DOCUMENT: Electrical Standard Specification

SUBJECT: PLC BASED CONTROL SYSTEMS
### PLC Based Control Systems

#### Project:

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CONTENT:

1. GENERAL DEFINITION ......................................................... 5
2. STANDARDS AND CODES ..................................................... 5
3. PLC-CS FUNCTION A REQUIREMENTS ................................. 6
4. SYSTEM CONFIGURATION AND INTEGRITY ............................. 6
   4.1 PLC-CS Configuration ................................................. 6
   4.2 Reliability, Availability and Maintainability ....................... 8
   4.3 Redundancy .......................................................... 9
   4.4 Spare Capacity ...................................................... 11
5. CONTROL SYSTEM HARDWARE ............................................. 11
   5.1 PLC CPU .............................................................. 11
   5.2 PLC Communication ................................................ 12
   5.3 I/O Modules ......................................................... 13
   5.4 Power Supply ...................................................... 15
   5.5 PLC Cabinets construction and mechanical requirements ......... 16
   5.6 Local HMI OWS and EWS ........................................... 16
6. SOFTWARE PLATFORM ........................................................ 16
   6.1 General Recommendations ......................................... 16
   6.2 Basic Software packages .......................................... 16
7. APPLICATION, ENGINEERING AND PROGRAMMING ................. 17
   7.1 OWS Software ...................................................... 17
   7.2 EWS Software ...................................................... 18
8. INTERFACE TO PLANT CONTROL AND MONITORING SYSTEM (if required) .................................................. 19
   8.1 Communication link ................................................ 19
   8.2 Hardwired signals .................................................. 20
9. INTEGRATION OF HMI IN THE MAIN CONTROL ROOM HMI (if required) .......................................................... 20
10. INSPECTION AND TESTING ................................................. 22
11. DOCUMENTATION .......................................................... 24
12. APPENDICES ................................................................. 25
   12.1 PLC-CS Configuration ............................................. 26
   12.2 HMI Configuration ............................................... 26
   12.3 PLC-CS Communication link to PCMS .............................. 28

Date: 08/04  Applicable: 08/04  Rev. -  Cancel: C-DC-032
12.4 Example of PLC datasheet…………………………………………………………30
12.5 Communication link, Analog type data transfer to PCMS………31
12.6 Communication link, Analog type data transfer from PCMS…31
12.7 Communication link, Digital type data transfer to PCMS………31
12.8 Communication link, Digital type data transfer from PCMS... 32
12.9 Hardwired signals, Analog type signal data to/from PCMS….. 32
12.10 Hardwired signals, Digital type signal data to/from PCMS…..32
12.11 Additional information (columns) in case of integration of PLC-CS HMI in the main control room HMI (Analog type signal)………………………………………………………………………………33
12.12 Additional information (columns) in case of integration of PLC-CS HMI in the main control room HMI (Digital type signal)………………………………………………………………………………33
13. Documentation package…………………………………………………………………34

LEGEND:

CPU Central Processing Unit
EWS Engineering Workstation
EEPROM Electrically Erasable Programmable Read Only Memory
F.O. Fiber Optic
HMI Human Machine Interface
I/O Inputs/Outputs
OWS Operator Workstation
OPC/DX/DA/HDA OLE (Microsoft's Object Linking and Embedding) for Process Control/ Data eXchange/ Data Access/ Historical Data Access
PLC Programmable Logic Controller
PLC-CS PLC based control and monitoring system
PCMS Plant Control and Monitoring System
STP Shielded Twisted Pair
SER Sequence of Events Recorder
TCP/IP Transmission Control Protocol/ Internet Protocol
RAM Random Access Memory
Asi Actuator-Sensor Interface

Date: 08/04   Applicable: 08/04   Rev. -   Cancel: C-DC-032

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IEC is the sole owner of all intellectual property rights associated with this document and any future work product thereof.
1. **GENERAL DEFINITION**

1.1 This standard defines the I.E.C. electrical control requirements for the PLC-CS that shall be made in accordance with this Standard, except as modified by the Project Specification. Process and Field Instruments requirements are not covered, and should be referred to in the Project Specification.

1.2 The PLC-CS is an Industrial Automation System based on PLC or PLCs and its associated peripherals which also contain other components, including their application programs.

1.3 The control system based on Programmable Controllers shall be designed to ensure a safe, reliable and convenient operation of the supervised process/equipment, together with improved throughput and increased flexibility. The operation and supervision shall be either from the local dedicated HMI-OWS and/or from the Power Plant Main HMI (so called "remote control").

1.4 The PLC-CS shall be capable of operating in a high electrical noise environment of a large power plant.

1.5 The PLC-CS shall provide full processing of various types of analog and digital input/output signals and shall control the installation in all modes of operation (fully automatic, semi-automatic, manual, local), according to the process technological requirements.

2. **STANDARDS AND CODES**

The PLC control system shall comply with the following standards:

1. IEC 1131 - Programmable controllers
2. IEC 61508 - Functional safety of Programmable Electronic Systems
3. IEC 801-4 or ANSI/IEEEC62.41 - 1980 (Electrical fast transient/burst immunity)
4. IEC 801-5 - Surge immunity requirements
5. IEC 801-3 - Immunity to radio frequency EM-fields

Date: 08/04    Applicable: 08/04    Rev. -    Cancel: C-DC-032
3. **PLC-CS FUNCTIONAL REQUIREMENTS**

3.1 The PLC-CS shall support the following functions:

- Control, Data Acquisition, Monitoring and Alarming of the process/equipment.
- Engineering (PLC programming, debugging, documentation, management, etc.)
- Diagnosis of field equipment and PLC equipment.
- Communication with field devices, PCMS or other control systems.

4. **SYSTEM CONFIGURATION AND INTEGRITY**

4.1 **PLC-CS Configuration**

The attached drawing (Appendix, Fig.12.1) provides an overview of the PLC-CS. The PLC-CS shall use a scalable architecture, supporting easy future expansion.

4.1.1 The PLC-CS shall be divided into the following functional levels:

a) Field Devices connected to the PLC-CS (not covered by this document)

b) PLC-CS Remote and Distributed I/O and their associated peripherals

c) HMI and its associated peripherals

d) PLC-CS Interface (bridges) to the Power Station PCMS or other control systems

d) PLC-CS Local and Control network

4.1.2 The PLC shall be able to work with Remote/Distributed I/O and Field bus I/O. Connections between PLC Control Panels and PLC Remote/Distributed Cabinets shall be dual cable (two channels) to protect the PLC-CS from single cable break or damaged connectors.
4.1.3 In order to permit the Operator to control and monitor any process aspect, the Contractor shall provide one or more OWS, including an HMI software package. The OWS shall be connected to both PLC-CS Control Network and Ethernet based PLC-CS local network.

4.1.4 For on-line/off-line PLC-CS configuration control tuning, debugging and documentation management the Contractor shall provide at least one desktop EWS, with software package(s) for PLC programming and HMI programming (the same as in OWS). The EWS shall be connected to the PLC, either local or remote, using one of the PLC-CS networks.

For small applications, when a desktop EWS is not part of the PLC-CS structure, all the above mentioned engineering functions from this paragraph will be included into the OWS (Contractor shall provide the software packages for PLC and HMI programming included in OWS).

4.1.5 For maintenance purposes, the Contractor shall provide a Portable PC (Laptop) EWS, including PLC programming software and the HMI software package for local monitoring and controlling of the automation process.

4.1.6 For control and supervision from Customer PCMS (Main HMI) located in Power Station Main Control Room the PLC-CS shall be connected (via communication links) to the Power Station PCMS (supplied by others) if required.

4.1.7 Critical alarms and interlocks shall be hardwired (between PLC-CS digital inputs/outputs) and the Power Station PCMS.

4.1.8 For local control purposes only, the Contractor shall provide (if necessary) suitable Local Control Stations with hardwire connection or communication links.

4.1.9 Communication Levels

As a consequence of the hierarchical architecture of the PLC-CS, the data traffic is also hierarchically organized:

a. Device bus level: is a communication link between "smart" field devices and PLC-CS, in both directions (Profibus DP, ASi-bus, Foundation Fieldbus or similar, pending IEC’s approval)
b. Field bus level: connects between remote/distributed I/O units and the PLC's CPUs, PLC's communication cards or PLC's network (Profibus PA, Modicon Remote, Modbus Plus, Ethernet I/O or similar pending IEC’s approval). The remote distributed I/O drop shall be connected to the system by either copper or fiber optic cable, as the distance requires.

c. PLC Control Network level: connects all the PLC's, the HMI workstations (Appendix, Fig. 12.2), the Engineering Workstations and all other communication devices of the PLC-CS with the outside world, including communication to PCMS (Modbus Plus, Siemens' Sinec, Allen Bradley's DH Plus or similar, pending IEC’s approval).

Local Ethernet TCP/IP network: connects the HMI workstations and the Engineering Workstations.

e. Communication link with PCMS (Appendix, Fig. 12.3).

4.2 Reliability, Availability and Maintainability

4.2.1 The PLC-CS and all its components shall be designed for maximum reliability, availability and maintainability, based on the following criteria:

a. The required reliability, availability and safety will be achieved by function distribution (protection, control) and/or by using redundancy of hardware responsible for corresponding functions

b. If redundant design is required, the PLC-CS shall be assembled, programmed and configured to survive the failure of a critical device or single process sensor with no degradation in process control capability, using the necessary level of redundancy for all the PLC-CS components. The fault tolerance attribute will be included on all system levels as follows:

- Data Communication
- Process Controllers
- Critical Input/Output
- Power Supplies
- Communication devices
- Cables
- Field devices and instruments

c. Each single failure shall be clearly reported to OWS(s).

Date: 08/04  Applicable: 08/04  Rev. -  Cancel: C-DC-032
d. The protection subsystems must be fail-safe or two out of three channel design. Failures in the PLC-CS must not cause the protective functions to fail.

e. Measures should be taken to check the continuity of the circuit breaker trip coil (trip-coil monitoring), by means of hardware (optocouplers, inputs) and PLC logic.

f. The following self-checking functions shall be included as a minimum:
   - Memory
   - Program execution
   - Internal communication
   - Power supply
   - I/O cards
   - battery status
   - networks
   - ports

4.2.2 For overcoming severe failures, such as the above, manual control will be possible via HMI, as permitted by safety interlocks.

4.3 Redundancy

4.3.1 Process Controller Level:

a. If hot-redundant PLC configuration is required, the failure of the main PLC shall activate the standby PLC in the same time-scan cycle (hot swap).
   The switchover shall be carried out without any impact on the Operator's ability to control or monitor the system, shall not depend on the availability of the communication system and shall be bumpless.
   The switchover shall be alarmed on local HMI and on the PCMS
b. The PLC shall enable on-line changes without interrupting the process.

c. The Contractor shall provide the detailed description of switchover procedure and switchover time and all the relevant information regarding the redundant structure.

d. Contractor shall provide redundant power supplies for each one of primary and secondary controllers.
e. Every PLC will have its PLC-CS control network ID for the connection bus; when the primary PLC fails, the secondary PLC will change its ID to primary ID.

4.3.2 I/O Level

a. The input/output signals integrity will be ensured by using various types of redundancy for sensors and I/O processing cards according to the signals function (critical, protection, control or monitoring).

b. No single sensor or I/O card failure shall cause a PLC-CS trip.

c. Diagnostic routines shall be provided to detect a failure and identify the failed card. The failure information shall be alarmed at HMI.

d. For critical I/O, diagnostic for input/output group of modules shall provide broken wire detection and loss of power detection.

4.3.3 Communication Level

a. Contractor shall provide redundant communication processors and related devices for each PLC.

b. Communication between the individual local buses shall be redundant. Both paths of the Communication bus shall be active at all times. No degradation of the PLC-CS performance or Controller functions shall result from the loss of any portion of the Communication bus. Diagnostics program, to check the status of both buses, will run continuously. Any interruption shall be reported as an alarm on the HMI.

c. Communication between Central Controller (main PLC) and remote or distributed I/O shall be redundant.

d. Address swapping on communication ports shall be carried out automatically, without special drivers.

4.3.4 Power Supply Level

a. Two power feeds from separate and reliable distribution centers will be provided by Purchaser for any part of the system so that no interruption occurs in the event of a single supply failure. The PLC shall be able to accommodate two external power feeds.

Date: 08/04  Applicable: 08/04  Rev. -  Cancel: C-DC-032
b. The internal power supplies shall be redundant. In the event of the loss of one power feeder or a power supply module failure, the second power supply will provide all internal power requirements, without affecting PLC-CS operation. The transfer of power shall be indicated to HMI.

4.4  **Spare Capacity**

4.4.1 Contractor shall provide 20% installed spare capacity, including processors (CPU's), I/O modules, power supply, terminals, user memory, etc.

4.4.2 Contractor shall provide 20% space for future expansion, including empty rack slots and cabinet space.

5.  **CONTROL SYSTEM HARDWARE**

The PLC-CS shall be suitable dimensioned and shall include the control panels, HMI's, printers and communication accessories. The control panels shall include (but not limited to) the following: PLC, internal wiring, terminals, miniature circuit breakers, power supplies, lighting, anti-condensing heaters.

5.1  **PLC CPU**

5.1.1 General

a. The PLC's user memory sizing, capable of fulfilling all Purchaser's requirements plus 20% spare capacity, as defined in para. 4.4, on the Contractor's responsibility.

b. The PLC shall be provided with a minimum three-year battery for RAM user memory (an addition EEPROM flash memory is preferred). The access to replace the battery shall be from the front panel, without removing any system component and without interrupting the PLC operation.

c. The CPU shall include a real-time clock, with a separate high quality (lithium) 10-year lifetime battery.

d. Application scan time shall not exceed 0.3 msec. per 1K memory instruction.

e. A CPU protect key switch shall be provided to prevent unauthorized access to user's program.
f. Interrupt-enabled function and/or card, for 1 ms interruptions, software configurable, shall be provided.

g. The critical outputs shall have a configurable output failure state.

i. Upon a power failure and after the re-appearance of the power in 10 ms, the CPU shall remain in operation (RUN).

j. Real Time diagnostics of the PLC equipment and components shall be available. The diagnostics shall be available to the operator on-line and shall include at least the following:
   - Processor(s) failure/or/changeover
   - Communication status at various levels
   - I/O modules status
   - Memory
   - Battery status
   - Power supply

5.1.2 The Contractor shall provide all necessary hardware in order to synchronize the CPU with an external IRIG-B signal.

5.2 PLC Communication

This paragraph refers to the data traffic to, from and within the PLC-CS.

5.2.1 PLC Communication Ports:

The following communication ports for data exchange with external devices shall be provided:

a. One communication port: for fixed connection of an engineering laptop PC, allowing PLC programming.

b. Two communication ports: for redundant connection with the customer PCMS.

c. Two communication ports for redundant connection with PLC-CS control network, using a standard control protocol-like Profibus, Modbus Plus or similar, pending IEC’s approval.

d. Two communication ports for redundant connection with PLC-CS Ethernet TCP/IP Local network.

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<tr>
<th>STANDARD No.</th>
<th>Page: 12</th>
<th>Of: 34</th>
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<td>13</td>
<td>34</td>
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e. One spare supplied communication port (future use).

f. For PLC's that do not have the a.m. number of ports as standard, additional port multiplication devices should be provided.

5.2.3 Communication cables

Typical copper communication cables (e.g. Belden 9841) will be subject to Purchaser’s approval based on detailed data sheets provided by Contractor. For Ethernet copper cables the physical characteristics must meet or exceed IEEE 802.3m 100 Base-TX Specifications. Category 5 wire or better is required and STP is recommended. Beyond distances to be decided per project and agreed between Contractor and IEC, F.O. cables shall be used for communication links. For each such cable, Contractor shall provide all necessary devices for F.O. cables connections on both sides. It is in the Contractor’s Scope to specify and supply the F.O. cable(s) that will be erected by Purchaser.

Note: The IEC Standard for F.O. cable is: F.O. cable (12 fibers, 62.5/125µm Graded Index Multimode, manufactured by Teldor, type 95M-51-6M-12B).

5.3 I/O Modules

5.3.1 I/O Requirements:

a. The I/O modules shall meet the requirements of the IEC standards for Industrial-Process Measurement and Control Equipment: IEC 61000-4-X

b. All I/O modules shall be electrical isolated type and contain field side status indicator and fuse indicator.

c. The minimum isolation between I/O channels and module case shall be 1500VAC or 500VDC.

d. The fuses shall be front access type for single or for group (per outputs- preferable).

e. Each I/O module shall be capable of self-diagnostic and status communication to CPU.

f. For Analog and Digital Output modules, the user shall have the possibility to pre-define the output fail state, or hold the last value the module received prior to moment of failure.
g. The modules removal with the power supply on, shall neither cause shutdown of PLC-CS nor module damage.

h. All external connections to I/O modules and PLC shall be done through terminal blocks. 20% spare terminals shall be provided.

5.3.2 I/O Module Types:

The following I/O modules shall be available:

a. 115VAC or 230VAC input, 16 points, or less per card. 32 points per input card, pending IEC's approval for a specific project.

b. 230VAC output, 16 points.

c. Power relay output, 8 or 16 points, dry contact type, pending IEC's approval. If the requirements to relay voltage and current cannot be fulfilled, adequate interposing relays should be provided. The contact rating of the Interposing relays should be according with EPD A.20

Note: 1. For the control of 6.9KV and 0.4KV LC circuit breakers (for electrical feeders and motors, rated 50 HP and above), power output relays rated 220VDC, making current capacity 1.5A, breaking current capacity 2A, are required. If these requirements cannot be fulfilled, adequate interposing relays should be provided for mounting either in the PLC control cubicles or in the switchgear cubicles, as mutually agreed upon between Contractor and IEC.

2. For the control of MCC feed motors (below 50HP), power output relays rated 230VAC, 10A are required

d. 24/48 VDC inputs/outputs, 16 points. 32 points input/output card, pending IEC approval for a specific project.

e. Analog input: 13 bit, 8 point (12 bit, 16 or 32 point requires IEC's approval), 4-20mA, RTD, T/C, etc. Analog output range 4-20mA, 4 or 8 points, self powered.
5.4  Power Supply

5.4.1  External power supply

The external power supply to the PLC-CS shall be 230VAC or 115VAC (+5%,-10%) 50Hz and will be provided by Purchaser.

The voltage and the number of feeders will be decided per project.

5.4.2  PLC Power Supply

a. The PLC (central and remote) shall be supplied with all features/devices to cover PLC internal needs (power supplies and I/O power supplies, as required by the project).

b. The internal Power supplies' modules shall be designed to operate in an electrically noisy environment of a power station without the need for an isolating transformer.

5.4.3  I/O Power supplies:

a. Contractor shall provide all AC/DC power supply and distributions for I/O modules, field interrogation voltages and transducer supply. For 24/48V/125 VDC, Lambda power supplies shall be used (or similar equipment, pending IEC's approval).

b. The internal Power supplies shall be redundant. In the event of loss of one power feeder or a power supply module/unit failure, the second power supply shall provide all internal power requirements, without affecting PLC’s operation. The transfer of power status shall be indicated to controller and available at HMI.

c. Equipment and configuration of power supply and I/O power distribution shall be approved by IEC.

d. Means to separately disconnect the important pieces of equipment (such as primary or secondary PLC's) shall be provided.

e. Power Distribution for solenoid valves shall be provided by Contractor. Miniature circuit breakers with auxiliary/trip contacts shall be used.

f. Service outlets shall be provided in the PLC-CS cabinets.
5.5 PLC Cabinets construction and mechanical requirements.

The requirements shall be according to: ”Auxiliary Equipment supplied with Mechanical Systems/Control Systems requirements” as defined in the Project Specification.

5.6 Local HMI- OWS and EWS

5.6.1 The OWS and EWS (desktop and/or laptop) PC hardware shall be based on the last version of required equipment available on the market and released for the system at the delivery date (see appendix 12.4 - example of PC datasheet).

5.6.2 The HMI hardware shall include all the communication devices (such as bridges, hubs, etc.) needed to interconnect the OWS with the PLC(s) network and with EWS.

5.6.3 EWS should be provided for on-line/off-line PLC programming. The EWS shall be supplied with "off the shelf" software package.

5.6.4 The laptop is a maintenance tool and can be directly connected to a PLC port even when desktop EWS is provided.

5.6.5. B&W and or Color Printers (if required) shall be laser printers generation or better. Printers shall be mounted on a printer stand. Contractor shall supply these stands complete with all the necessary hardware. The types of printers supplied will be subject to Purchaser's approval.

6. SOFTWARE PLATFORM

6.1 General Recommendations

The last proven version of the Standard Software packages available on the market at the time of the design freeze point shall be provided. The software platform shall be supported by the provided hardware and shall support the application engineering programs /tools.

The engineering and application software tools shall be unique and compatible between versions during the whole design period.

All software packages shall be supplied with licenses.

6.2 Basic Software packages

For OWS, EWS and portable Laptop the following software packages shall be provided:

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<th>Cancel: C-DC-032</th>
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a. Operating system: Windows 2000/XP, Hebrew enabled or better, as available on delivery time.

b. Microsoft Office 2000/XP or better, as available on delivery time.

7. **APPLICATION, ENGINEERING AND PROGRAMMING.**

7.1 **Operation Workstation Software**

7.1.1 "Off the shelf" software package shall be provided for Control, Operation and Supervisory of the PLC based system. The HMI Software shall be Citect (Ci Technologies Pty), Wiscon (Axeda System), PCIM (Afcon), RS view 32 (Rockwell Automation) Industrial IT (ABB) or similar, pending IEC's approval.

7.1.2 PLC software shall be available for on-line programming on OWS (comply with IEC1131 standard).

7.1.3 The HMI Software shall provide tools for Alarming, Data Monitoring, Communication, Networking, Reporting and Operator Interface.

7.1.3 Contractor shall supply the system with Application Software (Graphic Displays, Alarm lists, logs, trends, etc), according to the controlled system's technological requirements.

7.1.4 The quantities of graphic displays, trends, alarms, reports, will be defined per project, by IEC.

7.1.5 For development of application software, Contractor shall use and comply with IEC requirements (EPD-B. Device control and operation requirements for PLC/DCS based control system).

7.1.6 Operational Displays (Navigation and Process Graphics) shall be in Hebrew.

7.1.7 For any type of display the built-up time shall be max. 2 sec, while the update time no more than 1 sec.

7.1.8 Software for the protocol of PLC Control Network shall be provided.

7.1.9 The OPC technology

a. The OPC technology is the one preferred for field devices control and monitoring from HMI and also for data transfer with the PCMS.
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<td>18</td>
<td>34</td>
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b. Data's Real Time Stamp should be handled by OPC server and should be implemented by OPC server at PLC level.

c. All OPC products (OPC DA, OPC DX and OPC HDA) should be OPC Foundation tested.

7.2 The Software packages shall be complete, provided with full running and development modules.

### 7.2 Engineering Workstation Software.

#### 7.2.1 PLC Programming

a. The PLC programming language shall be supplied with licenses, compliant with IEC1131-3 standard, Windows XP\NT\2000 based and shall include as minimum "Ladder Diagram", "Function Block Diagram" and "Sequential Function Chart" editor types.

b. The PLC shall employ both on-line and off-line programming capability and capability to provide a back-up of the installed application program, that should be stored independent of the PLC.

c. Contractor shall be responsible for developing, debugging and testing of all software programs provided.

#### 7.2.2 Easy means to print the system's updated documentation (e.g. logic cross-reference diagrams, list of actual process parameters, I/O lists) shall be provided.

#### 7.2.3 EWS software shall be able to configure and to monitor the performance of the PLC and communication network.

#### 7.2.4 The software packages shall be complete, provided with full running and development modules.

#### 7.2.5 For small applications when a desktop EWS is not required, all the mentioned functions will be included in the OWS. Contractor shall provide only the mentioned software packages for the EWS.

#### 7.2.6 Time Tagging and Synchronization

a. Time tagging of events shall be performed by the primary signal processors and shall be synchronized with an external IRIG-B format signal on a per-system (unit) basis. The purpose is to assure a single overall Plant(s) time synchronization.
b. The precision of the synchronization relative to the reference signal for every piece of equipment shall be no more than one (1) millisecond.

8. INTERFACE TO PCMS (if required)

PLC-CS interface to PCMS shall be either:

a. Via communication link
b. Hardwired - for critical control and critical alarms.

8.1 Communication link

8.1.1 PLC-CS shall provide one or more redundant communication links for interfacing with PCMS (see Appendix, Fig.12.3). OPC technology is the preferable solution for PLC-CS PCMS connection.

Other communication protocol, like Profibus PA, Fieldbus Foundation, Modicon's Modbus Plus, Allen Bradley's DH Plus, Siemens' Sinec and the so called Ethernet I/O over TCP/IP should be approved by IEC depending on specific project requirements.

8.1.2 Following are the requirements for data transmission via communication links:

a. There is a contractual obligation to cooperate with the PCMS provider to satisfactorily implement and start-up the communication link.

b. Contractor shall specify quantities and type of data for each link at the engineering phase of the project.

c. Data transmitted via communication link shall be accompanied with time-stamp.

d. In order to achieve the PCMS requirements for data transmission speed, Contractor shall consider the use of few communication links instead of one.

e. Contractor shall provide the communication cable(s) for the link(s). If communication devices, such as modems, converters, security appliances, etc., are needed on the communication link, then the Contractor shall provide them on both - his and PCMS-sides.

f. All signals shall have clear and consistent design identification (tag-name).
g. The information to be provided for each signal is defined in Appendices 12.5…12.8.

h. Contractor shall use IEC Standard for signals identification (tag-name), in addition to his own tag-name.

8.2 Hardwired signals

8.2.1 Critical Analog and Digital signals will be wired to PCMS using conventional cables. Contractor shall terminate those signals at Terminal Blocks and clearly identify them. Shared common pole (wire) method should be avoided. Recommendations/Rules of grouping signals on cables, shields grounding, etc, should be provided for IEC's guidance.

Analog Signals may be one of the following types:
- High level: 4-20mA, 1-5 VDC
- Low level: T/C, RTD
- Pulse

Digital outputs shall be dry contacts rated at least 125VDC, 100mA.

8.2.2 SER: Signals from PLC-CS to PCMS

Since SER is an embedded function of PCMS, Field Signals dedicated to SER shall be hardwired directly from field to PCMS. The functionality of the signal as a SER one will be done internally (in PCMS).

8.2.2.2 Transmission of SER inputs via communication links is not permitted.

8.2.3 Database for signals interchange with PCMS should be provided as defined in Appendices 12.5-12.12

9. INTEGRATION OF HMI IN THE MAIN CONTROL ROOM HMI (if required)

9.1 The Integration of different Plant PLC-CS HMI within PCMS aims to offer the Operator in the Main Control Room, a unitary "window" to any Plant process.

9.2 The requirements for all necessary HMI Control and Monitoring functions from PCMS for the correct and reliable PLC-CS operation shall be provided by Contractor.
9.3 Contractor shall remain responsible for the proper functioning of his system including control, protection and supervisory functions, including operation of his system from PCMS HMI.

9.4 In order to allow integration with PCMS, meaning entire Remote Operating Control and Supervisory of the System, the Contractor shall supply the following:

9.4.1 Full Engineering of the System Remote Control and Supervisory, including at least but not limited to:

a. Logic sequence of remote operation(s).

b. Remote Control Interlock(s) - switch between local - remote operation.

c. Operating and Supervisory displays structure (hierarchy and navigation plan).

d. Definitions of inputs and outputs (including calculated values) needed for Remote Control and Supervisory (see Appendix 12.11 and 12.12).

e. Quantities of inputs and outputs used for the above functions.

f. Operating displays design and special requirements. Complete and clear documentation shall be provided in order to support the PCMS manufacturer in implementing the operating and supervising displays.

g. Contractor shall cooperate and provide any other technical requirements needed by PCMS manufacturer, in order to integrate the PLC-CS HMI in PCMS’s HMI.

9.5 Inputs/Outputs required for Remote Control and Supervisory (from PCMS) should either be:

a. Hardwired - for critical control and critical alarms or

b. Via Communication Links.

Since there are mandatory time requirements for PCMS displays, the link speed has to adequately support those requirements.

9.6 Contractor shall define at the Proposal stage what kind of signals (outputs from PCMS) his system requires, and this data shall be worked and made compatible with PCMS standard signals.

9.7 The data transmitted to/from PCMS shall be such that will enable to entirely control the PLC-CS tasks from the PCMS operator station in Main Control Room, using dedicated graphic displays.
9.8 The graphic displays design, as general architecture and detailed behavior, shall comply with PCMS's Standard(s) and will be defined during engineering stage of the project.

9.9 Contractor shall be responsible to support the above described engineering and embedding of PLC-CS graphic displays into PCMS’ ones.

9.10 Contractor shall conduct the complete test of PLC-CS remote control and supervisory functions integrated within PCMS.

10. **INSPECTION AND TESTING**

10.1 Factory Acceptance test

a. Prior to shipment of the PLC-CS, a simulation test of at least one (1) week shall be performed by the Contractor and witnessed by the Purchaser. During the test, all PLC-CS components shall be assembled and inter-connected. All PLC-CS digital inputs shall be simulated by clearly labeled switches. Each driver channel shall be tested with simulation equipment. Digital outputs shall be displayed on lights.

The purpose of this test is to prove the functional operation of all parts of the PLC-CS and to prove all internal electrical wiring. This test shall demonstrate channel response, interlocks and entire system response during a power supply upset. The operator's control switches and specific interlock controls shall be used in the test setup.

Any power supplies, static switches, batteries or other power conditioning equipment shall be connected to the system and shall be in full operation throughout the test. Transfer from normal to backup power and return to normal shall be demonstrated to cause no PLC-CS malfunction or mis-operation.

b. In the event of a complex system a process simulator is required. Among others, the following characteristics should be tested:

- response time.

- behavior of the system during PLC power failure, emergency stop and run mode change.

Date: 08/04    Applicable: 08/04    Rev. -    Cancel: C-DC-032
software testing, including simulation of expected error conditions, such as communication lines, operator mistakes, etc.

- filtering of I/O cables presumed to be sensitive to electrical noise.

- compliance with process environment conditions, such as temperature, shock and vibration, electromagnetic influence and lightening protection.

c. The test plan shall include:

    c1. Functionality check of the PLC in the different modes of operation (local mode, remote operation with PCMS integration, maintenance).

    c2. Fault simulation test (inputs/outputs, fuses and circuit breakers, interruption of external power supply, interlocks).

d. The simulation must verify that an identified fault causes an output to go into a pre-defined state, as required by system operation.

e. When the Contractor has completed his simulation of all provided equipment, the Purchaser reserves the right to perform a "hands on" demonstration of all the equipment. When the Purchaser is satisfied that all the Contractor-provided equipment functions as specified, the factory simulation test will be considered complete.

f. Test procedure

    The Contractor shall provide a complete, detailed procedure for Purchaser review 30 days prior to the test described above. This procedure shall be in the form of a check-off list and shall be used throughout the test. Each step shall consist of three statements as follows:

1. Status of system prior to this test.
2. Actions to be performed and results expected.
3. Results, system operation and final status.

10.2 Site test

    The PLC-CS shall be tested in the field by the Purchaser. This test program may be in addition to any testing performed by the Contractor during normal startup activities. These tests shall be performed prior to the unit's commercial operation date but not until after all work and testing are completed by the Contractor. A representative of the Contractor shall witness the site tests. Test procedures shall be agreed upon during the signing of the

<table>
<thead>
<tr>
<th>Date:</th>
<th>Applicable:</th>
<th>Rev.</th>
<th>Cancel: C-DC-032</th>
</tr>
</thead>
<tbody>
<tr>
<td>08/04</td>
<td>08/04</td>
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<td></td>
</tr>
</tbody>
</table>
contract. The PLC-CS will be tested in conjunction with PCMS including remote mode of operation. Special attention will be paid to link redundancy checking, communication links load during both normal and upset situations.

11. DOCUMENTATION

A documentation package should be provided, to fully describe the PLC-CS and the application (see appendix, documentation package 12.13).
12. **APPENDICES**
12.1 PLC-CS configuration (full variant)

12.2 a HMI configuration: Server & Clients

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<table>
<thead>
<tr>
<th>STANDARD No.</th>
<th>Page:</th>
<th>Of:</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPD-A.14</td>
<td>27</td>
<td>34</td>
</tr>
</tbody>
</table>

### 12.2 b  HMI configuration: Ethernet TCP/IP network based

- **OWS Server**
- **OWS Clients**
- **Printer**
- **Ethernet TCP/IP Network**
- **PLC control network**

### 12.2 c  HMI configuration: Multi-Master PLC's network based

- **OWS**
- **OWS**
- **OWS**
- **Printer**
- **PLC control network**

**Date:** 08/04  **Applicable:** 08/04  **Rev.:** -  **Cancel:** C-DC-032
12.3 PLC-CS Communication link to PCMS

12.3a Network to Network Bridge

12.3b Network to Device Bridge

12.3c Device to Network Bridge

12.3d Device to Device Bridge

Date: 08/04
Applicable: 08/04
Rev. -
Cancel: C-DC-032
12.3e  PLC-CS to PCMS Networks OPC-DA & OPC-DE based bridge

12.3f  PLC-CS to TCP/IP Networks OPC-DA Server/Client based bridge
12.4 Example of PC datasheet:

- Processor: Intel Pentium 4 - 1.8 GHz (or similar).

- Memory: 256 KB DDR or 400 MHz RDRAM.

- Hard disk: 40 GB, 7200 RPM.

- Floppy: 3½ inch, 1.44 MB diskette.

- CD-Rom: x 52 with ABS anti-vibration mechanism.

- Video card: 64 MB memory and graphic accelerator.

- Network card: 2 cards Ethernet TCP/IP 10/100 base T or 10/100 base FL.
- Network card(s) to connect on PLC(s) network and to communicate with EWS (if it exists).

- Ports/drivers: 2 Serial, 1 Parallel.

- Keyboard; Hebrew/English.

- 19” CRT flat, Mag or equivalent, pending IEC approval.

- Any communication devices (such as bridges, hubs, etc.) needed to interconnect the OWS with the PLC(s) network and with EWS.
12.5 Communication link, Analog type data transfer to PCMS

<table>
<thead>
<tr>
<th>Unit number</th>
<th>KKS</th>
<th>ID code</th>
<th>Description</th>
<th>Engineering Unit</th>
<th>Scale</th>
<th>Data Format</th>
<th>PLC-CS field (Register Number)</th>
<th>PCMS Field (Register Number)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PLC-CS Contractor shall provide special buffer block of registers for move (not dispense over all PLC memory) and etc.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1:
Communication link
Analog type data transfer to PCMS

PLC-CS Master/Slave Network node: Port number: Communication parameters:
PCMS Master/Slave Network node: Port number: Communication parameters:

PLC-CS contractor filling place

Max 32 characters

12.6 Communication link, Analog type data transfer from PCMS

Table 2:
Table of analog type data receive from PCMS

<table>
<thead>
<tr>
<th>Unit number</th>
<th>KKS</th>
<th>ID code</th>
<th>Description</th>
<th>Engineering Unit</th>
<th>Scale</th>
<th>Data Type</th>
<th>PLC-CS field (Register Number)</th>
<th>PCMS Field (Register Number)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PLC-CS Contractor shall provide special block of registers for receive data</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3:
Communication link
Table of digital type data transfer to PCMS

<table>
<thead>
<tr>
<th>Unit number</th>
<th>KKS</th>
<th>ID code</th>
<th>Description</th>
<th>PLC-CS field (Bits/Register/Bit Number)</th>
<th>PCMS Field (Bits/Register/Bit Number)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Contractor shall provide special buffer block of bits or within registers (preferably) for move (not dispense over of all PLC memory)</td>
<td></td>
</tr>
</tbody>
</table>

Date: 08/04  Applicable: 08/04  Rev. -  Cancel: 

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12.8 Communication link, Digital type data transfer from PCMS

Table 4: Communication link
Table of digital type data receive from PCMS

<table>
<thead>
<tr>
<th>Unit number</th>
<th>KKS code</th>
<th>ID code</th>
<th>Description</th>
<th>PLC-CS field (Bits/Register/Bit Number)</th>
<th>PCMS Field (Bits/Register/Bit Number)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Max 32 characters</td>
<td>Contractor shall provide special buffer block of bits or within registers (preferably) for receive data</td>
<td></td>
</tr>
</tbody>
</table>

12.9 Hardwired signals, Analog type signal data to/fromPCMS

Table 5: Hardwired signals
PLC-CS hardwired Analog type signal database

<table>
<thead>
<tr>
<th>Unit number</th>
<th>KKS code</th>
<th>ID code</th>
<th>Description</th>
<th>Source/Destination field device</th>
<th>Signal Type</th>
<th>Signal Function</th>
<th>I/O Card Type</th>
<th>Data Scale</th>
<th>Alarms: LL;L:H; HH</th>
<th>PLC-CS field (Register Number)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Max 32 characters</td>
<td>Bar</td>
<td>Analog Control</td>
<td>4...20 mA</td>
<td>0...4095</td>
<td>0...10</td>
<td>0.5;1;9;9</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Amper</td>
<td>Analog Alarm</td>
<td>1-5VDC</td>
<td>Point</td>
<td>0</td>
<td>RTD</td>
<td>TC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Status monitor</td>
<td>Trend Report</td>
<td>toPCMS SER</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12.10 Hardwired signals, Digital type signal data to/from PCMS

Table 6: Hardwired signals
PLC-CS hardwired Digital type signal database

<table>
<thead>
<tr>
<th>Unit number</th>
<th>KKS code</th>
<th>ID code</th>
<th>Description</th>
<th>Source/Destination field device</th>
<th>Signal Type</th>
<th>Signal Function</th>
<th>I/O Card Type</th>
<th>Alarm Status</th>
<th>PLC-CS field Bit number</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Max 32 characters</td>
<td>Digital Input</td>
<td>Control 220AC</td>
<td>Off</td>
<td></td>
<td></td>
<td></td>
<td>C-DC-032</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Digital Output</td>
<td>Alarm 24VDC</td>
<td>On</td>
<td>Report toPCMS SER</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Status monitoring Report</td>
<td>Relay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Date: 08/04  Applicable: 08/04  Rev. -  Cancel: C-DC-032
12.11 Additional information (columns) in case of integration of PLC-CS HMI in the main control room HMI (Analog type signal)

Table 7:

<table>
<thead>
<tr>
<th>Signal Type</th>
<th>Signal Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>MINfromHMI=…, MAXfromHMI=…</td>
</tr>
<tr>
<td>Alarm</td>
<td>LL=…, L=…, H=…, HH=…</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Trend Scan Time=…</td>
</tr>
<tr>
<td>Log</td>
<td>Yes/No</td>
</tr>
</tbody>
</table>

12.12 Additional information (columns) in case of integration of PLC-CS HMI in the main control room HMI (Digital type signal)

Table 8:

<table>
<thead>
<tr>
<th>Signal Type</th>
<th>Signal Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Normal Status=ON/OFF</td>
</tr>
<tr>
<td>Alarm</td>
<td></td>
</tr>
<tr>
<td>Monitoring</td>
<td></td>
</tr>
<tr>
<td>Log</td>
<td></td>
</tr>
</tbody>
</table>

Date: 08/04  Applicable: 08/04  Rev. -  Cancel: C-DC-032
### 12.13 Documentation package.

<table>
<thead>
<tr>
<th>Description</th>
<th>For Proposal</th>
<th>For Award of Contract</th>
<th>After Award of Contract</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Control Architecture Diagram (Configuration)</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>2 PLC-CS Layout</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>3 Equipment List (type, quantity, catalog pages)</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>4 Control Philosophy and Control Logic Diagrams</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>5 Schematic Diagrams</td>
<td>-</td>
<td>-</td>
<td>A</td>
</tr>
<tr>
<td>6 Terminal (wiring) Diagrams – typical</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>7 Cabinets Layout Diagrams</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>8 Arrangement Diagrams</td>
<td>-</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>9 HMI Interface (Graphic Displays, Alarm Lists, etc.)</td>
<td>I</td>
<td>I</td>
<td>A</td>
</tr>
<tr>
<td>10 Power Supply and Power Distribution Diagrams</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>11 Wiring Diagrams (lists or dwg’s.)</td>
<td>-</td>
<td>-</td>
<td>A</td>
</tr>
<tr>
<td>12 Internal Wiring Diagrams</td>
<td>-</td>
<td>-</td>
<td>I</td>
</tr>
<tr>
<td>13 I/O List in MS Excel or MS Access file format</td>
<td>I</td>
<td>I</td>
<td>A</td>
</tr>
<tr>
<td>14 Cables List</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>15 I/O List for Communication Links (if applicable) – in MS Excel or MS Access format</td>
<td>I</td>
<td>I</td>
<td>A</td>
</tr>
<tr>
<td>16 List of signals to/from Customer PCMS</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>17 Electrical &amp; Control Equip. Data Sheets and Bill of Materials</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>18 Site installation requirements, including shielding and grounding</td>
<td>I</td>
<td>I</td>
<td>A</td>
</tr>
<tr>
<td>19 PLC(s) application program printout and file</td>
<td>-</td>
<td>-</td>
<td>A</td>
</tr>
</tbody>
</table>

A-for approval by IEC
I-for information only

Date: 08/04    Applicable: 08/04    Rev. -    Cancel: C-DC-032