



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



Contents

1. Scope	5
2. Reference documents.....	5
3. Abbreviations	7
4. General.....	7
4.1 Description.....	7
4.2 Environmental data.....	8
4.3 Electrical service conditions	8
4.4 Deviations to specification.....	8
5. Electrical control philosophy	9
5.1 Electrical network description.....	9
5.2 Power generation control philosophy	9
5.3 Power distribution control philosophy.....	10
6. System Architecture	10
6.1 ECS Architecture - General Description	10
6.2 Time Synchronisation.....	12
6.3 Interfaces between ECS and other equipment	12
6.4 Interface with Perturbography Recorder.....	13
6.5 Equipment arrangement inside substation	13
7. Functional requirements	14
7.1 Level 1 - Automation	14
7.2 Level 2 - Supervision.....	14
7.3 Remote control of circuit breakers.....	14
7.4 Source automatic transfer	14
7.5 Intertripping and interlocking	15
7.6 Load shedding	15
7.7 Reacceleration and restarting	15
7.8 Event recording and alarming	16
7.9 Other electrical network management and monitoring functionality	17
8. Man Machine Interface - Supervision	17



8.1	General principles	17
8.2	Operator access.....	19
8.3	Events and Alarms Management	19
8.4	Historising, Archiving, Trending and Reporting.....	20
8.5	Interrogation of the parameters of the digital protection devices.....	22
8.6	On line parametering of load shedding and motor restart steps (when applicable)	23
8.7	ECS devices monitoring and tele-diagnostics	23
9.	Performance requirements.....	23
9.1	Time stamping discrimination / Clock synchro.....	23
9.2	ECS controls / display update	23
9.3	ICSS/ECS interface	24
9.4	Automation sequences.....	24
9.5	Analog input accuracy.....	24
9.6	Spare Capacity, expandability.....	24
9.7	Design Life & Obsolescence, Availability, Reliability, Maintainability	25
10.	ECS Equipment Description.....	26
10.1	General.....	26
10.2	Hardware requirements.....	27
10.3	Software requirements.....	30
10.4	Communication networks requirements (Field bus).....	30
11.	Inspection and testing	30
11.1	Preparation	30
11.2	Interface Validation tests.....	30
11.3	Typical Functions and HMI Tests	31
11.4	Factory acceptance tests	31
11.5	Tests after erection on site - Site Acceptance Tests-	31
11.6	System Precommissioning / Commissioning	32
11.7	Commissioning and Start-Up Assistance	32
12.	Training / Reference System	32
13.	Maintenance	33
14.	Limits of supply.....	34



15. Drawings and Documentations to be supplied by the Supplier.....	34
16. Services	36
16.1 Project execution	36
16.2 System analyses, development and configuration.....	37
17. Other references	37
Appendix 1 ECS Structure	38
Appendix 2 Input/Output list	39



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

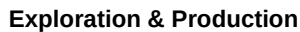
Note: The ICSS comprises the PCS, PSS, ESD, Fire & Gas detection and protection Systems and Process Operator HMI.

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.

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.