

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

GAS TURBINE COMBUSTION AIR INTAKE AND EXHAUST SYSTEMS

PTS 31.29.70.32

DECEMBER 2010



© 2010 PETROLIAM NASIONAL BERHAD (PETRONAS)

All rights reserved. No part of this document may be reproduced, stored in a retrieval system or transmitted in any form or by any means (electronic, mechanical, photocopying, recording or otherwise) without the permission of the copyright owner

PTS Circular 2010 – 31.29.70.32



PTS No.	31.29.70.32
PTS Title:	Gas Turbine Combustion Air Intake and Exhaust Systems

This PTS 31.29.70.32- Gas Turbine Combustion Air Intake and Exhaust Systems has been updated and has incorporated PETRONAS Lessons Learnt, Best Practice and new information issued by relevant industry code and standards. This PTS is still valid and with editorial changes only.

The previous version of this PTS 31.29.70.32 (December 1999) will be removed from PTS binder / e-repository from herein onwards.

The custodian of this PTS is:

Name: Zaharudin Ariffin

Tel. No: 03-2783 6231

Please direct any questions regarding this PTS to the above-named.

Document Approval

	Name	Designation	Date	Signature
Prepared/ Reviewed	Zaharudin Ariffin	Principal Engineer, Engineering, GTS	01/12/10	
Reviewed/ Approved	MK Shrivastava	Custodian Engineer Engineering, GTS	01/12/10	
Verified	Pau Kiew Huai	General Manager, Engineering, GTS	3/12/10	
Endorsed	Sazali Hamzah	Senior General Manager, GTS	10/12/10	

Revision History

Date	Version	Description of Updates	Author
Dec 1999	0		
Dec 2010	1	Periodic Review	ZA

PREFACE

PETRONAS Technical Standards (PTS) publications reflect the views, at the time of publication, of PETRONAS OPU/Divisions.

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 standardization.

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

When Contractors or Manufacturers/Suppliers use PTS they shall be solely responsible for the quality of work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, it is expected of them to follow those design and engineering practices which will achieve the same level of integrity as reflected in the PTS. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the owner.

The right to use PTS rests with three categories of users:

- 1) PETRONAS and its affiliates.
- 2) Other parties who are authorized to use PTS subject to appropriate contractual arrangements.
- 3) Contractors/subcontractors and Manufacturers/Suppliers under a contract with users referred to under 1) and 2) which requires that tenders for projects, materials supplied or - generally - work performed on behalf of the said users comply with the relevant standards.

Subject to any particular terms and conditions as may be set forth in specific agreements with users, PETRONAS disclaims any liability of whatsoever nature for any damage (including injury or death) suffered by any company or person whomsoever as a result of or in connection with the use, application or implementation of any PTS, combination of PTS or any part thereof. The benefit of this disclaimer shall inure in all respects to PETRONAS and/or any company affiliated to PETRONAS that may issue PTS or require the use of PTS.

Without prejudice to any specific terms in respect of confidentiality under relevant contractual arrangements, PTS shall not, without the prior written consent of PETRONAS, be disclosed by users to any company or person whomsoever and the PTS shall be used exclusively for the purpose they have been provided to the user. They shall be returned after use, including any copies which shall only be made by users with the express prior written consent of PETRONAS.

The copyright of PTS vests in PETRONAS. Users shall arrange for PTS to be held in safe custody and PETRONAS may at any time require information satisfactory to PETRONAS in order to ascertain how users implement this requirement.

TABLE OF CONTENTS

1.	INTRODUCTION	5
1.1	SCOPE	5
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS.....	5
1.3	DEFINITIONS.....	5
1.4	CROSS-REFERENCES.....	5
2.	GENERAL REQUIREMENTS FOR BOTH AIR INTAKE SYSTEMS AND EXHAUST SYSTEMS	6
2.1	SCOPE OF SUPPLY	6
2.2	OVERALL NOISE LIMITATIONS.....	6
2.3	QUALITY ASSURANCE	6
2.4	MATERIALS	6
2.5	FASTENERS.....	6
2.6	WELDING.....	7
2.7	ELECTRICAL	7
2.8	INSTRUMENTATION.....	7
2.9	FIRE AND GAS SYSTEM.....	8
2.10	UTILITY SERVICES.....	8
2.11	EXTERNAL INSULATION.....	8
3.	AIR INTAKE SYSTEM	9
3.1	SCOPE OF SUPPLY	9
3.2	OVERALL DESIGN	9
3.3	MECHANICAL DESIGN AND ARRANGEMENT	10
3.4	PRIMARY AIR INTAKE	10
3.5	MAIN AIR INTAKE FILTER.....	11
3.6	AIR INTAKE SILENCER	12
3.7	PLENUM CHAMBER	13
3.8	DUCTWORK	14
3.9	DOORS	15
3.10	ANTI-ICING SYSTEM	15
3.11	INSTRUMENTATION.....	16
4.	EXHAUST SYSTEM	18
4.1	SCOPE OF SUPPLY	18
4.2	GENERAL DESIGN	18
4.3	EXHAUST PLENUM CHAMBER	18
4.4	EXHAUST SILENCER	18
4.5	EXHAUST DUCTWORK	19
4.6	EXHAUST STACK	19
4.7	EXHAUST EXPANSION JOINTS	19
5.	DOCUMENTATION	21
5.1	TECHNICAL MANUALS	21
5.2	DATA/REQUISITION SHEETS.....	22
5.3	SPARE PARTS LISTS	22
5.4	OTHER DOCUMENTATION.....	22
6.	INSPECTION AND TESTING	23
6.1	GENERAL	23
6.2	INSPECTION	23
6.3	TESTS.....	24
6.4	REPORTS AND RECORDS	24
7.	REFERENCES	25

APPENDICES

APPENDIX 1	SUMMARY OF MONITORING AND PROTECTION INSTRUMENTATION	27
------------	--	----

1. INTRODUCTION

1.1 SCOPE

This new PTS specifies requirements and give recommendations for gas turbine combustion air intake systems and exhaust systems. It is intended to amplify those requirements included in PTS 31.29.70.11.

For the purposes of this PTS, gas turbine installations are divided into three categories:

- offshore;
- coastal (less than 15 km from the sea);
- inland.

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 or managed by a Group company, and to Contractors and Manufacturers/Suppliers nominated by them (i.e. the distribution code is "F" as described in PTS 00.00.05.05).

This PTS is intended for use in offshore and onshore oil and gas production facilities, but may be used for other applications.

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 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

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 or maintenance 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.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this PTS are made, the referenced section number is shown in brackets. Other documents referenced by this PTS are listed in (7).

2. GENERAL REQUIREMENTS FOR BOTH AIR INTAKE SYSTEMS AND EXHAUST SYSTEMS

2.1 SCOPE OF SUPPLY

Unless otherwise agreed in writing with the Principal, the Manufacturer/Supplier shall supply the complete air intake and/or exhaust system as specified by this PTS. If specified, the scope of supply shall also include the turbine enclosure ventilation air system.

NOTE: Air intake systems and exhaust systems are normally purchased as part of a package including the gas turbine and driven machine. This PTS is primarily directed at the Manufacturer/Supplier(s) of the air intake and exhaust systems. The Manufacturer/Supplier of the package remains responsible for the overall engineering and performance of the package.

2.2 OVERALL NOISE LIMITATIONS

The noise generated by the complete gas turbine package, including the combustion air intake system, the exhaust system and the driven machine, shall not exceed the limits specified in the main package order/enquiry. The Manufacturer/Supplier of the air intake and/or exhaust system shall liaise with the turbine Manufacturer/Supplier to ensure that the design and arrangement of the intake and exhaust systems with silencers will allow the overall limits to be achieved. See also (3.6.1) and (4.4.1).

2.3 QUALITY ASSURANCE

The Manufacturer/Supplier and any Sub-Manufacturer/Supplier shall maintain and operate a quality system which complies with the requirements of ISO 9001 and shall submit with his/their tender(s) a quality control plan for all equipment, listing sequentially all quality-related design, manufacturing, inspection and test activities.

2.4 MATERIALS

Except as otherwise specified in particular sections of this PTS, all construction materials including ductwork, all flanges, plenum chamber, filter housing and framework, panel stiffeners, louvres, silencers, doors and internal fittings shall be austenitic stainless steel. An easily weldable grade of austenitic stainless steel, such as AISI 316L, shall be used for plate materials, rolled sections and other parts that may require welding.

For air intake systems, Manufacturers/Suppliers may, in addition to the base quotation for stainless steel, offer an alternative quotation for aluminium material or non-metallic materials such as glass-reinforced plastic (GRP), indicating the possible weight saving and details of their experience with the alternative material.

If aluminium is offered, the corrosion resistance of that particular grade in a marine environment shall be demonstrated.

2.5 FASTENERS

Threaded and any other fasteners which could conceivably work loose during operation shall, where possible, be restricted to external flanges and brackets where such fasteners do not penetrate the internal surface of the ductwork or housing.

Unless absolutely essential, internal fasteners shall not be used in the air intake system downstream of the filter or in locations in the exhaust system where it is possible for them to fall back into the turbine. Where internal fasteners are absolutely unavoidable, they shall be retained by wire locking or tab washers or otherwise be positively secured. Wire locking shall be done through holes drilled in the nut and bolt heads. Wire shall be either austenitic stainless steel or Monel 400. Welding nut and bolt heads shall only be permitted where no disassembly is required for maintenance and where wiring is not possible. Lock nuts or methods of securing nuts which rely on friction shall not be used.

Pop rivets shall not be used as fasteners.

2.6 WELDING

Amended per
Circular 47/05

For additional welding requirements, reference shall be made to PTS 30.10.60.18.

All welding shall be performed in accordance with properly documented and controlled procedures and in a planned sequence. Procedures shall be identified on Manufacturer/Supplier drawings against the appropriate joints and shall include any pre- or post-weld heat treatments as well as details of repairs, and the non-destructive testing to be applied.

Only weld repairs which are performed in accordance with properly documented and controlled procedures are permitted.

All welds (except those for external stiffeners) shall be continuous, unless otherwise agreed by the Principal.

All welds shall be inspected in accordance with (6.2.2). Defect acceptance levels shall be in accordance with (6.2.2).

2.7 ELECTRICAL

All electrical equipment and fittings shall be in accordance with PTS 33.64.10.10. When necessary to meet hazardous area requirements, electrical equipment shall be certified for use in the appropriate zone and gas group conditions, in accordance with IEC 60079.

2.8 INSTRUMENTATION

2.8.1 General

Unless specified otherwise in the order/enquiry, the monitoring and protection instrumentation as required by this PTS and summarised in (Appendix 1) shall be provided as a minimum.

All instrumentation shall be easily accessible from grade or from permanent elevated platforms.

Unless specified or agreed otherwise, the Manufacturer/Supplier of the air intake and/or exhaust system shall supply all locally mounted instruments, transmitters, microswitches etc.

Remotely mounted instruments, alarm/shutdown switches etc. shall be supplied by the gas turbine Supplier.

The make/type of instruments shall be submitted for the Principal's approval. The Principal reserves the right to nominate the Manufacturer from whom certain instruments shall be obtained.

2.8.2 Pressure measurement

Differential pressure shall be indicated locally by diaphragm type instruments unless otherwise specified.

Remote indication of pressure and differential pressure and the provision of alarm and/or shutdown functions shall be achieved by the use of locally mounted electronic transmitters.

At least three tapings shall be provided for each pressure measurement point. They shall be located so that the possibility of blockage is minimised. The three tapings shall be manifolded together.

2.8.3 Temperature measurement

Air temperature measurement and temperature alarms and/or shutdown functions shall be achieved by the use of thermocouples or resistance temperature detectors (RTDs) in shielded thermowells, in conjunction with locally mounted amplifier/transmitters.

The thermowells shall protrude into the airstream to a sufficient extent (generally not less than 250 mm) to ensure representative temperature measurement and shall be adequately braced or otherwise supported to avoid aerodynamic excitation.

The arrangement shall be such that the thermocouples or RTDs can be replaced with the turbine in operation.

2.8.4 Position/status Indication

If the position/status of doors or other items shall be indicated, this shall be achieved by the use of sealed limit switches or proximity type switches.

The switches shall be mounted externally to the duct, plenum chamber etc. and shall be so arranged that they can be replaced with the turbine in operation.

Mercury switches shall not be used.

2.8.5 Alarms and shutdowns

Alarm and shutdown functions shall utilise separate dedicated switches and/or transmitters.

The alarm and shutdown functions located on a panel indicator in the local turbine control room shall be duplicated in the Installation Control Centre for manned installations and in the Local Control Centre for unmanned installations.

The final arrangement of the safeguarding system shall be subject to an IPF (Instrumented Protective Function) review in accordance with PTS 32.80.10.10. This should be completed as part of a wider review of the package and/or facility.

2.9 FIRE AND GAS SYSTEM

Three flammable-gas detectors of an approved type shall be located as far upstream as practicable in the combustion air intake. It shall be the Manufacturer/Supplier's responsibility to recommend the most appropriate orientation and position for each detector. The final location of all detectors shall be agreed by the Principal.

The sensor heads shall be certified flameproof for use in hazardous environments (Zone 1 Group II A) in accordance with local regulations. The sensor body materials of construction shall be stainless steel, as shall all fixing bolts and metallic internals. They shall be guaranteed for use without significant deterioration in the environment of use for at least 20 years.

The sensor heads shall be constructed in such a manner that they may each be installed without the sensing element but with all field wiring terminations made and the heads sealed against atmosphere until subsequent installation of the sensing element at commissioning. Sensor heads shall be supplied complete with mountings suitable for the intended location.

The sensors shall be installed in such a manner that they can be removed for calibration/cleaning/replacement with the turbine in operation. If possible, the gas sensors should be calibrated in-situ without being removed from the ducting.

2.10 UTILITY SERVICES

The Contractor shall advise the Manufacturer/Supplier of available utility services such as AC and/or DC electrical power (giving available voltages), instrument/service air, cooling water etc. The Manufacturer/Supplier shall state the quantity of each utility required.

2.11 EXTERNAL INSULATION

Where specified in particular sections of this PTS, suitable fixtures shall be provided for the attachment of external acoustic and/or thermal insulation for sound attenuation and/or personnel protection. Unless otherwise agreed, this insulation shall be applied on site by the The Manufacturer/Supplier of the package, the Manufacturer/Supplier of the intake or exhaust system or others as specified in the order/enquiry.

3. AIR INTAKE SYSTEM

3.1 SCOPE OF SUPPLY

Unless otherwise specified, all gas turbine combustion air intake systems shall comprise the following Manufacturer/Supplier-supplied elements:

- primary intake comprising inertial vanes, storm louvres or snow hood;
- air intake filter in a purpose-built housing;
- silencer section in a purpose-built housing;
- plenum chamber;
- interconnecting ductwork;
- expansion joints as required;
- anti-icing system (if specified in the order/enquiry);
- supporting steelwork as defined in the order/enquiry;
- associated electrical equipment;
- associated instrumentation and safeguarding equipment;
- permanent access facilities including ladders, walkways, platforms and lifting davits.

3.2 OVERALL DESIGN

If specified, and provided the specified margin between the turbine site power capability and the requirements of the driven machine is maintained, the Manufacturer/Supplier of the air intake system shall optimise the design of the air intake system in liaison with the turbine Manufacturer, taking account of the following:

- the effect of intake pressure drop on the performance of the turbine;
- the cost of fuel;
- the cost of the air intake system;
- in the case of offshore installations: the supporting platform costs associated with the weight and size of the equipment;
- in the case of onshore installations: civil and other installation costs;
- relative maintenance costs including the possible need for more frequent turbine maintenance.

If precise data are not available at the time of optimisation, the Contractor shall be consulted and any assumptions shall be documented.

The resulting total pressure drop of the optimised design at 110% of the turbine rated airflow at the minimum specified site ambient air temperature shall be stated and guaranteed.

If the Manufacturer/Supplier has not been required to optimise the design, or if sufficient information has been unobtainable, the overall pressure drop through the complete air intake system shall not exceed the following or such other values as may be specified:

- with clean filters, 981 Pa (100 mm H₂O) at 110% of the turbine rated air flow at the specified site minimum ambient temperature;
- with dirty filters, twice the clean filter pressure drop or that which would result in a 2% reduction in turbine power, whichever is the least.