be connected to the earth group through at least two points.

Protective conductors (PE) shall be made of stranded copper with overall green/yellow plastic covering.

Transformer/generator/CHP	Panel, /PLC	Lighting	Operation	CHP grounding
Operation grounding	grounding	conductor grounding	grounding	
≤3 ohm	≤1 ohm	≤5 ohm	\leq 3 ohm	≤3 ohm

9.8.7 Lightning and Overvoltage Protection

9.8.7.1 External Lightning Protection

An external lightning protection system of buildings shall be established to prevent damage to the building due to fire or mechanical destruction in the event of a lightning strike.

All devices to be installed outside the building for intercepting and discharging the lightning current to earth are described in DIN VDE 0185.

The lightning protection system to be adopted shall be performed according to the protection class I requirement of IEC *62305-1*, Protection of structures against lightning.

Transformer/generator/CHP Operation grounding	Panel, PLC grounding	Lighting conductor grounding	Operation grounding	CHP grounding
≤3 ohm	≤1 ohm	≤5 ohm	≤3 ohm	≤3 ohm

All the buildings, of which people work inside, shall be protected via Faraday Cage against the lightning. Other units except buildings shall be protected by active interception rods. Protection shall be included all Plant.

The earthing system for external lightning protection shall be connected to the building reinforcement.

9.8.7.2 Internal Lightning Protection

The heart of the internal lightning protection system is the equipotential bonding system to be established. All from field incoming and outgoing to field signal and control lines shall indirectly be incorporated in lightning protection equipotential bonding system via lightning and overvoltage arresters.

At inlet of main	At MCC board inlets	At /PLC board inlets	Local equipment
distribution board			boards (grating
			decanter, UVetc)
			, , ,
Type 1, B Class	Type 2, C Class	Type 3, D Class	MCC part; Type 2, C
			class
			If there is /PLC or
			controller Type 3, D
			class

Every arrester shall have an alarm contact to open if the arrester becomes defective. The alarm contact shall be wired to the PLC.

9.9 **Power Factor Correction**

All necessary compensation systems shall be provided and installed so that power factor of the facility would be 0.99.

Furthermore; no load loss of the transformers shall be compensated via fixed capacitor banks.

Necessary measures shall be taken in order to suppress harmonics if required. Harmonic filters for Fk and shunt reactor and tyristor control for fk shall be applied.

Automated power factor gear for correcting power factor shall be incorporated. Fixed capacitor banks are not permitted.

All required gear for power factor correction shall be supplied as one unit fully enclosed to a degree of IP54. The unit shall comply with *EN 61439* and be designed to maintain: $\cos \phi = 1 \pm \%3$ at all load conditions.

On the front of the unit the following instruments are to be found:

- Power factor [0-1-0].
- Step indicator (to indicate the current step).
- Indicating lamps:
 - Alarm
 - Normal operation

The alarm signal shall be wired to the PLC.

Capacitors shall be minimum 520 Volt PCB-free, with a loss < 0.2 W/kVAr and comply with:

- EN 60891.
- IEC 60831, Shunt power capacitors of the self-healing type.
- Capacitor; should be 480 V and also able to be use with shunt power reactor
- Shunt power harmonic reactor, well be edit if requirement, Tip %5,67 /215 Hz,
- Shunt power reactor, Tristor controlled, last 3 step,
- There should be block for early shut down and reducing resistors which limits current value during closure as max 60 In in contactors. Contactors should be contactor which is produced for compensation. Contactors should be selected accordingly with relevant IEC 60831-1 / 60871-1 and EU standards.

Power factor correction units shall incorporate suitably rated internal overcurrent protection of the capacitors and be with common phase sensing for correction of all three phases simultaneously. Single-phase correction is not required. Delay between corrections shall be adjustable from 30 - 120 seconds and be set to suit the requirement of the local electricity authority. If no requirements, 40 sec shall be used as the default setting.

Twelve step capacitor bank shall be provided as a minimum. Each step to be suitable sized with due regard to the inductive loads.

9.10 Motor Installations

Terminal boxes for motors are to be with bottom cable entry through cable glands.

Power connection will be made between MCC boards and local boards. Signal cable will be connected directly. Terminal box will be IP65 and aluminum in submersible pumps and pump power and signal cables will be connected in same terminal box.

9.11 Junction Boxes

General junction boxes are to be constructed of aluminium complete with lid and captive gasket to a degree of IP 65. The necessary number and size of entries together with terminals are to be designed according to circuit requirements. General junction boxes shall be suitable for direct mounting with external fixing holes, and are to be labelled with reference number.

Terminals are to be arranged at different heights for different services and a barrier is to be provided to shield instrument circuits from power circuits at different voltages. Terminals are to be of the necessary number and size (20 % spare) and determined according to respective circuit requirements.

9.12 Cable Entries

Cable entries from one room to another or from outside to inside shall be performed by watertight and fireproof multi cable penetration seals to provide an efficient barrier against fire, smoke, flooding and vermin.

The cable penetration system shall comprise a steel-mounting frame packed with insert blocks to accommodate the cables and to fill out surplus room. After cable installation the insert blocks shall be compressed to complete the sealing.

Each mounting frame shall be embedded in walls.

9.13 Cable Glands

All cable glands are to be of the compression type acting upon the cable sheath and where necessary provided with stockings, which grip the cable. All cable glands are tobe of corrosion resistant metal or plastic cable glands will be accepted if it is not original accessory of provided equipment. Cable glands are to be of a type, which will not reduce the degree of tightness of an enclosure, and are to be correctly sized to the cable they seal.

9.14 Cables

All cables used in the plant shall be of stranded type and shall have necessary protection against rodents.

Power cables are cables having operating range U \geq 50 V. Signal cables are cables having operating range U<50 V

9.14.1 Power cables

Cable sizes, types and construction must be chosen with due regard to the connected equipment requirements, ambient conditions, installation method, and fault and overcurrents. Generally, the cable manufacturer's published data are to be used in determining cable adequacy.

Power cables shall be selected such that the voltage drop does not exceed the maximum value defined in IEC 60364 at any point in the installation.

Power cables shall generally consist of two types:

- PVC for internal building.
- Cross-linked-polyethylene (XLPE) for all other locations.

PVC power cables shall comply with IEC 60227, 60228, and 60245, and must not be less than 1,5 mm² cross section. Generally, PVC power cables are to comprise stranded copper conductors with an extruded PVC insulation, laid-up in an extruded PVC bedding with PVC oversheath. Where mechanical

protection is required cables may be placed in metal conduits or be provided with armouring depending on the installation.

XLPE power cables shall comply with IEC 60228 and IEC 60502, and must not have less than 1,5 mm² cross section. Generally, XLPE power cables are to comprise stranded copper conductors with an extruded XLPE insulation, laid-up in an extruded bedding, galvanised steel wire armouring and an extruded PVC oversheath.

Selection of all the cables and capacity decreasing factors will be determined according to the items below:

- a) Environment and ground temperature
- b) Specific thermal resistance of the soil
- c) Cable depth O.G. 0.8 meter
- d) Cable depth A.G. 0.8 meter

Following factors will be taken into consideration in order to determine required capacity and width section for each cable:

- a) Short-circuit current
- b) Environment temperature conditions
- c) Installation of the cables inside air, channel or soil

For power circuits minimum 1.5 mm², cables with appropriate section for electronic equipment will be chosen.

9.14.1.1 MV Cables:

High voltage connections between transformer stations shall be for 34.5 kV. 20.3/35 kV cross-linked polyethylene (XLPE) cable will be manufactured in compliance with TSE and it will have bunched copper conductors, XLPE insulated cores, shielded sealed insulation mount, one galvanised steel wired sheath (and/or protected chemically against rodents) and finally on top a PVC mount. By conforming to all other requirements and corrections of TS 1618 and by taking into consideration physical and chemical features of the PVC mount, red coloured PVC must be chosen. In cable connection; proper cable termination accessories and materials shall be used.

MV Cables will be laid as one core and a spare core will always be provided.

According to TEDAŞ standard, cable diameter should be at least 95 mm2 XLPE.

PVC mount will comply with TS 1618 requirements, will keep its adhesiveness to the sheath wires and bedding and following long-lasting storage process, during direct sunlight exposure of the cable system, it will not be softened to be deformed or torn apart.

Also, in the condition where the line between the power generation point and the facility is aerial line, a conductor with appropriate cross-section and steel core aluminium in compliance with TSE and related international standards will be chosen and installation conforming to TEDAS Specifications will be performed.

9.14.1.2 LV Cables:

Generally, low voltage power cables shall be 600/1000 V grade.

Cable sizes, types and construction must be chosen with due regard to the connected equipment requirements, ambient conditions, installation method, and fault and over currents. Generally, the cable manufacturer's published data are to be used in determining cable adequacy.

Power cables shall be selected such that the voltage drop does not exceed the maximum value defined in IEC 60364 at any point in the installation.

Power cables shall generally consist of two types:

For Indoors

Cables that lead to the facility and machinery will be thermoplastic insulated type NYY, NYCY or NYMHY type, by using polyvinyl chloride (PVC) or cross-linked polyethylene.

For Outdoors

In case where indoor cables (NYY, NYCY or NYMHY) are used, these cables will not be laid directly into the ground. They will be passed through pipe or channel. In case where they are bedded into the ground they will have XLPE insulation, steel wire armoured and extruded PVC covered twisted copper conductor.

9.14.2 Signal cables

For signal cables thin multi-wired electrolytic copper conductor, PVC isolated, core, tinned copper mesh screened, out coating PVC in indoor environment, and PE in outdoor environment LIYCY cables will be used.

The cores of the signal cables will be numbered and panel outputs will be labelled at the device inputs.

Cables shall be provided in five times two pairs, ten times two pairs, twenty times two pairs or thirty times two pairs, as circuits require.

9.14.3 Lighting cables

Lighting cables indoors will be NYM type. External lighting cables will be NYY type inside PVC pipe.

9.14.4 Earthing and bonding cables

Bare earthing cables shall comply with IEC 60228 and must not be less than 16 mm² stranded copper single conductor and sized according to the requirements of the IEC 60364.

PVC insulated earthing cables shall comply with IEC 60227 and 60228 and must not be less than 2,5 mm² cross section with a single stranded copper conductor with an extruded PVC insulation coloured green/yellow in spiral stripes.

9.15 Cable Routing

9.15.1 Cable segregation

Cables operating at different voltages and for different purposes shall be properly segregated.

All power and signal cables will be laid in separate trays.

Throughout installations threecontinuous separate tracks shall be established for:

- MV cable in different cable tray
- LV power cable in different cable tray
- Signal cable in different cable tray

The distance between MV and LV cables must be min. 300mm and between LV and signal cables min. 200mm .

9.15.2 Cable trays, ladders and trunking

Cable trays, ladders and trunking shall generally comply with IEC 60364 and shall be constructed from mild steel sheet hot-dipped galvanised perforated, and of such a design that it is rigid in construction. The choice of manufacturer is to ensure that bends, tees, intersections, reducers, risers, and droppers are included as standard in the product range.

Cable trays will be hot dip galvanize, heavy duty type and shall have a minimum thickness of 2mm.

Cable trays, ladders and trunkings shall be sized and provided with isolating barriers in accordance with the spacing and segregation requirements of cables as mentioned above.

Connection from cable trays will be made with suitable glands.

Where the cable trays, ladders and trunkings are cut, drilled or where the galvanising is damaged in any way the surfaces shall be adequately treated to restore them to the original galvanised standard.

Earthing will be applied to cable trays, ladders and spares.

All cables will be fixed by clamps (brackets) or crochets or plastic bands along the path that they are installed.

In cases where power and control cables are laid together; a cable pan will be placed in between power and control cables and cables will be separated with this separator.

Supports shall be provided at intervals to assure that the maximum deflection allowed by the manufacturer for the given loading is not achieved. The weight and quantity of cables placed in cable tray or ladder must not exceed the manufacturer's recommendations. On selected cable trays, ladders and trunking sufficient space must be left for additional cables necessary for the future plant extension. The number of cables installed shall be limited ensuring the resulting space factor will not exceed 45%.

All vertical cable trays, ladders and trunking must be provided with perforated covers of equal treatment fixed in place by means of bolts until 2 m above floor level.

9.15.3 Conduit systems

Conduits within buildings and structures shall be either super-high impact heavy gauge PVC conduit, installed with solvent welded joints, or shall be manufactured from galvanised steel and shall be installed with screwed fittings. Conduits installed external to buildings shall be galvanised steel. Where galvanized steel conduit is cut or where the galvanization is damaged in any way the surfaces shall be adequately treated to restore it to the original standard.

Fittings and accessories associated with conduit systems shall be either manufactured from noncorrodible materials or suitably coated to render them non-corrodible. No conduit shall be smaller than 20 mm diameter.

Pull-boxes shall be spaced so that there is not more than two solid bends, or their equivalent, or more than nine metres of straight run between pull-boxes.

9.15.4 Cables in ground

All main race trays in ground shall be constructed as channels of concrete in the ground. At the walls of the channel 2 or 3 cable trays shall be installed at each side. The channel shall be covered by concrete

slabs. The installations are to ensure cables maintain required segregation by providing at least one cable tray for each type of cable (signal cables, power cables).

In routes with fewer than 10 cables, cables can be installed in pipes, one pipe for each type of cable. Generally pipes will be 100 mm diameter and in any event sized so that only half of their capacity is taken up by cables. Conduits are to extend beyond road edges by 500 mm. For the maximum length of every 50 meters the pipes must be connected to a manhole in order to ease installation of new cables.

If requested TECHNICAL GALLERY AND TECHNICAL CANALS

Technical gallery system and $1.00 \times 1.00 \text{ m}$, $1,60 \times 1,00 \text{ m}$ and $2.00 \times 1.00 \text{ m}$ technical canal connection system was maintained in necessary locations within plant. Gallery was built for units where piping and cabling systems are intense and connection systems with canal is installed for other units. Connection for galleries will be maintained through manholes which were left in plant units and site.

Technical galleries are class II structures. These structures will be manufactured form C25 reinforced concrete and S420a reinforcing Completed concrete surfaces of technical gallery will be F1.

Technical gallery which will serve for Facility area will be rectangular sectioned underground structure and particularly will be used for following functions.

- * Water distribution pipes(including fire water distribution)
- * Heating distribution pipes
- * Energy distribution cables
- * Phone and fire alarm cables
- * Other pipe systems of process units

Net height of gallery was taken as 2.10 m and width was taken as 1.60 and 2.00 m after considering functions which are mentioned above.

Design of technical gallery and canals will be accordingly with project and technical specifications. Drainage will be constructed in gallery even though they are not present in approved project of technical gallery and canals and water which may leak into gallery will be discharged to suitable location.

Heat isolation will be built accordingly with climate conditions for all pipes and any kind of equipment which needs heat isolation and passes through technical gallery and technical canal. There will be fire detection, vavienne LED illumination, CCTV system, gas detection, warning and ventilation.

Important notice: The electrical networks & cables will be installed in a different technical gallery from the one that will be used for the piping concerning water distribution network, waste water collection, fire fighting pipes, etc.

9.15.5 Installation of cables

Cables installed on trays, ladders and trunkings must be so arranged that there are nocrossings or interlacing of cables. The trays, ladders and trunkings must be sized for the cables' bending radius and weight. Cables shall be secured to the tray and ladder by means of ultra-violet stabilised tie-wraps at the necessary intervals commensurate with the cable size and weight. All cable tray, ladder and trunkings routes must be complete before cables are installed.

Cables individually run and direct mounted on walls or ceilings must only be installed after building trades and painters have finished their work. Cables may only be installed in vertical and horizontal planes and be aesthetically acceptable taking the most unobtrusive routes possible. Single hole plastic fixing cleats only shall be used.

All cables terminating at equipment are to employ screwed cable glands only - the use of epoxy putty is expressly forbidden.

Cable runs shall be continuous throughout. Jointing shall not be carried out in conduits or at pulling points under any circumstances.

Cables exposed to direct sunlight shall be able to withstand exposure.

Cables with different voltage levels shall be laid in different trays. If they are designed to be laid in the same tray (by using separators) due to small cable quantity in certain tracks, the approval of the Engineer shall be taken.

In cable connection; proper cable termination accessories and materials shall be used where necessary.

9.15.6 Cable identification

Cables and cable cores shall be identified at both ends by means of sleeve bands bearing the cable/core reference number, which shall relate to the reference number shown on the drawings. Where multiple cables are laid in troughs, duets, clipped on tray over long runs through several rooms in buildings, or laid in ground close together, intermediate markings to identify specific cables shall be applied.

Where cables are installed in duets, the cables shall be identified with the cable reference number within each cable draw chamber.

9.16 Security Systems

9.16.1 Fire Fighting System

The system shall be installed in accordance with the latest issue of "Turkish Regulations for Fire Protection in the Buildings" published in the official journal dated 26 July 2002 and numbered 24827 and international standards. All materials to be offered shall be manufactured in accordance with at least one of CE, EN, DIN, VDE, and etc. standards and shall have certificates obtained from at least one of UL or FM international approval foundations. The manufacturer company shall have ISO quality certificates.

Analogue Addressed Fire Alarm Network;

The control panel shall be modular and have the number of zones as indicated. It shall be 2-cycled with 24 zones, have analogue addressed fire alarm network addressing capability and 24 fire zone indicators. The analogue addressed fire alarm network shall be compatible with addressable smoke, heat, gas and temperature detectors, addressable internal and external type fire alarm buttons, input and output interface units, short circuit isolators and connections of addressable audible alarm devices. The network shall be manufactured with microprocessor technology and its capacity shall contain 1, 2 or 4 cycles. At least 127 addressable devices should be connectable to each cycle. The fire alarm network shall be selfoperable and inter-connectable with at least 32 analogue addressed fire alarm network systems in big distribution systems. When additional detectors or buttons are needed in the system, these additions shall be made freely and this process shall not hamper the existing local addressing arrangement. The network shall contain at least 4 programmable audible alarm outputs as standard and specially controlled alarm and fault outputs shall be available for signalling to fire brigade or a remote fire-fighting centre or observatory. Different working schedules for day and night hours in the network shall be applicable. In case very low-density smoke is present, a pre-alarm function shall be available for early response from the network (response to fire before audible alarms activate). The network shall control all detectors constantly for pollution level and shall give a "Service required" warning when pollution is detected. Repeating panels and mimic panels shall be connectable to the network. All cables going to

detection and alarm devices and all lines used for communication to remote control and inspection centres shall be continuously controlled for breakage, short circuit and fault currents. The network shall keep the last 200 events in its non-volatile memory.

The fire alarm network shall contain a general fire alarm and fault lamp, individual alarm and fault lamps for each fire zone, illuminated alphanumerical gauge with at least 80 characters and local sound warning device. A mini type thermal printer shall be installable on the network when necessary. All regional fire lamps shall contain a zone number on their side to indicate their fire zone. In case the main supply is out, the fire alarm system shall be equipped with fully closed, impermeable type, maintenance-free batteries to carry out detection functions for at least 24 hours and to execute alarm, control and communication functions for at least 30 minutes at the end of this duration. Also, the UPS system in the administration building can be used for supply as well. The network earthing shall be made independently with required ohm value. The network shall be in accordance with TS EN 54-2 and TS EN 54-4 and shall be manufactured by a ISO 9001 quality certificated manufacturer. The supply and delivery of the network tested for operation, including all types of small materials.

Analogue Addressed Ionized Smoke Detector;

The detector shall be sensible to smoke particles with sizes between 0.01 microns and 10 microns. The detector shall have a double-cubicle ionization cell to be immune to changes of humidity, ambient temperature, etc. The detector shall send the measured analogue smoke levels to the control panel as analogue information, the sensitivity, calibration and working performance of the electronic circuit shall be tested by the detector and this information shall be sent to the control panel via circuit cable. The detector shall contain at least one LED light for remote visual control and shall be suitable for parallel warning lamp connection. The detector shall be mountable and removable by a specific socket. The addressing of the detector shall be made by any position switch or manual type detector programming devices. The detector shall be in accordance with TS EN 54-7 and shall be manufactured by a ISO 9001 quality certificated manufacturer.

Analogue Addressed Temperature Detector;

The temperature measured by a semi conductive temperature detector shall be sent to the control panel as analogue information. The detector shall be programmable to operate as a constant temperature detector or temperature increase rate detector and the constant temperature activation value shall be adjustable to at least one of the 4 different temperatures. The detector shall send the measured temperature levels to the control panel as analogue information, the sensitivity, calibration and working performance of the electronic circuit shall be tested by the detector and this information shall be sent to the control panel via circuit cable. The detector shall contain at least one LED light for remote visual control and shall be suitable for parallel warning lamp connection. The detector shall be mountable and removable by a specific socket. The addressing of the detector shall be made by any position switch or manual type detector programming devices. The detector shall be in accordance with TS EN 54-5 and TS EN 54-8 and shall be manufactured by a ISO 9001 quality certificated manufacturer.

Analogue Addressed Fire Warning Button;

The addressable fire warning buttons shall be activated by a plastic film covered breakable glass on them. When the glass is broken, a micro switch normally in contact shall be free and change position and shall stay in this position until a new glass is installed. The button shall be testable by a test switch without breaking the glass. The button shall contain at least 1 illuminated gauge. The button shall be in accordance with TS EN 54-2 and shall be manufactured by an ISO 9001 quality certificated manufacturer.

Electronic Fire Warning Siren Flasher;

The casing of the siren flasher shall be durable and resistant to heat. The siren flasher shall have a minimum 100 dB / 1 m sound intensity and 32 different tones. The minimum flashing energy of the siren flasher shall be 2.5 Joules and the flashing frequency shall be 1 Hz. The siren flasher shall have a Xenon lamp and shall be visible even from long distances. The protection class of the siren flasher shall be at least IP 44. The siren flasher shall be in accordance with TS EN 54-3 and shall be manufactured by an ISO 9001 quality certificated manufacturer.

9.16.2 Telephone System

Telephone Exchange Unit shall be provided with the accessories. Main Unit shall be located inside the Administration Building. Telephone lines and sockets shall be foreseen for Administration Building, Guardhouse, Mechanical and Electrical Workshops, MCC rooms etc. Handset receivers shall also be provided by the Contractor.

IP type telephone system shall be provided.

Capacity of exchange unit shall be at least 6/40.

Contractor shall also be responsible for bringing of main telephone cable (PD-PAP) from outdoor telephone panel to the telephone exchange unit.

The contractor shall establish telephone lines (1 for pager system and 2 for other use).

There will be minimum 30 phone terminal and 1 main switchboard console.

9.16.3 Data main cable

Security system data will be transferred to the SCADA – automation system via fiber optic cable.

9.17 Tools and Maintenance Equipment

The Contractor shall provide all special hand tools needed for the proper maintenance of all the equipment delivered.

All the special tools shall be available and fully functional at the plant after Tests on Completion.

Special electrical tools are tools or instruments that are specifically used for testing of electrical circuits. The following is considered as special tools:

- Megger for measuring of insulation resistance
- Instrument for measuring of earth resistance
- Multimeter
- Instrument for measuring of direction of motors
- Instrument for indication of line voltage ON (screwdriver type).
- The Contractor shall also provide necessary maintenance tools for electrical and control system such as insulating carpets, maintenance hydrolic trucks for outdoor lightning poles, programming devices, 2 pcs of electrical set with bag including full of set etc.
- The Contractor shall with the tender provide a spare parts schedule including description and prices of spare parts, which are recommended to be kept in stock for general maintenance for a 2-years operation period; other than spare parts to be used during installation, testing, commissioning, which will be provided free of charge. The defects liability period are not considered as spare parts for 2-years operation period mentioned in the Contract.

9.18 Control and Monitoring System

9.18.1 General system description

A computer based control and monitoring system (also known as a SCADA system: Supervisory Control And Data Acquisition System) shall be provided for automatic control and monitoring of the MBT Facility.

A computer based control and monitoring system (also known as a SCADA system: Supervisory Control And Data Acquisition System) shall be provided for automatic control and monitoring of the Facility.

The system, in the following known as the CMS (Control and Monitoring System), shall be used for the following:

- Supervision of the MBT Facility
- Monitoring of alarms and status of the facility
- Changing of timers and parameters
- Calculations
- Real-time collection and storing of data and alarms
- Handling of data and alarms
- "Forced" stop and start of components from the operator station
- Automatic control of part of the treatment process

The control part consist of a distributed system with distributed local intelligent controllers (PLC's 's) to carry out the control and monitoring of the equipment connected to the PLC's 's. The PLC's 's will work autonomously if the communication network fails and the control will continue.

The system shall be designed to operate 24 hours a day without any necessity of attendance from the personnel.

The requirements for the control and monitoring system are described in the following.

Automatic control of the component shall be possible when the control switch for the component in the front of the panel is in the position "auto".

By-pass of the PLC control will be possible when the control switch is in the position "manual".

The CMS consist mainly of the following hardware components:

- rack type 2 server and 2 operator station
- Report and graphic printer
- Industrial network
- PLC's s
- Distributed I/O modules

The CMS shall be provided with all hardware and software necessary for the operation including cables, modems, interfaces etc.

Automation system where plant can be controlled and commanded over central Operator Interface Computer will be designed(As hardware and software)

Supply, installation and configuration or control interfaces which are close to field, local control room interfaces, local instrumentation interfaces, works for supplying energy for these and all kind of cable and additional hardware works for those.

Control Panel for (CMS/PLC) for processing manually handled control commands and monitoring process, Local instrumentation boards and buttons for these panels, indicator lamps and all other necessary equipment and parts.

The contractor must provide before the automation system construction & execution the:

- Source code in digital format along with the SCADA system
- Ladder diagrams
- Controlling and monitoring of the systems that will be monitored via the SCADA system. It must be clearly mentioned the systems that will be monitored and controlled.

CMS; Controlling and monitoring system

Supply, installation and commissioning will be implemented for Ethernet and necessary cables for maintaining communication between Controller/CMSs and Operator interface within plant. Communication infrastructure to be installed will have Ethernet based structure with ring topology. In case of line disconnections System will continue to work without interruption in communication due to ring structure.

GENERAL

Any kind of Controller/CMS equipment, License of programs which are used in Operator Interface/SCADA and HMI(Operator Panel) which are supplied by tenderer, software and programs will be delivered to enterprise at the end of work. Documents regarding with each equipment, necessary programming software which is necessary for operation of automation system will be delivered together with system including spare parts.

Automation technical specification

Plant will be controlled and commanded by Controller/CMS, Operator Interface and HMI system within scope of project. Controller/CMS, Operator Interface and HMI system will consist of CPUs, input/output units, communication modules and cables and industrial switches. Communication between Controller/CMS, Operator Interface and HMI(Operator Panel) will be Ethernet communication and will communicated with existing and to be installed control structures.

Controller/CMS,I/O cards remote controllers, Operator Interface, reporting, HMI, Operator Panel and Industrial switches will be same brand for system reliability, responding rapidly, storing spare parts and not to have failure for long time period.

Controller Technical Specification:

- It will be controller structure which will be required for controlling, commanding and monitoring system and it will be installed. All data exchange with CPU will be made with minimum impact during cycle time period in each data scanning time period. TCP/IP with minimum 100 Mbits/s will be used for communication between HMI(Operator Panel) and Operator Interface/SCADA system.
- Data which are acquired from field (Digital and Analog) or signals which are sent from CPU for control will be received from or transferred from Remote I/O(Input/Output) cards and will be communicated to CPU by this manner. CPUs and Remote I/O structures will have same brand depending on system and process structure.

- I/O cards which are present in system will have hot swap(installed and removed under energy) in all rack(backbone structure). Also system will remain in RUN mode while performing all these operations. Operation of modules except faulty module should not be interrupted during this replacement.
- CPU will allow to make digital signals 1/0 over program and should support to give simulation values for analog signals.
- CPUs should support 1ms time labeled cards which can be installed over them if necessary.
- All CPUs within system should be programmed with same software.
- Communication infrastructure between all CPUs and Remote I/O modules will be standard Ethernet based.
- I/Os should be accessed for diagnostic and maintenance purposes over web browser(internet explorer) over computer which is connected to network. This CPUs should be programmable such that they can send E-mail.
- All explanations regarding with program should be stored in controller CPUs. All data, variable and remarks should be able to be retrieved from CPUs after connection is made by computer software.
- There will be USB port over controller for making programming easier.
- There will be simulation property in controller software program and thereby program can be tested and controlled even though there is not controller.
- Controller will have capacity to process and support minimum 2000 I/Os.
- Controller will have capability to increase programming memory of CPU is necessary and will have minimum 1 MB memory.
- Remote I/O terminals will have capacity to support and process 1024 I/Os
- . CPUs should have real time clock, Controller module internal clock should be able to be synchronized with Operator Interface by time synchronization command over NTP server.
- Cards to be used in system will have standards and certificates which are mentioned below.
 - ▶ IEC/EN 61131-2
 - ► CSA 22.2 N 142
 - ▶ UL 508
 - ➢ ABS, BV, DNV, GL, LR, RINA, RMRS
 - ▶ UL 746C, UL 94
 - CSA 22.2 No: 213, Class I, Division 2
- All cards to be used in system will be able to work at 0.. 600C and will be stored at -25.....+70 C
- Controller software will strictly support IEC 61131-3 standard and all of software languages which are mentioned below will be able to be used.

- ≻ FBD
- > SFC
- ≻ IL
- ≻ ST
- Strictly there will not be any limitation regarding with use of blocks which are present in software library.
- Remote inputs and outputs should communicate with controller over TCP/IP and Ethernet IP over Ethernet structure.
- Controller Inputs/Outputs cards to be used will meet minimum following requirements.

PROPERTIES OF DIGITAL INPUT CARDS

- Each digital input card will include 64, 32 or 16 channels.
- Inputs will have maximum 16 unit group isolation.
- Digital inputs will have spring, screw or connector connection
- There will be LED status indicator for each input.

PROPERTIES OF DIGITAL OUTPUT CARDS

- Each digital output card will include 64, 32 or 16 channels.
- Outputs will have maximum 16 unit group isolation.
- Digital outputs will have spring, screw or connector connection
- There will be LED status indicator for each output

Input voltages can be driven by 24 VDC 500 mA

PROPERTIES OF ANALOG INPUT CARDS

- Each analog input card will include 8 or 4 analog inputs for providing place saving.
- Inputs will have isolation.
- Analog inputs will have spring, screw or connector connection. It will be suitable for 2,3 or 4 wire connection.
- Each analog input should support all 0.10V, 0..20 mA, 4..20 mA input types.
- Each Analog input should be minimum 16 bit sensitive.

PROPERTIES OF ANALOG OUTPUT CARD

- Each analog output card will include 8 or 4 analog outputs for providing place saving.
- Outputs will have isolation.
- Analog outputs will have spring, screw or connector connection. It will be suitable for 2,3 or 4 wire connection.
- Each analog output should support all 0.10V, 0.20 mA, 4.20 mA input types.
- Each Analog output should be minimum 16 bit sensitive.

System Design and Configuration

Automation system will have structure which is suitable for extension. Software to be offered should use windows based datatabase of which graphical interface and logical interface software are single. Also software will create all variables, alarms, trends and control blocks (motor and pump) and faceplates automatically from relevant library and will submit report.

Single software environment

Single software environment is compulsory. No package with software which are dependent with each other will be accepted. Software medium should be suitable for major and minor applications without requiring other software medium. Single medium should cover applications design, topology structure for control, operator screens, hardware configuration(controller, rack and remote I/O, network, field communication, operator screens)

Object Model

System should rely on objects which are inspired from real world. Software should maintain data to be created automatically in control and operator interfaces when object is created in application. Software should allow user to create new object and make modification over objects within library.

System Design

User should be able to design process as hierarchical tree. System software should allow easy way for adding object in configuration mode rather than programming. User interface should be maintained for adding object(valve motor etc..) without requiring deppd programming knowledge.

Operator Interface

Operator interface to be used in system will consist of 2 servers, 2 clients and 1 client with license for 1250 object. Servers will work as redundant. When of these licensed clients shut down or has failure it will be able to retrieve data from other server. Properties regarding with operator interface also mentioned below.

Operator interface software will write data over field control devices for easy and fast implementation of operation and maintenance of system by operators, controllers and maintenance personnel, will read data from these equipments, will archive and monitor historical data and will provide graphical screens and reports.

All operator interface functions such as communication drivers, graphical properties, reporting, storing historical data, trend and alarm indicators, and development medium are expected to be delivered as integrated software package or package set. If software has to be supplied from more than one vendors for meeting this specification, software components and dealers should be given as separate list.

In addition to this, Party and Solution management, material tracking, calculation of non operation period and similar management reporting and OEE and similar top level software products will be purchased from Operator interface dealer as single software package or integrated packages.

Operator interface software will write data over field control devices for easy and fast implementation of operation and maintenance of system by operators, controllers and maintenance personnel, will write data to these equipments, will archive and monitor historical data and will provide graphical screens and reports.

All operator interface functions such as communication drivers, graphical properties, reporting, storing historical data, trend and alarm indicators, and development medium are expected to be delivered as integrated software package or package set. If software has to be supplied from more than one vendors for meeting this specification, software components and dealers should be given as separate list.

Control and Surveillance Software which is present in Operator Interface Computer(hereinafter will be referred as only Software) will be operated in Windows operation system environment. Infrastructure where software will operate was is specified with detailed manner as following. Software will have structure which can use all graphical and functional properties of current windows technology. Software will be accessed over internet by TCP/IP protocol. Configurable web server will allow only authorized persons to access process information. Process images which are prepared as Java applet in web server can be monitored in Administrative units by standard web browser. Webserver will store all connections.

Software should support latest technology graphical techniques for visualization of plant(movable graphs and animations. Software should have advanced alarm system. Alarms which exist in system should be archived, should be classified according to priority order and should inform operator visually and acoustically. Software should record events in system as event lof. At the beginning which interventions are made by operators and when they intervened and software start up time should stored in these events. Process data which are stored in software database should be displayed as trend in time axis together with data value. Time axis should be able to be extended and narrowed by operator without requiring any program. (zoom property). Stored format should be able to be accessed by MS Office Programs (Excel, Access Etc).

Software should be scalable such that user can start with small system and can extend database to any size by only upgrading license. It should be able to add stations to system by only adding licenses and configuring stations. No change should be required for supporting new additions in enabled stations and project configurations.

Performance

Software producers should have maintain minimum 5 plant references indicating that software will meet following specifications.

- 60 workstations which are simultaneously connected;
- 200.000 variable tags from field devices
- 20.000 alarm tags from field devices
- 7.500 pieces historical trend tags which are read from field devices.

Scalability

Software should be scalable such that user can start with small system and can extend database to any size by only upgrading license. It should be able to add stations to system by only adding licenses and configuring stations. No change should be required for supporting new additions in enabled stations and project configurations.

9.18.2 Architecture (System Architecture)

Operator interface should consist of Operator Interface Subsystems and different server subsystems which include following items for central operation.

- I/O Devices subsystem
- Monitoring, reporting, distributing and acknowledging alarms
- Collecting, storing and distributing historical trends
- Processing, storing and distributing reports

• Internet services for internet browser based clients.

Subsystems should be designed as separate series where one subsystem will not effect operations of other subsystem adversely and subsystem which generates error should be able to be reset and recovered without closing computer or application. This will maintain to store all historical records in central pool for preventing process doubling, reducing network bandwidth and field device operations and maintenance and repair operations.

Operator interface which is recommended for managing different stations where test, development, operation, local monitoring, remote monitoring and maintenance operations should support following Microsoft ® operation systems

- Windows[®] 8.1 Pro or 10
- Windows Server® 2008
- Windows Server® 2012
- 32 and 64 Bit

Operator interface was designed for supporting all development and operation applications at same time. Operator interface should support application of all combinations for operation systems which are mentioned above. For example Operator interface should be able to be implemented in Windows Server 2012 platform, clients in Windows 10 pro or Windows 8.1 Pro Platform and development should be able to be applied in Windows platform.

Also system should support ordinary Internet browser based clients for providing personnel who is present in WAN with proper security configuration to access to system. Internet browser clients should support view and control properties which are controlled by both login security and license types. Internet browser client should provide including but not limited to graphical screens, trend pages, alarm pages and system security for standard client software. Internet browser clients should support view and control features which are controlled by both login security and license types. Internet browser client should support view and control features which are controlled by both login security and license types. Internet browser client should not require additional design or customized software for exporting configuration.

Operator interface should be able to be configured as single global database notwithstanding with number of stations within system. User should be able to make configuration modifications over global database in station within system provided that all operations are transparent. Each operator interface should have option for remote accessing to database in file service medium in networks which have local storage or high bandwidth capacity.

Operator interface should be able to be configured as series of project for facilitating maintenance and commissioning and it should be interconnected (or intranet) for providing to work as single global database.

All server based software tasks will be present in primary and standby computers for each task. Also software will support smart full redundancy property. Thereby there should be not only reproduction but also uninterrupted back up property for providing uninterrupted and trouble free operation in any hardware or software failure in subsystem and for copying operator processes from one server to other without requiring any additional configuration or code.

Also in the event that more than one Server is operated in single computer, failure in one subsystem should not delay processes in other subsystems and remaining part of Operator interface system should continue to work correctly while reset is made for faulty subsystem.

Task at least which should be executed uninterruptedly are:

- I/O device subsystems
- Monitoring, reporting, distributing and acknowledging alarms
- Collecting, storing, distributing historical trends
- Processing, storing and distributing reports
- Storing and distributing configuration for remote client stations.
- O, Network communication between operator interface stations.
- Field device communication (in positions where field devices support).

Software will be supplied as complete package. Additional software should not required for running or configuring all properties of system.

Software should support workstation which can use upto 255 databases as single integrated system simultaneously. It should be able to expand system by adding hardware which is not special.

It should be able to Operator Interface clients which belong to Operator Interface server to other server clusters by minimum engineering efforts. Operator interface clients should request and view live data, historical data and alarm data from Server in network without requiring restart or operator intervention.

9.18.3 Operation Interface

Software should use I/O server for reading and writing variables and tags in I/O(Input/output) subsystems. I/O servers should manage reading data from I/O device subsystems and writing to these systems and should provide these data for any client based upon request.

I/O servers should read and write only request is received from client or server system within network for reducing network traffic and operational burden over field devices.

I/O devices for proper protocols such as telemetri should have ability to collect time labeled data which comes from field equipments in addition to historical data in alarm and data log file. These information should be reproduced automatically in Operator interface historical records without requiring any user configuration or intervention.

Software should be available for working as redundant by supplying second computer or license without requiring any user interface or creating program if necessary.

All drivers which are present should be supplied together with software and included in price. Any additional license fee should not be necessary for use of one driver or all drivers.

Instant process data which is present in system should be able to be transferred easily to any OPC client application over OPC DA 2.0 Server which is present in system, archive information for system will be transferred over OPC HDA 1.0 Server and alarms and events which may occur in system will be transferred over OPC AE Server.

Software should have following connection options minimum for third party programs or databases without paying any fee.:

- o OPCClient
- OPC Server 2.0 DA
- ODBC Client

- ODBC Server
- DDE Client
- DDE Server
- Open API (2 license)

Third party applications which were written API, C, C++ or VBA should allow access to tag, alarm and trend data

It should be able to define time based or periodic schedule for reading variables from field devices and writing to field devices. There should fixed cache memory which will provide last known best values to be viewed immediately after restart without requiring memory for reading again.

Detailed diagnostic should be maintained internally by system and it will supply information regarding with each communication bus and communication with each processor. Any configuration or writing program should not be required for accessing to diagnostic information.

These diagnostic should maintain statistic for minimum following information.

- Number of retrials
- Number of timeouts
- Read and write for control equipments
- Minimum, maximum and average respond time for control equipments.

There should be debugging property which will allow read and write without requiring any configuration in graphic interface for tag for facilitating commissioning. This property should be security protect for preventing undesired access to tag values or commands.

In the event that failure occurs for whatsoever reason in communication line for remote field devices which can provide historical alarm records and tag value changes, after establishing remote connection remote terminal unit (PLC) should supply backup for all archived historical records, event and trend data into Operator Interface Alarm and Trend History files. Data should be able to be monitored by Operator Interface Alarm and Trend monitoring tools.

Operator interface software vendor will have package for users which will provide easiness for equipment drivers which have user software. Package will provide samples including source codes for operation drives for similar example types with respect to user requirements (for example serial driver, TCP/IP driver, report with exceptions, special board etc)

9.18.4 Software development environment

Development software will provide features such as being able to make calculations and comparisons over logical and numerical values within program, and provide advanced properties such as cycle, deviation etc. Some values which have to be measured (pump running hours) will be able to be obtained by making calculations in application software.

9.18.5 Engineering with Multiple User

CMS software should support server-user structure in terms of engineering. Multiple engineering users should be able to connect same engineering server at the same time and should be able to perform activities such as commissioning, maintenance and failure tracking. Logic, visual or system configuration changes which were made by engineering users should be recorded for security and

traceability. Thereby all changes which can be made in programs will be recorded. Engineering users which are connected to same network should be able to make all operations as if they are in same engineering server without having any restriction.

9.18.6 Security

Operator interface should support double signature property, operations which have major importance should not be operated without having approval from 2^{nd} person.

Security should be completely integrated to operator interface software for allowing access to any part of system for users which have suitable security level. Security in server should be controlled and passwords should be encoded.

Software should be able to group users according to their roles. Roles should be identified clearly and should be configured according to privilege levels and plant section.

Operator interface should be able to work integrated with windows firewall. Software should support Operator interface users which are identified in a windows domain. Operator interface users should be able to add, remove and provide access to Operator interface roles over windows domain server without requiring to make change in Operator interface configuration. Identity information for windows users whose identities are verified should be taken into cache memory securely in Operator interface node for allowing to log in Operator Interface node in the event that control device is unavailable in domain. Valid windows user should be able to open Operator Interface session automatically and entering identity information again should not be necessary. Both internal operator interface and windows users should be able to use.

Request for one user to shut down system will not lead shut down in system, system should switch to read only security status.

It should be able to define minimum 8 privilege level. Software should control user who logged in to have correct privilege level in all functions. If user does not have correct privilege level for function or object, it should be able to display message informing operator due to inadequate right.

It should be able to assign each graphical object to plants area also identify privilege level whether authorization is granted for operator entry or whether object is visible or whether existing user in certain plant areas will rely on certain privilege level. Access of unauthorized people to operation systems should be able to be prevented. Ctrl, Esc, Ctrl Alt Del and similar windows hot keys should be able to be disabled for preventing unauthorized access for operator.

There should be mechanism in software for limiting access for individual user or user groups to access to different areas of plant. Maximum 255 different plant areas should be able to be identified.

Access of unauthorized personnel to operation system should be able to be prevented.

9.18.7 Operator Screens

Number of graphical displays to be used will not be restricted by software.

Graphical pages will be resized notwithstanding with resolution where pages are formed or configured or whether vector or bitmap graphs are used and without closing operator interface, without recompiling without taking more than one copy with different resolutions from graphical pages accordingly with screen resolution. In addition to this, it will be able to resize window which includes graphical page and all components will be resized automatically according to window dimensions. Graphical system will support screen resolution upto 4000 x4000 pixel and connection more than one monitor to one computer. This support will include opening different windows in one monitor or same window in more than one monitor depending on configuration.

Graphic system will support 32 bit(65 million) color it will be able to monitor imaged which were taken from third party packages to be used in Operator interface screen including animating images and color lighting application.

I/O server will perform receiving data into cache memory during reading and writing within time period which can be configured separately for each field equipment. Objective for this is to prevent reading data unnecessarily and influencing bandwidth of field equipment communication that is cache memory should only perform reading in the event that same tag is required by more than one processor and/or subsystem.

Other graphical page screen targets will be selected and will be able to be viewed automatically according to status of tag for example certain graphical screen will be called automatically during an alarm.

Keypad macros will be able to be configured according to graphs or in form of macros which will be valid for all screens.

In the event that more than one object will flash in one page, all these objects will flash simultaneously.

Software will have capabilities accordingly with objective of pop up windows for trends, cycles, equipment status page and other graph viewing. Popup windows will be configured such than more than one window copy can not be opened at the same time for preventing confusion for operator.

Software will support opening up to 100 windows simultaneously. Software will have property to determine number of windows to be opened at any time simultaneously as being between 1 and 100.

Name of page, clock and date information and also details regarding with last occurred 3 alarms will be present in full screen pages.

Operational graphics will consist of minimum following dynamic objects :

- Free line
- Flat line
- Poly line
- Rectangles (Including rounded corners which can be identified by user)
- Ellipses
- Pie slices
- Text
- Button, newest windows style
- 3D Canals
- Bitmaps

Dynamic objects will have following properties which will change object with respect to tag or expression value:

- Horizontal, vertical and rotation movement
- Up, right, left or right level matching for local and retrieved objects(Including 3D- bitmaps)

- Inclined Level Matching
- ON-OFF, Multiple status, integer, threshold or inclination color change
- Vertical or horizontal dimension
- Visibility
- Keyboard input
- Clicking(mouse up, down, while at bottom
- Horizontal or vertical or rotation sliding bar
- Security access
- Disable
- Tip for popup tool

Properties which are mentioned above can be used at same time.

All color change types will be supported.

- ON_OFF: ON Color and OFF color changes according to result of a status.
- Multiple Status: All possible Boolean results of upto 5 conditions will be viewed with color which can be identified.
- Integer: Each different integer will be displayed with color which can be identified. Up to 256 colors can be identified.
- Threshold: Color which can be identified with respect to more than one threshold expression will be displayed. For example a color filler should turn into red when motor revolution is 4500 rpm or more and should turn into white when it is 100 rpm or less, it will remain in gray color for values between those.
- Slope: Color will change within color range with respect to analog tag value. Start and end color will be able to be identified.

Dynamic object graphs will be able to be grouped and dynamic properties will be able to be applied over entire group instead of objects individually. Objects within group will continue to support its own properties independent from group. For example articulated group component will have individual ON/OFF status but these will act as groups. Object properties within group can be arrange without disrupting group.

Each screen object will support keyboard inputs which will enable changing tag within system. When operator wants to enter value, she/he should select object then when operator input is written, it will be displayed in tool tip which is adjacent to object. System will control whether value is within approved range before sending it to field device. Value which is displayed or introduced by object will strictly be value which is read from field rather than value which is entered but not confirmed by user.

Software will support full screen, live camera video images and video viewing from disk (MPEG,AVI) simultaneously without any interruption. Screen window refresh speeds will not be influenced from this.

In the event that communication with certain I/O tag is disconnected, software will send a visual warning to location where these data are displayed regarding that value is not valid.

Software should be designed such that changes can be made in graphs while system is running. It should not be necessary to close system for making changes.

There should be Active X in operator interface software and software should allow implementing Active X objects. Operator Interface Software will interact with ActiveX objects by following manners.

- Changing properties of Active X objects dynamically over tag of field device.
- Changing dynamically by Operator Interface software high level language.
- Triggering activities in Operator interface software by Active X object accordingly with events of ActiveX object.
- Ability to read ActiveX ratio values by Operator Interface Software.

User will be able to navigate in graphical system by utilizing from several navigation methods. There will be switching keys which will provide fast connection to certain graphical pages.

There will be switching keys in windows keyboard which will maintain fast connection to certain graphical page.

There will be windows style navigation menus which provide access to all configured pages from other pages in system.

Graphical screens will be configured together with areas with problems where user can switch to detailed view of plant(if any) by clicking over it.

There will be windows style navigation menus which provide access to all configured page from other pages within system. Windows style navigation menus will be able to be configured during operation and will be able to be recorded by auxiliary program by project backup/reload auxiliary program and will be able to be reloaded.

Trend and alarm group assignments will be able to be configured during operation and will be able to be recorded within project configuration as it will be present in back up and reloading auxiliary program.

9.18.8 Alarms and Events

Number of supported alarms will not be limited by software. Maximum 2 billion alarm summary will be able to be stored in local alarm archive and they will be stored in memory such that they will be able to be called by standard alarm monitoring screens after minimum 10 days. Consider that each event will require 202 byte memory and consider the length of comment. 32.000 events will require minimum 6,2 MB memory. If you use too many events be sure that there is sufficient RAM. Speed of processer varies with respect to power of processor.

Alarm events will be written in log files and will be stored individually based on periodic files for archiving.

Software will be integrated such that an alarm which is acknowledged in operator station will be recognized in both primary and standby server and will be seen as acknowledged in all client stations. This will be configured as single common database where alarms can be acknowledged commonly from any PC without requiring any program or software part.

Operator Interface software will support use of event time label instead of its own time labels forAlarm events where time is stamped by field control device for maintaining more accuracy. Operator interface will support accuracy at milli second level for these time labels.

Analog Alarms

An alarm can be configured for each analog tag where relevant limits can be identified for following requirements.

• Low-low, low, high, high-high, deviation lo, deviation hi, variation ratio

All analog alarm limits will be able to be adjusting without closing system. Changes will be recorded to database automatically such that alarm adjustments will be correct when system is restarted.

Use of deadzone values will be supported in analog alarms.

Digital Alarms

Alarm can be assigned for each following condition over each digital tag.

- Tag ON
- Tag OFF

Alarm can be configured with respect to combination of more than one digital tag and each status combination will be able to be configured as alarm output. Additionally if multiple digital alarm is enabled in an alarm version, alarm will be generated if other status is switched.

Alarm with two status		
Tag 1 Status	Tag2 Status	
OFF	OFF	
OFF	ON	
ON	OFF	
ON	ON	

Alarm with three status:			
Tag 1 Status	Tag 2 Status	Tag3 Status	
OFF	OFF	OFF	
OFF	OFF	ON	
OFF	ON	OFF	
OFF	ON	ON	
ON	OFF	OFF	
ON	OFF	ON	
ON	ON	OFF	
ON	ON	ON	

Alarm Viewing

All alarms and/or latest alarms can be viewed or acknowledged in any page together with proper priorities.

There will be more than one alarm priority level or category within software. Priority of alarm can be specified by color type of text in alarm message in screen. Color codes for alarm messages with priority can be configured by engineers. System will support 10.000 alarm categories and up to 255 alarm priorities.

Audible warning property can be configured for each alarm category. This operation should be able to be made through all stations. Alarm audible warnings can be received by internal or external speakers.

. Software will have standard alarm view page which can be arranged for project. Transitions will be made in alarm page for acknowledging and deactivating alarms.

Following information can be viewed for each alarm in alarm viewing page:

- Alarm tag name
- Alarm definition
- Tag value
- Trip limit
- Alarm status, disabled, acknowledged not acknowledged
- Alarm Category
- Alarm Priority
- Date and Time in international format
- Priority
- Category
- Operator comments
- Value of tag or calculated result.

Each alarm category will be able to be viewed with different text types and colors according to alarm status such as active, not acknowledge, Active and Acknowledged, Acknowledged and deleted and disabled.(including flashing colors.

Alarm screen will support both proportional and fixed text types, All viewed alarm fields will be aligned properly.

Alarms can be disabled individually, with respect to page, alarm category or all together. When an alarm is disabled will be displayed in separate disabled alarm pages thereby users within system will easily determine which alarms are disabled.

Alarms which are present in all stations within system will be able to be acknowledged individually, with respect to category and page.

Operator comments can be added to alarms when they are acknowledged or later by using software. These operator comments will be displayed together with alarms when alarms are clicked.

All graphical screens can be displayed in alarm case or view of graphical object will be able to be changed dynamically according to status of alarm such as ON, OFF, acknowledged, faulty communication or disabled.

There will be mechanism in alarm screen which will ensure filtering alarm dynamically with respect to status, type, area, category and priority including sub status for alarm for analog inputs and alarm tag for operators, name of alarm, alarm definition, date/time interval. Additionally special filters to be identified for each alarm during development will provide fast access with operators during operations.

Alarm sorting

Sorting will be made in alarm screens according to one or more alarm lists without having any grouping limitation. (Ascending or descending). It will be able to make sorting by clicking over headers in alarm list.

Tag, Name, Category, Field, Priority, Status, ON Time, OFF Time, Acknowledge Time

Alarm Delay

Time when alarm will remain active before notification to operator will be able to be adjusted. Time label which is present over alarm should be time when alarm is enabled rather than completion time of time delay.

Alarm record

Different alarm recording method will be able to be specified for each alarm category. It will be able to be determined whether alarm is recorded When Alarm status changes as ON, OFF or acknowledged

Alarms will be able to be recoded in printer, disk file or database together with text, time and date. Alarms will be printed or filed in format which can be changed by user.

Operator interface software will provide opportunity for all users over network to record. Software will be able to direct printing operations to other printer when system is online.

9.18.9 Trends

Gathering trendes

Number of trends to be collected will not be limited by software.

Trend information will be able to be recorded with sampling periods which can be configured between 1 millisecond and 24 hours by using software. Trend data will be able to be configured by number of file, size of file, sampling period, file location, priority and trend tag and will be recorded in circular file system together with field information. Length up to 255 characters will be supported for Name and path for stored files

Historical data upto for last one years will be present in each file with 3 second sampling interval. Files will be joined for creating configurable historical data. Minimum 3 year data with 10 seconds sampling interval will be stored in historical data archive.

Trend data will be retrieved transparently from historical data archive independent from archive file where data is located and from date of data which is received. Trends will be accessed online by operator research without requiring backup or reload historical data file.

Trend data can be executed as periodically for example as sample for each sampling period or according to event for example retrieving in the event that certain condition is realized. Storage of trend data can be started or stopped with respect to several conditions such as status and time or manually by operator.

Trend values will be stored by fluctuating point resolution and rescaling will not be required for retrieval or viewing. This will prevent deviation from accuracy also it will ensure labels to be configured according to new scaling intervals without compromising from integrity of storage pool.

Viewing trends

There will be graphs where time will be present in linear, continuously vertical or horizontal axis and where values of which trend are monitored are present in vertical or horizontal axis. Resolution of each graph will be within 0,1% of full scale when more than tag is graphed, graph regarding with each tag and relevant information will be displayed with different color.

Trend view will support both analog and digital pen in same graph. Trend pen assignment will be able to be defined for easily creating and managing frequently used trend groups and will be accessible while software is running.

32 pens which can be adjusted as samples with 1 second period and which can make report upto 10.000 points with time intervals which can be defined by users by software will be viewed in each trend graph.

Graph will be able to view all trend history for certain pen group in single screen.

More than one pen belonging to same pen or drawing trend should be able to be created over several temporal periods.

Separate intervals and engineering units will be displayed in each pen. Each pen will be independent from other pens to be viewed in page and will be able to be scaled for viewing.

Progress can be made backward or forward in certain time interval by using software and exact value of tag will be able to be read by selecting a point over table. System will monitor historical data by moving backward with desired time period and it will be viewed in average 1 second together with all necessary information. There will be sliding bar which will be moved over page in trend screen for viewing trend date, time and trend tag value when it is intersected with trend tags.

Trend screen will be dynamic, will be able to be shifted in time it will have the property to be displayed again and historical data will be able to be shifted in addition to existing data. There will be property to stop automatic shifting for detailed analysis of certain data in historical data. Pens which are present in same windows will be able to be separated in time and interval axis.

User can switch from local hour to UTC time in trend screen. When it is in local hour, switch from summer hour application will clearly be expressed in trend screen.

Software will have zoom and pan property for both trend tag interval and time axis interval. Zoom allows compression and extending axis interval by operator and pan will allow operator to go origin of axis. Software will allow user to determine a zoom area by dragging mouse within axis.

Software will provide minimum, maximum and average summaries for all viewed analog pens.

Trends which were retrieved and stored with respect to events instead of periodically will be able to be viewed in both time axis and with respect to number of event.

Software will be able to monitor 32 tags in single trend screen.

Tags will be able to be distinguished by different colors. Raw data and time/date values will be able to be taken from screen or one trend or trend group or detailed analysis.

Software will be able to transfer trends, historical data to disk files or external databases. Part of trend to be transferred will be able to be defined by clicking mouse or dragging cursor inside trend. Data will be able to transferred to files in .csv, .dbf or .txt format. Any part of historical data will be able to be sent over ODBC, DDE, dbf, CSV and TXT formats.

Software will allow printing trends based on historical data in trend plotters. Software will have feature to print out trends(not screenshot). Trend printing function will use objects instead of bitmaps while printing. Trend printouts will include engineering units and intervals for each trend, trend grid and trend period. Each trend will be specified with certain line in monochrome printers (for example dot, line, straight etc) and with different color in color printers.

Each operator or person who log in will be able to access fully customized trend pages. These pages should be able to be customized by each user online by using drag and leave method or by using standard configuration methods. All configurations which are present in certain configuration medium will be able to be used by user for changing trend graphs while system is running. These will include minimum pen color, pen scaling, grid, and trend tag assignments for each trend page.

Historical Analysis

Alarm pen will provide detailed information regarding with any point which is selected by operator in addition that will specify active/inactive/acknowledge status for alarm pen. For example high and deviation status should displayed based upon request of user.
Alarm pens will be able to be shifted in addition to trend pens and alarm status will be able to be displayed real time. Operator will be able to select which alarm pens will be monitored for getting view for certain process unit or historical data.

Alarm pens will display historical status in line with trend pen history in historical data screen while access is maintained for historical data. Operator will make single request for certain date and time for historical data view and all pens including alarm and trend pens will be configured for getting mentioned time interval.

9.18.10 Historical Trend Data Analysis View

It will be possible to set/configure trend graphs in graphical display interface and to save this configuration into a file for loading again. Graphical interface will be able to transfer trend data to .csv file.

It will be possible to display real time graphs for several tag and alarm tag information. It will be possible to view Temporary graphs for real time tag data(instant trend) without requiring to set historical data which were retrieved before.

9.18.11 Reports

Operator Interface will perform creating report, planning and management activities internally and there will not be need for software packages from third parties for realizing these functions. No long period data or collector will be required for sending data to operator interface for reporting except for high speed collectors. It will not be necessary to make programming in controller subsystems. Operator interface will have functions to be used for these purposes and triggering will not be required for triggering.

Report can be planned by using software such that it can be made periodically in certain hours of day, periodically, based upon request of operator or when and event occurs. (for example alarm conditioned or collectively at the end of the work.

Software will support printing operations in specified reporting printer. Also Software will be able to record all reports in disk file or database (SQL, ODBC, DBF) or internet server, HTML and similar rich text format.

Software will be able to display all reports with text types and colors which can be identified by user.

Software will be able tp define reports according to archived data. Reporting with respect to single point within time(online and historical data) and reporting with time interval will allow reporting infinite tags in single report.

Reports will provide opportunity to make comprehensive calculation data by instant data, historical data and other data which are retrieved from system.

Reports will be able write over any tag in system during reporting.

Reports will be sent to specified printers automatically. Software will provide reporting over screen. Also system will provide interface by report generation packages from third parties, it will be able to retrieve data from those and will be able to transfer data to external databases.

Web Browser Integration

Operator interface software or integrated package will be able to publish information in standard web browser. Particularly Microsoft Internet Explorer will be supported by Client software. Published information will include historical data in instant view (real time) data in ruler format and time series graphic format and alarm history will be provided in list format.

Additionally data which is recorded into database with this manner will be able to be published in web browser as operator interface data.

Data images and frequently used items will be integrated with web browser session and individual users will be able to maintain access data which were assigned to them and it will have ability to create image and to make these images to accessible from any web client.

Furthermore in addition to web based reporting, operator software itself will be able to be operated in remote webserver over public interner or by firewalls or intranet. (See webserver clients section). Dealer will meet all firewall requirements which are necessary to implement this function.

Recipes

Software will be able to perform recipe management including creating of new recipe, changing existing formula parameters and loading to field devices.

Forms which are opened in screen will allow operator to make selection in recipe parameters and collective works. Forms which are opened in this screen will allow users having suitable access level to add new reciper, modify existing recipes and delete older recipes.

There will not ne any limitation regarding with number of recipes or number of tags in recipe.

Operator event log

Software will support function to write all operator activities into disk, printer or screen.

Software will record following information. User name, activity, time, date, time, value and comment of which format will be determined by user.

Languages

Software will support applicable languages in addition to English. (including local character sets for these languages). Fixed and dynamic texts, alarm tags and definitions, variable tags and definitions, report printouts will be able to be displayed in local language by using local character set. Also users will be able to enter information local language while system is running. Leaving digital data in English can be acceptable.

Switching can be made between languages while software is running. Solution by creating same page in each language can not be acceptable. Translators will be able to make translation from one language to other by using standard tools without requiring any information regarding with operator interface software.

There will not be limit in number of languages which can be change while system is running.

Installation for only runtime mode

It should be able to install software such that it will run without integrated development components. Software should run in runtime environment for viewing graphical page, real time data. Tools which will organize configuration will not be used in installation.

Multiple monitor mode

Graphical system will support multiple monitor layout.

- 1x4
- 2x2

• 4x1

End user will be able to configure which graphical page will be viewed in start up in each monitor.

High Level Languages

Firstly any software, special code will not be required for standard functions such as back up, reload and adding historical data. There will be integrated high level language which is designed particularly for operator interface applications and it will have multiple task and preventive properties. Besides there will be documentation language in language which is compatible with VB.

Document

Comprehensive documents regarding with configuration and system development regarding with software will be maintained online.

Start up and installation manual, user manual and high level manual will be included in technical manuals. Comprehensive field device manual will be available within online documents for all protocols and dirvers.

Online Modifications

It will be possible to add, modify, refresh alarms, trends and reports online without rebooting server.

It will be able to modify alarms, trend and report servers without rebooting server. It will be possible to add new configuration, recompising and apply modification by only reloading suitable server.

Only modifications will be reloaded again. Alarms, trends or loads which are not modified will continue to work without interruption.

Video Integration

Video camera integration will be possible for live video monitoring.

It will be possible to use user friendly controls such as Pan, Tilt, Zoom (PTZ) brightness and contrast.

It will be possible to use additional features such as mocement/intrusion detection, establishing connection with video functions between events.

Database Integration

Operator interface software or integrated package wil be able to store important Operator Interface Data to Associative database including MS SQL Server and Oracle. Software will support recording instant view(real time) data and historical data in ruler format and alarm history in list format into database

Record configuration will be made by mark and click format and it will not require any code writing. Target database will be full licensed database version and will provid all normal data cess, data changing and reporting options for end user.

Operator interface will maintain interface for getting fata from Active X Data Objects(ADO) Data sources(SQL Server, Oracle,etc). Receiving data, long term query and slow connection will work asynchronously such that it will not effect other Operator interface functions.

Access will be provided for ADO data as connected or disconnected data set.

It will have integration with MS Office Excel which is suitable for access and reporting without requiring programming.

It will have record system which is installed over MS SQL Server 2008 R2 platform.

It will be structure which is open to integration with ERP and MES system.

Record system will collect data from redundant Operator Interface Server structure. It will continue to record data over redundant server in server failures. In the event that server connections are disconnected completely, data which were buffered and coult not be retrieved in real time will be transferred to record system with respect to time values when connection is established with server system again.

Record system will be able to make record at 100 ms or slower speeds

Deadband filtering will be able to be made baed on data for data to be recorded in record systems.

Record system will have ability to make archiving for at least 100 tags.

Record system should be open to different report and data access without making any change in client structure and operator interface.

Record system should be suitable with Microsoft Reporting Services, MS Office Excell Add In Support and reporting to be prepared in this medium. Also access should be maintained for data which is recorded bt web client structure from different locations within enterprise.

Operator Panel (HMI)

- There will be operator panels with minimum 10 inch screen size indicating all analog and digital data including color scheme for group for monitoring stations where they are connected with. They will be placed over control boards.
- Operator panels should have UL 508, CSA C22.2 (#142), UL1604, ANSI/ISA 12.12.01, CSA C22.2 (#213) certificates
- TCP/IP communication should be maintained as standard.
- Operator panel software should support Microsoft Windows 7 64 bit version.
- Alarms which occur in system should be able to stored in memory and printout should be able to be taken from printer when required.
- Different functions should be able to be created by writing code by HMI software.
- Screen will have QVGA resolution and will have minimum 65000 color capacity.
- It will be considered that operator panel will work continuously and for long term and display will have minimum 50000 hour operation lifetime and display backlight will be LED type.
- Operator screen view should be able to be monitored and controlled by IP address in form of remote access over computer over web browser if requested(by filtering protection of IP addresses)
- It will have property to send email or attaching file to email for making information regarding with any failure or maintenance.
- Operator will have minimum one RS 485/232 RJ45 serial , 10/100 BaseT RJ45 Ethernet and mini-USB Device + 1 USB Host V2.0 ports.
- Application of recipe should be able to be made standard within software. Functions should be able to be changed and configured for special requirements.
- There should be simulation opportunity in software and Application should be able to be tested without having HMI. Also it should be able make simulation without having controller by means of online simulation.

- Historical data information for requested changes should be able to be stored in memory by software. Also memory size should be able to be increased by compact flash card or USB memory stick option.
- Mouse, keyboard or barcode reader should be able to be connected over USB port when requested.
- Panels should be able to share data with each other without requiring any
- Operator panels should be able to be monitoted and controlled by wireless network or 3G communication by smart phone or tablet PC.
- Illuminated columns(Beacon lamp) to be used over system should be connected to HMI by USB and should be able to be programmed over HMI when requested.

Industrial Ethernet Switch

- It should have CE and ISO certificates
- It should be designed for industrial environments
- All ethernet switches should have same brand
- Ports will have autosense property
- All ports should have 10/100 Mbit speed
- It should have manageable structure and management should be able to be made by software and/or over http://
- It should have dry contact output indicating system failure and supply failure
- It should have diagnostic LEDs for each ethernet port,
- It should have at least IP 20 protection class, it should be able to work at 0°C / +55°C degrees, it should be able to work at %10 %90 humidity

9.18.12 Standards and Approvals

Manageable ethernet switches should have following approvals.

- UL 508 and 1604
- CSA 22.2 No. 142
- CE Mark per EN61131-2
- FM Class 1, Div 2
- UL1604 Class 1 Div2
- C-Tick for Australia
- Substation IEC 61850 EMC levels tested
- Maritime approval (GL)

9.19 Network Firewall (firewall)

9.19.1 General

Firewall is a tool which controls data which is received from internet and prevents or allows passage according to your firewall configuration.

9.19.2 Properties of Industrial Firewall

- Firewall will maintain copper cable and fiber ethernet connection.
- Firewall will be switch in layer 2 mode and will be router in layer 3 mode or it will be able to operated as PPPoE Point to Point Protocol Over Ethernet
- Firewall will be equipped with firewall access controls
 - \circ SNMP v1/v2/v3 password
 - SSH (Secure shell protocol) input
 - External identity
- Package filtering for creating firewall rules:
 - IP packages incoming from device which is connected to external connection point.
 - o IP packages which are delivered to internal connection point
 - Incoming MAC packages
 - Outgoing MAC packages
- NAT (Network Address Translation):
 - P Masquerading
 - 1:1 NAT (network address translation)
 - Port routing
- Network security capacity
 - o IP Masquerading
 - 1:1 NAT (Network address translation
 - Port routing
 - DoS (Denial of Service)
 - Firewall input for more than one user (maximum 32)
- Ability to connect Up to 256 VPN(ViPLCal Private Network)
- Time protocols which can be used for synchronizing network time by using SNTP or NTP
- Firewall failure diagnosis capacity
 - Ports, Usage, Statistics and ARPS
 - Finding topology
 - Device status
 - Alarms(traps)
 - Reports System information
- Firewall list MAC and IP address

9.20 Communication Network

9.20.1 Data Handling

General:

All data necessary for control and monitoring of the plant shall be collected.

The program shall collect the real-time data that is necessary for a correct calculation and transmission of all service parameters.

The program shall be arranged in a way that allows the operator to select the service parameters. In addition it shall be possible for the operator to extent the number of service parameters.

The data collection shall function independently of all other program facilities in the control centre.

All data shall be identified with the time of collection. The time interval shall not be higher than 0.5 sec.

The cycle time for data collection shall be adjustable by the operator from 1-30 sec. The data collected is named scandata. It is accepted that scandata only is logged when there is a change in the value. This is to reduce the extent of the logging. <u>All</u> changes shall nevertheless be logged. This goes for parameters, analogue values, states etc.

Calculation of the minimum mean-value of the scandata shall be possible within an interval of 1-30 min. (basic time). The calculated mean values are named basic data. These basic data are used for calculation of hour-, daily-, monthly and yearly mean values that are used in the reports.

The data shall be stored in accordance with the values indicated below:

TYPE:	DATA USED FOR:	STORED IN:
Scandata	Generating of basic data and curves	1 month
Basic data	Print of daily curves	180 days
Hour mean	Daily reports and curves	12 months
Daily mean	Monthly reports and curves	3 years
Monthly mean	Yearly reports and curves	10 years

It shall be possible to delete data. The program shall however automatically prevent data to be deleted that have been stored less than indicated in the above table.

It shall be possible to select the parameters for data collection and the time interval for the data collection.

In addition it shall be possible to key in data manually. The manual keyed in data shall be included in the data collection program and be part of the reports.

A program for calculation shall be included. It shall include all common arithmetic functions.

The program for calculation shall have access to all elements, name, parameters and data in the system.

It shall be possible to include time marking of the calculation program in order to control the calculations after a calendar program.

Programming of the calculations shall be in a high level language.

9.20.2 Data Presentation

Reports and Lists:

The format of reports for indication on the monitor and for printing shall be generated from data base programs. It shall be possible to select the data to be indicated on the monitor or printed from menu commands that automatically will start the report in question. It shall be possible to print reports automatically.

It shall be possible to select the following reports from the menu:

- Event list
- Alarm report
- Daily report
- Monthly report
- Yearly report.

The data base program shall include the possibility of configuration and editing the format of the reports.

Format and lay-out of all reports shall be approved by the Engineer.

General Lay-out of Reports:

- Date and time for printing of the reports shall be indicated.
- The period the report covers shall be indicated.
- In column no. 0 the period shall be indicated.
- Data shall be indicated in column no. 1 and onwards. A minimum of 8 characters shall be included in each line.
- In line 1 and 2 the name and component number shall be indicated (space for 16 characters).
- In line 3 the unity shall be indicated.
- In the following lines the measured value or calculated value shall be indicated for the data.
- The second last line shall include the mean value for the period of the report.
- The last line shall include the accumulated value for the period of the report for the data collections.

Daily Reports:

- The periods shall be of 1 hour each. The hour-mean value shall be included for each hour.
- The daily mean shall be included in the second last line.
- All measurements and parameters shall be included in the report.
- The accumulated value for sum up values (water quantities etc.) at the time the report ends shall be included in the last line.
- The daily report shall automatically be printed.

Monthly Reports:

• The periods shall be of 24 hours each. The daily mean value shall be included.

- The monthly mean value shall be included in the second last line.
- All measurements and parameters shall be included in the report.
- The accumulated values for measurements at the time the report ends shall be included in the last line.

Yearly Reports:

- The periods shall be of 1 month each. The monthly mean value shall be included.
- The yearly mean value shall be included in the second last line.
- All measurements and parameters shall be included in the report.
- The accumulated values for measurements and parameters at the time the report ends shall be included in the report.
- The report shall automatically be printed the 1st of January.

Alarm Report:

- The alarm report shall be printed at the operator's request. It shall be possible to select start and stop time for the period of report.
- Automatic printing of the report shall at a defined time be possible.

The report shall as a minimum include the following information:

- Component no.
- Alarm text (min. 25 characters)
- Time for start of the alarm
- Time for acknowledge of the alarm
- Time for stop of the alarm
- Alarm priority
- Name of person that acknowledged the alarm
- The actual alarm value
- The maximum value for the high alarm
- The minimum value for the low alarm.

Time shall be indicated with year, month, day, hour, min, and sec. in order to clearly identify the alarm.

9.20.3 Maintenance application

General:

The maintenance application shall mainly be for automatic planning of preventive maintenance.

The system shall manage all typical maintenance activities such as preventive maintenance, work orders, inventory, purchasing and organizing equipment and vendor data.

In addition to planning of preventive maintenance it shall include facilities for word processing and spread sheets. The program for preventive maintenance may be stopped when using word processing

and spread sheet programs. When starting the maintenance program again data shall automatically be updated.

Operation of the station shall be interactive and suitable for operators with no computer skills.

Maintenance Management Facilities:

The system shall be designed as a card file system with an index card for each piece of equipment. The index cards shall contain detailed information of the equipment including the following:

- Component no.
- Name
- Location
- Make
- Model
- Serial no.
- Purchase vendor
- Maintenance vendor
- Warranty
- Parts usage
- Equipment history
- Date since last service
- Condition
- Work orders
- Hour run time (999999 hours)
- No. of starts (999999 hours).

The hour run time, the number of starts and other data necessary to plan the maintenance shall automatically be updated every second hour 24 hours a day.

The system shall contain the double number of cards necessary.

Preventive Maintenance Schedule Types:

It shall be possible for the system to generate the following schedules:

- A work order after a specific time period (days)
- A work order a certain length of time after the last maintenance has been done
- A work order after a certain meter interval (hours, Cycles)
- A work order after a certain meter interval or time period
- A work order on any number of different days in the year. Also used for seasonal work order.
- A work order based on high and low warning values.

It shall be possible for the operator to reset the counters if he has gained access.

Editing of Data:

The editing shall be carried out via a menu program.

It shall be possible to write text on screen pictures including on flow-diagrams and curves.

Curves:

Curves shall be selected via a menu. It shall be possible to select pictures of curves of 1 year, 1 month, 7 days, 24 hours, 6 hours, 1 hour and 1/4 hour.

It shall also be possible to select historical curves from and to a specific date. It shall for example be possible to shown curves of 24 hours duration from 5 days ago.

It shall be possible to indicate a minimum of 8 different curves on the same picture. Each curve shall be presented in a different colour.

The unit, the Y-axe and the name of the curve shall be indicated in the same colour as the curve.

Static and dynamic screen pictures shall be shown. For dynamic pictures the screen picture shall be updated every time new data is being recorded.

• Zoom-in and zoom-out shall be possible for the X- and Y-axe direction.

It shall be possible to print the actual digital values for the curves including the time for the actual value.

Print of curves shall be initiated by activating a function key or by operating the mouse.

Configuration of screen pictures of curves shall be easy and only involve a few commands.

Screen pictures of curves shall be provided with explanatory text and date and time for print shall be included. It shall as a minimum be possible to include up to 60 curves.

9.20.4 Flow pictures

A number of flow pictures of the process shall be provided. The flow pictures shall indicate the actual status of the process and the pictures shall continuously be updated. Updating of the pictures shall be less than the following time values:

- Updating of picture after change of picture: 2 sec.
- Updating of digital value after change: 2 sec.
- Updating of analogue value: 3 sec.
- Response of a command: 2 sec.

Updating does not include the cycle time for data collection of scandata.

The mouse must not be locked when the flow pictures are being updated.

The flow pictures shall be shown on the colour monitor and the graphical presentation shall utilize the maximum possibilities of the monitor.

The outline flow picture of the Facility including shall be the basic picture. It shall be possible to select sub-pictures, curves and other pictures from this picture.

It shall be possible to select flow pictures in a minimum of four levels via menu commands. Additionally it shall be possible to select pictures directly by keying-in the id-no. for the picture.

Alarms shall be indicated on the flow pictures.

Modification of signatures for components shall be simple. The system shall include a library with all the commonly used signatures and it shall be easy for the operator to select the signatures from this library.

It shall be possible to design/draw new flow pictures by using a program specifically for this purpose. The program shall also be used for modification of the existing flow pictures.

Values shall be indicated in metric unit. All relevant measured values shall be indicated on the respective flow picture.

The indication can be:

- Metric values
- Bar graphs.

If the bar graphs are used values shall be indicated in percentage or in metric units.

Status of valves, motors etc. shall be indicated by colour shift or changing of signature.

A minimum of 40 flow pictures (exclusive pictures of each component) shall be provided. The following pictures shall as a minimum be included:

- Outline. Level 1.
- Simplified picture of the whole Facility. Level 2.
- Detailed picture of the status of the communication network. Level 2.
- Detailed picture no. 1 of the Facility. Level 3.
- Parameters and settings for detailed picture no. 1. Level 4
- Detailed picture no. 2 etc.

Detailed pictures of each component shall be provided as level 5.

It shall be possible to operate all components from the pictures, i.e. stop and start of motors, opening and closing of valves etc.

Operating shall be by pointing out the component via the mouse or by keying in the component no.

9.20.5 Alarm Handling

Any alarm shall be reported and indicated as follows:

- On the mimic panel
- By an acoustic signal
- On the monitor on the screen pictures
- By printing an alarm text on the monitor in a separate field of the monitor. The field shall be dedicated to alarm messages.
- By printing an alarm text on the alarm printer
- By sending an alarm text to the mobile telephone

Alarms on the mimic shall be indicated by flashing the respective LED. The flashing shall continue until the alarm has been acknowledged, it shall then turn to fixed light if the alarm is on. When the alarm has been acknowledged and the alarm has stopped the light in the LED shall be turned off.

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It shall be possible to provide all alarms with an alarm priority. The indication of the alarm shall depend on the specific alarm priority. Up to 5 alarm priorities shall be provided.

Alarms shall always be indicated on the mimic, in the field on the monitor, on the screen picture (if the picture is on-line) and printed on the monitor.

The following information shall be stored in the alarm data base:

- Year, month, day
- Time for start of the alarm
- Alarm priority
- Description of component
- Component no.
- Alarm message (min. 25 characters)
- Time for acknowledgement of the alarm
- Time for stop of the alarm.

It shall only be possible to acknowledge (reset) the alarm from the operators station.

It shall be possible to acknowledge single alarms or all the alarms shown on the monitor. This applies for flow pictures as well as for alarm files.

It shall be possible to suppress commuting alarms. It shall be clearly indicated if an alarm is suppressed.

Alarm shall also be indicated on the process flow pictures and the picture for the individual component.

It shall be possible for the system to handle up to 1000 alarms and alarm messages.

It shall be possible for the operator to edit the alarm messages.

Each alarm shall be provided with a detailed description with instructions of how to handle the alarm situation. It shall be possible for the operator to activate the description with 1-2 operation by the mouse. The description shall include up to 400 characters and it shall be easy to edit the instructions.

Alarm Messages to the mobile telephone (SMS-messages):

Transmitting of alarm messages to the mobile telephone shall depend on the priority of the alarm and on the time when the alarm arises.

Alarm messages shall normally be transmitted via the modem connected to the server. The paging modem connected shall only be used for transmitting when the operator station is not functioning correct.

Alarm messages shall be transmitted to the telephone in accordance with a calendar-type schedule that indicates the working hours for the staff. Alarm messages shall only be transmitted outside normal working hours in accordance with the schedule.

It shall be possible to indicate what telephone the alarm shall be sent to.

It shall be easy for the operators to edit in the schedule.

Editing of the schedule shall be blocked by password.

In addition it shall be possible to sent messages to the telephone that the operator has keyed in via the operators station.

9.20.6 Configuration

It shall be possible for the operator to extent and change the control and monitoring, the reporting and the process configuration.

The configuration shall be carried out via a well documented standard program specifically designed for configuration of the system (not via programming in a standard high level programming language).

The program shall be easily accessible, and it shall be easy to use the program. The program shall preferably be the interactive type with explanatory messages to the operator.

Changing or extension of the configuration shall include removing and/or adding of components (motors, valves, instruments etc.), and it shall include all disciplines such as addresses, conditions, alarms, reports, monitoring etc.

Access shall be limited via password.

The program for configuration shall include a check program that will detect and disclose all errors.

It shall be possible to print the configuration.

Only fault free configurations shall be operational.

It shall be possible to carry out the configuration by the following ways:

- By down-loading of the new configuration from the programming unit connected to the communication network
- On-line.

Back-up of the configuration shall be stored on disks.

The programming language shall be self documented.

And it shall be possible to print parameters, cross reference lists etc.

9.21 Application Programs, Functions

9.21.1 General

The following is a description of the main control principles (functions) to be included in the application programs for the control and monitoring system.

The detailed control programs shall be designed by the Contractor in close cooperation with the Engineer.

The software for control, monitoring and regulating of the individual machines shall be based on relevant measurements and/or time control.

The software shall ensure easy and fail-safe operation of the plant and protect the plant against any operators fault.

All software shall be well structured and future modifications shall be easy.

The Contractor shall include a 10% extension/modification of the application programs in addition to the necessary modifications to fulfil the requirements.

In programs with multiple start of machines, starting between the individual machines shall be time delayed (adjustable 1-10 sec.).

Start/stop of machines that is part of the programs shall not be possible before the program is stopped or the machine has been put into operator mode from the monitoring station. It shall be possible to operate all components when the program is stopped, including the following:

- Start/stop of motors
- Operating of a motor valve to a specific position
- Opening/closing of magnetic (solenoid) valves.

The programs in the PLC's 's shall in general be designed for adjusting of parameters via the operator station. Examples of such parameters are timers, limit values for measurements, limit values for step controls, constants used in calculations, pumping capacities, values for controllers etc.

The program system shall include facilities for 10 parameter sets for each component that is included in the control and monitoring system.

It shall be possible to store and modify the parameter sets. It shall be possible to recall, modify and activate the parameter sets from the screen pictures. Parameters for controllers shall be adjustable and included in the parameter sets.

The parameter sets shall include a stop/start function for programs.

Set points and other parameters shall be adjustable from the operator station and from the operator units.

Timer values shall be monitored on the screen as dynamical values.

All input/output signals shall be incorporated in the control and monitoring of the plant in accordance with their logical function and the description for the individual signal.

The descriptions of the individual applications programs groups are only intended as a guide for designing of the specific applications programs.

The descriptions include only the most essential parameters for the programs and it should be expected to include additional parameters in order to fulfil the requirements

9.21.2 Tag numbering

Individual signals and components are identified by means of tag numbers.

Tag numbers must be unique and matching main station software as well as in electrical installations and documentation.

9.21.3 Emergency control

The contractor must analyse any risk and effects of any failures of the system. The automation shall react in an appropriate way of any failure such as:

- Missing/bad signal from a transmitter
- Failure in a component

Failure mode analysis report should be submitted and after that based on this report, ifnecessary signal receiving and transmitting details should be revised

If appropriate, an emergency control for a function should be developed.

9.21.4 Group control

The group start object is a standard routine handling start/stop of a group of objects. (Ex. a pumping station includes all pumps, level meters, and automatic control)

9.21.5 Motor routine 1

The object is a standard motor routine handling motors with one direction.

The object can be in 3 different modes:

- Auto
- Operator (from operator station)
- Manual (from local panel)

It handles the following input signals or communication:

- Auto
- Thermal Faults
- Moisture faults (if available)
- Safety switch
- Emergency stop
- Actual current (motors with frequency and soft starter)
- It handles the following output:
- Start contactor

A global function shall prevent more objects to start at the same time.

The fault inputs will make the object go into fault. The actual fault will be indicated on the CMSsystem until the object is reset or as long as the fault is active.

The object supervises that a running signal is coming within a specific time after a start command has been given. If the running signal is not present before the time has elapsed the object will go into fault and the supervision fault will be indicated. The function works both ways, i.e. if the running signal is present when the start command is zero.

Hours and start counters is handled by the object.

9.21.6 Motor routine 1-1

The object is a standard motor routine handling motors with no command outputs (Motors controlled by local machine installations).

The object can be in 2 different modes:

- Auto
- Manual (from local panel)

It handles the following input signals or communication:

- Auto
- Thermal Faults
- Moisture faults (if available)
- Safety switch
- Emergency stop

• Actual current (motors with frequency and soft starter)

The fault inputs will make the object go into fault. The actual fault will be indicated on the SCADA system until the object is reset or as long as the fault is active.

Hours and start counters is handled by the object.

9.21.7 Motor routine 2

The object is a standard motor routine handling motors with two directions or two speeds.

The object can be in 3 different modes:

- Auto
- Operator (from operator station)
- Manual (from local panel)

It handles the following input signals:

- Auto
- Thermal Faults
- Moisture faults (if available)
- Safety switch
- Emergency stop
- It handles the following output:
- Start contactor 1
- Start contactor 2
- Actual current (motors with frequency and soft starter)

A global function shall prevent more objects to start at the same time.

The fault inputs will make the object go into fault. The actual fault will be indicated on the SCADA system until the object is reset or as long as the fault is active.

The object supervises that a running signal is coming within a specific time after a start command has been given. If the running signal is not present before the time has elapsed the object will go into fault and the supervision fault will be indicated. The function works both ways, i.e. if the running signal is present when the start command is zero.

Hours and start counters is handled by the object

9.21.8 Motor valve routine 1

The valve routine object is a standard routine handling a mono-stable motorvalve control.

The object can be in 3 different modes:

- Auto
- Operator (from operator station)
- Manual (from local panel)

It handles the following input signals or communication:

- Auto
- Thermal Faults
- Safety switch
- Emergency stop
- End limit switch high
- End limit switch low
- Moment fault
- It handles the following output:
- Start contactor open
- Start contactor close

The fault inputs will make the object go into fault. The actual fault will be indicated on the SCADA system until the object is reset or as long as the fault is active.

The object gives alarm if a maximum time for opening or closing is exceeded.

Start counters is handled by the object

9.21.9 Motor valve routine 1-1

The valve routine object is a standard routine for supervision only.

The object can be in 2 different modes:

- Auto
- Manual (from local panel)

It handles the following input signals:

- Auto
- Thermal Faults
- Safety switch
- Emergency stop
- End limit switch high
- End limit switch low
- Moment fault

The fault inputs will make the object go into fault. The actual fault will be indicated on the SCADA system until the object is reset or as long as the fault is active.

Start counters is handled by the object

9.21.10 Standard regulator (Controller)

A standard regulator shall as a minimum be provided with the following functions and parameters:

• Status of the regulator : Auto, Local, Manual

- PID-regulator with adjustable parameters. The I-time shall be adjustable from 5 sec. to 5 min.
- Calculation set-point, low and high (option)
- Limitation of regulator output, low and high

Set point for regulator

- Manual adjusting by operator of set point
- Manual adjusting by operator of regulator output (regulator in manual).

Running in of all regulators shall be carried out by the Contractor.

9.21.11 Status/alarm handling 1

The status-handling object is a standard routine handling individual status/alarm inputs and command outputs. (Level switches etc.) or communication

All input can by means of the option word individually be configured to be status or alarm.

Status inputs will be indicated in the status word as long as the input is activated.

Alarm inputs will make the object go into fault. The actual fault will be indicated in the status word until the object is reset or as long as the input is active

9.21.12 System alarm

The system alarm handling object is a standard routine handling specific system alarms generated by CMS s and communication units.

The following alarms shall be generated and displayed at the CMS system.

- Cycles time limit exceeded
- Battery exhausted or missing
- I/O error with diagnostics
- Fault in expansion rack or remote IO-station
- Error in communication
- Programming error

9.21.13 Instruments

The object handles signals from a process instrument. It shall be able to handle: or communication

- Scale incoming signal
- Freezes the output by request of the operator
- Indicated valid measurement
- Instrument warning
- Instrument alarm
- Measurement above limit (short current in loop)
- Measurement below limit (broken wire)

9.22 Tests

The objective of the tests is to verify that the system works in accordance with the Contract and the detailed design.

All tests of equipment and of the complete system shall be performed in accordance with the Contractor's approved Quality Assurance system.

All tests have to be documented in test forms defined as part of Quality Assurance system covering:

- Date of test.
- Description of test.
- Actual method of test.
- Output of test.
- Remarks regarding deviations from the expected output.
- Accepted/rejected.
- Supervisor's signature.
- Comments.

9.22.1 Handling of Deviations

Before the report is completed and can be approved; all significant deviations have to be corrected.

In case of deviations, the following issues have to be decided:

- What are the consequences of the deviation? Which part of the installations will be influenced by a revision, and which tests already accepted will have to be done over again (if any)?
- Date of a new test of the revised system included repetition of already accepted tests.

The acceptance test report shall be approved when significant deviations have been corrected and tested.

All tests have to be planned so the Employers Representative has the possibility to comment on the tests planned and to supervise the tests. That means that all tests shall be announced at least two weeks in advance. This goes also for any repetition of tests.

9.22.2 Electrical - General

The following electrical functions shall be tested, and shall be verified to be in accordance with the herewith Employer's Requirements:

- Earth resistance and boundary system.
- Function of all emergency stop circuits.
- Function of all safety circuits.
- Lighting systems.
- Emergency power supply system. The external power supply shall be switched off and it shall be verified, that the emergency power supply system starts up automatically. Furthermore it shall be verified, that all emergency control functions start up automatically (automatically by-pass of waste water, handling of alarms etc.)

• Signal test of all signals according to signal lists. All signals shall be tested from source to software. For analogue signals range and scale shall be verified. For level transmitters offset and range shall be related to fix points in the construction.

9.22.3 Panel factory test

The Panel factory test shall as minimum covers:

Power section

- Control of all power circuits
- Control of isolating
- Control of tightening moments
- Control of component sizes
- Control of conductor dimensions
- Control of conductor colours
- Control of wiring numbers
- Control of loose connections
- High voltage tests
- Control of phase orders
- Control of measurement transformers
- Operation of fuses, motor protection, disconnectors etc.
- Control of fault current relays with tester
- Control of setting of thermal relays etc
- Control of fuses
- Control of settings of soft starters etc.
- Control of Cu rail connections
- Control of PE-conductors
- Control of PE-conductors for doors
- Control of PE-conductors to all flanges (EMC-requirement)
- Control of PE-conductors to all components (transformer and DC-units)
- Control of PE-conductors to -parts
- Control of PE-conductors to plug outlets
- Control of EMC correct connection of components (shields to back plates)

Control section

- Control of control voltage, primary and secondary
- Control of conductor dimensions, control circuits
- Control of conductor colours, control circuits

- Control of wiring numbers
- Control of loose connections
- Control of lamp test
- Control of lamps
- Control of operations (buttons etc.)
- Control of documentation
- Control of digital inputs
- Control of digital outputs
- Control of analogue inputs
- Control of analogue outputs
- Control of analogue loops
- Control of fixing and protection of wires
- Control of codes for components in sockets
- Control of tagging of components
- Control of dimensions of terminals
- Control of terminal numbers
- Control of tagging of internal wires
- Control of setting of electronic components

Miscellaneous

- Control of section covers
- Control of labelling
- Control of panel marks and certificates
- Control of earth system
- Control of covered race trays
- Control of sufficient spare capacity and room
- Control of cleaning
- Control of drawings in panel
- Control of handles and locks
- Control of front layout
- Control of component layout in accordance with the documentation

After installation on site

- Control of inside temperatures under max. load.
- Control by use of thermal photographing under max. load

9.22.4 Automation

• The automation system covers the CMS system.

The test shall cover a number of different issues:

- Usability (general operation of the automation and CMS system).
- Efficiency (performance).
- Accuracy (correct handling of values and calculations).
- Security (protection against unauthorised use of the CMS system).
- Flexibility (verification that the automation system is suitable for upgrading).

Below, each issue is described. At the end of each item, a number of criteria for passing test are described.

9.22.5 Usability

This part describes the tasks to be performed to test the usability of the program.

9.22.6 Installation and start up

The purpose of this test is to make sure that the installation and start-up procedure functions well and is described correctly in the Operation and Maintenance Manual.

The test shall:

- Perform an installation procedure in accordance with the O&M Manual.
- Check if the procedure is in accordance with instructions.
- Check if the program can start up normally.
- Perform a normal removal of program.
- Make a subsequent reinstallation.

The criteria for passing the final test will be:

- No errors occur during the installation procedure.
- The procedure is in accordance with the instructions.
- The program is able to start up normally.

9.22.7 Normal Operation

The purpose of the test of the normal operation of the SCADA system is to make sure that it is possible to operate the program in a logical way and in accordance with the specifications/documentation/O&M Manual.

During the test of the normal user operation, the test operator shall:

- Guide him-/herself through a large number of menus and dialog boxes and test a large number of various commands.
- Print different kinds of reports.

The criteria for passing the final test will be:

- Every activity of normal operation leads to the expected result, and activating a command leads to the expected dialog box.
- A printing command leads to printing of the correct output.

Handling of errors:

The purpose of this test is to verify correct and logical handling of errors.

The test operator shall:

- Provoke a number of errors and verify that the system responds to these errors as described in the requirements.
- Report any unexpected error during all tests in order to verify robustness.

The criteria for passing the final test will be:

• Indications of errors must be reasonable, and the user shall be able to continue the work on a well-defined basis.

Handling of Help functions:

The purpose of the test of the handling of help functions (on-line or in manual) is to make sure that the on-screen help function is adequate and works in accordance with the requirements and the actual program. In particular, it shall be verified that terms are used consistently.

The operator shall perform the following tests:

- The help system shall be consulted a large number of times in different situations. The operator shall focus on the existence of relevant help, on clear language, on relevant link(s) to more help and on consistent use of terms.
- The text in the on-line help shall be read and compared with relevant specifications.

The criteria for passing the final acceptance test will be:

• The on-line help function provides relevant help to the operator in most situations, and the terminology is clear and consistent.

9.22.8 Efficiency

The purpose of the efficiency test is to verify that the operation and response times are at an acceptable level.

The verification of efficiency values shall be based on well-defined situations. The operator shall perform different kind of situations:

- Changing a set-point/sending a command.
- Open a new diagram.

Open an graph.

• Require a report based on historical data's.

Five different types of response times have to be taken into account:

• Response time for a transaction, which is the time interval from sending a command until the result is visible and the user can send a new command. Sending a command can be executed by the

"Enter"-button, by a mouse click etc. This type of transaction is defined as typing data in an input data field with no calculations, change of diagram etc. related to the transaction.

- Response time for opening a new part of the program, such as a new diagram. Opening a diagram for the first time after start of the program may take longer time.
- Response time for opening a graph showing curves for 24 hours. In this case, the response time is the time interval from sending an "open graph" command until the result is visible.
- Response time for opening a report showing values for 1 month. In this case, the response time is the time interval from sending an "open report" command until the result is visible.
- Response time for creating a background job such as a printing command.

The criteria for passing the final acceptance test will be:

- The response time for sending a command is almost negligible (less than 1 second). Return of the value from the shall be fulfilled within 2 seconds.
- The response time for opening a new diagram is less than 2 seconds.
- The response time for opening a graph is less than 10 seconds.
- The response time for opening a report is less than 20 seconds.

All tests shall take place from the secondary operator station (not the server).

9.22.9 Accuracy

The purpose of the accuracy test is to verify that the system generates correct output results.

Based on the detailed project for automation the functionality described here shall be verified.

All functions shall be simulated so electrical connections the software and correct parameter settings can be verified.

The real check of the results will be done manually. A selection of output data will be made, and manual recalculation of this output data will be performed. The documentation will include all the intermediate results.

The system has to be designed in a structure with well-defined modules or classes. The classes shall be defined with interfaces where inputs and outputs are available for investigation. A complete test is divided into several accounts. The number of accounts shall be sufficiently high to allow verification of the sequence between two accounts by use of a pocket calculator.

The criteria for passing the final test will be:

• Manual calculation proving correct relations between all generated accounts.

9.22.10 Security

The purpose of this test is to verify correct security functions in accordance with the requirements.

A number of security levels have been specified.

For each security level, the following has to be verified:

• A person at each level (if defined) shall be able to log into the system and have access to the system in accordance with his/her status. It shall also be verified that the user does not have access to part of the system not covered by his/her rights. This test shall be performed for a person at each level.

- Each person defined shall be able to change his/her own password.
- The administrator shall be able to define and remove users and to change a user's password. If specified, the administrator shall be able to look into database structures, as well.
- The designer shall be able to look into database structures and source codes. The test of access to source code can be carried out on the development system, only.

The criteria for passing the final acceptance test will be:

- The number of users has been successfully defined at different levels.
- A user has successfully logged in and out.
- A user successfully changed his/her own password.
- The administrator has successfully changed the password of a user.
- The system has been successfully accessed at the different levels.

9.22.11 Flexibility

The purpose of this task is to verify that the structure of the system is suitable for upgrading to additional functionality. The source code and programmers' documentation shall be investigated.

The test shall verify that:

- The program and database structure of the program developed have well defined interfaces in order to add new modules and new technical solutions under existing SCADA systems.
- The source code is well documented with comments and descriptions in the code and variables are described in a logical way.
- The compilation and installation of the software are well described.
- The criteria for passing the final acceptance test will be:
- The structure of the documentation is in accordance with the specifications.
- Investigation of several classes, selected arbitrarily proves a comprehensive amount of relevant code line comments so that the source code is understandable.
- The compilation and installation of the software are adequately described in the documentation.

9.23 TRAINING

9.23.1 General Issues

The Contractor shall provide a wide-range training service in order to instruct End Recipient personnel. The Contractor, prior to starting the training activities, shall prepare a document containing information on the program content, training activities, the number of people participating the training, prior knowledge required of the attendants, starting time of the training, and duration of training, and shall submit it to the Engineer for approval.

Unless otherwise stated or agreed with End Recipient, the training activities shall begin after the provisional acceptance and shall be completed within the first year after the provisional acceptance. Contractor shall also clearly indicate when the training activities shall begin and how long the training activities shall last, in the training program to be submitted to the Engineer for approval.

The Contractor is responsible for supplying the documents, equipment such as audio and video devices and similar resources to be used during the training activities, together with the expenses related to these items. Nevertheless, the Contractor by obtaining approval of the Engineer may use in the training activities the documents, hardware or software items to be supplied by Contractor according to definitions specified in this specification or to the agreements made with the End Recipients.

The Contractor shall provide a training service in order to instruct End Recipient personnel consisting of technical manager for the operation of SCADA system, the operators responsible for the maintenance, technicians and system engineers regarding operation and maintenance of SCADA system. The Contractor, prior to starting the training activities, shall prepare a document containing information on the program content, training activities, the number of people participating the training, prior knowledge required of the attendants, starting time of the training, and duration of training, and shall submit it to the Engineer for approval.

9.23.2 Scope

The Contractor shall prepare a training program to cover all hardware and software items present in the SCADA system; the training service shall cover different course groups at different levels by taking into account such issues as who shall be responsible for these hardware and software items or who shall use them. The Contractor, besides the training service mentioned above, shall also give a course to End Recipient personnel who shall not participate to these trainings to ensure that such personnel have sufficient knowledge about the SCADA systemto be installed.

Consideration shall be given to the fact that the personnel who shall participate to the course are not only the technical staff, the contents of the course shall be determined by paying attention to include general information free from technical details of the SCADA system. The contents of the information to be given in this course shall also be prepared by Contractor before the training service is provided and submitted to Engineer for approval.

9.23.3 Commencement and Duration of the Training

Unless otherwise stated or agreed with Engineer, the training activities shall begin one month before the completion date and shall continue during DNP.

9.23.4 Responsibilities of Contractor

The Contractor is responsible for the employment of the necessary personnel qualified to fulfill above mentioned training services in a manner to satisfy the Engineer. The Contractor may also employ the personnel who provide training services to fulfil Contractor's obligations for the operation and maintenance of SCADAsystem at the same time. However, in this case, Contractor is responsible to ensure that these personnel are experienced in both subjects and the obligations set forth in this specification regarding the operation and maintenance of SCADAsystem are fulfilled without being hindered while the training activities are carried out.

The Contractor is responsible for supplying the documents, equipments such as audio and video devices and similar resources to be used during the training activities, together with the expenses related to these items. Nevertheless, the Contractor by obtaining approval of the Engineer may use in the training activities the documents, hardware or software items to be supplied by Contractor according to definitions specified in this specification or to the agreements made with the Engineer.

9.23.5 Example Course Groups

In this section, definitions of example course groups are provided in order to help to Contractor create the contents of the training program. The Contractor shall use the definitions made herein but shall not

be restricted only with these, he shall prepare the necessary training program in order to give the training service which the Contractor considers to be the most appropriate for the SCADA System to be installed. Even though the Contractor shall prepare the necessary training program in order to give the training service which the Contractor considers to be the most appropriate for the system, training content shall at least assure specific preparation for the different personnel roles that shall use the system.

9.24 Documentation

9.24.1 General Conditions

The Contractor shall prepare and submit for the approval of the Engineer operating and maintenance procedure manuals in English and Turkish which shall describe the complete functions and requirements for start-up operations, system control, maintenance, safety, record keeping, emergency response and shut down.

All information in these manuals shall apply specifically to the equipment being supplied. The documentation shall be free from irrelevant matters such as might be contained in the manufacturer's general literature.

The manuals shall be arranged to provide separate volumes for each principal items of the Works.

Manuals shall relate to as-built conditions and shall include all necessary drawings and diagrams for a proper understanding of the System.

They shall include the following information:

- Final design documents for the construction and installation.
- As-built drawings.

Operation and maintenance manuals

- Descriptive overview of the whole of the MBT Facility;
- Description of all process with relevant design and operating parameters;
- Descriptions of all systems installed,
- Description of all equipment supplied including manufacturers' leaflets, which are to be scheduled for easy reference;
- Schedules and manufacturer's catalogues for all equipment supplied, giving duties, electrical loads, etc.;
- Schedule of all equipment suppliers (and their local agents) including names, addresses, telephone, telex, fax and email numbers;
- Start-up, operation, and shutdown instructions for system. These shall include process control, hydraulic control, power, and auxiliary systems;
- Procedures to deal with breakdown and emergencies;
- Safety requirements;
- Full maintenance instructions for all equipment including planned maintenance schedules or charts giving daily, weekly, monthly, quarterly, half yearly, annually and overhaul instructions, together with recommended lubricants and spares. These should also include details of routine maintenance work that shall be within the competence of the normal maintenance staff, and notification of maintenance work that shall done by the manufacturer, his agent or other specialist operator;

- Step by step procedure for the dismantling, repair and re-assembly of all items of equipment which shall be complemented by photographs and exploded diagrams;
- Fault finding charts;
- Certified suppliers drawings of all equipment supplied, which are to be scheduled for easy reference;
- Site test reports for all electrical, electronic, mechanical and water systems. Site test process reports for proving tests, commissioning reports, and suppliers test certificates;
- Copies of performance curves;

List of settings of all parameters for Facilityautomation and control at the time of handing over the Works to the End Recipient.

Four (4) copies of each set of manuals, in English and Turkish shall be submitted to the Engineer before taking over. The manual shall be submitted to the Engineer both soft copies and hardcopies.

Each volume shall be durable and permanently bound within a stiff binder of a design to be approved by the Engineer. They must each permit the subsequent incorporation of revisions to be necessary during the Defects Liability Period.

The Contractor shall provide in addition to the above a complete set of the operating and maintenance manuals on the corresponding computer files (AutoCAD, MS Office, etc.) on CD's [4 sets].

All drawings, unless within word-processing documents, shall also be provided in AutoCAD format on disk, or other media agreed with the Engineer. All documentation shall conform to ISO 6592 Code of Practice for Documentation of Computer Based Systems. The documentation must be designed such that the system design and function are clear and easy to recognize, and that optimum maintenance and repair are guaranteed.

9.24.2 Documentation in respect of the Control Centre

9.24.2.1 Hardware Layout Drawings

These shall consist of schematic drawing indicating computer hardware to be present in the control centre, the peripherals, display systems, etc. Important technical features belonging to all parts to be included in this diagram shall also be provided in list format.

9.24.2.2 Source Code

This shall consist of a documentation showing all source codes of the programs to be written according to instructions of the Engineer for the applications that cannot be performed by the standard functions of the SCADA software, and a copy of the source code created in a digital medium.

9.24.2.3 Data Base List

This shall consist of a list containing all definitions relating to the central database of the SCADA System.

9.24.3 Operation and Maintenance Manual

The Contractor shall prepare a fully comprehensive operation and maintenance manual to serve as a guide for the assembly and operation personnel. In this manual, methods proposed for the structure details for the hardware, assembly, disassembly, maintenance and operation shall be described. This manual shall be submitted to Engineer for review and approval. After the approval, 4 copies bound

properly shall be delivered to The Engineer. The general requirements for the said document are as follows:

- a) Operation and maintenance manual shall be prepared in Turkish and English language.
- b) The manual shall be submitted to the Engineer both soft copies and hardcopies.
- c) Complicated texts shall be made easily understandable by using drawings, diagrams, pictures or actual photos.
- d) Measures and warnings related to the hardware and life safety shall be stated.

A file simply containing the various manufacturers' or suppliers catalogues shall not be acceptable.