



Exploration & Production

GENERAL SPECIFICATION

ELECTRICAL

GS EP ELE 221

Electrical Control System (ECS)

05	01/2012	Minor revision as marked
04	01/2011	Obsolescence requirements
03	10/2008	General Revision
02	10/2005	Addition of "EP" root to GS identification
00	03/2001	First issue
Rev.	Date	Notes

Owner: DEV/TEC

Managing entity: DEV/TEC/ELE



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1. Scope

This specification defines the minimum requirements for the design, manufacture, materials, software, inspection and test of the electrical control system equipment (Electrical Control System - ECS) to be installed on the offshore or onshore Company electrical facilities.

The Supplier shall ensure all the coordination required with its Sub-Contractors.

The Supplier shall be responsible for supplying the system complete in every way and shall advise the Company of any deviations/omissions in the specification prior to placement of the Purchase Order.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Design, materials and performance of the ECS shall be in accordance with the current edition of the following documents:

Standards

Reference	Title
IEC 60332-2-1	Tests on electric and optical fibre cables under fire conditions - Part 2-1: Test for vertical flame propagation for a single small insulated wire or cable Apparatus
IEC 60364 (All parts)	Electrical Installation in Buildings - (All parts)
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 61000 (All parts)	Electromagnetic compatibility (EMC) - (All parts)
IEC 61131 (All parts)	Programmable controllers- (All parts)
IEC 61850 (All parts)	Communication networks and systems in substations- (All parts)
IEC 62402	Obsolescence management - Application guide

Applicable recognized standards (UTE, BS, VDE, etc.) and codes where IEC publications have not yet been issued.

Professional Documents

Reference	Title
Not applicable	



Regulations

Reference	Title
	EMC (Electromagnetic compatibility) European Directive 89/336 EEC and 92/31 EEC and 93/68 EEC (CE marking)

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
	General single line diagram (*) HV single line diagrams (*) LV single line diagrams (*) UPS AC & DC single line diagrams (*) Technical Room Layout (*) Overall Plot Plan and Main Communication Network Cable Routing (*)

(*) These documents shall be provided during the project basic and detailed engineering phases.

Total General Specifications

Reference	Title
GS EP ELE 001	Electrical design criteria
GS EP ELE 021	Electrical design criteria for floating units
GS EP ELE 031	Design of earthing and bonding systems
GS EP INS 108	Instrumentation for the design of plant rooms and control rooms
GS EP INS 135	Cyber Security requirements for design and supply of ICSS and Package Systems
GS EP TEC 007	Obsolescence and Lifetime Cycle Management
GS EP TEL 180	Engineering and installation of telecommunication network pre-cabling

NB: Reference to **GS EP TEL 180** is limited to the Optical Fiber cable definition.

3. Abbreviations

CCR	Central Control Room
CPU	Central Processor Unit
CRS	Clock Reference System
DCS	Distributed Control System
ECS	Electrical Control System
EDG	Emergency or Essential Diesel Generator
ESD	Emergency Shut Down
FAT	Factory Acceptance Test
GEG	Gas Engine Generator
GTG	Turbine Generator
HMI	Human Machine Interface
ICSS	Integrated Control and Safety System
IP	Internet Protocol
PCS	Process Control System
PDS	Process Data Server
PLC	Programmable Logic Controller
PSS	Process Safety System
SAT	Site Acceptance Test
VDU	Visual Display Unit

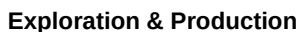
Note: The ICSS comprises the PCS, PSS, ESD, Fire & Gas detection and protection Systems and Process Operator HMI.

4. General

4.1 Description

The ECS shall be suitable to manage power supply supervision of the whole electrical facilities. For that purpose, it shall be designed to carry out the following principal tasks:

- Control/monitoring of power distribution and power generation systems
- Data acquisition and display of power generation and power distribution parameters
- Load shedding
- Re-acceleration and restarting
- Source automatic transfer
- Alarm and Event management



- The Electrical Control system shall be achieved by means of one dedicated system. This system shall, in conjunction with the relevant ICSS (mainly PCS), facilitate the control and supervision of the power generation and distribution systems.

All equipment of ECS shall be interfaced by means of an appropriate communication network.

The ECS shall be capable of interfacing with all the equipment of the power generation and distribution systems (i.e. control panels of turbine/emergency generating sets, HV, LV switchboards and other switchgear, UPS cubicles, etc.).

The ECS shall also be designed to allow additional software and hardware facilities for future extension.

For small projects and/or projects with only one low voltage level (e.g. 400 V) and after Company approval, the possibility of integrating the ECS within the ICSS shall be studied.

The structure of the ECS with equipment relevant to each room is shown on the diagrams of Appendix 1.

ECS equipment shall be installed inside air conditioned electrical, technical or control room. Nevertheless, the equipment shall be capable of operation at 40°C ambient temperature without deleterious effects. As a minimum cubicles and cabinets shall be fitted with heaters; electronic cards shall be double varnished.

The minimum degree of protection of enclosures shall be IP 21 (according to IEC 60529).

The available voltages for the equipment shall be:

- 230 V AC from UPS for workstation, visual displays units, printer(s) and clock reference system
- 230 V AC from UPS or 24/48 V DC unearthed from batteries for PLC's.

Equipment shall be suitable for operation with Voltage variations within the following limits:

- 230 V AC - Normal or UPS ± 10% steady state conditions
 -20% transient conditions
- Frequency 50 or 60 Hz ± 5%
- 48 V DC / 24VDC ± 10% steady state conditions

4.4 Deviations to specification

No deviations from the requirements of this specification are allowable unless itemised in the Supplier Bid and subsequently agreed within the Purchase Order or Order Supplement Documents.



Should this specification conflict with requirements of the listed standards or Company specifications, the Supplier shall request clarification from the Company at the time of tendering.

5. Electrical control philosophy

5.1 Electrical network description

Electrical networks will be largely dependent on the project type and size (onshore, offshore) and are generally split into two parts:

- The power generation system (Main, Essential and Emergency) and/or connection to an external grid
- The power distribution system.

The main power generation generally comprises Gas Turbine Generators, Gas Engine Generators or Diesel Generators operating in islanded configuration or coupled to an external grid.

Essential and/or Emergency Power Generation are mainly based on Diesel Generators.

The power distribution system may range from simple architecture (one LV switchgear) up to more complex ones, including multiple substations, multiple voltage levels, power generation interconnection, overhead lines, etc.

GS EP ELE 001 (or **GS EP ELE 021**) and project specific documents shall be referred to for complete description of the electrical networks.

5.2 Power generation control philosophy

Gas Turbine or gas engine generator sets (when applicable) shall be capable of operating without help from the ECS.

Only status, measurements, alarms, faults and relevant calculations shall be exchanged between the ECS and the generator sets control panels.

The ECS shall be interfaced with normal and emergency diesel generator sets to allow auto synchronization of the main circuit breakers and normal stop of emergency set(s).

The GTG power capabilities shall be calculated by the turbine control panel based on the ambient conditions (temperature, pressure, ageing, etc.) and shall be made available to the ECS for load shedding calculations.

A load sharing system of the PLC type is basically foreseen in the turbine generator set control panels to regulate, under steady state conditions:

- The flow and sharing of active and reactive power between the generators
- The system voltage
- The frequency.

When specifically required within the project specific documents, load sharing and system voltage and frequency control may be included within the ECS functionalities.

The GTG voltage regulators control, independently from the ECS, the generator excitation according to the normal system voltage setpoint.



For electrical network such as FPSO where essential generators may be running in islanded or in parallel conditions, the essential generator Supplier shall provide suitable active and reactive load sharing and voltage/frequency control.

5.3 Power distribution control philosophy

The ECS shall facilitate the supervision of the power generation and distribution systems. The ECS shall show via mimics on the VDU the status of:

- HV circuit breakers
- Main LV circuit breakers, (Incomers, Tie and Main outgoers)
- Turbine or gas engine generators
- Transformers
- Essential/Emergency diesel generator(s)
- AC/DC UPS
- Neutral Earthing Transformers
- Interconnecting feeders
- Overhead lines
- Other equipment, such as Lighting and Small power DB, HVAC panels, etc. (if required)
- ECS architecture.
- Etc.

The ECS shall allow Operator having suitable access level, to remotely control the main distribution HV and LV circuit-breakers via the Operator station and shall perform network configuration automatic sequences (auto-transfer, etc.).

6. System Architecture

6.1 ECS Architecture - General Description

6.1.1 General

The ECS architecture shall be based on a distributed structure following up the electrical network architecture with centralised HMI both in the CCR and in the Main Substation and local HMI in the main secondary substations.

The subsystems within the substations shall remain autonomous and will interface with the Main Substation equipment and supervision level via dedicated ECS networks.

The ECS can be split in the following levels:

- Level 2 - Supervision
- Level 1 - Automation
- Level 0 - Acquisition/command.



6.1.2 Level 2 - Supervision level

The CCR shall be equipped with an Operator Workstation embedded within the ICSS control desk and VDUs.

An Engineering/Operator workstation shall be installed within the Main Electrical Substation.

Both CCR and Main Electrical Substation Operator Workstation shall allow for the control and monitoring over the complete electrical network.

Depending on the electrical network architecture, main secondary substations/Electrical Technical rooms shall be equipped with a Local Workstation connected to the substation PLCs in order to allow for the monitoring of the complete electrical network but control limited to the substation equipment. Control of the rest of the installation may remain possible through high level password.

Redundant servers shall be implemented and installed within the main substation and shall allow for the overall data acquisition and data historical management.

6.1.3 Level 1 - Automation level

This level consists of redundant PLCs installed in each Substation/Electrical Technical Room closed to the equipment to be controlled and communicating with the level 2. This level shall be self supporting even in case of communication failure with upper level.

6.1.4 Level 0 - Acquisition / Command

This level consists in field mounted equipment which communicates with Level 1 by means of serial links or hardwired connections:

- HV digital protection relays
- LV main incomers/bustie/feeder protection relays
- Remote I/Os
- Etc.

6.1.5 Main Communication Networks

An appropriate communication network (typically Ethernet TCP/IP, etc.) shall be provided for the interface between the PLC'S, data server, thus allowing a multistation configuration.

It shall be possible for any workstation or PLCs to be added, or removed from, the communication network without having to shutdown the network and without impairing the safety and security of the system.

Optical fibre links shall be used to interconnect part of the ECS:

- Short length optical fibre network related to the ECS shall be designed and supplied by the ECS Supplier
- Optical Fiber cables for building interconnection shall be designed as per **GS EP TEL 180**. Dedicated Optical fibre cables shall nevertheless be provided for the ECS.

As a general rule, such links shall be redundant and run on separate cable routings from end to end in order to avoid common fault mode.



The network topology can be based on 2 redundant FO cables or on either redundant star configuration or self healing optical rings.

6.2 Time Synchronisation

A master clock shall be provided at the Main Substation level. All ECS equipment shall be synchronised to this master clock.

6.3 Interfaces between ECS and other equipment

6.3.1 General

The ECS shall be interfaced with several type of equipment:

- Power generation: Gas Turbine Generators, Essential and or Emergency Diesel Generators
- HV Switchgears
- LV switchgears
- UPS
- ICSS
- Small power distribution
- VSDS, etc.

The data to be exchanged for each type of equipment shall be defined in detail during the Basic Engineering phase. Appendix 2 may be referred to.

6.3.2 Interfaces between ECS and electrical equipment

HV switchgear protection relays shall be interfaced with the ECS using RS485 Serial Link and Modbus protocol type, or, alternatively, [IEC 61850](#) based network and protocol. Proprietary protocols are not allowed. However, other protocols than above mentioned ones may be used after Company prior approval.

LV switchgear protection relays (incomers; bus ties and main feeders) shall communicate with the PLC via RS 485 Serial Link and Modbus Protocol.

Other equipment such as UPS, shall also be interfaced with the ECS using RS 485 Serial Link and Modbus Protocol.

All critical controls and/or statuses (especially when used in automation functions/sequences with time constraints) shall remain directly hardwired to the ECS.

In order to minimize physical interfaces between with the ECS, ECS remote I/O cards may be implemented within the electrical equipment.

6.3.3 Interface between ECS and Power generation

GTG and EDG UCP shall be interfaced with the ECS using RS 485 Serial Link and Modbus Protocol.



Nevertheless, all critical controls and/or statuses (especially when used in automation functions/sequences with time constraints) shall remain directly hardwired to the ECS:

- Turbine generator operating status, trip order,
- CB statuses
- Actual power delivery (P, Q) via 4.20 mA converters
- GTG power capability via 4.20 mA converters
- Etc.

6.3.4 Interface between ICCS and ECS

Interface between the ECS and the ICSS (mainly the PCS - Process Control System) shall be at the Substation PLCs level and based on RS 485 Serial Link and Modbus Protocol and / or Ethernet TCP/IP.

6.3.5 Interface between ICSS and LV Motor Starters

As a general rule, ICSS / PCS shall be directly interfaced with the motor starters via either hardwires or Serial Link.

PCS start / stop orders should not be run through the ECS unless stated otherwise in the project specific documentation and further to Company prior approval.

ESD shall remain hardwired whatever the configuration.

The following interface may therefore be considered (final selection shall be performed during the Basic Design):

- Direct hardwire connection through marshalling cabinets inside Substation (ICSS/PCS remote I/Os may potentially be installed in the marshalling cabinets)
- ICSS/PCS remote I/Os integrated within the Electrical Switchgears (allowing FAT at the switchgear Manufacturer's premises)
- Direct serial link between the ICSS/PCS and motor feeder communicant relays.

6.4 Interface with Perturbography Recorder

In case perturbography recorder is implemented at the Main Substation, it shall be interfaced with the ECS using RS 485 Serial Link and Modbus Protocol and / or Ethernet TCP/IP.

The recorder shall be time synchronised as for any other equipment requiring fine time stamping.

6.5 Equipment arrangement inside substation

ECS equipment shall be provided within dedicated cabinets installed close to HV and LV equipment. Some ECS parts (data concentrator, remote I/O cards, etc.) may be implemented within electrical equipment.

7. Functional requirements

7.1 Level 1 - Automation

Level 1 shall be fully autonomous at the substation level. PLCs shall continue to perform the assigned tasks/automatism (such as Automatic Transfer, load shedding, etc.) even if level 2 fails.

7.2 Level 2 - Supervision

The level 2 shall provide the following functionality:

- Human Machine interface: display, animation and control
- Events and alarm management
- Online set up of load shedding and motor restart parameters (load blocks, time delays, etc.)
- ECS device architecture display, monitoring and tele-diagnostics
- Historic management, trending and archiving, reporting
- Operator access.

7.3 Remote control of circuit breakers

It shall be possible to remotely control each HV and main LV distribution system circuit breakers (close and open) from the Substation HMI; however all interlocks (independent from the ECS) shall remain in service. Control circuits shall be hardwired between PLCs and the relevant circuit breakers.

In case of operation of protective devices, tripping of all circuit breakers and contactors shall be achieved independently of the ECS, by hardwired links.

7.4 Source automatic transfer

7.4.1 Automatic transfer (double radial feeders distribution)

The ECS shall automatically initiate the switching of distribution system circuit breakers for each switchboard in such a way that in case of under voltage at any half bus-bar (and subject to other additional conditions, such as voltage level on the “healthy” busbar, undervoltage not linked to any fault prohibiting the transfer, etc.), the bus-tie will be automatically closed and the two half bus bars fed from one incoming feeder.

7.4.2 Manual transfer

Source transfer shall also be achieved manually either from the Central Control Room or Main Electrical Substation HMI (or from the Substation HMI) via an Operator action. Such manual transfer shall also be possible from the switchgear itself.

Note that check synchronising relays prevent closure (for any reason) of either incoming or bus section circuit-breakers unless supplies are synchronised or at least one bus is dead.

For load test purposes, it will also be possible to manually initiate starting of the emergency diesel generator(s) from the ECS through the relevant PLC, in which case the diesel generator will synchronise to the normal supply and operate in parallel.

In all cases, return to normal configuration shall be initiated manually, and shall occur without supply interruption.

7.5 Intertripping and interlocking

Intertripping and interlocking **shall operate independently of the ECS**, by hardwired links (HV/LV transformers intertripping, etc.).

7.6 Load shedding

The load shedding function of the ECS shall protect the power generation system against failure or instability due to sudden overload following the loss of one or two of the normal operating generators, or the sudden application without warning of a large load.

All sheddable loads shall be disconnected by motor contactor or circuit breaker tripping.

The PLC of the ECS shall monitor continuously the power system load balance and frequency and shall evaluate for each potential scenario (trip of GTG, lost interconnecting feeders, etc.) the necessary loads to be load shed.

Two levels of load shedding shall be foreseen:

- **The first level**, to be implemented following detection of an under frequency condition or GTG exhaust High Temperature, shall consist of step by step (if required) shedding of HV outgoers, according to the preset priority, which shall continue until the frequency returns to normal.
- **The second level** of load shedding, to be implemented following loss (i.e. tripping) of an operating power source (turbine generator) shall consist of a general shedding of load blocks. The amount of load to be shed shall depend on the power which was previously provided by the source which was lost and the capability of the remaining turbines (provided by the GTG UCP). The load shed orders shall be applied individually to each HV circuit breaker outgoer.

The load shedding will be initiated and achieved by the Main Substation PLC or the Substation PLC. The transmission of the load shedding commands from the central equipment to the substation equipment must occur in the shortest possible time to ensure that the stability of the generation system is maintained. Hardwiring shall basically be considered but for certain applications, dedicated High Speed redundant network may be considered as well.

The load shedding commands shall be hardwired from the substation PLC'S to the equipment to be loadshed (common tripping order).

Facilities shall be provided in the ECS to change lists of sheddable loads and load blocks.

7.7 Reacceleration and restarting

Facilities should be provided to initiate restarting of 400 V motors following short power supply disturbances such as, for example, source transfer.

Reacceleration will be natural (out of ECS functions) and applied to all motors following very short ($t < 0.5$ sec) power supply interruptions or voltage dips, and restarting shall be applied to

motors where applicable following short power supply interruption ($t > 0.5$ sec but inferior to 10 seconds). All motors will be capable of re-energisation without damage against 100% residual voltage.

The normal starting and stopping of all motors will be controlled by the Process Control System (PCS) however the control of motors for restarting shall be by the ECS.

The control voltage for HV or LV motors will derived from an Uninterruptible Power Supply - UPS (stationary batteries and chargers).

All 400 V motors shall be fed by contactors which will normally remain closed (Contactor coils to be fed from UPS supply) until the applicable maximum time during which reacceleration applies (e.g. 0.5 sec) is reached. On restoration of the voltage within this time, the motors will naturally reaccelerate without action from the ECS.

If the voltage is not restored within the allowed time, control voltage supply shall be tripped by undervoltage relays and contactors will open naturally.

On restoration of the voltage within the applicable maximum time during which restarting applies (e.g. 10 seconds), commands shall be given by the ECS to restart 400 V motors subject to restarting.

400 V motors shall be restarted by means of switchboard "restart" bus bars (based on control voltage bus).

6.6 kV motors shall be individually restarted.

Restarting will occur for blocks of motors in timed steps to avoid excessive demand on the power system.

Restart commands shall be provided from the relevant substation PLC by hard wired links.

Facilities shall be provided in the ECS to change lists of blocks of motors.

The ECS shall inform PCS of the presence of emergency supply in order to automatically restart emergency loads.

Restarting for 400 V motors shall only occur so long as Process Control System (PCS) start signal to the motor is still present. Reacceleration and restarting shall not occur for motors which have been stopped by the PCS either by fault or by local stop push buttons or by any other interlock. This aspect shall be carefully considered during selection and design of the control system hardware and software.

7.8 Event recording and alarming

The ECS shall record all significant events, alarms and actions which occur in the power generation and distribution systems, with **discrimination between events of 10 ms or less** over the whole electrical network.

All faults shall be discriminated and correctly recorded in date and time.

It shall be also possible to assign priorities (and change them) to each event, e.g. record only, low priority alarm, high priority alarm.

Only alarms and faults shall be acknowledged. No acknowledgment is required for status/events.

Each event and further action (including Operator acknowledgment), whether automatically initiated or by Operator, shall be recorded and stored in event history files in permanent memory



(e.g. hard disk), with the date and time of occurrence clearly indicated. Alarms shall be displayed on a HMI alarm page, and shall remain active until acknowledged. The printer is normally dedicated to event recording as soon as an event appears, but it shall be possible to retrieve, display and print extract of the event history file for each substation or for the complete system or for specific Operator defined search requests and filters (combination of tags, switchgear, substation, date/time, acknowledgment, etc.).

Management of discrepancies

All open/close (CB, contactor, etc.) and multi-position (3-position switches, On Load Tap Changers, etc.) items shall have a discrepancy alarm.

This alarm shall be generated when either of the following situations is seen by the ECS:

- Several positions of one item activated at the same time and during a (adjustable) time operation delay.
- None of the positions of one item is activated at the same time and during a (adjustable) time operation delay (e.g. a contactor neither open nor closed for more than 2 s).
- Action issued by the ECS not applied by equipment for a (adjustable) time operation delay (e.g. a distribution circuit breaker does not open within the 2 s after order issuance).

7.9 Other electrical network management and monitoring functionality

ECS may be implementing the following functionality:

- Automatic and/or Operator control of transformer On-Load Tap Changers
- Power factor regulation by acting on capacitor bank steps
- Perturbography recorder management
- Etc.

Such functionality and any additional ones will have to be assessed and detailed by project specific documents during the Basic Design stage.

8. Man Machine Interface - Supervision

8.1 General principles

The man/machine interface is implemented by Operator Workstations. The following is indicative of minimum requirements by Company. The Supplier shall describe more extensively in his HMI specification the different functionalities offered by his proposed software.

The supervision software shall be based on Windows Operating System or equivalent and as such shall possess multi screens (up to 2 screens may be considered for the Main Substation Operator Station) and multi windows functionalities. Interface and export of ECS stored data to EXCEL spreadsheet software or other data-base format shall be possible.



General presentation of the screens:

The Operator shall systematically have access to the following information:

- Current date and time
- Name of the Operator logged into the system, validated by his key code for access, pertaining to a given level of control
- List of the last five alarms.

He shall access to the following functions via scroll-down menus:

- Animated electrical power distribution supervisory control screens:
 - Overall SLD
 - Substation SLD
 - Detailed Switchgear SLD
 - Detailed Substation Layout view
 - Detailed Switchgear front view (applicable when most of the drawers are monitored from the ECS)
- Status logging and alarm management:
 - Access to alarm list screens
 - Access to data logging
 - Alarm horn shutdown, alarm acknowledgment
 - Measurements and trending curves.
- System view: control system status, Operator help, access to tools, saving/restoring automation parameters, system implementation.

The assembly of the screen functions shall be a pre-engineered software for electrical network supervision.

Standardized use of colours:

Beside colour identification, change of status, activation of an object on screen may be obtained by change of depth between layers on screen.

The number of colours used shall be deliberately limited in order to give each one a simple, unambiguous meaning. The following colours can be used as an example:

- Statuses of equipment:
 - Green = device stopped
 - Red = device in operation
 - Pale blue = device energized
 - Flashing red Square = device in alarm mode (and / or discrepancy state)
 - Flashing yellow = device in downgrade mode.

- Control buttons of equipment (network circuit breakers only)
 - Green for closing push button
 - Red for tripping push button.
- Alarms
 - Alarm shall be blinking up to acknowledgement
 - 4 colour levels from Red (Critical alarm - immediate intervention required) to Yellow (less critical alarm - normal intervention required).

It should be noticed that the standardization of colours may be modified in order to comply with local regulation or standard practice.

8.2 Operator access

There shall be 6 user access levels:

- **Level 1: View only.** This is the lowest level allowing for monitoring only. The user can navigate through various displays, filter the events, print any view, but cannot control any equipment nor acknowledge alarms.
- **Level 2: View and Acknowledgment.** Same as level 1 with acknowledging rights.
- **Level 3: Electrical Operator Local Access** - Monitoring and Local Control. Same as level 2 with control of electrical equipment limited to secondary substations.
- **Level 4: Electrical Supervisor Access** - Monitoring and overall Control. This level allows for the overall network control and configuration. The Supervisor can also modify motor loadshedding and restarting steps.
- **Level 5: Administrator.** Same as level 4 with facilities to exit the Control System application and download updates according to Supplier's instructions.
- **Level 6: Engineer Access.** At this ultimate level, all data bases, parameters and full functionality shall be available. Operator can modify/update/create any automation sequence parameters (threshold, timers, etc.) as well as functional sequences, displays, etc.

Depending on the overall ECS architecture, some of the above access level may be combined.

8.3 Events and Alarms Management

This function, which consists in signalling and recording electrical equipment status changes and fault occurrences, is mainly located at level 2 (supervision).

Event and alarm logging

Status logging consists of saving on hard disk all the important events occurring in the system (appearance, acknowledgment and disappearance of alarms, threshold overshooting, device status change, etc.)

Alarm logging shall allow identification of "first in time" event.

Alarm management

Alarm management is based on two separate notions:

- Appearance/disappearance of alarms: an alarm is declared “in progress” when the cause of the alarm appears (cause identified by the supervised devices). It disappears at the same time as the cause if it has been previously acknowledged.
- Acknowledgment of alarms: an alarm is acknowledged when the Operator declares he has taken this alarm into account.

An alarm managed by the system can thus assume one of the four statuses below:

- Alarm at rest
- Alarm in progress and not acknowledged
- Alarm disappeared and not acknowledged
- Alarm in progress and acknowledged.

The system shall offer to the Operator facilities to filter the alarm according to their status and their criticality:

- Fine Stamped critical alarms
- Non critical alarms
- “Alarms in progress “ (acknowledged or not acknowledged)
- “Alarms not acknowledged” (in progress or disappeared)
- “All alarms”.

The screens take the form of scroll-down lists. Each alarm is presented on a line the colour of which corresponds to the alarm status.

These screens are also used to:

- Select and acknowledge an alarm
- Sort alarms according to their type, tags, time of appearance, etc.
- Acknowledge all alarms.

NB: Alarms which have disappeared and which have been acknowledged are cleared from the screen and are stored as a log only.

Events and alarms are recorded with their date/time of occurrence, Operator acknowledgement are also logged as events.

8.4 Historising, Archiving, Trending and Reporting

Operator Configurable Historising

It shall be possible, in a user-friendly manner, without resort to an Engineer’s Keyboard, for an Operator to configure online a minimum of six historic trend displays, each containing up to 10 variables and to also configure a minimum of six event and alarm reports.

The display and report assignments and their associated data shall be stored for display as required.



These displays and reports shall be easily printable either on the color printer or as Acrobat PDF files that can be saved in specific section of the hard-disk to be transferred later on to disconnectable media.

Alarm and Event Recording (including Operator actions)

The system shall have a capacity to store a minimum of 100,000 alarms and events. All alarms, all changes in the status of digital inputs, and all information on the disabling and reinstatement of alarm sensors shall be recorded in the history file.

It shall be possible to retrieve the stored data using a variety of sort functions (for example, by time of alarm or event occurrence, duration, alarm type, when inhibited, tag, etc.). The system shall permit the archiving of alarm and event files to disconnectable media for analysis at a future date.

Such analysis shall be facilitated by being able to print out (PDF files or real print out) the archived alarm and event files using sorting criteria such as: time of occurrence, process units, type of event, etc.

Facilities shall be provided to save the event files to Windows Excel software format and/or data base format that shall easily be retrieved by Excel and/or any current data-base software.

Historical trends / perturbography

Each analog value entering the ECS shall be able to be trended on different time periods. Operator with minimum level 4 access rights (as defined in section 8.2) can define for each analog value the sampling period (every 24 hours, 6 hours, 1 hour, 10mn, 1mn, 1 sec, or 0.5 s) to be accounted for the trend historising. For some more fine analyses, such as follow up of power generation load and when the analogue value is connected to the ECS via 4.20 mA, shorter time sampling may be considered for short period of time.

It shall be possible to have at least ten (10) curves on a Historical Trend, each one having a different colour.

Each Historical Trend Display shall contain the following:

- The value in engineering units
- The engineering units
- Indication of the minimum and maximum values displayed on the trend; no indication is directly indicated but, by bringing the cursor onto the curve, the value can be read on the trend
- The Name of the Variable (its Tag) (12 characters minimum)
- The Descriptor (24 characters minimum).

The Historical Trending Functionality shall include the facility to obtain further historical information, utilizing the display trend, i.e. using a pointing device or the keyboard, it shall be possible to move a vertical line (vernier) along the time axis of the trend displayed. When the line is stationary, the time that the value(s) were recorded and their magnitude in engineering units shall be displayed.

It shall be possible to scroll through all the historical data stored in either direction.



It shall be possible for the Operator to change the scales of the trends displayed. Such changes shall not be committed to system memory - i.e., on recalling the trend, it shall have returned to its initial scaling.

Analogue input archiving for trend display shall be sufficient for a minimum of 1 month storage capacity of every analogue inputs with shortest time sampling. Analogue value remaining within individual predefined dead band may be considered as constant for the archiving process. These individual dead bands shall be agreed upon at the tender stage.

Perturbography

When implemented, the perturbography recorder HMI shall also be performed by the ECS and shall be included in the trending functionality with additional analysing tools (harmonics, etc.). Data from the perturbography recorder shall be retrieved on Operator request basis or on automatic initiation on identified fault, CB status change. The data shall be uploaded to the ECS and stored for direct or later on analysis. Merging the ECS recorded data/trends and the ones stored by the perturbography recorder shall be possible to allow for complete detailed analysis having the complete network overview.

Archiving

Archiving is the process of saving short and long term data by recording it on disconnectable/demountable media.

When the hard disk memory space is reaching an adjustable space occupation, an alarm shall be generated to the Operator to perform the necessary archive back-up operation.

By clicking on an area in a Utility Display, the complete archive including events and trend data shall be stored in a special area on disc with assigned unique file names. The file set-up and sizes shall allow for archiving by blocks on DVD-Roms.

The Operator can, should the need arise, copy the file to an external, demountable media device such as a tape-streamer and/or DVD Recorder.

When required, the Operator must be able to easily retrieve archived data (from a system disc or from an external demountable media device).

8.5 Interrogation of the parameters of the digital protection devices

It shall be possible to interrogate from the ECS supervision (by means of a specific request), the digital protection devices installed in the HV switchgears. For each cell of the considered switchgear (i.e. incoming, bus-tie, motor outgoer, etc.), Operator can display, record and/or print the settings of the protection devices.

Settings shall not be remotely adjustable from ECS. The relays resetting after an electric fault shall be done manually and locally in front of the faulty equipment.

In case of HV protection relay trip on fault, the relay integrated short time perturbography shall be uploaded to the ECS historic file for later analysis. Facilities shall be provided to allow for the display of this relay recorded perturbography with suitable zoom, selection, pointer for fine analysis.

Based upon project specific documents, automatic uploading of HV motor starting data (starting current and time or even current versus time records) from the HV motor protection relays can be implemented. At least 10 records per HV motors shall be recorded in the historical file.



8.6 On line parametering of load shedding and motor restart steps (when applicable)

Each HV motor can be assigned to specific load shedding block and restarting step (when applicable) from the Supervision Level. Reassignment to new block and / or step shall be possible even with the motor on line.

For LV motor, load shedding buses (based on specific control voltage busses) may be implemented. Therefore, reassignment of LV motor to specific load shedding block shall be both performed on the Software and hardware side.

Modification of motor load shedding and restarting shall be possible on line from the supervision

8.7 ECS devices monitoring and tele-diagnostics

This function is located at level 2 (supervision). Monitoring is performed from graphic displays known as system views and ECS equipment alarms are grouped in a dedicated system alarm group. The retained ergonomic principles are the same as for electrical equipment monitoring and associated alarm management.

There is only one normal operating mode, i.e. all ECS equipment are running continuously without error. In such a case, ECS equipment are considered as "healthy". Some equipment can run in degraded mode, in which case they shall be considered as "faulty". It is the case for the redundant equipment (such as PLC modules, fiber optic cables, etc.).

When equipment are stopped or failed or isolated from the upper level (complete loss of network connection), they are considered as "disconnected".

9. Performance requirements

9.1 Time stamping discrimination / Clock synchro

Time synchro accuracy shall be 1 ms.

For critical I/Os such as electric fault resulting in trip orders, the requested time discrimination between two critical events shall be 10 ms or less over the whole plant (list of such events shall be provided in the ECS I/O list). To fulfill this requirement, information issued from HV switchgear protection relays, shall be time stamped at their origin.

Other non critical I/O shall be time stamped as closed as possible to the source at the substation ECS CPU level.

The commands issued by the ECS Operators are time stamped at the supervision level.

The orders received from the DCS (motor starting and stopping when applicable) are not recorded as events; only the consequences of these orders, i.e. when a motor starts or stops, are recorded.

9.2 ECS controls / display update

The maximum duration between any order given by Operator at Supervision level and the display of corresponding status change shall not exceed 1 s for an hardware output, 2s for an output connected to final equipment via Modbus serial link.

Display of any critical alarm shall also be performed in less than 1 s after occurrence.



Update of data on the display (analog value, status, etc.) shall also be performed in less than 1 sec.

Calling up of any display shall be completed within 2 sec.

Unless reduced to an icon, all windows available on the screens shall be updated in line with above stated time delays.

ECS Supplier shall estimate these times with considering the worst network activity with the whole electrical network in operation i.e. with every I/O monitored, including the required 20% spare capacity.

9.3 ICSS/ECS interface

In case motor start/stop controls from the ICSS are performed through the ECS, the Supplier shall guarantee the following times from the start/stop order writing in the ICSS/ECS exchange table up to equipment status confirmation writing on exchange table:

- In case of Serial Link connection between the ECS and the motor control: 1.5 sec
- In case of Hardwire connection between the ECS and the motor control: 1 sec.

9.4 Automation sequences

The following shall be complied with

- **Automatic transfer sequence (when implemented within the ECS): 200 ms** from receipt of the information triggering the transfer (voltage drop, transformer fault, etc.) up to the back up supply confirmed closed CB feedback status.
- **Load Shedding Sequence:** A maximum delay time of not more than **200 ms** between detection of the need for load shedding and opening of the corresponding circuit breaker or contactor (including detection, treatment and opening of the contactor/circuit breaker, and up to the CB status confirmed open in the ECS).

9.5 Analog input accuracy

For all circuits, accuracy shall be 0.5%.

9.6 Spare Capacity, expandability

The ECS shall be designed to facilitate possible extensions. It shall be sized to include all the components (hardware and software) needed for future extensions (over and above spare parts):

- | | | |
|---|-----|--------|
| • Installed input/output (per I/O type and per system) | 10% | Note 1 |
| • Spare space for additional I/O | 10% | Note 2 |
| • Processing capability (per processor or controller) for each part of the system | 30% | |
| • Power supply capacity | 40% | |

Note 1: Each cabinet shall be provided with terminals to accommodate spare installed I/Os.

Note 2: Each cabinet shall be provided with spare space to accommodate such extensions.



The network architecture shall be designed to allow for the above required spareage while maintaining all performance requirements.

The ECS shall be sized in accordance with these values at installation start-up, unless otherwise specified by project requirements.

9.7 Design Life & Obsolescence, Availability, Reliability, Maintainability

Design Life & Obsolescence

The obsolescence shall be managed as per **GS EP TEC 007**.

Facilities are typically designed with an expected design life in the order of 20 to 25 years.

The ECS design shall therefore take into account the requirement that the system will most probably require to be upgraded during the design life of the facilities. These requirements shall be incorporated from Basic Engineering stage.

The design will include provisions to allow an upgrade of the ECS to be performed with minimal disturbance to the power generation and distribution systems, fixed cabling infrastructure and infrastructure. Such provisions shall include:

- Tie-in points for the future ECS equipment, while the original equipment is still functioning
- Allocation of sufficient space for the future equipment.

All hardware and software that may be developed by the Supplier further to the ECS delivery, shall ensure full ascending compatibility to allow for easy replacement of equipment that became obsolete with limited reconfiguration.

At the Bid stage, the ECS Supplier shall detail his lifecycle management strategy focusing on product obsolescence, support options and further migration alternatives. The lifecycle/obsolescence management plan and associated cost shall be part of the Bid process evaluation.

The ECS Supplier shall complete an inventory of all provided equipment (hardware and software) matching to different lifecycles phases, including all Sub-Vendors equipment (e.g. servers, Operator stations, switches, routers).

ECS Supplier shall guarantee that:

- ECS components (including software and hardware) shall remain in the “active products” range (i.e. supporting developments and releases) over a period of at least 5 years after the SAT
- An announcement to Customer is provided 5 years prior the end of the commercial phase
- ECS components (including software and hardware) shall be fully supported and available over a period of at least 15 years after the SAT
- Maintenance services including availability of engineering services shall be available to support the ECS during the plant life time.

Availability, Reliability

Standard equipment shall be used wherever possible. All materials shall be new, unused and of well proven type.



High reliability is essential for this system (ECS) and the Supplier shall quote MTBF and MTTR for each item and the system as a whole. The ECS shall be a high security equipment, which on failure of any part shall not give an inadvertent trip order or signal

The required availability of the ECS should be at least 99.95% based on an MTTR of 4 hours, unless otherwise specified in the project specifications.

Maintenability

The system shall be designed to allow for easy maintenance.

Access to all equipment for maintenance shall be designed into the system from the start. Failure and subsequent on line replacement of any module shall not affect the working of any other components or cause a system failure.

On line replacement of any faulty redundant module shall be performed without affecting the relevant application.

“Hot” modification, upgrade, tests of any redundant PLC configuration shall be performed from one of the engineering station and/or maintenance portable PC while the other PLC remains in operation.

Change over of any redundant faulty equipment (from duty to back-up and back-up to normal configuration) shall be performed without affecting the relevant application.

After any outage, the system shall automatically resume normal operation, specific fall back position may have to be defined during the project development. Any output shall be designed to have a settable fall back position as either close or open.

The system shall incorporate a comprehensive set of diagnostic facilities to enable efficient fault detection. These diagnostics shall allow for the identification of faults down to individual module level. System fault repair shall consist in the replacement of faulty modules.

The ECS shall be equipped with all necessary software/hardware tools allowing accurate system and network trouble shooting, with clear displays showing the faulty elements, and management of the system networks including security aspect.

Project specification will address “hot” spare requirement.

10. ECS Equipment Description

10.1 General

The ECS equipment shall mainly comprise:

- 1 Operator workstation embedded in the ICSS control desk
- 2 Operator / Engineer Workstations to be desk mounted in the Main Substation complete with one Black and White laser printer and one Color Laser Printer
- One control panel in Main Substation including redundant servers (PC based) in Hot/Standby configuration for data acquisition
- 1 Master clock reference system inside the main substation



- Control cabinets inside each substation including:
 - Redundant power supplies
 - redundant PLCs
 - I/O cards
 - Local workstation (except for the Main Substation)
 - Time synchronisation system.
- ECS communication networks, network switches
- 2 portable PCs for maintenance
- Etc.

10.2 Hardware requirements

10.2.1 General

The hardware of all parts of the ECS shall be designed to carry out the functions described in this specification.

Special considerations shall be given to:

- Environmental (temperature, humidity, vibration, etc.) and transport conditions
- Design of the cooling requirements for equipment mounted in enclosures
- Protection of the electronic components from static electricity and electromagnetic radiation; all hardware components of the ECS shall be immuned to the use of High Frequency Communication tools such as walkie-talkies, and shall comply with [IEC 61000](#).

10.2.2 Power Supplies

The PLCs and other ECS equipment shall be fed from redundant power supplies. The ECS equipment shall support automatic switching between the power supplies for continuous service without risking spurious voltage effects.

Each power input to the ECS control cabinets shall be fitted with dedicated breakers and protections circuits such that no single system component failure causes loss of power supply to other components. The design of the electrical distribution shall include the short circuit and selectivity calculations.

Power supply failure shall be alarmed and logged.

I/O and system components power distribution shall be designed to avoid common mode failure.

10.2.3 Operator / Engineer Workstations and Servers

Two Operator / Engineering Workstations shall be implemented in the Main Substation to allow for maintenance, upgrade, replacement... to be carried out without ECS monitoring and HMI functionality interruption.

Local Operation Workstation shall be installed within the Secondary Substation Control cabinets and one shall be embedded in the CCR control desk.



The redundant servers shall be implemented in a Control Cabinet inside the Main Substation.

The workstations and servers shall be Personal Computer based with the best proven technology and performance at the time of the Purchase Order: The minimum configuration shall be based on tower type PC with latest processor, Hard Disk (min 200 GB), minimum 4 GB RAM and CD/DVD writer with keyboard and optical mouse. The VDU shall be at least a 21" TFT Flat Screen.

10.2.4 Clock Reference System (CRS)

A Master clock together with one GPS or equivalent system shall be provided at the Main Substation together with all necessary time synchronisation system to ensure proper time/date synchronisation of all the ECS equipment and interfaced devices/equipment (UPS, Protection relays, etc.).

10.2.5 Control cabinets

The control cabinets shall be of metal clad construction, vertical, free-standing with front access only via hinged lockable doors. The degree of protection shall be IP 21 as a minimum. The cabinets will be floor mounted, and cable access will be from below. They shall be naturally ventilated (Except for PLC ventilation).

Internal wiring shall be by stranded copper conductors, with 1000 V flame retardant PVC insulation to [IEC 60332-2-1](#). Conductors shall have a minimum cross sectional area of 0.5 mm². Wiring shall be securely and neatly held in position, either loomed or run in trunk. Each wire shall be identified by numbered ferrules. Wiring for external connections shall be brought to terminals, which shall be arranged for easy access for cable connections, testing, inspection and fault finding. Not more than two wires shall be terminated to each terminal - 1 on each side. Terminals shall be "cage clamp" type mounted on DIN rails.

Spare terminals, spare space and relevant space for wiring/trunking shall be provided.

All conductors of multicore cables shall be connected including the spare ones.

Each cabinet shall be fitted with an earthing terminal for connection to the external earthing system, and equipotential bonding of all parts shall be ensured, including doors.

Equipment requiring specific earthing (e.g. instrumentation, etc.) shall be isolated from the cabinet and connected to a separate clearly marked earthing terminal.

Control cabinets shall include CPUs, I/O cards, communication cards / switches / hubs, redundant power supplies, optical fibres patch panels.

Secondary substation control cabinets shall also include the Operator Workstation. Non lockable access shall be limited to the keyboard and mouse compartment.

All network components (hubs, switches, routers...) shall be of industrial type: either rack or DIN mounted with redundant power supplies,

The fibre ends of optical fiber cables shall be connected into a 19" drawer equipped with drums (for fiber coiling), a cover and cable glands. A minimum of 1m of buffered fiber is to be stored on the drums.

All interconnecting cables between ECS equipment shall be prefabricated with suitable connectors to allow for easy and fault free connections.



10.2.6 Programmable Logic Controllers (PLC)

Redundant PLC's shall be provided for each substation (main and secondary). From a maintenance point of view, all the components shall be standardized as much as possible for the whole system. The Dual redundant CPU (Central Processing Unit) shall operate in the hot, stand-by mode. Memories shall be sized according to I/O quantities and automation sequences performed inside each substation.

The Power Supply shall be redundant and shall be monitored by the ECS.

Adequate provision for RAM memory (with standby supply) and memory for program on EEPROM shall be provided for each PLC in order to achieve the reliability required of the system.

Each PLC shall be provided with facilities for the plug in connection of a servicing and monitoring pocket terminal or portable computer.

Input cards shall be 24 V DC or 48 V DC.

Output cards shall be 24 V DC or 48 V DC.

Analog input shall be 4-20 mA.

Each ECS input/output shall be individually protected against electrical failure.

All digital outputs shall have a configurable failure position (hold, close or open).

All equipment shall be provided with self testing facilities allowing easy trouble shooting.

Input and output cards shall have a minimum impulse voltage withstand rating of 2000 V.

For analog input card a minimum impulse voltage withstand rating of 1500 V is required.

Internal logic of each PLC shall be galvanically isolated at 2000 V minimum from the input/output external circuits

All cards shall be withdrawable and all cards of the same type shall be interchangeable.

All input/output status shall be displayed by LED's on the front of each card. It shall be possible to force each input/output status on each card by the use of a removable testing facility.

The Supplier shall take adequate precautions and guarantee operation of the slave PLC's to be integrated in switchboards (when applicable), with regard to the vicinity of switchgear and transformers.

The scanning time of each PLC shall be such that discrimination time between two alarms/or faults complies with the requirements stated in section 9.1.

The clock reference system shall send the date and time to specific input cards of ECS and to external equipment (turbogenerator PLC'S, protection relays by MODBUS serial link or TCP/IP, etc.).

The clock reference system shall also send a synchronisation signal by hardwire to specific input cards of ECS and to external equipment in order to implement the same date and time in that equipment.



10.3 Software requirements

The Supplier shall supply a fully working system, including software, programming and configuration. For this purpose, control logic diagrams, shall be provided by the Supplier to Company. Software shall be fully documented, and cross referenced to the logic diagrams.

VDU Operator interface software shall be standard, commercially available and fully proven in the field. Engineering and operating shall be separate, menu driven and user friendly

Site modifications to configuration shall be possible, without detailed knowledge of programming languages or third party products. All engineering and configuration tools shall be DOS based with a Windows style environment.

PLC programming software shall be included, preferably IBM PC compatible and DOS or UNIX based. Full labelling and cross-referencing facilities shall be incorporated.

10.4 Communication networks requirements (Field bus)

Communication networks shall be inherently immune to electrical noise and shall be unaffected by ground potential as a result of earth faults.

Communication and synchronisation cables within the ECS Supplier equipment shall be provided with sufficient protection to sustain harsh conditions in the field. Nevertheless, when armoured cables cannot be provided, a specific routing, including additional mechanical protection shall be designed and implemented by the Contractor.

11. Inspection and testing

11.1 Preparation

The Supplier shall prepare a full test procedure at least two months prior to implementation of the following tests for Company approval.

The Supplier shall make available a team and all necessary measurement, control and simulation apparatus.

The test procedures shall consider extra equipment not part of the ECS project scope of supply, which shall be provided by the ECS Supplier for the test purpose.

Before commencement of tests witnessed by the Company, Supplier shall produce evidence that the tests have been carried out successfully during the Supplier internal acceptance testing.

The test arrangement will be as close as possible as the future site architecture specifically in terms of communication network.

11.2 Interface Validation tests

The Supplier scope of supply shall include communication tests with all interfaced equipment such as HV and LV protection relays, UPS, EDG UCP, etc.

In addition, Supplier shall foresee coordination meetings, test procedure to be written and test sessions in other Supplier premises. These tests will enable a proper assessment of the interfaces with other equipment at design stage.



11.3 Typical Functions and HMI Tests

Typical functions (such as auto-transfer...), typical HMI views shall be validated prior to full system Factory Acceptance. Company attendance for such tests shall be mandatory. This will allow for early validation of HMI, displays and of simulated automation sequences.

11.4 Factory acceptance tests

The complete software and hardware including the configuration shall be tested in Supplier's premises as per testing procedure previously agreed by Company.

The Supplier shall provide all testing facilities and equipment to allow testing of each part of the ECS. To record the performances, appropriate measuring tools (digital oscilloscope with an adequate number of input channels, communication analyser...) shall be made available by the Supplier.

HV and LV switchgear equipment, including incomer and bus tie and other typical cubicles shall be provided by others for testing of both the communication links and automation sequences.

Each I/O shall be tested. All I/O's shall be wired to switches and lamps for a complete simulation.

A complete simulation shall be executed successively with each ECS equipment. The behaviour of the ECS in downgraded situation (redundancy, network alarm management, stop, start and initialisation of sub-system, etc.) shall be validated.

The specific functions (load shedding, restarting, auto-transfer, etc.) and all the HMI displays shall be fully tested.

The communication link with the ICSS, the ICSS displays related to the ECS and any interlocks between the ICSS and the ECS shall be tested. The ICSS Supplier shall attend this part of the FAT and shall supply the required interface means with the ECS as well as the minimum equipment to simulate operation and monitoring from the ICSS HMI.

All these tests shall be performed in the presence of the Company's representative.

These tests shall also include interface tests with TG's and EDG sets operation. For that purpose, coordination with both TG's and EDG's Suppliers shall be included in the ECS Supplier scope of supply in order to achieve a high level of testing.

11.5 Tests after erection on site - Site Acceptance Tests-

In addition to factory acceptance tests, the ECS shall be tested on site:

- To confirm that the System has been installed correctly and has not been damaged during shipment and installation
- To validate all interfaces with the power generation and distribution systems.

The installation on site of all the Enclosures and Operator Stations, as well as connection to the plant I/O and to external equipment, shall not be within the Supplier's scope, but the Supplier shall be required to supervise the work. The Supplier shall be responsible for powering up the system, installing software, and carrying out the series of tests required.

This SAT shall be carried out prior to switchgear energisation (only control voltages will be available), as per the FAT. All voltage information required for automation sequences will be simulated using voltage sources or simulators for complex sequences.



Complete testing procedures shall be prepared and submitted for Company approval.

11.6 System Precommissioning / Commissioning

The Supplier shall comply with the Project precommissioning and commissioning procedures prepared by the EPC Contractor. This dossier shall comprise all precommissioning and commissioning record sheets and procedures:

- Loop checks
- Functional test record sheets
- Operating test procedures.

The Supplier shall provide technical assistance for both precommissioning and commissioning.

Loop Checks

Prior to loop check, as a minimum all the activities including necessary testing, calibration and precommissioning of other Supplier devices (relays, etc.), shall be completed by EPC Contractor as per Company precommissioning/commissioning procedures.

Final interconnections of all the I/O from the power generation and distribution equipment shall be made and each and every I/O point shall be "loop checked" to ensure the correctness of the installation up to the HMI displays. At that stage, Supplier shall also check calibration of analog input / output in ECS.

Once the correctness of installation has been demonstrated and loop check has occurred, the loops shall be signed off as being complete and shall be reported ready for functional tests.

Functional and Integration tests

All ECS functionality and automation sequences shall be validated in two steps:

- Off line with no voltage on busbars
- On line with all equipment/switchgear energised.

11.7 Commissioning and Start-Up Assistance

The Supplier shall provide assistance for both Commissioning and Start-Up. Daily rates for Yard, offshore activities shall be defined at the bid stage.

12. Training / Reference System

The Supplier shall provide a "Reference System" / simulator that shall include Operator interface and a simulation of a complete substation. It shall be suitable for familiarising Operators and Maintenance personnel in the utilization and maintenance of the system. This "Reference System" shall also be used for the validation by Company of the system displays as well as any software upgrade and / or modification during the life of the System.

The Supplier shall also quote the following training:

- **Operators Training:** Three sessions of three days duration, for 5 people, providing a general introduction to the system and how it is used to control the electrical network of the plant. These sessions shall take place on site.

- **Training for Maintenance Technicians:**

- Three sessions of five days' duration, for 5 people, on site, covering:
- A general introduction to the system
- Utilization of system Alarm Displays
- Replacement of I/O and Control/Processing Modules
- Modification of I/O and Control/Processing Module parameters.

- **Training for Engineers and System Development Technicians:**

- Training at the Supplier's premises for six Company personnel. This shall be of a minimum duration of fifteen days. It shall have sufficient in depth and scope to provide the knowledge necessary to carry out full configuration and maintenance of the system. This training can, with the approval of Company, include standard, scheduled training sessions.

The Supplier shall provide full details of their standard training offered, including cost, either on site or at the Supplier's establishment, for each type of training provided.

All training shall take into account schedules imposed by Company, and necessary support documentation for each one of the people attending the courses.

Note: All the training shall be given in english language unless otherwise stated in the Project specification.

13. Maintenance

The Supplier shall specify what is required to enable Company to carry out first level maintenance: Training of maintenance personnel; frequency of maintenance; the means for diagnosing faults; etc.

First level maintenance, such as replacing Modules and bringing replacement Modules into service, shall be carried out by site personnel.

The system architecture proposed by the Supplier shall take into account the fact that such first level maintenance must be possible while the system continues to control the plant network.

The Supplier shall propose a remote maintenance service for problems which cannot be solved by first level maintenance. The possibility of a remote interrogation of ECS shall be stated with necessary coupling card and telecom interfaces. Remote assistance definition shall comply with the requirements of the **GS EP INS 135**.

A remote 24h/24h assistance hot line with specialist engineer shall be included for the 3 first years of operation.

The Supplier shall also offer a Maintenance Contract that shall include periodic site visits to carry out a full system check-up to confirm that it is functioning correctly. During these visits, the Supplier shall also carry out system back-ups. The optimum frequency of such visits shall be indicated.

Supplier shall provide a recommended spare parts list for two year's operation.

The number of spare parts recommended by the Supplier shall be based on the Manufacturers' MTBF data, with a minimum of one of each component of the system, excluding the Operator Suites - A Maintenance Console shall be constituted by a portable PC with necessary software.

During the system warranty period, maintenance shall be carried out free of charge. The service provided shall be the best level of Contract maintenance that the Supplier has to offer.

14. Limits of supply

Unless otherwise specified, the following shall be included in the scope of supply:

- Design of the complete ECS, including liaisons with other equipment Suppliers, (TG and EDG sets, etc.)
- Supply of all hardware, software and programming required to achieve the specified functionalities
- Supply of interfacing equipment
- Supply of programming equipment, standard software and application software
- Factory tests
- Site tests
- Supply of all current loops/serial link cables, communication network and termination between ECS and Supplier's equipment
- Drawings and documentation as specified in the requisition.
- Commissioning Spare Parts
- List of recommended spare parts for 2 year operation.

Unless otherwise specified, the following items are excluded from the scope of supply:

- Uninterruptible power supplies
- Supply of power cables and instrument and control cables on site
- Installation of equipment and cables on site.

15. Drawings and Documentations to be supplied by the Supplier

The Supplier shall include in his supply all engineering services necessary to provide and finalise the following documentation:

- Technical description of the system, HMI and of each component. These approved specifications will be the basis for construction and final system design
- Architectural schematic of the system, with all subsystems, peripherals and addresses
- ECS block diagrams with all cabinets and peripherals showing the interconnecting cables
- Overall dimension drawings of each equipment (cabinets, video, monitor, printer, etc.) indicating also weight, centre of gravity and the requirements for equipment erection and installation
- Lay-out of Operator consoles
- Lay-out of the various racks with indication of electronic cards location and schedule items
- Cable schedules for all cables supplied by the Supplier which connect the different cabinets and ECS equipment, with tag, type reference and routing of each cable



- Internal cable drawings which indicate terminal blocks or connector's wiring arrangement
- Single line diagram of electrical supply for all devices of the system with indication for each of start up and normal current
- Earthing principle/scheme of the different parts of the system to the central earthing point and indication of resistance earthing leg
- Obsolescence management Dossier
- Troubleshooting drawings.

A specific "What If" Study shall be prepared and issued by the Supplier so as to analyse and to clearly assess any failure impact, degraded mode and potential mitigation (converter fault, etc.) especially on load shedding aspects.

The Supplier shall perform complete schematics for all input/output signals connected to the system. These schematics are composed of two parts:

- The field part defined by others
- The control and technical rooms part defined by the Supplier except for cabinets or equipment not in the scope of Supplier for which information will be given by others.

The Supplier shall submit to Company typical drawings for each type of input/output signal. The drawings are to show the cabinet parts from the field cables terminal block to the ECS I/O board, the field part being defined by others.

The general arrangement of these schemes with indication of power fuse size, earthing, wiring, etc., shall be agreed between Company and Supplier. After agreement, the Supplier shall perform all schematics for all inputs/outputs connected to the system and send them to Company.

- Wiring drawings of the input/output terminal blocks or plugs
- Software schemes: each sequence shall be represented by a software scheme which indicates the different software standards block linked together in order to meet the sequence requirements; when a link is done to application software it shall also be indicated.

All documentation which permits the user to understand the software algorithms, to build his proper software control loops, to write and read parameters and to modify display organisation. Sufficient examples must be included in the documentation.

- Reference manuals of all software packages
- Listing, or print out of configuration for:
 - Complete ECS data base
 - PLC data bases
 - Computer, Network and PLC gateways
 - Parameters loaded in the different input/output cards
 - All displays and reports available in the stations and printers
 - All test software used to test communication with other equipment and/or for inspection
 - Specific software.

- Operation and maintenance manuals of all equipment including configuration tools
- Acceptance test procedures to be approved by Company
- Reports and certificates
- Copies of Manufacturer test reports or certificates shall be available during the factory acceptance tests, including original Manufacturer certificate
- Inspection and factory acceptance test reports shall be supplied
- In addition, the Supplier shall provide a complete functional analysis. A sole document shall detail all the functions included and within the scope of the ECS. This functional analysis shall be agreed by Company in accordance with the contractual schedule.

The list must not be considered as exhaustive, the Supplier's attention is drawn to the fact that Company shall require any drawing which may be needed to allow correct installation, start-up and maintenance.

16. Services

16.1 Project execution

16.1.1 Project management

The project manager proposed by the Supplier and approved by Company before the order will have the full responsibility of the Project. He will act as a focal point for any communication with the Company.

He will be also responsible for any subcontracted or purchased subsystems. These subsystems will be identified and the Sub-Contractors will be approved by Company before the order.

Project manager and key personnel of Supplier's team will not be changed during the project except if required by the Company.

16.1.2 Project reporting

The Supplier is requested to submit a general schedule for both hardware and software starting from the purchase order. This schedule shall be built on the basis of the date of Company documents issue, agreed between Company and Supplier before the order. It shall indicate the time elapsed from the placement of order to the design development installation and implementation.

Check point should be defined for the intermediate work:

- End of functional analysis
- Availability of all functions offered (end of debugging)
- Hardware freeze date
- Configuration freeze dates (Controllers/Operator's interfaces)
- Internal test for hardware and software at Supplier's location
- Typical functions and HMI tests
- Factory acceptance tests for hardware and software at Supplier location

- Beginning of installation on site
- End of installation on site
- Mechanical completion
- On site acceptance tests for hardware and software
- Precommissioning activities (onshore)
- Commissioning activities (offshore).

The schedule will identify the critical path and the constraints between the different activities. It will clearly give for all software (packaged and/or specific) the major implementation milestones.

Every month, a progress report will be issued by the Supplier with an updated schedule, the report on previous month's activities, the list of forecasted activities for the next three months and the list of pending points with the latest acceptable date of resolution. The general content of this report will be agreed by Company.

16.2 System analyses, development and configuration

The first phase of the studies shall include a system functional analysis handled by others but which requires the ECS Supplier to highlight specific features of the system and to give information on the capabilities of the system.

The development shall include any studies, programming and tests necessary to implement the functionalities required by the analysis into the system and which cannot be performed by standard features of the system itself.

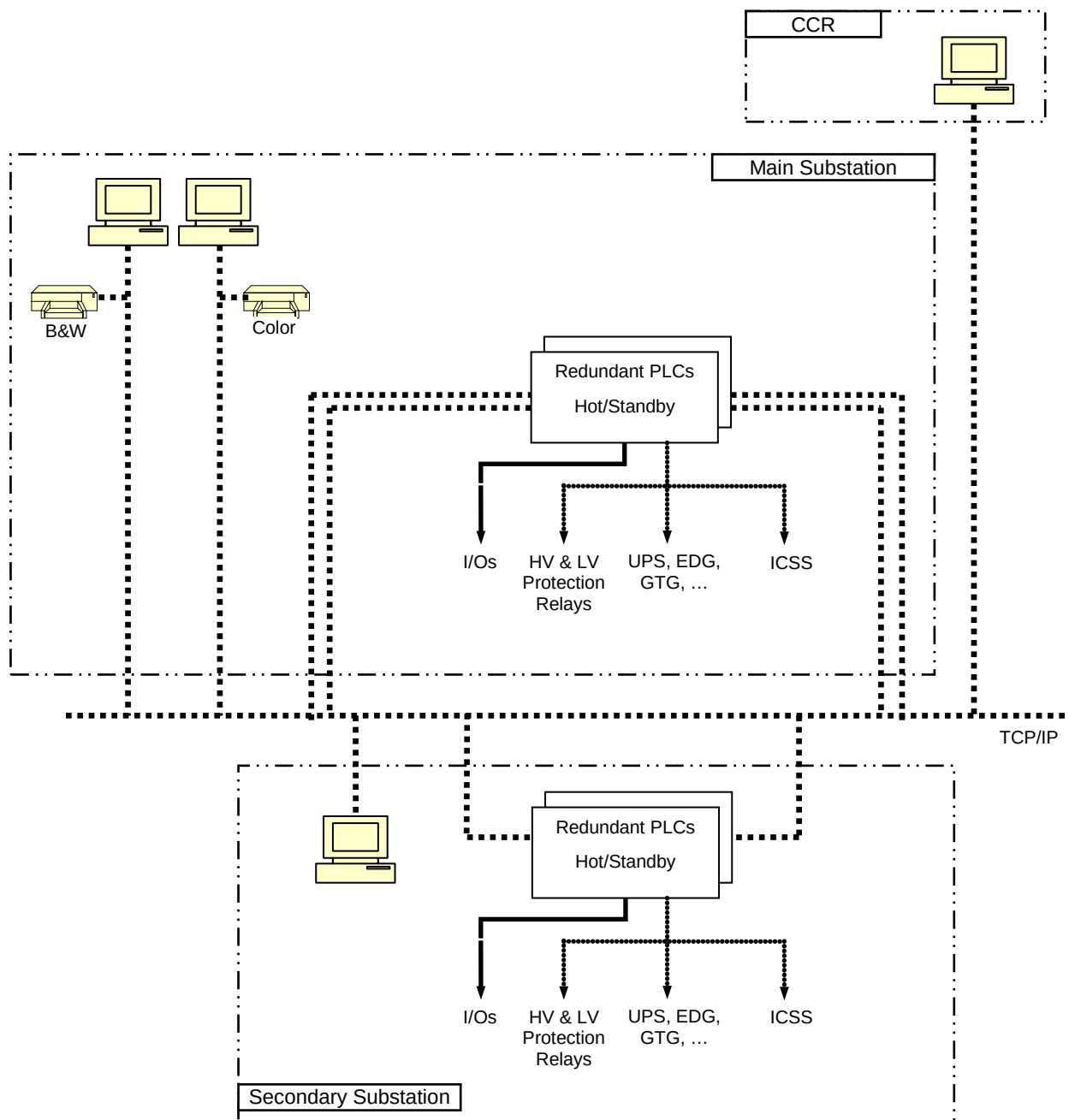
All necessary technical meetings shall be foreseen by the Supplier in order to allow full control in due time of the quality of the work and in respect of Company requirements and specifications.

17. Other references

Following documents are applicable:

- Standards: [IEC 60364](#), [IEC 61131](#), [IEC 62402](#)
- Regulation EMC (Electromagnetic compatibility) European Directive 89/336 EEC and 92/31 EEC and 93/68 EEC (CE marking)
- Other documents (they shall be provided during the project basic and detailed engineering phases) : General single line diagram, HV single line diagrams, LV single line diagrams, UPS AC & DC single line diagrams, Technical Room Layout, Overall Plot Plan and Main Communication Network Cable Routing
- Total General Specifications: [GS EP ELE 031](#), [GS EP INS 108](#).

Appendix 1 ECS Structure



Appendix 2 Input/Output list

Input/Output designation	Hardwire		Serial link		4-20 mA	Note
	in	out	in	out	in	
1. Turbogenerator package (per TG)						
Turbine exhaust Temperature			X			
Turbine exhaust Temperature alarm	X					
Turbine fault			X			See note (*1)
Turbine Trip Order	X					Grouped Trip at GTG UCP (CB opening and Turbine Shutdown order)
Turbine ready to load			X			
Turbine ready to start			X			
Turbine status (running)	X					
Turbine status (stopped)	X					
Turbine start order		X				Starting sequence initiation
Turbine stop order		X				Stop sequence initiation
Analogue signal			X			Info available from UCP. See note (*2)
2. Diesel generator package						
Diesel generator fault	X					
Diesel generator fault			X			See note (*1)
Diesel generator ready to load			X			
Diesel generator ready to start			X			
Diesel generator status (stopped)	X					
Diesel generator status (running)	X					
Diesel generator start order		X				Starting sequence initiation
Diesel generator stop order		X				Stop sequence initiation
Analogue signal			X			Info available from UCP. See note (*2)
3. HV Switchboard						
3.1 Generator incomer (per incomer)						
Circuit breaker open	X					
Circuit breaker closed	X					
Circuit breaker drawn out			X			
Circuit breaker plugged in			X			
Circuit breaker closing						No action from ECS - Part of UCP starting sequence
Circuit breaker tripping						No action from ECS - Part of UCP starting sequence
Electrical fault			X			Available fault list from Protection Relay. See note (*1)

Input/Output designation	Hardwire		Serial link		4-20 mA	Note
	in	out	in	out	in	
Analogue signals (P, Q)					X	
Analogue signals			X			Available list from Protection Relay. See note (*2)
3.2 Tie						
Circuit breaker open	X					
Circuit breaker closed	X					
Circuit breaker drawn out			X			
Circuit breaker plugged in			X			
Circuit breaker closing		X				
Circuit breaker tripping		X				
Electrical fault			X			Available fault from Protection Relay. See note (*1)
Analogue signals			X			Available from Protection Relay. See note (*2)
3.3 Power transformer outgoer (per outgoer)						
Circuit breaker open			X			
Circuit breaker closed			X			
Circuit breaker drawn out/plugged in			X			
Circuit breaker drawn out/plugged in			X			
Circuit breaker closing		X				
Circuit breaker tripping		X				
Electrical fault			X			Available fault from Protection Relay. See note (*1)
Analogue signal			X			Available from Protection Relay. See note (*2)
3.4 Feeder outgoer (per feeder)						
Circuit breaker open			X			
Circuit breaker closed			X			
Circuit breaker drawn out			X			
Circuit breaker plugged in			X			
Circuit breaker closing		X				
Circuit breaker tripping		X				
Electrical fault			X			Available fault from Protection Relay. See note (*1)
Analogue signal			X			Available from Protection Relay. See note (*2)
3.5 Motor outgoer (per outgoer)						
Circuit breaker or contactor open			X			
Circuit breaker or contactor closed			X			
Circuit breaker or contactor drawn out			X			
Circuit breaker or contactor plugged in			X			

Input/Output designation	Hardwire		Serial link		4-20 mA	Note
	in	out	in	out	in	
Circuit breaker or contactor closing		X				Only when Restarting is required
Circuit breaker or contactor tripping		X				
Electrical fault			X			
Analogue signal			X			Available from Protection Relay. See note (*1)
3.6 Homopolar generator						Available from Protection Relay. See note (*2)
Circuit breaker or contactor open			X			
Circuit breaker or contactor closed			X			
Circuit breaker or contactor drawn out			X			
Circuit breaker or contactor plugged in			X			
Circuit breaker or contactor closing		X				
Circuit breaker or contactor tripping		X				
Electrical fault			X			Available fault from Protection Relay. See note (*1)
Analogue signal			X			Available from Protection Relay. See note (*2)
3.7 HV switchboard common fault	X					
4. Normal LV switchboard						
4.1 Transformer incomer (per incomer)						
Circuit breaker open	X					
Circuit breaker closed	X					
Circuit breaker drawn out			X			
Circuit breaker plugged in			X			
Circuit breaker closing/tripping		X				
Circuit breaker closing/tripping		X				
Electrical fault			X			Available fault from Protection Relay. See note (*1)
Analogue signal			X			Available from Protection Relay. See note (*2)
4.2 Tie						
Circuit breaker open	X					
Circuit breaker closed	X					
Circuit breaker drawn out			X			
Circuit breaker plugged in			X			
Circuit breaker closing		X				
Circuit breaker tripping		X				
Electrical fault			X			Available fault from Protection Relay See note (*1).
Analogue signal			X			Available from Protection Relay. See note (*2)

Input/Output designation	Hardwire		Serial link		4-20 mA	Note
	in	out	in	out	in	
4.3 Main outgoer						
Circuit breaker open			X			
Circuit breaker closed			X			
Circuit breaker drawn out			X			
Circuit breaker plugged in			X			
Circuit breaker closing		X				
Circuit breaker tripping		X				
Electrical fault			X			Available fault from Protection Relay. See note (*1)
Analogue signal			X			Available from Protection Relay. See note (*2)
4.4 LV switchboard common fault	X					
5. Emergency LV switchboard						
5.1 Diesel generator incomer						
Circuit breaker open	X					
Circuit breaker closed	X					
Circuit breaker drawn out	X					
Circuit breaker plugged in	X					
Circuit breaker closing		X				Start Up or auto synchronisation initiation only
Circuit breaker tripping		X				Stop sequence or return to normal operation initiation.
Electrical fault			X			Available fault from Protection Relay and or EDG UCP. See note (*1)
Analogue signal			X			Available from Protection Relay and or EDG UCP. See note (*2)
5.2 Normal incomer						
Circuit breaker open	X					
Circuit breaker closed	X					
Circuit breaker drawn out	X					
Circuit breaker plugged in	X					
Circuit breaker closing		X				
Circuit breaker tripping		X				
Electrical fault			X			Available fault from Protection Relay. See note (*1)
Analogue signal			X			Available from Protection Relay. See note (*1)
5.3 Emergency LV switchboard common fault	x					



Appendix 2

Input/Output designation	Hardwire		Serial link		4-20 mA	Note
	in	out	in	out	in	
6. 230V AC UPS						
Electrical fault			X			Available fault from UPS. See note (*1)
Equipment Statuses			X			Available from UPS. See note (*2)
Analogue signals			X			Available signals from UPS. See note (*2)
Battery Low Voltage Alarms	X					
Common fault	X					
7. DC battery charger						
Electrical fault			X			Available faults from Battery Charger. See note (*1)
Equipment Statuses			X			Available statuses from Battery Charger. See note (*2)
Analogue signals			X			Available signals from Battery Charger. See note (*2)
Battery Low Voltage Alarms	X					
Common fault	X					
Loss of DC supply	X					
8. Turbine DC battery charger						
Electrical fault			X			Available faults from Battery Charger. See note (*1)
Equipment Statuses			X			Available statuses from Battery Charger See note (*2)
Analogue signals			X			Available signals from Battery Charger See note (*2)
Common fault	X					
9. Lighting panel						
Common fault	X					
10. HVAC panel						
Common fault	X					
12. Load shedding						
HV outgoers tripping						Included with tripping orders
LS by pass order			X			1 per outgoer to be load shed
13. LV exceptional coupling			X			



Input/Output designation	Hardwire		Serial link		4-20 mA	Note
	in	out	in	out	in	
14. Information to PCS (per equipment)						To be further detailed during the Basic Design
TG run/stopped/fault				X		
TG ready to start				X		
TG power				X		
DG run/stopped/fault				X		
DG ready to start				X		
HV switchboard fault				X		
400 V normal switchboard fault				X		
400 V emergency switchboard fault				X		
AC UPS fault				X		
DC UPS fault				X		
HVAC panel fault				X		

Note (*1): Each main fault shall be provided and displayed on the Alarm List. Final list of fault shall be agreed upon during Basic Design.

Note (*2): List of analogue signal and or statuses to be provided to the ECS shall be agreed upon during Basic Design.