TECHNICAL SPECIFICATION

ELECTRICAL NETWORK MONITORING AND CONTROL SYSTEM - SPECIFICATION

DEP 33.64.10.32-Gen.

January 1999

DESIGN AND ENGINEERING PRACTICE

PREFACE

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The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

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NOTE: In addition to DEP publications there are Standard Specifications and Draft DEPs for Development (DDDs). DDDs generally introduce new procedures or techniques that will probably need updating as further experience develops during their use. The above requirements for distribution and use of DEPs are also applicable to Standard Specifications and DDDs. Standard Specifications and DDDs will gradually be replaced by DEPs.

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1. INTRODUCTION

1.1 SCOPE

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

An ENMC system comprises micro-processor based systems, associated software and required peripherals for monitoring and controlling an electrical network.

Notes:
1. A bullet (●) in the margin indicates where a design by and/or information from the Principal is required. These designs and information will be indicated in the requisition.
2. An asterix (*) in the margin indicates where design alternatives may be acceptable. In certain cases these alternatives are subject to approval by the Principal.
3. A diamond (♦) in the margin indicates where information from the Manufacturer is required. This information shall be indicated in the requisition.

This DEP shall be applied in conjunction with DEP 33.64.10.11-Gen. which covers the application of ENMC systems.

ENMC functions, hence equipment, shall be dedicated to level 1, 2 or 3 depending on operational or safety requirements or the requirements of the installations. For each function the level at which it shall be implemented shall be noted in the requisition, if applicable.

Transmission functions are considered to be beyond the scope of this DEP. However, as a number of these functions may become applicable in a large electrical network, functional diagrams and descriptions of these functions are incorporated in the ENMC System Application Guidelines (DEP 33.64.10.11-Gen.).

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIOP and SIEP, the distribution of this document is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group Company, and to Contractors nominated by them (i.e. the distribution code is "C", as defined in DEP 00.00.05.05-Gen.).

This DEP is intended for use in oil refineries, chemical plants, gas plants, exploration and production facilities and supply/marketing installations.

If national and/or legal regulations exist in which some of the requirements may 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 as regards safety, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this document 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 with the objective of obtaining agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS AND NOMENCLATURE

1.3.1 General definitions

The **Contractor** is the party which 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 which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. 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.

1.3.2 Network function definitions

Consistency analysis	Determining anomalies and inconsistencies in network operation data.
Distribution power flow analysis	Analysing actual power flow in the distribution network and checking for out-of-range operating conditions.
Economy A	Evaluation of a possible energy transaction with an external company in terms of costs/profits without altering the unit commitment schedule.
Economy B	Evaluation of a possible energy transaction with an external company in terms of costs/profits taking into account alternative unit commitment schedules.
Economic dispatch	Allocating power resources to feed the network at a particular time, i.e. meeting the network load at that time with minimum overall production costs.
Energy demand control	Optimising the use of electrical energy over a particular time period.
Fault calculation	Calculating currents and all contributions to fault currents, comparing fault currents against circuit breaker ratings for each circuit breaker involved.
Fault location	Determining the probable equipment location of a fault.
Fault isolation	Indicating which equipment is faulted and should be isolated.
Feeder reconfiguration	A proposed feeder configuration that optimises the feeder according to a number of objectives.
Generation area control	Control of the total power output of selected generation units in a predefined area.
Interchange transaction scheduler	Planner and scheduler for energy exchange.
Load/frequency control	Control of the power output of a generator according to set points and generator constraints.
Network security analysis	Determining the security of the power system under specified contingencies.
Network sensitivity analysis	Calculating, for the actual network state, the sensitivity of network losses to changes in unit generation and to interchanges with other networks.
Network voltage scheduler	A real-time optimisation of the network voltages and MVAr flows, recommending control settings to minimise active power losses and maintain bus voltages and branch flows within limits.
Optimal power flow	Determining a network solution that optimises performance under certain operational constraints.
Power flow analysis	Examining the steady state conditions of the power network that may exist under a wide variety of conditions.
Production cost monitoring	Monitoring and summarising production costs and fuel consumption of generating units, comparing them with optimum production costs.

Real time sequence control	A sequential run of network application functions.
Reserve monitoring	Calculating actual figures for active/reactive spinning and operating reserves, comparing these with defined classes and indicating shortfalls.
Security checked switching	Checking the power system state for limit violations as a result of an intended switching action.
Security dispatch	Achieving an optimum balance between security, costs and other operational constraints, and determining the most effective remedial actions if operating constraints are violated.
Service restoration	Determining alternatives for re-energising equipment and sections that are switched off but not identified as faulted.
State estimator	Providing a complete network solution from real-time measurements and network data, calculating the best possible 'image' of the actual load flow situation within the power system and creating pseudo measurements to allow estimated solutions for unobservable parts of the network.
Transformer load management	Utilisation of short-term overload capabilities of a transformer; load balancing between transformers by feeder reconfiguration.
Unit commitment	Scheduling operation of generating units to supply the load under certain constraints.
Volt/Var control	Determining settings of transformer taps, voltage regulators and shunt capacitors/reactors to achieve selected objectives.

1.3.3 Terminology

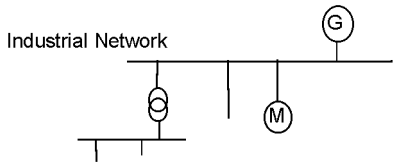
Availability	The ability of an item to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval assuming that the required external resources are provided. Availability is calculated from the formula: Availability (%) = (total time - total down time) / (total time) x 100.
Burst	An avalanche of information in the event of a fault in the electrical network.
Distributed Control System	A computerised system which is dedicated to monitoring and controlling defined aspects of process installations.
Electrical Network	The complete electrical network consisting of generation, transmission and distribution. Four types of networks are distinguished: G-type, GPO-type, P-type, PGD-type and PGT-type.
Electrical Network Monitoring and Control system	A computerised system which is dedicated to monitoring and controlling defined aspects of an electrical network.
Electromagnetic Compatibility	The ability of an equipment or system to function satisfactorily in its electromagnetic environment without imparting intolerable electromagnetic disturbances to

anything in that environment.

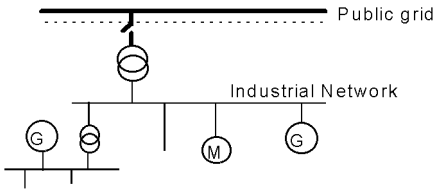
Emission level — The amount of electromagnetic emission that is permitted

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.

G (Generation) Type Network — Electrical network, self supporting, no coupling to the public network possible.



GPO (Generation, Public Optional) Type Network — Electrical network, normally self-supporting, coupling to the public network possible.



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.

Inputs / Outputs — The actual interface of the ENMC system to other systems or equipment. It does not mean a ‘serial link’.

Inspection — Covers verification of all procedures and activities during the project which are carried out in mutual coordination, in order to complete a system according to the specifications.

Level 1 — All equipment on this level is dedicated to a part of the electrical network with a specific function (i.e. bay, generator, busbar, line etc.) and is located nearby the primary equipment concerned. This level is self supporting, meaning that all control and protection equipment on this level can support the primary function of this network part without communication to other levels.

Level 2 — On this level monitoring and (co-ordinated) control of level 1 systems is located.

Level 3 — On this level monitoring and (co-ordinated) control of levels 1 and 2 is located.

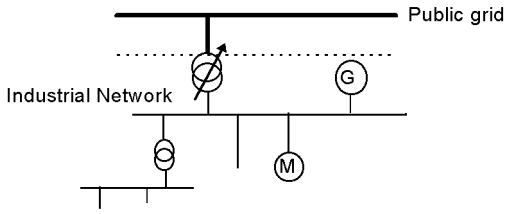
Maintainability — The probability that a given active maintenance action, for an item under given conditions of use, can be

carried out within a stated time interval when the maintenance is performed under stated conditions and using stated procedures and resources.

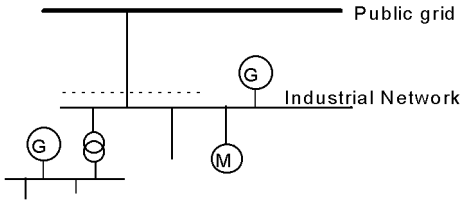
Network function — Function needed for (electrical) network operational reasons, i.e. to operate the network in a safe and/or economical way.

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.

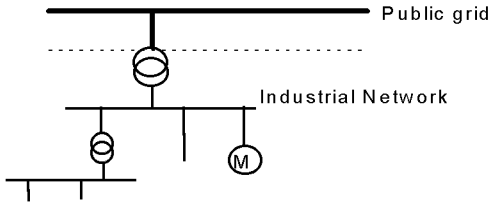
PGT (Public/Generation, Transformer connected) Type Network — Electrical network coupled to the local public network through transformer with on load tap changer, own generation in parallel.



PGD (Public/Generation, Directly connected) Type Network — Electrical network coupled directly to the local public network, own generation in parallel.



P(Public) Type Network — Electrical network coupled to the local public network, no own generation available.



Reliability — The probability that an item can perform a required function under given conditions during a given time interval.

Satellite equipment — ENMC subsystems that are not at the ‘central location’ (which is usually the control centre), but are distributed over the electrical network.

Supervisory Control And Data Acquisition — 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 computerized ENMC system.
Test procedures	Activities to verify the actual performance of a system or part thereof.
Witness point	A point in time at which the project shall not proceed without the Principal's attendance or written approval

1.3.4 Abbreviations

CRT	Cathode Ray Tube (= monitor)
DCS	Distributed Control System (process control)
EMC	Electromagnetic compatibility
ENMC	Electrical Network Monitoring and Control
FAT	Factory Acceptance Test
FAR	Field Auxiliary Room
FDS	Functional Design Specification
HMI	Human Machine Interface
I/O	Input/Output
MCC	Motor Control Centre
MTBF	Mean Time Between Failure (hours): defined as: (Operation time) / (number of faults that have resulted in outages)
MTTR	Mean Time To Repair (hours): defined as: (time to repair and restore service) / (number of faults that have resulted in outages)
PCB	Printed Circuit Board
RTU	Remote Terminal Unit
SAT	Site Acceptance Test
SCADA	Supervisory Control And Data Acquisition
SIT	Site Integration Test

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 in this DEP are listed in (9).

2. RESPONSIBILITY

2.1 GENERAL

• The order for the ENMC system shall be placed direct with the Manufacturer of the ENMC system, who must be approved by the Principal. If there is a significant data exchange between the ENMC system and the Distributed Control System (DCS), the ENMC system shall be ordered via the DCS Manufacturer.

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

Functions may be related to each other, hence the necessity and the details of functions may depend on the presence and aspects of other functions in the ENMC system. The specific requirements resulting from this shall be the responsibility of the Manufacturer.

2.2 SUPPLY OF DATA

♦ Unless otherwise stated in the requisition the Manufacturer shall provide the following data at the appropriate stage of design and manufacture:

At tender:

- a technical specification of the ENMC system including a description of the design, operation, construction, performance and maintenance aspects (preventive, corrective, remote login, help desk);
- installation conditions and/or environments;
- conformance list describing all deviations from this DEP including any consequences for the performance of the system;
- block diagrams of the complete ENMC system, i.e.
  - functional
  - hardware
  - scope of supply boundaries;
- an overview of EMC measures/requirements including EMC significant boundaries (zoning);
- an overview of purchasing, engineering and maintenance costs associated with optimisation functions for the project concerned;
- a plan how to incorporate information from the Principal during the project;
- the method of incorporating future developments into the system;
- project specific quality assurance program including a proposal for the inspections to be carried out by the Contractor/Principal;
- a proposal of all tests to be performed including a functional description of each test;
- the country of origin of the main components of the system;
- indication of the Manufacturer's capabilities for carrying out site installation work;
- the nearest service organisation recommended for the location concerned;
- list of recommended spare parts ;
- list of all documentation to be delivered with the system;
- list of communication protocols to be applied;
- list of training courses available.

On receipt of order:

- detailed planning schedule including a proposal for hold, observation and witness points;
- proposed schedule for project meetings;
- installation guidelines;
- rated power of equipment.

During the project:

- monthly: activities and planning overview;
- test reports of (sub)systems;
- connection lists, circuit diagrams and other information needed for integration of the system;
- submit a Functional Design Specification (FDS) based on this DEP;
- all documents as mentioned in (8).

2.3 PRE-AWARD MEETING

If deemed necessary, a pre-award meeting shall be arranged with all parties concerned. This will be stated on the requisition or may be initiated by any party. The purpose of this meeting will be:

- to define the scope and parameters of the order and the responsibilities of each party involved;
- to agree the final list of deviations to this DEP;
- to reach agreement with respect to administrative, production and test procedures.

2.4 STATEMENT OF COMPLIANCE

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

2.5 SCOPE OF SUPPLY OF THE ENMC SYSTEM

The scope of supply of the ENMC system shall include all design activities, supply of materials, factory acceptance tests and provision of documentation and instructions as stated in this DEP.

The scope of material and functional supply includes all ENMC system components as listed in the ENMC System Requisition Sheets (DEP 33.64.10.93-Gen.).

The scope of supply of an ENMC system also includes start-up assistance and, if specified in the requisition, site installation and training.

2.6 INTEGRATION WITH THE DISTRIBUTED CONTROL SYSTEM (DCS)

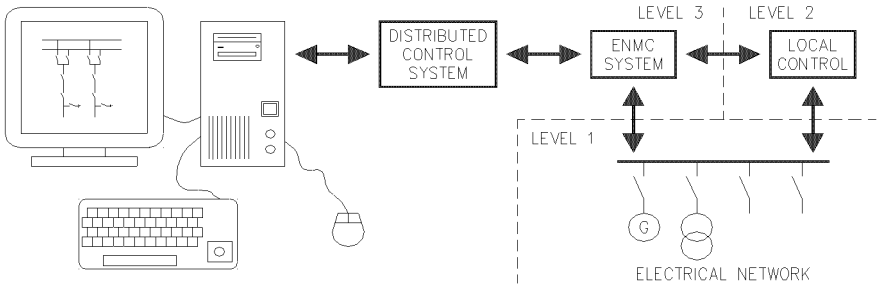
Integration of the ENMC system, Human Machine Interface (HMI) and engineering facilities with the DCS shall be considered when all following situations apply:

- the electrical network is coupled to the public network and no own utility generation is available;
- the DCS has enough spare capacity, even after integration;
- the DCS is capable of performing the required functionality;

- the ENMC system will not degrade the performance of the DCS;
- operating the electrical network does not interfere with DCS.

It is possible that similar functions can be implemented in both the ENMC system and the DCS. In this case the Contractor shall investigate the consequences of an overlap and shall advise how to deal with it. An overlap shall never result in unsafe situations for the network, persons or the control systems.

Functional diagram 1 Integration of the ENMC system in the DCS



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.

The design and selection of equipment, components and functions shall be based on an expected technical lifetime of 20 years. Standard systems shall be applied utilising standard hardware and software so as to assure support from the Manufacturer as much as possible.

If the new ENMC system equipment, or parts thereof, are envisaged to replace existing equipment, special attention shall be given to compatibility of existing software with the new system.

The reliability and availability of the ENMC system and sub-systems shall be in accordance with the functional and operational requirements as laid down in this DEP, and will be based on the conditions stated in (3.2) and (3.3).

3.2 SITE CONDITIONS

- Unless otherwise specified in the requisition, the ENMC equipment at level 2 and level 3 shall be installed in a room where the following conditions apply:
  - maximum ambient air temperature: 40 ^{o}C
  - relative humidity not exceeding: 90% non condensing
  - altitude not exceeding: 1000 m

ENMC equipment located at level 1 may be subject to ambient air temperatures higher than 40 ^{o}C. Where applicable, these temperatures will be specified in the requisition.

The noise level produced by level 3 ENMC equipment shall be less than 50 dB. For level 1 and level 2 ENMC equipment this level shall be less than 55 dB.

The ENMC equipment shall be able to withstand environmental conditions during transport and storage according to:

- IEC 60068-2-1/2: maximum ambient air temperature
- IEC 60068-2-30: maximum and minimum relative humidity
- IEC 60255-21-1/2: mechanical vibrations

3.3 MAINS ELECTRICITY SUPPLY

- Unless otherwise indicated in the requisition, all ENMC equipment shall be powered by an AC power supply according to IEC 60038.

♦ The Manufacturer shall make available the power ratings of all equipment.

For AC power supply the following conditions apply:

- variations shall be limited to between plus 15% and minus 15% (IEC 60255-4);
- - 30% for 10 ms;
- - 50% for 100 ms;
- interruptions of the power supply of 10 ms.

For DC power supply the following conditions apply:

- variations shall be limited to between plus 15% and minus 20% (IEC 60255-4);
- may be subject to a ripple of 12% peak-peak (IEC 60255-11);
- interruptions of the power supply of 10 ms.

Conditions as listed above shall not interfere with the functioning of the system or parts thereof (IEC 60255-11).

In addition to this the power supply may also be subject to transients due to interference from other equipment. See also (5.5).

Wrong polarity or connection of plus or minus of the battery to earth shall not damage any equipment.

Short and long term harmonics shall comply to IEEE 519.

- Where special power supply requirements are needed (for instance to meet availability requirements), these shall be indicated by the Manufacturer.

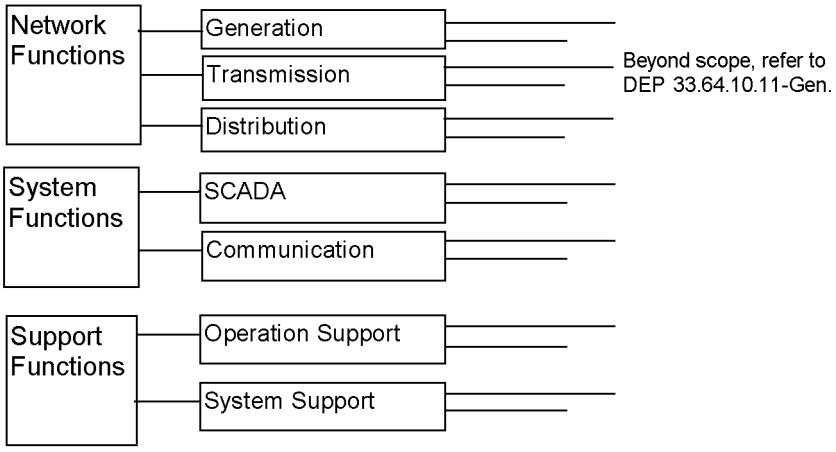
4. REQUIRED FUNCTIONS

4.1 GENERAL

The primary purpose of the ENMC system shall be to monitor and control the electrical network and equipment incorporated in it, in an efficient and cost effective way without compromising safety.

An overview of an ENMC system is given in Functional diagram 2. Three main function categories can be distinguished: Network, System and Support functions. For every function category a set of functions can be distinguished.

Functional diagram 2 ENMC main system functions



Starting from Functional diagram 2, for every function category the applicable functions shall be determined in respect to the type of network involved (P, G, PGD, PGT and GPO). In sections (4.2, 4.3 and 4.4) functional diagrams are given, showing the possible functions in each category.

In these functional diagrams the types of network that each function is relevant for are indicated by shaded areas at the bottom of the diagram. At the top of the diagram, shaded areas indicate functions that are specified as a minimum requirement for an ENMC, irrespective of the type of network.

Subsequently, for each function the minimum requirements and function objectives as listed at the top of each block diagram shall be evaluated to determine whether that function is actually necessary for the type of network concerned. The result shall be noted down in the requisition sheet.

* Concerning functions that are not indicated as minimum requirement: these shall be regarded as optional. The Contractor shall take the economic benefits into consideration when determining whether such a function is necessary. These evaluations shall be carried out in accordance with DEP 33.64.10.11-Gen., and shall be submitted to the Principal for comments and approval. The agreed functions shall form part of the scope of supply if safety and/or economic benefits are confirmed.

♦ The Manufacturer shall give information to allow the Contractor to make an indication of the economic benefits of the functions concerned.

• To achieve a fine tuning of the ENMC system and the electrical network it covers, including control aspects, the Manufacturer shall acquire sufficient knowledge of the control philosophy of the electrical network and the processes involved. The Principal's intended mode of operation is reflected in Guidelines for Electrical Supply and Generation - Design and Operation (DEP 33.64.10.12-Gen.).

4.2 NETWORK FUNCTIONS

The functions needed for the electrical network can be classified into 3 types:

- Generation
- Transmission (DEP 33.64.10.11-Gen.)
- Distribution

4.2.1 Generation

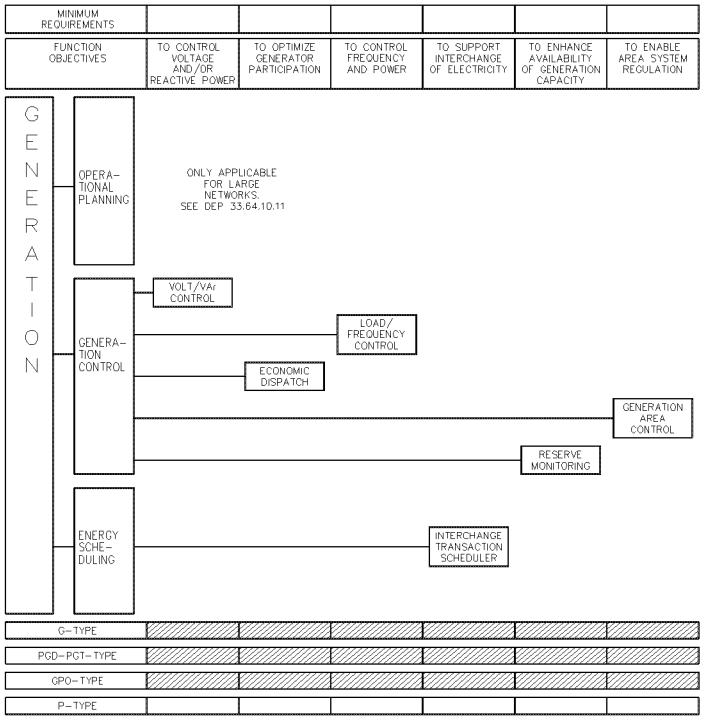
These functions only apply to G-, PGD-, PGT- and GPO-type networks.

Generation functions are subdivided into 3 classes:

- operational planning
  described in ENMC System Application Guidelines (DEP 33.64.10.11-Gen.);
- generation control;
- energy scheduling.

Functional diagram 3 gives an overview of all network functions related to generation including their governing requirements and their applicability to the different types of network.

Functional diagram 3 Functions related to generation



The functions *volt/VAr control* and *load/frequency control* are minimum requirements for an ENMC- system when applied to control a G-, PGD-, PGT-, or GPO-type network.

- Depending on the functions required within this type, the following subjects shall be specified:

– the number and type of generation units to be controlled;

– how units will be regulated (setpoint or raise/lower control).

4.2.2 Distribution

The applicability of these functions greatly depends on the properties of the distribution network, i.e.:

– the actual electrical topology of the network;

– capacities versus loads;

– available sectionalizers;

– available capacitors/reactors;

– current, voltage or MVA limits for the feeder network;

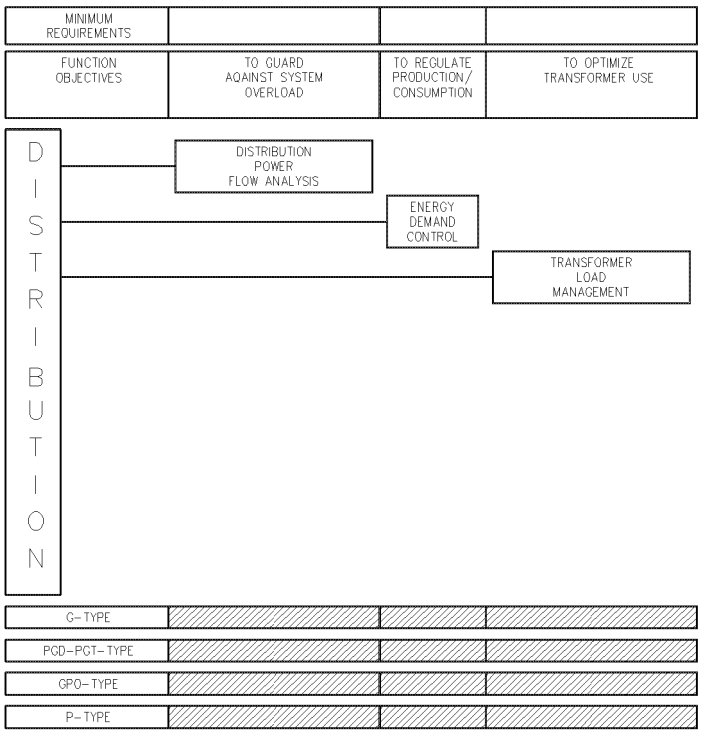
– line / transformer apparent power (MVA) limits for the network;

– relay settings;

– apparent power (MVA) ratings of the circuit breakers.

Functional diagram 4 gives an overview of all network functions related to distribution including the determining requirements.

Functional diagram 4 Functions related to distribution



4.3 SYSTEM FUNCTIONS

These functions apply to all types of networks (P, G, PGD, PGT and GPO) and are inherent to a computerized system.

These functions are subdivided into:

- SCADA functions;
- Communication.

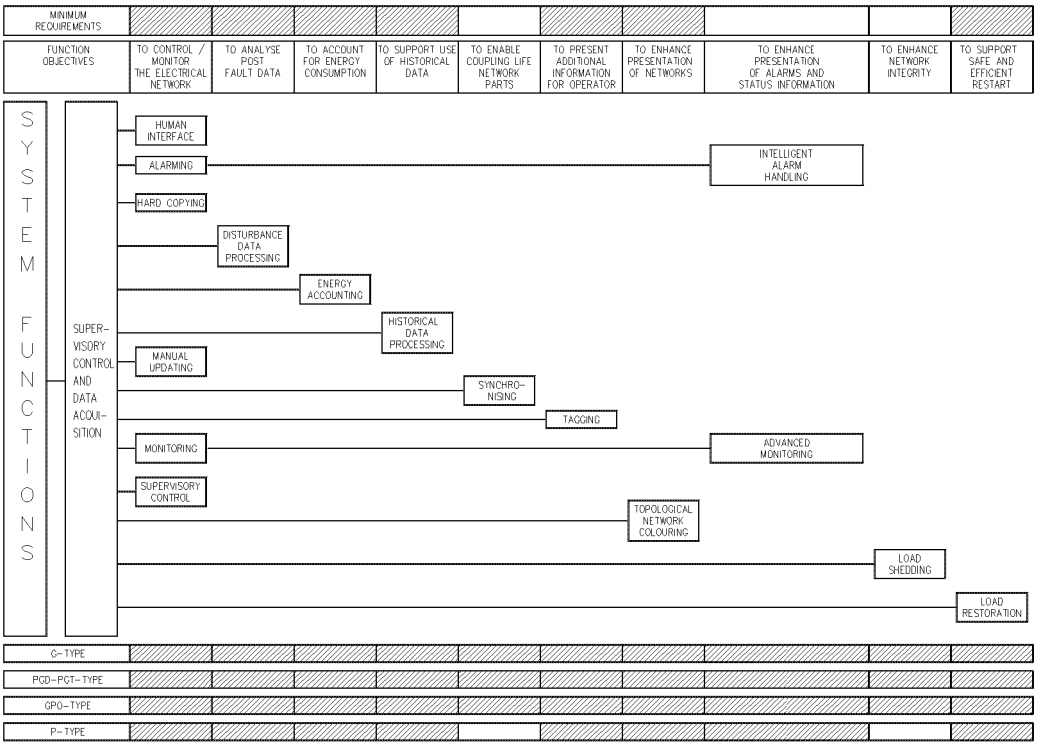
- Where data to be used to build displays or to fill the database has to be imported from other systems, the format required for this data exchange shall be a state of the art standard like Microsoft COM (Component Object Model) or API user interface and shall be specified in the requisition sheets.

4.3.1 SCADA

SCADA functions are dedicated to control and monitoring aspects of the ENMC system.

Functional diagram 5 gives an overview of all SCADA - related system functions including the governing requirements.

Functional diagram 5 SCADA functions



The following principles apply to SCADA aspects:

Human Machine Interface (HMI)

A full graphic HMI shall be available at level 3. In the requisition it shall be laid down whether the ENMC system has its own level 3 human interface or the human interface of the DCS is utilised. If a dedicated HMI is to be applied, the number of CRTs shall also be specified.

* Unless otherwise specified in the requisition, no permanent user or engineering interfaces shall be implemented at levels 1 and 2.

♦ Where applicable the Manufacturer shall prepare a proposal for the kind of human interface to be utilised for every location as indicated in the requisition. Means for presentation and control shall be suitable for the location and the application concerned.

Presentation

The ENMC system shall be able to present all information that is available within the system. Information shall be presented in a clear and structural way.

At least the following types of information shall be available:

- general network information, giving a quick overview of all main network components;
- general system information, giving a quick overview of all ENMC (sub)systems;
- overviews of:
  - generation;
  - transmission (if applicable);
  - distribution, down to high voltage feeder level;
- information on:
  - control status;
  - alarm status;
  - object status;
  - measurements;
- reports;
- trends;
- recorded transients;
- information on:
  - system support;
  - operation support;
  - disturbance handling.

Information shall be organized into a hierarchy that resembles the network and/or the ENMC system hierarchy.

Information shall be called up directly (i.e. by name) or from a menu.

If information ranges over several pages, page down and page up shall be possible.

Presentation of information shall be independent of the control authorization.

English language and SI units shall be used for all presentations. National language shall be supported.

Colours shall be used to distinguish network voltages, alarms, operation conditions etc. The colours used will need the approval of the Principal.

Hard copies

Information shall be printed at the request of the operator. It shall be possible for the operator to define information to be printed automatically at a certain time or condition: daily logs and reports shall be supported. Archiving information to be printed shall also be possible.

Unless otherwise specified in the requisition, one hard copy unit (printer etc.) for the ENMC

system shall be available at level 3, even if it is integrated with the DCS. If more hard copy units are available, it shall be possible for the operator to direct (types of) hard copies to a certain printer.

At least the following types of hard copies shall be possible if the relevant functions are included in the scope of supply:

- alarm reports;
- status reports;
- disturbance reports;
- transient reports;
- accounting reports;
- daily logs (i.e. event and operator actions; continuously);
- periodic reports (e.g. daily, weekly, monthly and at operators request);
- single line diagrams;
- trend information;
- measurements.

Every log shall have a clear identification. Each different type shall start at a new page.

In the event of failure of a printer, another printer shall take over if available or the information shall be archived. No information to be logged shall be lost.

ENMC systems at level 2 shall be provided with a facility to connect a printer semi-permanently (i.e. for maintenance purposes).

Operation

On a graphic HMI all operator actions shall be menu driven, possibly combined with function keys.

On every HMI all control operations shall consist of two steps: a selection phase and an execution phase. It shall be possible to interrupt a selection at any time. A selection shall automatically be interrupted if the given command is not the right one or is not given within a certain, adjustable, time period after the selection has been made.

All operator actions shall be reported by the ENMC system.

For all operator commands, it shall be possible to define checks (for instance interlockings). If a command is blocked or, for whatever reason, is not executed, this shall be presented to the operator.

Monitoring

All data (status, numerical) entering the ENMC system (events, alarms, measurements) or generated within the ENMC system shall be monitored for:

- violating minimum or maximum levels/thresholds;
- status change;
- too long transition time.

The occurrence of the above mentioned situations or combinations shall be reported and the item in question identified.

It shall be possible to initiate or carry out actions in the event of a certain situation (status, value, combinations) for instance:

- giving an acoustic signal;
- starting a program;
- generating a message;
- logging.

System hierarchy and authorization

System hierarchy shall be level determined; systems at a lower level always have a higher control authorization than systems at a higher level.

Access authorization shall be used to govern access to functions. Network control and ENMC system maintenance shall be clearly separated and need separate authorization.

There shall always be one and only one HMI in control of a network area or equipment at a time. Emergency buttons shall always be in overriding control of the equipment concerned, irrespective of control authorization. Presentation of information shall not depend on control authorization.

4.3.2 Communication

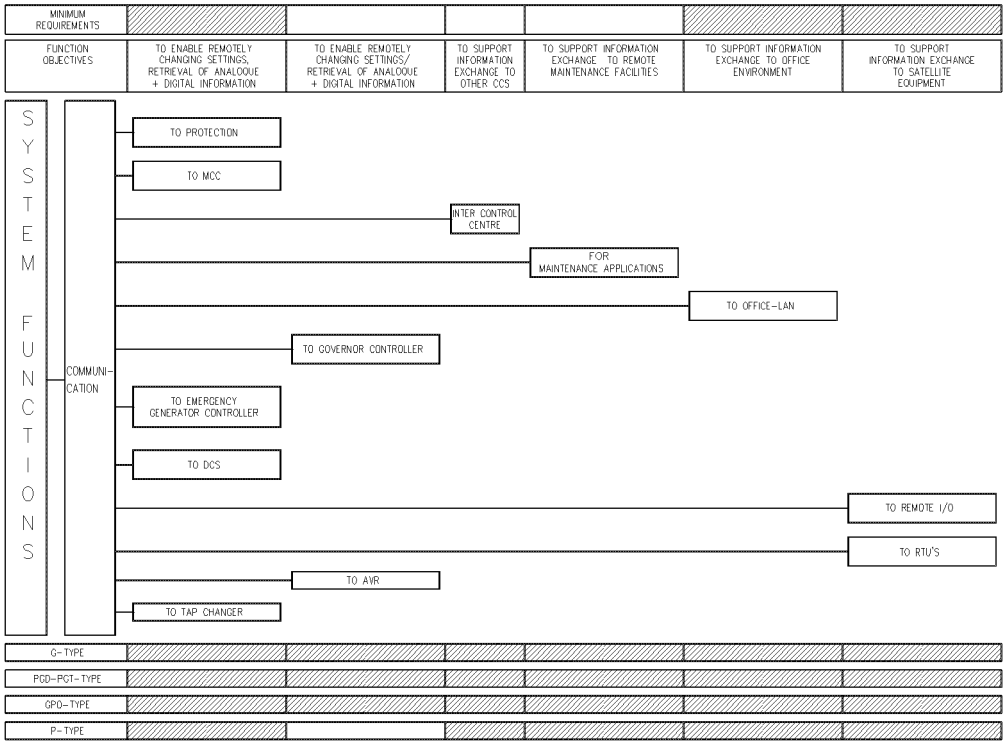
* The ENMC system shall be able to communicate with other systems by means of standard interfaces and protocols, including LANs, WANs, point-to-point data links, gateways to external networks and connections to X.25 public packet-switched networks.

• The requisition specifies those systems or equipment with which the ENMC system shall communicate. The following items shall be specified:

  – the kind of system/equipment in communication;
  – the data to be exchanged;
  – the protocol and type of messages to be used;
  – the type of link to be used.

Functional diagram 6 gives an overview of all system functions related to communication including the governing requirements.

Functional diagram 6 Functions related to communication



4.4 SUPPORT FUNCTIONS

Implementation of these functions is irrespective of the type of network.

The necessity of some support functions is a matter of choice to a certain extent. In determining the necessity of these functions non technical aspects shall also be examined i.e.:

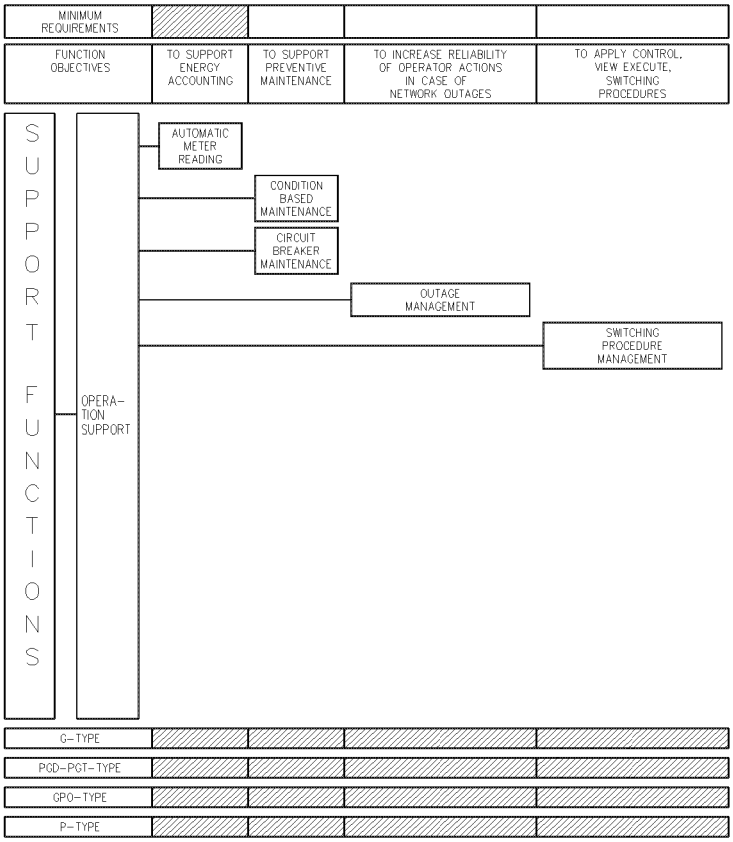
- extensiveness of the network;
- importance of the network control (i.e. cost factor);
- contracts with utilities or government authorities.

4.4.1 Operation support

The purpose of these functions is to support the operator's activities directed towards the performance of the electrical network.

Functional diagram 7 gives an overview of all support functions related to operation of the network including the governing requirements.

Functional diagram 7 Operation support functions



These functions shall be accessible from the user interface at level 3.

4.4.2 System support

The purpose of these functions is to support activities concerning the functioning and performance of the ENMC system itself.

Functional diagram 8 gives an overview of all support functions related to support of the ENMC system including the governing requirements.

* Unless otherwise specified in the requisition, these functions shall be accessible from the user interface at level 3 only. This level 3 shall be provided with a facility to connect an ‘engineering’ PC, giving the engineer access to all information and permitting engineering of all ENMC systems at all levels.

Engineering facilities shall also be accessible from levels 2 and 1 by connecting an ‘engineering’ PC. These engineering facilities shall be restricted to the (sub)systems concerned.

An historical database shall be built by means of a relational database.

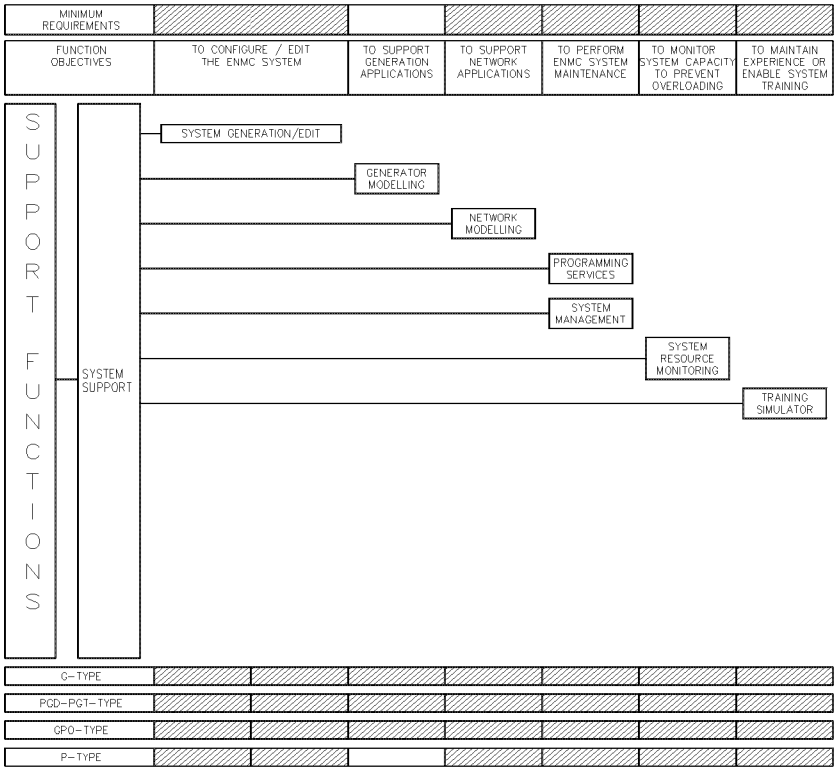
The system shall have extensive trouble-shooting and help functions available as well as information to support the operation of the network and its components (vademecum function). Vademecum information can consist of:

- time of appearance;
- meaning of the information;

– possible cause of an alarm or event;

– who is to be warned in a certain situation.

Functional diagram 8 System support functions



5. PERFORMANCE REQUIREMENTS

5.1 GENERAL

♦ The Manufacturer shall specify the functioning of the ENMC system under normal, abnormal and emergency operating conditions in terms of:

- response times;
- accuracy;
- integrity;
- availability;
- reliability;
- maintainability;
- EMC;
- environmental conditions;
- life cycle.

5.2 RESPONSE TIMES

* Unless otherwise specified in the requisition, the following minimum response times shall hold:

Item		minimum response time
starting up the complete ENMC system after a power breakdown		in line with hardware
starting up satellite equipment after a power breakdown		30 s
starting up the 'central' unit of the ENMC system after a power breakdown	for PC-based systems	2 min
	for systems based on workstations	8 min
issuing a command in response to the operator's command		1 s
updating information on the screen after change of value		1 s
completion of a newly selected display after call up		2 s

♦ The Manufacturer shall give an overview of the actual response times in the requisition along with the average CPU loading for each network activity scenario. The Manufacturer shall guarantee these response times as well as the CPU loading figures.

For determining response times, worst case operating conditions including future expansions shall be taken into account.

5.3 INTEGRITY

Information presented to the operator or used by the ENMC systems shall always and in all situations be reliable and real-time. Information that is not real-time or reliable shall be identified as such. Faulty information shall not be utilized by the system unless this has been approved.

All failures or discrepancies from normal functioning shall be reported by the system to the operator including identification of the problem and the function or hardware concerned.

After a power breakdown the ENMC system equipment shall restart automatically when

power is restored, updating automatically all network information and resuming normal operation. Loss of power supply shall not result in loss or failure of system or application software.

The total ENMC system and every subsystem shall be fail-safe. Faults occurring in a (sub)system or equipment shall never propagate to other (sub)systems or equipment. In the event of communication failures between levels, the systems concerned shall continue operation and perform their functions as far as the missing information allows this. Systems at a lower level shall always be able to function independently of the higher level.

System maintenance and supervisory control shall only be possible after authorization.

The implementation of new (system) software releases shall never jeopardise the integrity of the ENMC system.

No false commands are allowed under any circumstances.

No information shall be lost due to overloading of the system.

All information shall be time stamped.

The status (failure/functioning/activated) of equipment and protection functions shall be visible at the equipment itself.

- The Manufacturer shall describe:
  - measures to enhance integrity of serial communication;
  - measures to enhance reliability of information;
  - measures for blocking false commands;
  - system behaviour during startup and shut down sequences of ENMC equipment;
  - the behaviour of the system when limits or capacities are or will be violated.
- The Manufacturer shall make clear the system's ability to handle the information coming from the network in the event of a major network fault (a burst) without losing that information.

5.4 ACCURACY

* Unless otherwise specified in the requisition, the following requirements apply:

analogue measurements: inputs/outputs	0.25% full scale accuracy
analogue measurements: sampling time	1 s
analogue measurements, presentation	1% full scale accuracy
time stamps	1 ms accuracy
system time relevant to absolute time	1 ms accuracy
minimum pulse width to be detected	10 ms
commands (pulse)	0.1 to 50 s in 0.1 s steps

All information shall be in SI units if applicable.

5.5 ELECTRICAL ENVIRONMENT

* Unless otherwise specified in the requisition, the following dielectric tests are required:

insulation test; 50Hz: 1 min	Class III; IEC 60255-5
impulse voltage test: 1.2/50 µs (Ri=500Ω)	Class III; IEC 60255-4

♦ The Manufacturer shall be responsible for the power distribution within the ENMC system including DC/AC converters if applicable. The Manufacturer shall state the power supply needed for each location in the requisition sheet.

5.6 ELECTROMAGNETIC COMPATIBILITY

The ENMC system shall function according to this DEP in its electromagnetic environment.

The Manufacturer shall be responsible for the electromagnetic compatibility of the ENMC system.

5.6.1 EMC standards and test levels

The following EMC standards and test levels shall apply to the ENMC system.

Immunity

* Unless otherwise stated in the requisition, all ENMC equipment (including communication links) shall be specified with a Class III immunity level.

Class II may be required if special measures are taken, i.e.:

- equipment is used in a non-industrial environment;
- equipment is used in a protected environment;
- equipment is not coupled to galvanic connections needing a Class III immunity level.

Applicable standards and required test levels are given in EN 50082-2 including annex A plus the requirements as laid down in IEC 60255-22-1.

Unless otherwise stated in the requisition, the performance criterion shall be A, according to EN 50082-2.

Emission

* Unless otherwise stated in the requisition, all ENMC equipment shall be specified with a Class B emission level.

Equipment shall comply with EN 55022. Equipment not covered by EN 55022 shall comply with EN 50081-2.

5.6.2 Mitigating the electromagnetic disturbance level of the environment

To decrease the possibility of EMC problems suitable measures shall be taken.

EMC measures and specifications shall not be restricted to the ENMC system as the applicability of measures and their effects depend on the actual installations and equipment.

♦ The Manufacturer shall demonstrate that EMC is achieved throughout the system in accordance with IEC 61000-5. For this reason the following documents shall be handed over (if applicable):

- equipment specifications;
- applicable engineering practices;

- implementation reports;
- construction files;
- test reports.

5.7 AVAILABILITY, RELIABILITY AND MAINTAINABILITY

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.

5.7.1 General

Requirements shall be quantified wherever possible. Qualitative requirements may be appropriate where quantitative requirements do not specify the availability, reliability or maintainability performance with sufficient precision or where supplementary requirements are necessary (i.e. the behaviour of a product under single/multiple fault conditions, critical function monitoring facilities, self testing etc.).

Requirements shall be specified in a way that allows verification. It shall be clearly stated what constitutes a fault (hardware as well as software) for the item concerned and in the intended application; the (permitted) behaviour of the system or its components shall be specified including the (permitted) influence of faulted equipment on the rest of the ENMC system.

Performance levels shall be verified by:

- analysis during design;
- laboratory tests or field tests after production;
- field tests at the actual location after delivery (in situ).

5.7.2 Applicable levels of availability, reliability and maintainability

The design and selection of equipment and components shall be based on achieving an MTBF of not less than 100 000 hours.

Equipment at level 2 and level 1 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.

All components shall be of a quality and reliability commensurate with the overall controlling and monitoring requirements in continuously operating oil refineries, chemical plants and other such facilities.

Redundancy shall be considered to increase the availability and reliability of the ENMC system or parts thereof (for instance redundant communication links, CPUs/computers, mass data storage systems etc.).

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

The loss of critical functions shall not exceed 5 hours per year.

The loss of non-critical functions shall not exceed 15 hours per year.

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 noted down in the requisition sheet.

♦ The Manufacturer shall:

- make a proposal for verification of the specified performance levels;
- specify the extra costs, if any, of achieving the specified performances.

The methods used by the Manufacturer to compile the availability, reliability and maintainability data of equipment and systems shall comply with IEC 60409, IEC 60605,

IEC 60706, IEC 61070, IEC 61123 and IEC/FDIS 61124.

5.8 COMMUNICATION

Communication software shall be designed in accordance with the International Standards Organization (ISO) Open Systems Interconnect (OSI) model.

For communication, (industry) standard protocols shall be utilized where applicable, for instance TCP/IP, FDDI, X.25, ELCOM and ICCP for inter-Control-Centre communication and IEC 60870-5-101, Profi-bus, RS232, Modbus, DNP 3.0 etc. for communication to remote ENMC equipment (for instance RTUs, MCCs, protection relays etc.).

WSCC and IDEC need to be supported if the new system shall communicate with existing systems that only support these protocols and not more recent protocols such as ELCOM and ICCP.

If the ENMC system has no Operator Human Machine Interface capabilities but the information is presented via the DCS, the X-Workplace-Server protocol shall be supported as well.

Multiple standard data input formats shall be supported to provide importing of data for the purpose of system updates and initial loading of databases. For exporting of data to other systems, several standard data formats shall also be available.

In specifying communication requirements the following items shall be considered:

- interfaces to other systems;
- the possibility of future expansions or connections to other systems.

Optical fibre is preferred for communication links.

* Data import/export formats to support import/export of data shall be noted down in the requisition .

* Communication facilities of existing systems with which the new ENMC system shall communicate shall be noted down in the requisition.

All communication links shall be monitored in terms of overruns, quality errors and response time-outs. Repetitive failure of a communication link shall initiate an operator alarm.

• A communication network may already be available at the location.

* Where possible, already available communication facilities shall be utilized. This shall be indicated in the requisition.

Communication facilities shall be adequate for the functioning of the systems to be connected.

♦ The Manufacturer shall make clear:

- the communication protocols to be utilized in the data connections to other systems;
- costs of each connection including gateways, converters and/or adaptations to systems;
- the reliability and availability of each connection.

For every standard communication protocol to be utilised, the Manufacturer shall give a conformance statement or PID (= Protocol Implementation Document).

5.9 CAPACITY AND EXPANDABILITY

Capacity

The number of I/O per location is given in the requisition.

♦ The Manufacturer shall state:

- suggested buffer capacity to cope with abnormal operating conditions (i.e. lack of

communication, printer out of order, etc.);

- the number of data that can be handled in a limited time (i.e. during a burst) without disturbing critical functions which have to deliver their results within a predefined time;
- the (number of) functions that can run at the same time without significant mutual interference;
- the maximum number of I/O that can be handled.

A spare capacity of 40% shall be available without major modifications to the system. 25% of this spare capacity shall already be installed. If this 40% spare capacity is used, the performance of the system shall not degrade more than 10%.

Expandability

* The number of functions or equipment items which the ENMC system is expected to cover during its life cycle by process of expansion is specified in the requisition as a percentage of actual capacity. If expansion is implemented the remaining spare capacity shall not be less than 10%.

5.10 LIFE CYCLE

* The expected technical lifetime shall be 20 years. The Manufacturer shall clarify how this requirement will be met, in particular giving attention to the availability of spare parts.

The system shall have an open architecture, meaning that:

- changes can be implemented incrementally;
- portability across a wide range of platforms with minimal changes is possible;
- interoperation with local and remote applications is supported;
- user interaction is implemented in a way that facilitates application portability.

In achieving this open architecture, standards shall play an essential role.

The operating system shall be standard and unmodified, meeting all Open System standards, and shall be applied regularly for this application.

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

The Manufacturer shall guarantee hardware and software support during the lifetime of the equipment. This includes the availability of spare parts.

6. CONSTRUCTIONAL REQUIREMENTS

6.1 GENERAL

The ENMC system shall comply with sound engineering practices.

All applied components, equipment and software shall be standard products from reputable and acknowledged Suppliers/Manufacturers.

Equipment to be applied in substations shall comply with EN 50178.

To minimise parallel wiring I/O shall be located as close as possible to the objects to be controlled/monitored.

6.2 INPUTS AND OUTPUTS

All I/O circuits shall be powered from the ENMC mains power supply. The voltage level shall be specified in the requisition sheet.

For all status signals a level of < 80% of the nominal input voltage shall be regarded as a logical ‘null’.

Unless otherwise specified in the requisition, all I/O shall be:

- galvanically separated from other I/O and from earth;
- able to withstand short circuits;
- able to be connected to inductive loads (L/R specified in the requisition).

6.3 ENCLOSURES

The ENMC system shall be supplied completely installed in cabinets and including all internal connections. All cables, wiring, connectors and connection points shall be labelled and coded. Connectors shall utilize an alignment feature to indicate and ensure proper insertion and shall have a mechanical locking mechanism.

All metallic enclosures shall be connected to the earthing system. Earthing connections shall be non-corrosive and mechanically safe.

All equipment shall be clearly identifiable by means of a name plate.

System cabinets shall comply with DEP 32.37.20.31-Gen and T-2.934.007.

Enclosures of equipment at level 1, level 2 and level 3 shall have a degree of protection not less than IP 41. The degree of protection shall be in accordance with IEC 60529.

The floor shall not be considered as forming a part of the enclosure.

Cabinets shall be connected to a fire prevention/extinction system if applicable.

6.4 SOFTWARE

The operating system shall be a standard O.S. If applicable, the O.S. shall conform to the latest IEEE Portable Operating System Interface (POSIX) standards and directions. The supplier may only apply value added utilities that utilise the operating system services if they are fully supported.

The O.S. shall support multi-tasking.

The O.S. shall be sufficient safe to prevent the O.S. from the need of being restarted in case of crashing of an application.

Application software shall, where ever possible, utilise O.S. facilities.

For database access and developing displays and application programs, structured techniques and high level programming languages shall be used.

Interfaces to relational databases shall comply with the SQL standard.

All system software, including all compilers, assemblers, editors etc. shall be standard and shall not be modified by the Supplier.

Standard available software for data processing shall be used.

- All standard software shall be Shell-compliant and shall need approval of the Principal.

6.5 HUMAN MACHINE INTERFACE

The HMI shall be realized according to applicable standards (e.g. X-Windows, OSF/Motif, Open/Look etc.).

The system shall have a uniform HMI (e.g. the menu structure has the same 'look and feel' across all applications) and a uniform naming convention of objects across all applications.

For every location the human interface shall be suitable for the site conditions (3.2).

Printers shall be easily accessible to facilitate paper refilling and removing print-outs.

- Unless otherwise specified in the requisition, CRTs shall be utilized. Touch screen CRTs are allowed.

If the ENMC system is not integrated with the process control system (2.6), CRTs shall be placed on a desk with sufficient area to write/read, use a mouse and place telephone equipment. All equipment shall be accessible for the operator while seated.

6.6 SYSTEM COMPONENTS

All applied components shall have sufficient lifetime to comply with a system lifetime of 20 years.

Where applicable, PCBs and /or equipment frames shall be easily removable and indicate their status (failure, functioning) to facilitate fault diagnosis.

I/O boards shall be provided with status LEDs for every in- and output.

Changing I/O boards shall be possible without switching off the power of the equipment concerned.

All external ENMC components shall be clearly identifiable by means of permanent descriptive labels, facilitating easy recognition.

6.7 WIRING

Wiring to secondary equipment shall be PVC or XLPE-insulated and have stranded copper conductors. The size and type of the wires shall be based on mechanical strength, voltage levels and prospective current levels. The minimum allowable cross-sectional area of the wires shall be 1.5 mm^2. Current transformer secondary circuits with 5A rating shall be 2.5 mm^2 minimum.

Colour coding of secondary wiring shall be in accordance with IEC 60446. Earth wires shall be green/yellow striped. Wiring between two terminals shall be continuous and without joints.

Wiring ends of stranded conductors which have to be connected into bus-type contacts of terminals shall be provided with compression-type pre-insulated wire pins with insulation support. In general, when lugs, wire pins, etc. are used, they shall be of the compression type.

All wires shall be identified at both ends by means of ferrules of insulating material or by plastic code markers.

Marking shall be in accordance with the Manufacturer's drawings and IEC 60391.

Rail-mounted terminals shall be identifiable by numerical or alphabetical markings in accordance with the Manufacturer's drawings and IEC 60445.

6.8 OPTICAL FIBRES

In order to minimise signal attenuation, as few connectors and splices as possible shall be used. Connectors shall only be used to connect equipment and in patch panels.

The fibre type to be used shall be suitable for the distance to be spanned and the protocol to be used.

6.8.1 Colouring

Optical cables shall be colour coded as specified in IEC 60304.

The colouring including marking shall be unambiguous. It shall be possible to identify all the optical fibres within each loose tube in a 30 cm length of optical cable core, provided that each loose tube is coded.

The colouring shall be permanent; it shall only be possible to remove the coloring by stripping off the coating or by using special solvents. The colours shall not fade inside the cable or as a result of exposure in a junction box or at the terminals. Colouring shall not prejudice any of the properties of the optical fibre of the cable.

- The colouring schedule as applied in the installation concerned shall be applied.

6.8.2 Applicable standards

Optical fibres shall be standard and shall comply with the requirements laid down in IEC 60793-1 amended by the requirements mentioned in ITU-T G.651 for multimode graded index fibres and ITU-T G.652 for single-mode fibres.

Cables incorporating optical fibres shall comply with IEC 60794-1.

Connectors shall be of a suitable and commonly used type, e.g. SC, SMA, ST.

7. INSPECTION AND TEST PROCEDURES

7.1 GENERAL

Inspections and tests shall be carried out to demonstrate that the ENMC complies with the requirements laid down in this DEP.

ENMC system requirements shall be specified in sufficient detail to allow the conformity of the ENMC system with this DEP to be assessed.

Hold, observation and witness points shall be incorporated in the manufacturing schedule so that the Principal can check or test designs or results.

The Manufacturer shall submit a proposal for tests for review by the Contractor/Principal which shall be representative for the manufacturing process of the ENMC system. This proposal shall also include hold, observation and witness points. Items to be specified are:

- the object to be tested;
- the kind of tests to be carried out;
- the conditions under which the tests shall be performed;
- the procedures to be followed;
- the aspects of the object to be tested;
- how the results will be evaluated;
- when the tested aspect has passed the test.

All functions implemented in the ENMC system shall be tested.

Test protocols and criteria shall be agreed upon between the Manufacturer and the Principal.

Test results shall be measurable; the performance of the test object shall be clearly specified in terms of conditions, inputs and outputs. The specification of the whole system or relevant part shall form the starting point in all cases.

The following types of tests can be distinguished:

- type tests
  carried out to verify design characteristics. May be performed on any (sub)system and may cover hardware and/or software.
- routine tests
  a series of tests to confirm that each individual (sub)system has been correctly manufactured and set up, that protection against electric shock is provided and that functional requirements are met.
- sample tests
  a sufficient sample of devices shall be tested at appropriate time intervals to give reliable information on the uniformity of the manufacturing process.
- factory acceptance test (FAT)
  performed to verify the performance of the system. Inspection of documentation and test protocols is also a part of this test.
- fool-proof test
  this is a set of unstructured tests.
- site acceptance test (SAT)
  required to check that:
  - no damage has occurred in transit;
  - protective and control devices operate as intended;
  - interfaces with other systems (if applicable) are compatible and function correctly.
- site integration test (SIT)
  - the system is suitable and functions correctly in its environment;
  - to check that the system has been properly integrated in the installation.
- availability test

after the SAT and when the system is fully integrated, an availability test shall prove that the required and specified availability of software and hardware that have been specified as critical is achieved. During this test, hardware and software reliability shall also be checked.

- EMC test

  may be performed on the ENMC system or parts thereof to check the implementation of EMC measures.

Tests may also include checks of drawings and lists.

The Manufacturer shall ensure that specified (environmental) conditions are effective during the test, taking into account tolerances and inaccuracies.

Prior to dispatch, the functioning of all equipment shall be verified by means of a factory acceptance test.

7.2 RESPONSIBILITIES

The Manufacturer shall deliver test protocols for review by the Contractor at least 8 weeks before the test concerned is carried out.

The Manufacturer shall be responsible for performing the tests.

The Contractor/Principal or a representative may witness a test.

The fool-proof test will be performed by the Principal with the Manufacturer present.

The Manufacturer shall submit to the Contractor/Principal a report of the results of each test within 1 week after the test has been carried out.

Test results will be evaluated by and need the approval of the Contractor/Principal.

It shall be the Manufacturer's responsibility to ensure that all equipment is delivered in conformance with the prescribed and agreed tests.

7.3 REQUIRED TESTS

Unless otherwise specified in the requisition, the following tests shall be performed on the ENMC system:

Type test	Shall have been performed on every (sub)system or part that is utilized in the ENMC system. If modifications are made that might affect performance a type test shall also be performed.
FAT	The test shall apply to all aspects of the ENMC system, including communication with other systems. Every type of equipment in the ENMC system shall be subject to this test. For the level 3 equipment FAT, a representative number of the lower level equipment shall be used to simulate the network requirements.
Fool-proof test	In addition to the FAT this test shall be performed.
SAT	This test shall be performed on the complete ENMC system. All functions shall be tested. The SAT may be an integral part of the overall test of the electrical network installations.
SIT	This test shall be performed on the complete ENMC system. Every process point shall be tested.
Availability test	This test shall be performed for a period of 2 200 hours. During the last 200 hours of this test no failures or switchovers (in hot-standby redundant systems) are allowed. The system is regarded to be 'down' if the Principal cannot use functions that are regarded to be essential to monitor and control all or part of the electrical network. The Contractor shall specify these functions in the requisition sheets as critical. Down time due to equipment that is not part of the ENMC system is ignored.
EMC test	This test shall be performed on specified equipment. Equipment located in the vicinity of high voltage systems or known to be sensitive to electromagnetic fields is the most probable candidate. The equipment to be tested shall also be specified in the requisition.

8. DOCUMENTS

The Manufacturer shall provide the following documents as a minimum:

During the project (2.2):

- functional descriptions and specifications of:
  - the complete system and subsystems;
  - standard and specific application systems;
  - user interfaces (including a description of operator logs),
- software flowcharts and listings;
- hardware specifications;
- overview of capacities and performance;
- quality assurance procedures;
- test and inspection reports;
- system specific documentation:
  - configuring information (including function schemes);
  - processing of information including suppression and classification in groups, lists, categories, archives etc.;
  - data exchange with other systems;
  - interlocks;
  - sequential switching programs;
  - control schemes;
  - authorization schemes;
  - screens and paging structure;
  - displays (static + dynamic information + control points);
  - help/editor functions.

At hand over:

- ordering specifications and ordering letters;
- service contracts;
- service requirements;
- manuals (system operation, installation, maintenance, training).

9. REFERENCES

In this DEP, reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments, supplements or revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.
System cabling	DEP 32.37.20.31-Gen.
Data requisition sheet for ENMC systems	DEP 33.64.10.93-Gen.
Data/requisition sheet for LV switchgear including addendum IMCS	DEP 33.67.01.93-Gen.
Data/requisition sheet for synchronous AC generators	DEP 33.65.11.93-Gen.
Data/requisition sheet for electric motors: case inductions and synchronous type	DEP 33.66.05.93-Gen.
Electrical variable speed drives	DEP 33.66.05.33-Gen.
Guidelines for electrical supply and generation - design and operation	DEP 33.64.10.12-Gen.
System cabinet specification	T-2.934.007

EUROPEAN STANDARDS

Electronic equipment for use in power installations	EN 50178
Electromagnetic compatibility; generic emission standard	
Part 2: Industrial environment	EN 50081-2
Electromagnetic compatibility - Generic immunity standard	
Part 2: Industrial environment	EN 50082-2
Limits and methods of measurement of radio disturbance characteristics of information technology equipment	EN 55022

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INTERNATIONAL STANDARDS

IEC standard voltages	IEC 60038
Environmental testing	
Part 2: Tests	
Test A: cold	IEC 60068-2-1
Test B: dry heat	IEC 60068-2-2
Test Db and guidance: Damp heat, cyclic (12 + 12-hour cycle)	IEC 60068-2-30
Electrical relays	
Part 5: Insulation tests for electrical relays	IEC 60255-5
Part 11: Interruptions to and alternating component (ripple) in d.c. auxiliary energizing quantity of measuring relays	IEC 60255-11
Part 21: vibration, shock, bump and seismic tests on measuring relays and protection equipment	
Section two: shock and bump tests	IEC 60255-21-2
Electrical relays	
Part 22: Electrical disturbance tests for measuring relays and protection equipment	
Section one: 1 MHz burst disturbance tests	IEC 60255-22-1
Dependability management	IEC 60300
Standard colours for insulation for low-frequency cables and wires	IEC 60304
Marking of insulated conductors	IEC 60391
Guide for the inclusion of reliability clauses into specifications for components (or parts) for electronic equipment	IEC 60409
Identification of equipment terminals	IEC 60445
Identification of insulated and bare conductors by colours	IEC 60446
Classification of degrees of protection provided by enclosures	IEC 60529
Equipment reliability testing	IEC 60605
Guide on maintainability of equipment	IEC 60706
Optical fibres	
Part 1: Generic specification	IEC 60793-1
Optical fibre cables	
Part 1: Generic specification	IEC 60794-1
Telecontrol equipment and systems	
Part 5: Transmission protocols	
Section 101: Companion standard for basic telecontrol tasks	IEC 60870-5-101
Electromagnetic compatibility (EMC)	

Part 5: Installation and mitigation guidelines	IEC 61000-5
Compliance test procedures for steady-state availability	IEC 61070
Reliability testing; compliance test plans for success ratio	IEC 61123
Reliability testing - Compliance tests for constant failure rate and constant failure intensity	IEC 61124

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Characteristics of a 50/125 µm multimode graded index optical fibre cable	ITU-T G.651
Characteristics of a single-mode optical fibre cable	ITU-T G.652

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