

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

POWER QUALITY GUIDELINES

PTS 33.64.10.14

December 2010



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This PTS **33.64.10.14 - Power Quality Guidelines (December 2010, Revision 1)** has been developed to provide guidelines on how to deal with power quality issues. It incorporates best practices and lessons learnt from PETRONAS operating units on the subject of power quality.

The previous version of this PTS **33.64.10.14 - Power Quality Guidelines (March 2010)** shall be removed from PTS binder / e-repository and replaced by PTS **33.64.10.14 - Power Quality Guidelines (December 2010, Revision 1)** herein onwards.

Document Approval

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PREFACE

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They are based on the experience acquired during the involvement with the design, construction, operation and maintenance of processing units and facilities. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good technical practice to be applied by PETRONAS' OPU/Divisions 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 gives recommended practices and requirements to attain and maintain power quality in PETRONAS facilities. It provides an overview of what are required to be done to mitigate typical power quality problems found in the plant or any facilities in PETRONAS. This PTS is developed based on lessons learnt, best practices and experiences.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by PETRONAS, the distribution of this PTS is confined to companies forming part of PETRONAS group and to Contractors nominated by them.

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

If national and/or local 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, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this PTS 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 object of obtaining agreement to follow this PTS 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 for maintenance 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 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 **must** indicates a requirement.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 TECHNICAL BASIC DEFINITIONS

Power Quality

Ability to maintain (in AC circuit) a sinusoidal voltage and current at stipulated magnitude, frequency and continuity.

Disturbance in AC System.

In AC system, disturbance or elements that can affect the quality of supply include among them (compare to nominal value):

- i) Voltage deviations – over, dip/sag, flicker, transient.
- ii) Frequency – high/low
- iii) Harmonics – voltage and current
- iv) Resonance
- v) Electro-magnetic interference

Electromagnetic Compatibility (EMC), 161-01-07, IEC 60050

The ability of a device, equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.

Frequency deviation, 604-01-06, IEC 60050

The difference between the system frequency at a given instant and the nominal value.

Harmonics

Frequency components that are integer multiples of the fundamental line frequency.

Voltage deviation, 604-01-17, IEC 60050

That difference, generally expressed as a percentage, between the voltage at a given instant at a point in the system, and a reference voltage such as nominal voltage, a mean value of operating voltage, or declared supply voltage.

Voltage dip, 604-01-25, IEC 60050

A sudden reduction of the voltage at a given point in the system, followed by voltage recovery after a short period of time, from a few cycles to a few seconds.

Voltage surge, 604-03-14, IEC 60050

A transient voltage wave propagating along a line or a circuit and characterised by a rapid increase followed by a slower decrease of the voltage.

ATS

Automatic transfer system. Works by transferring power supply from one feeder or bus section to another as a result of a voltage dip of preset magnitude and duration.

PCC

Point of a power supply network where the plant power system is interconnected with the grid. This point is mutually agreed between the interconnected parties and is usually also the synchronizing point between the two systems.

1.4 ABBREVIATIONS

ATS	-	Automatic Transfer System
AVR	-	Automatic Voltage Regulator
EMC	-	Electromagnetic Compatibility
ENMC	-	Electrical Network Monitoring and Control system
FAT	-	Factory Acceptance Test
MCC	-	Motor Control Center
OLTC	-	On-Load Tap Changer
PCC	-	Point of Common Coupling
PMS	-	Power Monitoring System
PQ	-	Power Quality
UPS	-	Uninterruptible Power Supply
VSD	-	Variable Speed Drive
VFD	-	Variable Frequency Drive

2 INTRODUCTION TO POWER QUALITY

The impact of poor power quality on oil, gas and petrochemical industries can be tremendous, running into millions of dollars on account of a single disturbance. These industries run many sensitive or mission-critical operations which when interrupted even momentarily, can take days to recover with the inevitable consequences of lost production opportunities, product loss due to flaring and perhaps more importantly, loss of reputation. Examples of these operations are:

- Continuous process operations driven by electric motors where a short voltage dip can cause motors to drop out thus interrupting the process. This is compounded by the fact that a large proportion of a plant load is made up of motors.
- Multi-stage batch operations where an interruption during one process can destroy the value of previous operations or result in off-spec products.

2.1 TYPICAL POWER QUALITY PROBLEMS

The chart in Appendix 1 shows the type of power quality problems that had caused plant upsets in sixteen plants with data taken from two surveys. Each survey collected data over a 2¹/₂ year period. From the surveys, the electrical disturbances encountered were:

- Voltage dip
- Relay mal-operation
- Under-frequency
- Poor power factor
- Harmonics
- Electro-magnetic interference
- Over-frequency

Relay mal-operation is not typically regarded as a power quality issue. However, it is seen to be a key contributor to equipment or power outages based on the surveys carried out.

2.2 CAUSES AND EFFECTS OF POOR POWER QUALITY

The table below summarizes the impact poor power quality can have on plants.

Impact / Effects of poor power quality		
Type	Typical Cause	Impact / Effects
Voltage dip	Faults, switching of large loads e.g. motor starting	Motor drop-out, VSD trip, ATS transfer, motor stalling, generator trip, loss of synchronism
Voltage swell	Switching transients, lightning	Over-fluxing of transformers, insulation failure, generator trip
Voltage unbalance	Asymmetric loads, unequal system impedances	Loss of motor full load torque, overheating of rotor/stator and bearing damage. De-rating of cables, transformers.
Under-frequency	System overload due to loss of generation capacity (trip),	Load shedding, power swing to the grid, power blackout
Over-frequency	Loss of large loads, system faults	Generator trip, power swing from the grid
Poor power factor	Large inductive load, lack or loss of power factor control.	Low power factor penalty, de-rating of equipment