DEP SPECIFICATION

ELECTRICAL NETWORK MONITORING AND CONTROL SYSTEM FOR INDUSTRIAL NETWORKS

DEP 33.64.10.32-Gen.

September 2011

DESIGN AND ENGINEERING PRACTICE

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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations and options for an electrical network monitoring and control (ENMC) system.

This DEP does not cover the specific requirements for large generation and transmission systems such as power plants and electrical networks operated by public utility companies. If the need arises to design and install such a system, the Principal shall seek advice from specialist consultants in this field.

An ENMC system comprises microprocessor based systems, associated software and required peripherals for monitoring and controlling an electrical power network.

A set of Requisition sheets (DEP 33.64.10.93-Gen.) is available to assist communication between the Principal and Manufacturer and vice versa.

This DEP is a revision of the DEP with the same number dated December 2008; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorisation to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in oil refineries, chemical plants, gas plants, exploration and production facilities and supply/distribution installations. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process should be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases, the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

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1.3.2 Specific definitions

Term	Definition
Availability	Total operating period minus total down time, divided by total operating period (x100 %).
Distributed Control System (DCS)	Configurable microprocessor-based (process) control system.
Electrical Network	Complete electrical network consisting of generation, transmission and distribution.
Electrical Network Monitoring and Control (ENMC) system	Computerised system which is dedicated to monitoring and controlling defined aspects of an electrical network.
Electromagnetic Compatibility (EMC)	Ability of an equipment or system to function satisfactorily in its electromagnetic environment without imparting intolerable electromagnetic disturbances to anything in that environment.
Emission Level	Amount of electromagnetic emission that is permitted.
Fail-Safe	In the event of a fault, system breakdown or lack of power, the functions concerned pass into a defined state or are taken out of service safely.
Hold Point	A point in time during the project where a specified product requires the approval of the Contractor or the Principal, without which the project shall not proceed.
Immunity Level	The electromagnetic disturbance that is permitted without degradation of the performance of an equipment or system.
Intelligent Electronic Device (IED)	Numeric control and protection device.
Inputs / Outputs (I/O)	The actual interface of the ENMC system to other systems or equipment. It does not mean a ‘serial link’.
Maintainability	The probability that a given active maintenance action, for an item under given conditions of use, can be carried out within a stated time interval when the maintenance is performed under stated conditions and using stated procedures and resources.
Mean Time Between Failure (MTBF)	Total operating period divided by number of faults that have resulted in outages (hours).
Mean Time To Repair (MTTR)	Total time to repair and return to service divided by number of faults that have resulted in outages (hours).
Network Function	Function needed for electrical power network operational reasons, i.e. to operate the network in a safe and/or economical way.
Observation Point	A point in time in the project for which the Principal shall be notified, but the project may proceed if the Principal is not present.
Point of Common Coupling (PCC)	The point of coupling at the public utility network to which the industrial network is connected.
Reliability	The probability that an item can perform a required function under given conditions during a given time interval.

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Term	Definition
Supervisory Control And Data Acquisition (SCADA)	A set of functions responsible for the acquiring and processing of data and issuing of commands.
Support Functions	Functions not explicitly needed for the network but supporting the operation of the ENMC system or the operator.
System Functions	Control and monitoring functions, inherent to a computerised ENMC system.
Technical Lifetime	The design lifetime of the system given that normal maintenance has been carried out.
Witness Point	A point in time at which the project shall not proceed without the Principal's attendance or written approval.

1.3.3 Abbreviations

Term	Definition
AVR	Automatic Voltage Regulator
CCR	Central Control room
CER	Central Electrical Room
CSER	Central Service Electrical Room
CCU	Central Control Unit
CPU	Central Processing Unit
DCS	Distributed Control System
EDG	Emergency Diesel Generator
EMC	Electromagnetic compatibility
ENMC	Electrical Network Monitoring and Control
FAT	Factory Acceptance Test
FAR	Field Auxiliary Room
FDS	Functional Design Specification
FDDS	Functional Detailed Design Specification
FMEA	Failure Mode and Effect Analysis
GPS	Global Positioning System
GTG	Gas Turbine Generator
HMI	Human Machine Interface
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
IMCS	Integrated Motor Control System
I/O	Input/Output

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Term	Definition
ISO	International Standard Organisation
LAN	Local Area Network
LER	Local Equipment Room
MCC	Motor Control Centre
MOC	Management of change
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
OLTC	On Load Tap Changer
OS	Operating System
OSI	Open Systems Interconnect
PCB	Printed Circuit Board
PCC	Point of Common Coupling
PCAD	Process Control Access Domain
PID	Protocol Implementation Document
PLC	Programmable Logic Circuit
POSIX	Portable Operating System Interface
RTU	Remote Terminal Unit
SAT	Site Acceptance Test
SCADA	Supervisory Control And Data Acquisition
SIT	Site Integration Test
TAMAP	Technically Approved Manufacutrers and Products list
TFT	Thin Film Transistor (monitor)
UPS	Uninterruptible Power Supply
VSDS	Variable Speed Drive System

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets ( ). Other documents referenced by this DEP are listed in (10).

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1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated December 2008. This has been an extensive revision including the merge of DEP 33.64.10.11-Gen., the ENMCS Application.

The main technical changes are:

Section	Change description	Reason
2.1	Addition of TAMAP	Alignment
3.3.2	Redundancy for controls	Increased clarity
3.5	Power supply from DC deleted	Mixed supply requirements
5.3.2.1	Communication protocols defined	Not defined
6.6	Spares and expandability defined more clearly	DEP requirements unclear
6.5	DACA requirements improved	Reference to DACA compliance made
7.7	DCS/ENMCS integration, removed requirement	Incompatibility
Appendix 1	Appendix 1 updated	In line with Manufacturer
Appendix 2	Appendix 2 list of signals added	Signal descriptions not given

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of "DEPs on the Web", available through the Global Technical Standards web portal http://sww.shell.com/standards and on the main page of the DEPs DVD-ROM.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 DATA SHEETS

Requisition/data sheet DEP 33.64.10.93-Gen is applicable to this DEP.

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2. RESPONSIBILITY

2.1 GENERAL

The order for the ENMC system shall be placed directly with the Manufacturer/Supplier of the ENMC system.

The Manufacturer/Supplier shall be approved by the Principal; refer to the Principal's technically approved manufacturers and products list (TAMAP).

The Manufacturer/Supplier shall be responsible for the correct functioning of the ENMC system to specification, including all interfaces with other systems and equipment.

2.2 SCOPE OF SUPPLY OF THE ENMC SYSTEM

The scope of supply of the ENMC system shall include:

a) Detailed design of the system and the interfaces with other equipment and systems such as generators, switchgear, transformers control systems, Distributed Control Systems (DCS) of utility and the plant process installations, etc.

b) Hardware forming part of the ENMC system.

c) Software required for the functioning of the ENMC, including communication to other systems. This shall include the supply of the relevant software licences.

d) Factory tests during the fabrication process and final factory acceptance tests.

e) Communication interface tests with 3rd party equipment and systems.

f) Documentation and instructions as specified in this DEP.

g) Site inspections, testing, commissioning and start up assistance.

If specified on the Requisition, the following shall be included in the scope of supply:

- Installation of the hardware at site.
- Training of the Principal's personnel.

2.3 PRE-AWARD MEETING

One or more pre-award meetings shall be arranged with the parties concerned. The minimum attendance requirement should be the EPC Contractor, the Principal, and the Manufacturer/Supplier.

The purpose of these meetings shall be:

a) to clarify the scope and parameters of the order and the responsibilities of each party involved;

b) to agree the extent of supply as far as interfaces with other systems not directly belonging to the ENMC system are concerned;

c) to decide the basic structure of the ENMCS (3.2);

d) to agree on the type and number of operator and engineering work stations that will be included in the HMI;

e) to agree on the extent of which IEC 61850 will be applied (e.g., hardwired or serial link communication);

f) to agree on the redundancy requirements and communication infrastructure, i.e., ring or radial distribution;

g) to agree on the number of I/O including spares to be included;

h) to agree to the final list of deviations to this DEP;

i) to reach agreement with respect to administrative, production and test procedures.

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The minutes of these meetings shall be approved by the parties involved and shall form an integral part of the order documentation.

2.4 SUPPLY OF DATA

2.4.1 General

During the project, there will be an exchange of information between the various parties involved in the specification, development, design, manufacturing, implementation, testing and commissioning phases. Unless mutually agreed otherwise, the parties indicated shall provide the data as listed in the following sub-clauses at the appropriate stage of the project. This list, amended where necessary, shall form an integral part of the order documentation.

2.4.2 At enquiry, invitation to bid stage

The Principal shall provide:

a) Requisition sheets detailing the basic requirements, applicable standards, site conditions, etc.;

b) Key single-line diagram(s) showing the main equipment of the electrical generation and distribution system that needs to be monitored and controlled;

c) Overall plot plan, giving details of the location of control centre(s), substations, power plants etc.;

d) Main equipment data of generators, transformers and switchgear (type, power rating, voltages, impedances, etc.). This shall also include the operational range of the on-site generators and the dependence of their prime drivers on the process as applicable;

e) Detailed description of the required functionality of the ENMC system. This shall include information whether islanding and load shedding will be applicable;

f) Overall block diagram;

g) Information on the redundancy requirements;

h) Operational philosophy of the electrical generation (including that of the prime movers) and distribution system;

i) Information on the interfaces and communication with other systems such as DCS, 3rd party systems and systems that already exist on site, as applicable (6.5);

j) Specific requirements for data security (firewalls, etc.) (6.5);

k) Schedule information in the form of a high-level time schedule, indicating, e.g., the approximate timing of tie-ins, availability of buildings, deadline for final commissioning, etc.

l) Intended make and type of the different protection relays.

2.4.3 At quotation / tender stage

The Manufacturer/Supplier shall as a minimum provide:

a) Detailed technical specification of the ENMC system including, but not limited to, a description of the design, operation, construction, performance and maintenance aspects (preventive, corrective, remote login, help desk);

b) Preliminary listing of the I/O per location and the number of I/O that are included in the tender as spare. This shall be based on the key single-line diagram and other information provided by the Principal in the enquiry;

c) Proposal for the type and number of operator and engineering work stations (HMI) that will be supplied;

d) Proposal for the type and number of displays that will be available at the various HMIs;

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e) Information on licensing requirements for software used in the system;

f) Information on redundancy that will be provided;

g) Proposal for the type of communication infrastructure (ring or radial distribution);

h) Confirmation that the distances between the various parts of the ENMC as stated on the overall plot plan are taken into account in the preliminary ENMC design;

i) Information, as requested further on in this DEP, and in the relevant Requisition sheet(s) ;

j) Confirmation that the system will:

   a. be designed in accordance with the requirements of this DEP specification;

   b. be designed to fulfil the basic requirements as stated in the Requisition;

   c. be fully compliant with the relevant parts of IEC 61000;

   d. operate at the site conditions as stated in the Requisition.

   Deviations from and exceptions to the requirements stated in the enquiry documents shall be highlighted separately, including the consequences of such deviations;

k) EMC management plan for design and execution phases;

l) Generic quality assurance programme including a proposal for the inspections to be carried out by the Contractor/Principal;

m) Proposed high-level overall time schedule (Design Management Plan) for the project from tender award to final commissioning/site acceptance highlighting, as a minimum, the following aspects:

   a. Availability of critical data (both from the Principal and from the Manufacturer/Supplier);

   b. Proposed schedule for meetings with the Principal and third parties (e.g., DCS Manufacturer/Supplier);

   c. Proposed factory test schedule (hold points for witnessing by the Principal);

   d. Factory acceptance test, site testing (including site integration) and acceptance test , final commissioning and overall completion.

n) Details of communication protocol(s) to be applied (5.3.2);

o) Proposal for enhanced security of communication links (6.5);

p) Test and inspection details (factory and site);

q) The country of origin of the main components of the system and information on the nearest service location for the ENMC system;

r) Indication of number and capabilities of personnel involved during the various stages of the project;

s) Breakdown of the total cost as applicable to the various phases of the project (hardware, software, installation, labour, training, etc.);

t) Cost implications for addition / reduction of components or I/O during the project;

u) Information on the documentation that will be provided during the project, including ‘as built’ information;

v) Information on training available;

w) Preliminary proposal (technical and commercial) for a maintenance/service contract.

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2.4.4 On receipt of order

The Principal shall provide:

- Information agreed to be submitted to the Manufacturer/Supplier during the tender stage.

The Manufacturer/Supplier shall provide:

- Detailed planning schedule including a proposal for hold and witness points;
- Detailed schedule for project meetings;
- Schedule of documentation to be prepared in accordance with this DEP.

2.4.5 During the implementation of the project

The Principal shall provide:

a) Information, as and when it becomes available, about the hardware (e.g.,generators) and systems (e.g., DCS) to which the ENMC is linked;

b) Detailed information on the specific equipment and system identification (tag numbers) that shall be implemented by the Manufacturer/Supplier throughout the ENMC system;

c) Information on islanding requirements, if applicable;

d) Information on load shedding requirements, if applicable;

e) Details of the available supply systems (UPS), refer to (3.5);

f) Detailed planning information.

g) The Manufacturer/Supplier shall provide:

h) Functional Design Specification (FDS) based on this DEP;

i) Functional Detailed Design Specification (FDDS) based upon the FDS;

j) Installation requirements with respect to EMC (6.4);

k) Information on supply system requirements (voltage, power, etc.) including detailed consumer listing, power consumption calculations and heat gain calculations;

l) Failure Mode and Effect Analysis (FMEA) of the system including fault tolerance capabilities;

m) Monthly report on progress and impact on planning;

n) Tie-in information for the connection to other hardware and systems (e.g., connection schedules, circuit diagrams, etc.);

o) Documentation as specified in this DEP (9);

p) Test reports.

2.4.6 At Principal's acceptance of the system

The Manufacturer/Supplier shall provide:

- ‘As built’ documentation;
- Final documentation as detailed in this DEP (9).

2.5 STUDIES

During the various phases of the project, studies shall be performed that will provide input to the ENMC design. The Principal and the Manufacturer/Supplier shall agree prior to contract award which studies will be required and the involvement of the Manufacturer/Supplier in those studies. Typical studies are load flow, transient behaviour, protection studies and SAFOP.

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2.6 TRANSPORT AND STORAGE

The ENMC equipment shall be able to withstand environmental conditions during transport and storage. The Principal shall identify any special transport and/or site storage conditions. The Manufacturer/Supplier shall be responsible for suitably packaging the ENMC system components to avoid damage.

2.7 STATEMENT OF COMPLIANCE

The Manufacturer/Supplier shall guarantee that the ENMC system complies with the contract and that the equipment is properly designed, constructed and suitable for the specified use. The complete system shall be tested at the Manufacturer/Supplier's works, in conjunction with the process control system and all other systems, if applicable, to prove its capability and compliance with this DEP.

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3. BASIC REQUIREMENTS

3.1 BASIS OF DESIGN

The design of the ENMC system shall be such as to optimise control and monitoring of the electrical network concerned, utilising the functions implemented. It shall ensure personnel and operational safety at all times.

An overview of a typical ENMC system is given in (Appendix 1).

The Manufacturer/Supplier shall in principle, offer hardware and software from his standard range, and where applicable, modified to achieve conformity with this DEP and/or the specific project requirements.

The functionality of commercially available ENMC systems generally allows users to make a selection of the functions required for a particular installation. During the tender stage, the Principal shall define what the functionality of the system shall be. At a later date, it shall be possible to incorporate additional functions without a major upgrade of the system during the lifetime of the ENMC system.

The design and selection of equipment, components and functions shall be based on a technical lifetime of 20 years.

The expected lifetime of some of the hardware involved may be less than 20 years. The Manufacturer/Supplier shall state in the quotation the expected technical lifetime of these components. This shall not be less than 10 years. The Manufacturer/Supplier shall also confirm that replacement components will be available and indicate an expected duration of the replacement process. In the quotation the Manufacturer/Supplier shall give documented evidence that replacement of the electronic controls shall not have an impact on the rest of the ENMC.

The Manufacturer/Supplier shall also confirm that he shall provide software support for the ENMC during the lifetime of the system.

New generation hardware and software, developed subsequent to delivery, shall be compatible with the design of the original equipment. It shall be possible to extend, modify or adapt the original equipment to incorporate new developments. The Manufacturer/ Supplier shall clarify the method by which this aspect can be demonstrated.

SI units shall be used in all documents related to the ENMC system.

3.2 CONFIGURATION OF THE ENMC SYSTEM

ENMC systems for industrial electrical networks shall generally be configured so that three levels of control can be distinguished:

- **Level 1**

  All equipment on this level shall be dedicated to a part of the electrical network with a specific function (i.e., panel, generator, transformer, busbar, etc.) and shall be located nearby the equipment concerned. This level shall be self-supporting, meaning that all control and protection equipment on this level shall support the primary function of this network part without communication to other levels.

- **Level 2**

  At this level, the monitoring and control of the Level 1 systems shall be located. An example of this would be a local control desk in a (plant) substation.

- **Level 3**

  At this level, the monitoring and control of the Levels 1 and 2 shall be located. This is the highest level of ENMC control, generally located in a central control location

Reference is made to (Appendix 1).

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However, in installations, where the main equipment and systems that need to be controlled are installed in a centralised location, it may be beneficial to establish the highest level of control locally. In this case, a central control location may have only a monitoring and alarm function. The Principal and Manufacturer/Supplier shall decide whether this is desirable during the enquiry stage, and adapt the specification accordingly.

ENMC control functions in a particular substation (Level 2) shall be connected to controllers dedicated to that particular substation. Control functions shall not be distributed among different controllers at different locations.

3.3 RELIABILITY, AVAILABILITY AND MAINTAINABILITY

3.3.1 General

Availability, reliability and maintainability requirements shall be determined according to the need and intended use, and shall be in accordance with the definitions laid down in IEC 60300 and IEC 60706-2.

The ENMC system including all system-critical components shall have a Mean Time Between Failure (MTBF) of not less than 100,000 hours.

Equipment at Level 2 and Level 1 (3.2) shall have a maintenance interval of not less than 50,000 hours. Equipment on Level 3 shall have a maintenance interval of not less than 25,000 hours.

All (sub)systems shall be designed to achieve an MTTR of not more than 8 hours.

This performance shall be achieved by installing electronic modules and data communication links which incorporate redundancy and/or fault tolerance technology.

Although hardware reliability is important, the availability of the system (hardware plus software) for critical functions shall be the only representative reliability figure.

Whether a function is critical or not is to be determined by the importance of the function for operating the electrical network within the operational constraints. The criticality of a function shall be specified in the Requisition.

The Manufacturer/Supplier shall make a proposal for verification of the specified performance levels.

3.3.2 Redundancy

The Principal shall specify in the enquiry which equipment and systems require redundancy. The Manufacturer/Supplier shall prove to the Principal, in the quotation phase, that the redundancy requested will be sufficient to achieve the above availability figures and, where applicable, advise additional measures to be taken.

Although the Principal shall confirm the project-specific redundancy requirements prior to contract award, the following should be taken into account. Redundancy of Level 1 equipment, I/O and their communication links is generally not required. Main communication infrastructure shall be redundant. Controllers, servers, etc., at Levels 2 and 3 shall also be redundant.

Where redundancy is required, it shall be ensured that there is no equipment in the system that could cause common mode failure.

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