

PETRONAS TECHNICAL STANDARDS

MANUAL

Electrical Network Monitoring And Control System (ENMC) Specification

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This revision of PTS **33.64.10.32 – Electrical Network Monitoring And Control System – Specification (February 2011)** has been reviewed and updated to incorporate PETRONAS Lessons Learnt, Best Practice and new information issued by relevant industry code and standards. All updates in the document are highlighted in *italic* font (if any).

The previous version of this PTS **33.64.10.32 – Electrical Network Monitoring And Control System – Specification (February 2010)** will be removed from PTS binder / e-repository from herein onwards.

Document Approval

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PREFACE

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The objective is to set the recommended standard for good technical practice to be applied by PETRONAS' OPU in oil and gas production facilities, refineries, gas processing plants, chemical plants, marketing facilities or any other such facility, and thereby to achieve maximum technical and economic benefit from standardisation.

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1. INTRODUCTION

1.1 SCOPE

This PTS 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 PTS shall be applied in conjunction with PTS 33.64.10.11. 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 PTS. 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 (PTS 33.64.10.11.).

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by PETRONAS, the distribution of this document is confined to companies forming part of the PETRONAS or managed by a Group Company, and to Contractors nominated by them (i.e. the distribution code is "C", as defined in PTS 00.00.05.05.).

This PTS 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 PTS, 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 PTS 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

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

	conditions.
<i>Production cost monitoring</i>	Monitoring and summarising production costs and fuel consumption of generating units, comparing them with optimum production costs.
<i>Real time sequence control</i>	A sequential run of network application functions.
<i>Reserve monitoring</i>	Calculating actual figures for active/reactive spinning and operating reserves, comparing these with defined classes and indicating shortfalls.
<i>Security checked switching</i>	Checking the power system state for limit violations as a result of an intended switching action.
<i>Security dispatch</i>	Achieving an optimum balance between security, costs and other operational constraints, and determining the most effective remedial actions if operating constraints are violated.
<i>Service restoration</i>	Determining alternatives for re-energising equipment and sections that are switched off but not identified as faulted.
<i>State estimator</i>	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.
<i>Transformer load management</i>	Utilisation of short-term overload capabilities of a transformer; load balancing between transformers by feeder reconfiguration.
<i>Unit commitment</i>	Scheduling operation of generating units to supply the load under certain constraints.
<i>Volt/Var control</i>	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:

$$\text{Availability (\%)} = (\text{total time} - \text{total down time}) / (\text{total time}) \times 100.$$

Burst

An avalanche of information in the event of a fault in the electrical network.

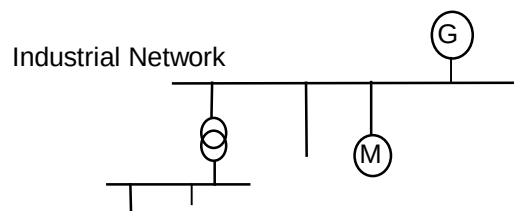
Distributed Control System

A computerised system which is dedicated to monitoring and controlling defined aspects of process installations.

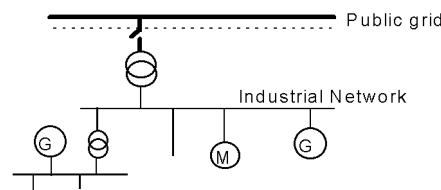
Electrical Network

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.

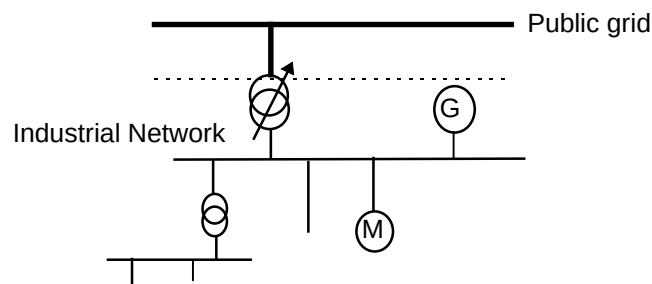


GPO (Generation, Public Optional) Type Network	Electrical network, normally self-supporting, coupling to the public network possible.
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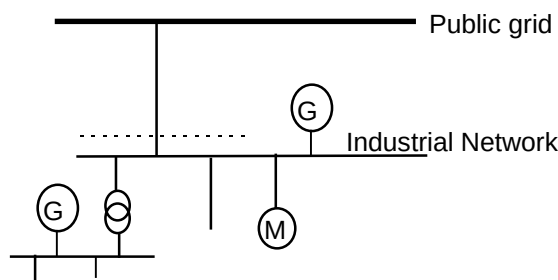
Hold point	A point in time during the project where a specified product requires the approval of the Contractor or the Principal, without which the project shall not proceed.
Immunity Level	The electromagnetic disturbance that is permitted without degradation of the performance of an equipment or system.
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.



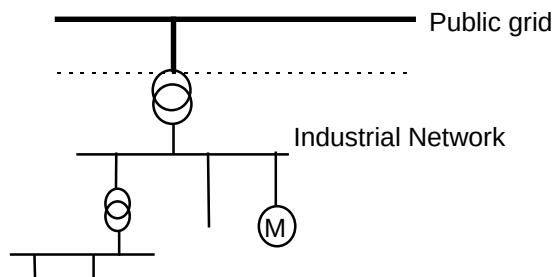
PGD (Public/Generation, Directly connected) Type Network

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 PTS are made, the referenced section number is shown in brackets. Other documents referenced in this PTS 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 PTS 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 PTS;
- 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 PTS;
- 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 PTS.

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 PTS.

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

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

