



**Resalat Oil Field Development Project
Phase 1 (EPC-EPD)**



Contract No.

Specifications for GTG Package

Class

1

5365

Pr. Code

Area

Disc.

Type

Seq.

Rev.

LRSL

000

RE

SP

256

00

Page 1 of 42

Specifications for GTG Package

					<i>P. Kamyab</i>	<i>A. Mirshamsadi</i>	<i>H. R. M.</i>	
00	08-Jan-24	Issued for Comment	IOEC	-	R.K	A.M	H.M	-
REV.	Date	Purpose of Issue	ORIG.	BY	PREP'D	CHECK'D	APP'D	COMPANY APP'D



**Resalat Oil Field Development Project
Phase 1 (EPC-EPD)**



Contract No.

Specifications for GTG Package

Class

1

5365

Pr. Code

Area

Disc.

Type

Seq.

Rev.

LRSL

000

RE

SP

256

00

Page 4 of 42

Table of Contents

1. INTRODUCTION.....	5
1.1. DEVELOPMENT OVERVIEW	5
1.2. PURPOSE OF SCOPE.....	6
1.3. DEFINITIONS	6
2. CODES AND STANDARDS	6
3. REFERENCE DOCUMENTS.....	6
4. ABBREVIATIONS.....	6
5. GENERAL STATEMENT.....	7
6. ADDITION/MODIFICATION/DELETION	7



**Resalat Oil Field Development Project
Phase 1 (EPC-EPD)**



Contract No.

Specifications for GTG Package

Class

1

5365

Pr. Code	Area	Disc.	Type	Seq.	Rev.
LRSL	000	RE	SP	256	00

Page 5 of 42

1. INTRODUCTION

1.1. Development Overview

The Resalat Field previously known as Rakhsh Field, is located in the Persian Gulf, some 80 km to the South of Lavan Island, in water depth of 65-75 meters. The facilities which were originally developed in 1968 have sustained some damage due to the Iran/Iraq war and adverse climate conditions thereafter.

To increase oil production capacity from this field (adding 12,000 stock barrels per day to current production), Iranian Offshore Oil Company (IOOC) has defined new project which includes Engineering, Drilling, Procurement, Construction for following items:

- New satellite Wellhead Platform (WHP1) with totally nine (9) conductor slots.
- Development and renovation of Existing offshore complex consist of new power generation, control system, HVAC, Electrical /control room, electrical panels(LV &MV),process & utility piping, and all necessary activities which shall be done for connection to existing facilities(Tie in requirements)
- Drilling of two new production wells in R1 and **three** wells in WHP1 platform and Re-entry and work-over of **one** existing well in R1 platform.
- One 10" productions submarine pipeline from WHP1 to PP and a single submarine cable (power and data) from SP to WHP1
- Inspection, Strengthening, Modification and Repair of existing R1 complex Jackets and topsides and replacement of boatlanding and Barge Bumpers.

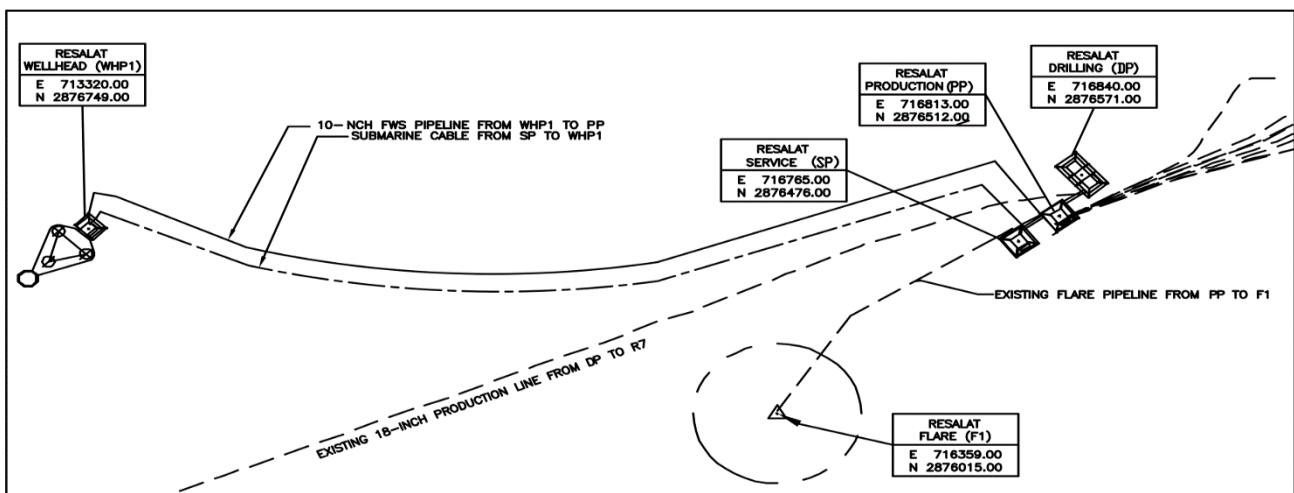


Figure 1: Resalat Development Field Layout (Datum ED 77, Zone 39, Cent. Meridian 51° East)



**Resalat Oil Field Development Project
Phase 1 (EPC-EPD)**



Contract No.

Specifications for GTG Package

Class

1

5365

Pr. Code

Area

Disc.

Type

Seq.

Rev.

LRSL

000

RE

SP

256

00

Page 6 of 42

1.2. Purpose of Scope

Refer to Specification for GTG Package, document No. "ENG-ME-SP-005-Rev.B0".

1.3. Definitions

PROJECT	Resalat Oil Field Development – Phase 1
COMPANY	Iranian Offshore Oil Company (IOOC)
CONTRACTOR	Consortium of Iranian Offshore Engineering and Construction Company (IOEC)
PURCHASER	Any firm who buy services, material and/or equipment for execution of the project within a dedicated contract.
SUPPLIER	Any vendor, manufacturer who supply any Service, Material or Equipment for the project
SHALL	Refer to a mandatory requirement
SHOULD	Refer to a recommendation
MAY	Refer to one acceptable course of action

2. CODES AND STANDARDS

Refer to Specification for GTG Package, document No. "ENG-ME-SP-005-Rev.B0" and List of Applicable Codes and Standards, document No. "LRSL-000-PM-LI-743".

3. REFERENCE DOCUMENTS

Refer to Specification for GTG Package, document No. "ENG-ME-SP-005-Rev.B0".

4. ABBREVIATIONS

Refer to Specification for GTG Package, document No. "ENG-ME-SP-005-Rev.B0".



Resalat Oil Field Development Project
Phase 1 (EPC-EPD)



Contract No.

Specifications for GTG Package

Class

1

5365

Pr. Code

Area

Disc.

Type

Seq.

Rev.

LRSL

000

RE

SP

256

00

Page 7 of 42

5. GENERAL STATEMENT

Refer to Specification for GTG Package, document No. "ENG-ME-SP-005-Rev.B0" is confirmed, except as added/modified/deleted herein.

6. ADDITION/MODIFICATION/DELETION

The latest edition of API 616 (sixth edition, 2022) shall be considered for design, manufacture, performance tests, delivery, etc to have a reliable and appropriate GTG package. Therefore, all the criteria and statements that have been mentioned in the Specification for GTG Package, document No. "ENG-ME-SP-005-Rev.B0", as addition/modification/deletion, shall be revised and restatement based on the latest edition of API 616 (sixth edition, 2022).

The following is the Specification for GTG Package, document No. "ENG-ME-SP-005-Rev.B0".



I.O.O.C
Iranian Offshore Oil Co

**GENERAL SPECIFICATION OF
IRANIAN OFFSHORE OIL COMPANY
ENGINEERING DEPARTMENT**





I.O.O.C
Iranian Offshore Oil Co

Document Title	Document Number						Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV	Page: 1 of 35
		ENG	ME	SP	005	B0	



SPECIFICATION FOR GAS TURBINE

B0						
REV	DATE	PREPARED	CHECKED	APPROVED	APPROVED	DESCRIPTION
		IOOC			IOOC	

 I.O.O.C <i>Iranian Offshore Oil Co</i>	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C <i>Iranian Offshore Oil Co</i>												
Document Title	Document Number	Page Number												
SPECIFICATION FOR GAS TURBINE	<table border="1" style="width: 100%; text-align: center;"> <tr> <td>AREA</td> <td>DIS</td> <td>DOC</td> <td>SCOPE</td> <td>SEQ</td> <td>REV</td> </tr> <tr> <td></td> <td>ENG</td> <td>ME</td> <td>DC</td> <td>005</td> <td>B0</td> </tr> </table>	AREA	DIS	DOC	SCOPE	SEQ	REV		ENG	ME	DC	005	B0	Page: 2 of 35
AREA	DIS	DOC	SCOPE	SEQ	REV									
	ENG	ME	DC	005	B0									



TABULATION OF REVISED PAGES

SHEET	REVISION							SHEET	REVISION						
	A0	A1	A2	00	01	02	03		B0	B1	B2	B3	B4	B5	B6
1	X							30	X						
2	X							32	X						
3	X							33	X						
4	X							34							
5	X							35							
6	X							36							
7	X							37							
8	X							38							
9	X							39							
10	X							40							
11	X							41							
12	X							42							
13	X							43							
14	X							44							
15	X							45							
16	X							46							
17	X							47							
18	X							48							
19	X							49							
20	X							50							
21	X							51							
22	X							52							
23	X							53							
24	X							54							
25	X							55							
26	X							56							
27	X							57							
28	X							58							
29	X							59							
30	X							60							



 I.O.O.C <i>Iranian Offshore Oil Co</i>	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C <i>Iranian Offshore Oil Co</i>				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 3 of 35

Contents

PART I INTRODUCTION	5
1.1 SCOPE	5
1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	5
1.3 DEFINITIONS.....	5
1.3.1 5	
1.4 CROSS-REFERENCES.....	5
PART II GENERAL INFORMATION.....	7
PART III AMENDMENTS/SUPPLEMENTS TO API 616	8
1. SCOPE	8
1.1 CONFLICTS.....	8
2. REFERENCES	8
3. DEFINITION OF TERMS.....	8
4. BASIC DESIGN	10
4.1 GENERAL.....	10
4.2 PRESSURE CASINGS	12
4.4 CASING CONNECTIONS	13
4.5 ROTATING ELEMENTS.....	13
4.6 SEALS	13
4.7 DYNAMICS	14
4.8 BEARINGS AND BEARING HOUSINGS	14
4.9 LUBRICATION.....	14
4.10 MATERIALS.....	15
4.11 NAME PLATES AND ROTATIONAL ARROWS.....	15
5. ACCESSORIES	16
5.1 STARTING AND HELPER DRIVER.....	16
5.3 MOUNTING PLATES	17
5.4 CONTROLS AND INSTRUMENTATION.....	18
5.5 PIPING AND APPURTENANCES.....	23
5.6 INLET COOLERS.....	24
5.7.1 Insulation	24
5.8 FUEL SYSTEM.....	29
6. INSPECTION AND TESTS	31

 I.O.O.C <i>Iranian Offshore Oil Co</i>	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C <i>Iranian Offshore Oil Co</i>				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 4 of 35

6.1	INSPECTION	31
6.2	TESTING.....	31
6.4	PREPARATION FOR SHIPMENT	32
	PART IV REFERENCES	33

 I.O.O.C <i>Iranian Offshore Oil Co</i>	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT						 I.O.O.C <i>Iranian Offshore Oil Co</i>
Document Title	Document Number						Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV	Page: 5 of 35
		ENG	ME	DC	005	B0	

PART I INTRODUCTION

1.1 SCOPE

This specification specifies requirements and gives recommendations for gas turbines for the petroleum, chemical, and gas industry services, and is based on API 616, fourth edition.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

This document is intended for use in facilities related to oil refineries, chemical plants, gas plants and exploration and production facilities.

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

1.3 DEFINITIONS

1.3.1 General definitions

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

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor. The Principal is the party that initiates the project and ultimately pays for it.



The **Principal** may also include an agent or consultant authorized to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.



The capitalized term **SHALL** [PS] indicates a process safety requirement.

The word **should** indicates a recommendation.

1.4 CROSS-REFERENCES

 I.O.O.C <i>Iranian Offshore Oil Co</i>	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT						 I.O.O.C <i>Iranian Offshore Oil Co</i>
Document Title	Document Number						Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV	Page: 6 of 35
		ENG	ME	DC	005	B0	

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



 I.O.O.C <i>Iranian Offshore Oil Co</i>	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C <i>Iranian Offshore Oil Co</i>				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 7 of 35

PART II GENERAL INFORMATION

Part III of this document is written in the form of amendments and supplements to API 616, fourth Edition, August 1998. Wherever reference is made to API 616, it shall be understood to mean API 616, fourth Edition, August 1998, as amended/supplemented by this document.

For ease of reference, the clause numbering of API 616 has been used throughout Part III of this document. Clauses in API 616 which are not mentioned shall remain valid as written.

A bullet (•) in the margin against certain clauses (paragraphs) in API 616 indicates that a decision by the Principal is required. This document addresses the decisions required by most of the API 616 bullet clauses. The remaining decisions shall be indicated directly on the relevant data/requisition sheet when provisions are made for them; otherwise they shall be indicated on the data/requisition sheet(s) under the heading 'Additional Requirements' or stated in the purchase order.

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 8 of 35

PART III AMENDMENTS/SUPPLEMENTS TO API 616

1. SCOPE

Replace this clause by:

This specification covers the minimum requirements for:

- Open, simple and regenerative cycle combustion gas turbine units for mechanical drives or generator drives.
- Industrial gas turbines, modular or aero derivative gas turbines.
- Land based, offshore and mobile trailer mounted gas turbine units.

All necessary auxiliary equipment is included directly or by reference in this specification.

1.1 CONFLICTS

Replace this clause by:

In the event of conflict between documents relating to the inquiry or purchase order, the following hierarchy of documents shall apply:

- Upper level : purchase order and variations thereto
- Second level : data/requisition sheets and drawings
- Third level : this specification

Any apparent conflict between the requirements of this specification and any other relevant document in the purchase order shall be notified to the Principal for clarification purposes.

2. REFERENCES

2.1 REFERENCED STANDARDS



Add to this clause:

The additional publications referred to in this document are listed in Part IV.

3. DEFINITION OF TERMS

3.45 Replace this clause by:

Site rated power: The shaft power developed by the gas turbine when it is operated in a new and clean condition, including clean air filters and air compressor at site rated firing temperature, rated speed and site conditions of air inlet temperature, air inlet pressure, exhaust back pressure and specified fuel composition.

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 9 of 35

The site rated power shall be regarded as the guaranteed power capability of the gas turbine and shall be the power available at the gas turbine load coupling after extracting parasitic losses such as fuel and lubricant pumps, internal speed changers, etc.

3.50 *Add to this clause:*

For multi shaft engines, the turbine trip speed shall be 110% of the rated speed or 105% of the maximum continuous speed of the driven equipment, whichever is lower.

For single shaft engines the turbine trip speed shall be mutually agreed between Vendor and Principal.

Add the following definitions:

3.55 Single-shaft industrial type gas turbine

Arrangement in which the turbine shaft that is connected to the driven equipment is also connected to the gas turbine air compressor shaft.

3.56 Two-shaft Industrial type gas turbine

Arrangement in which the turbine shaft that is connected to the driven equipment is not connected to the gas turbine air compressor shaft

3.56 Multi-shaft aero derivative type gas turbine

3.56.1 Two-shaft arrangement consisting of:



- Gas generator (GT air compressor coupled to HP turbine stage) plus a free running power turbine driving the load; or
- Gas generator (GT HP air compressor coupled to HP turbine stage) plus a power turbine driving the GT LP compressor stage and the load

3.56.2 Triple-shaft arrangement consisting of:

- Gas generator (GT HP air compressor coupled to HP turbine stage) plus an IP turbine driving the IP compressor plus a free running power turbine driving the load; or
- Gas generator (GT HP air compressor coupled to HP turbine stage) plus an IP power turbine driving the IP GT compressor plus a LP turbine driving the GT LP compressor stage and the load

- NOTES: 1) GT: Gas Turbine
 2) HP: High Pressure
 3) IP: Intermediate Pressure
 4) LP: Low Pressure

3.57 Heavy duty gas turbine:

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 10 of 35

This gas turbine is designed originally for the large power industry as a single shaft turbine; including the two-shaft designs derived from it.

3.58 Light duty gas turbines:

This gas turbine is designed for power generation and/or mechanical drive applications for industries other than the power industry, and is mainly available as two-shaft designs; some designs are also available in single or multi-shaft.

3.59 Aero derivative gas turbines:

This gas turbine design is derived from the flight engine industry, whereby the fan is replaced by a power turbine for driving a load, for some designs plus air booster.

3.60 Hybrid gas turbines:

This gas turbine design combines industrial and aero derivative technologies in to a multi-shaft design gas turbine.

4. BASIC DESIGN

4.1 GENERAL

4.1.5 *Replace the second sentence of this clause by:*

Where only one operating speed is specified for an application, the speed range for single shaft machines shall be mutually agreed between Vendor and Principal, and the speed range for two or more shaft machines shall be 55% (from 50% to 105% of rated speed).

4.1.6 *Add to this clause:*

This period between major overhauls, when running on natural gas fuel, at base load, shall be at least:



- 48,000 hours for heavy duty gas turbines
- 32,000 hours for light industrial gas turbines
- 25,000 hours for aero derivative gas turbines

4.1.7 *Replace in this clause in the third sentence the word "purchaser" by the word "Principal"*

4.1.8 *Add to this clause:*

In order to meet the requirements specified in the requisition data sheets, proven NO_x, CO and SO_x reduction measures shall be applied. Dry low emission combustors or catalytic combustors of proven design shall be used for emission reduction. Only if even greater emission reduction is required should additional systems in the GT exhaust be considered.

4.1.10 *Add to this clause following new clauses:*

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 11 of 35

4.1.10.1 The maximum sound pressure level at 1 m (3 ft) distance of all equipment shall be 85 dB(A) or as required by local regulations, whichever is less.

4.1.10.2 The Vendor shall submit with the tender guaranteed sound power levels and sound pressure levels of the equipment, together with any other relevant information as requested in the data sheet. The Manufacturer shall indicate what special silencing measures, if any, are proposed in order to meet the specified levels.

4.1.10.3 If noise enclosures are supplied, full and easy access to the equipment for maintenance purposes shall be ensured by means of an appropriate design.

4.1.11 *Replace this clause by:*

Cooling water systems shall be designed for the conditions specified in the data/requisition sheet, but shall be at least suitable for a working pressure of 5 barg (75 psig).

The minimum operating oil pressure (at maximum filter fouling) shall be at least 1 bar (15 psi) higher than the maximum operating cooling water pressure.

Provision shall be made for complete venting and draining of the system.

4.1.14 *Replace this clause by:*

All electrical components and installations SHALL [PS] be suitable for Zone 2, Gas Group II (Class I, Group D, Div. 2) or the area classification and grouping as specified in the requisition, whatever is more stringent.

4.1.16 *Add to this clause:*

The hot gas generator of a modular or aircraft derivative gas turbine shall be easily removable.

The Vendor shall include with the bid a detailed description of what steps are followed to exchange a gas generator or core engine, the total duration of the activity from fuel out to fuel in (including cool down time), and the number and skills of people required at site.

The Vendor shall provide all instructions, tools, lifting tackles, rigs and fixtures to achieve such replacement.



4.1.18 *Delete in this clause in the third paragraph the word "When specified"*

4.1.19 *Add to this clause:*

Any winterizing, enclosures, weather or sun protection required by the Manufacturer shall be included in the package.

4.1.21 *Add to this clause:*

Gas turbine ratings shall be well within the Manufacturer's design limits and actual experience. Flat rating of gas turbines, i.e. allowing for a constant power irrespective of ambient temperature, by compensating the increased firing temperatures at high ambient temperatures with reduced firing temperatures at low ambient temperatures, is not permitted.

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 12 of 35

4.1.22 Add to this clause:

Bleed air shall not be extracted from sealing air lines, but only from anti-surge blow off lines or compressor discharge lines.

4.1.23 Add new clause:

A gas turbine or its flange to flange component whose leading engine has not yet achieved 98% reliability over 25 000 fired hours, or where the total population of identical gas turbines has achieved less than 100 000 fired hours, require approval of the Principal.

4.2 PRESSURE CASINGS

4.2.4 Add to this clause:

The gas turbine casing SHALL [PS] be designed to contain failed blades, which could cause hazard to life or property. Otherwise, containment shields shall be provided by the Manufacturer.

4.2.7 Replace this clause by:

Inspection ports, appropriately marked for identification purposes, shall be provided in the casing to allow internal visual examination of the compressor, combustion chambers, nozzles and blading in the hot gas path, using flexible or rigid fibre optic inspection devices.

Adapters and guide tubes for fibre optic inspection shall be provided by the Manufacturer.

Inspection ports shall be readily accessible without the need to dismantle any component or accessory, and their location shall be shown on the Manufacturer's drawings.

4.2.9 Add to this clause:

Field balancing by adding weights to couplings is prohibited.

4.3 COMBUSTORS AND FUEL NOZZLES

(Moved to clause 4.3.9)

4.3.3 Add to this clause:



For viscous liquid fuels, preference shall be given to air atomisation.

4.3.4 Replace this clause by:

Dual-fuel nozzles shall be provided with air or gas purge to the liquid fuel nozzle when the gas turbine is running on gas fuel alone. The air supply may be taken from the turbine air compressor bleed system, or from a separate air compressor. A check valve shall be installed in the liquid fuel supply to each nozzle to prevent escape of the purge air through the fuel drain system.

4.3.7 Delete from this clause the words "When specified".

Add new clause:

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 13 of 35

4.3.8 When specified, fuel nozzles shall be equipped with water or steam injection to suppress NOx emission. The water shall not be injected directly into the fuel supply but via separate nozzles or orifices strategically placed in the fuel nozzle. The Vendor shall provide a full description of the system proposed.

Add New Clause

4.3.9 For engines that require in situ combustion liner exchange, the combustion chamber liners shall be replaceable without the removal of major casing components.

4.4 CASING CONNECTIONS

Add new clause:

4.4.8 Flanged drain connections shall be provided, appropriately positioned for the removal of spent crank soak washing liquids and any accumulated liquid fuel.

4.5 ROTATING ELEMENTS

4.5.2 Rotors

Add new clauses:

4.5.2.4 On gas turbines for generator drives, rotors SHALL [PS] be mechanically designed to withstand safely and without failure the transient torque produced in the event of a generator short circuit. The transient torque considered shall not be less than 600% of full load torque. Out-of-phase synchronization shall also be considered in the design of the rotating components.

4.5.2.5 If a number of gas turbines are ordered, all of the same rating, all rotors shall be interchangeable.

4.5.2.6 The rotor, excluding blading shall have a design life in excess of 200,000 hours at rated turbine inlet temperature and speed.

4.5.3 Disk and Blading

4.5.3.1 *Add to this clause:*

Rubbing shall not affect the internal cooling and sealing air flows or cause hot gas bypasses around components such that turbine operation must be discontinued.



Add new clause:

4.5.3.5 For aero-derivative gas turbines, power turbine blading and nozzles shall have a design life in excess of 100,000 hours at the rated turbine inlet temperature and speed.

Add new clause:

4.5.36 Rotor blades shall be moment-balanced and all marked to allow field retrofitting of the blades without the need to rebalance the rotor. Moment-balancing data shall be furnished with the operating manuals.

4.6 SEALS

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 14 of 35

Add new clause:

4.6.3 Air-buffered seals shall be provided wherever there is a risk that hot combustion products may enter bearings or other components containing lubricants. The Manufacturer shall include in his supply any coolers that may be required for the sealing air. Placing the coolers in the combustion air intake is not permitted.

4.7 DYNAMICS

4.7.3 Torsional Analysis

4.7.3.4 *Replace the words “specified in 4.7.4.2” by the words “specified in 4.7.3.2”*

Add to this clause:

The Vendor shall give the Purchaser and Principal the opportunity to review and agree to his procedures for carrying out stress analyses and the corresponding criteria

4.7.3.5 *Delete from this clause the words "when specified".*

Add to this clause

If the vendor has identical trains in operation for which the torsional analysis has been carried out and it has proven operating performance, this can be submitted for conformation instead.

4.8 BEARINGS AND BEARING HOUSINGS

4.8.5.5 *Delete from this clause the words "Unless otherwise specified,"*

4.9 LUBRICATION

4.9.1 *Add to this clause:*

Only commonly available lubricants shall be specified by Vendor.



4.9.8 *Replace this clause by:*

For industrial gas turbines, the same lubricating oil from a common supply system shall be used for the combustion gas turbine, the driven equipment and the speed changers, except as otherwise agreed by the Principal.

Add new clauses:

Lubrication systems for hot gas producers designed for synthetic fire retardant lubricants shall comply with the requirements of this specification. The design of the synthetic lubricating oil system shall be such that mingling of this lubricant with any other is positively prevented.

4.9.9 A main oil pump, shaft-driven via the main drive or accessory gearbox, may be offered where the design is well proven. An AC electric motor driven pump of the same capacity shall be provided for start up, standby during normal operation, and shutdown.

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co					
Document Title	Document Number						Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV	Page: 15 of 35
		ENG	ME	DC	005	B0	

The design shall allow both pumps to run simultaneously for an unlimited period without causing damage to the equipment.

4.9.10 Where the electricity supply cannot be considered as secure, and when required by the Manufacturer's design, a separate, emergency DC pump shall be provided for supplying lubricating oil for post-shutdown cooling. The Manufacturer shall supply batteries with sufficient capacity for the duration of the post lube cycle, together with a battery charger.

4.9.11 Atmospheric vents from the lubricating oil tanks shall be open to the atmosphere, piped to a strategic, safe location. A filter coalescer shall be provided to minimise oil carry over to the atmosphere. The coalescer shall be located as close as practicable to the reservoir, in such a location as to allow easy maintenance without the need for scaffolding or special equipment.

4.9.12 Oil tank de-mister fans may be required to maintain sufficiently low pressure in the oil tank. Where de-mister fans are required in relation to the system pressure, these shall have a 100% operational, spared fan.

4.10 MATERIALS

4.10.1 General

4.10.1.1 *Add to this clause*

Fuel gas system components in contact with gas containing hydrogen sulphide, including trace quantities (25 ppm vol or more), shall comply with ISO 15156 or NACE MR0103, as applicable; and this also applies to the external bolting of such components. Ferrous materials not covered by ISO 15156 or NACE MR0103 shall have a maximum hardness of 248 HV10. This hardness limitation also applies to the heat affected zone of welds. Steel plate materials shall comply with the through-thickness tensile test of ASTM A 770 (S3) and shall have a minimum reduction of area of 35%.

Add new clause:

4.10.1.12 Copper and its alloys shall not be used in the presence of hydrogen sulphides, acetylene, ammonia, ammonium chloride or mercury.

4.10.2 Castings



4.10.2.1 *Add to this clause:*

Repair by welding or by plugging shall be undertaken only when permitted by the material specification, and then only in accordance with the procedures detailed below.

4.11 NAME PLATES AND ROTATIONAL ARROWS

4.11.3 *Add to this clause:*

m. Year of manufacture.

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 16 of 35

The text on nameplates shall be in English.

5. ACCESSORIES

5.1 STARTING AND HELPER DRIVER

5.1.1 General

5.1.1.1 *Remove from this clause: “steam turbines” and “small gas turbines”*

5.1.1.2 *Replace this clause by:*

Starting steam turbines shall not be used.

5.1.1.9 *Add to this clause:*

Starter drives shall be de-clutched when the gas turbine is running at self-sustaining speed and their re-engagement before the gas turbine rotor is completely stationary shall be prevented.

5.1.1.10 *Add to this clause:*

5.1.1.10.1 Use of gas-expansion starter or helper turbine is strongly discouraged due to safety reasons and requires Principal’s approval. An air start system shall be instead of.

5.1.1.10.2 The gas for the starter shall not be extracted from the fuel system. The Vendor shall furnish a separate connection and piping system from the starter to his limit of supply.

5.1.1.10.3 The starting gas valve shall be a three-way quick-acting valve, with the starter side vented to flare or dedicated safe vent when the valve is not actuated. Flexible elements in the valve shall be compatible with the fuel gas.

5.1.1.10.4 Exhaust from a gas expansion starter shall not be connected to any common vent system. The exhaust should be as short as possible, discharging in a location and direction which minimizes hazards.

5.1.1.10.5 Lubrication systems requiring operator attention to starter lubricant oil levels are not permitted.

Add new clause:



5.1.1.11 Starting equipment located within the air intake plenum shall have all bolts and fastenings wire-locked, tack-welded or otherwise positively secured to prevent inadvertent loosening or detachment. Wire shall be either 316 stainless steel or Monel 400. Lock nuts or methods of securing nuts which rely on friction alone shall not be used.

5.1.1.12 Starter diesel engines shall be procured from Manufacturers with adequate service facilities locally available.

The fuel tank shall be sized for at least 4 hours' continuous operation of the diesel engine.

5.1.2 Ratings

5.1.2.1 *Add to this clause:*

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 17 of 35

Starting driver ratings shall allow the continuous cranking for crank soak washing of the gas turbine air compressor, followed by three consecutive starts with due consideration to the purge time required for the gas turbine and its auxiliaries.

NOTE: The purge time will depend on the volume of the inlet and exhaust duct, whether any waste heat recovery equipment is fitted, and so on

5.1.2.2 *Add to this clause:*

For single-shaft gas turbines in mechanical drive applications, helper drivers which are also used as a starter driver shall be rated such that during acceleration the gas turbine is exposed to a similar speed & load/temperature profile as for a generator drive application.

5.2.2 Couplings and guards

5.2.2.2 *Replace this clause by:*

Main load couplings SHALL [PS] be sized for maximum transient load condition and maximum continuous torque, based on the potential maximum power of the gas turbine plus, if applicable, the maximum helper driver power output.

Add new clauses:

5.2.2.5 Dry diaphragm-type load couplings with hubs flange mounted on the shaft are preferred. Alternatively, coupling hubs may be hydraulically fitted to tapered shaft ends.

5.2.2.6 For both power generation and mechanical drive units, spacers of adequate length shall be provided to allow removal of coupling hub and driven equipment bearing and seals without disturbing the shafts.

5.2.2.7 Flexible pin and bush couplings are not permitted for any main or accessory drive.

5.2.2.8 Internal couplings for starters and accessories may be the Manufacturer's standard.

5.3 MOUNTING PLATES

5.3.1 General

5.3.1.2.2 *Replace the first sentence of this clause by:*



All equipment supports and pedestals shall be fitted with horizontal and vertical jacking screws to facilitate alignment.

5.3.2 Base plate

5.3.2.1 *Replace the first sentence of this clause by:*

The gas turbine unit with starting equipment, lubrication system and other auxiliaries shall be supported by a single rigid steel base plate, unless otherwise specified.

Add new clause:

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co					
Document Title	Document Number						Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV	Page: 18 of 35
		ENG	ME	DC	005	B0	

5.3.2.5.1 When the base plates are lifted, complete with all equipment mounted, beam deflection shall not exceed $L/1200$, where L is the total length of the beam.

5.3.2.7 *Replace the last sentence of this clause by:*

All necessary shims, sole-plates and leveling screws shall be provided by the Vendor.

Add new clauses:

5.3.2.10 For on base enclosures the base plate shall be sealed on its underside to maintain ventilation pressure within the enclosure and to prevent oil spillage spreading from the mounted equipment. All voids shall have a flanged drain not less than DN50 (NPS 2).

5.3.2.11 Lubricating oil tanks may be accommodated within the base plate framework, if the arrangement complies with (4.9) and the rise in oil temperature does not create misalignment.

5.3.2.12 For installation on concrete foundations, base plates shall be designed for supporting by the 'Chock-and-Block' method with spherical shims and shim packs greater than 25 mm (1 in), as described and shown in Appendix 2 of this specification.

Add new clause:

5.3.4 Offshore/steel structure applications

5.3.4.1 All connecting cabling and pipe work shall be anchored to the base plate to prevent pipe work misalignment caused by piping or cabling movements.

Add new clause:

5.3.7 Painting

5.3.7.1 Vendor standard painting scheme and systems shall be submitted for review and acceptance.

5.4 CONTROLS AND INSTRUMENTATION



5.4.1 General

5.4.1.1 *Replace this clause by:*

Vendor shall include in his proposal the controls and instrumentation, procedural specification for review and acceptance. The vendor's detailed controls and instrumentation specification shall be submitted for review and acceptance after placement of the order.

Add new clause

5.4.1.1a Depending on the complexity of the package and whether there are elements of extended scope of supply, the Principal may require that certain instrumented protective functions are subject to an IPF/SIL classification exercise. The requisition should provide information on endor's involvement and timing aspects of any IPF/SIL classification exercise and information on handling the resulting design impact.

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 19 of 35

5.4.1.6 *Add to this clause:*

The control and instrumentation system SHALL [PS] protect personnel and plant against injury or loss under all conditions of operation or malfunction. The monitoring and supervisory instruments shall provide information for the diagnosis of the gas turbine health during operation and for warning of deterioration of its condition.

Add new clauses:

5.4.1.7 The instrumentation and control system may require signals from primary elements outside the Vendor's scope of supply. Conversely, the Vendor's instrumentation and control system may be required to supply information to the Purchaser's control system. In such cases, the Vendor shall liaise with the Purchaser regarding these interface requirements.

5.4.1.8 The gas turbine shall be designed for the following control features:

- Automatic acceptance of load, including adjustment of speed as necessary;
- Adjustments to speed or load in response to a remote signal;
- Manual adjustments of speed or load from a location in the vicinity of the turbine.

5.4.1.9 An instrumentation system shall be furnished for on-line monitoring of the health and performance of the gas turbine and its auxiliaries. The scope of the monitoring system shall be agreed between the Principal and the Manufacturer.

5.4.1.10 The Vendor shall furnish baseline information to enable future performance monitoring.

5.4.1.11 Primary instrumentation elements shall be mounted within the limits of the base plate(s) of the gas turbine and its driven equipment. All signal processing and monitoring shall be performed within a separately mounted control panel.



5.4.1.12 All instrumentation shall be readily accessible and rigidly supported. Vibration isolation shall be considered for all base-mounted instruments and gauge boards.

5.4.2 Starting control systems

5.4.2.1 *Replace this clause by:*

The starting cycle of the turbine shall be automatic, requiring only a single action by the operator to complete the sequence. The starting sequence shall be monitored by the gas turbine controller, which shall indicate each stage of the start-up in sequence. If there is a failure in starting the gas turbine, the controls shall initiate a normal shutdown procedure for the gas turbine and its driven equipment. The sequence recorder shall hold at the state at which failure occurred to allow trouble-shooting of the cause.

5.4.2.2 *Replace this clause by:*

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 20 of 35

During the start-up sequence the control system SHALL [PS] provide for a purge period of sufficient duration for at least five complete changes of air during the start-up procedure to purge the gas turbine, the exhaust system and any exhaust heat recovery equipment prior to admitting fuel to the combustors and activating the igniters. The purge period shall be active irrespective of the mode of starting.

Add new clause:

5.4.2.6 An off-local-remote selector switch shall be provided and located in the vicinity of the turbine, if the turbine is to be started remotely. The selector switch shall:

- In ‘Off’ position, prevent the turbine from being started;
- In ‘Local’ position, allow the turbine to be started only from a location near the turbine;
- In ‘Remote’ position, allow the turbine to be started by a remote signal.

5.4.4 Alarms and shutdowns

Add new clauses:

5.4.4.2.1 The normal shutdown procedure shall not use the Emergency Shutdown (ESD), but shall allow the gas turbine to shut down in accordance with a controlled program. The program shall provide for any necessary post-shutdown lubrication and, where applicable, shall maintain the ventilating system of the acoustic enclosure in operation.

5.4.4.2.2 All electricity supplies shall remain live after normal shutdown of the gas turbine.

5.4.4.2.3 Emergency Shutdown SHALL [PS] be initiated by any of the situations listed for ESD action in Appendix 1.

5.4.4.4 *Add to this clause:*

The vent from this valve shall not be connected to any other venting or blow-down system.

5.4.4.7 *Replace the words “Table 1” by the words “Appendix 1”.*

5.4.4.9 *Add to this clause:*

For mechanical drive gas turbines, all alarm and shutdown devices shall have test facilities.



It shall be possible to test the entire alarm and shutdown loop, including the primary element without shutting down the gas turbine. The method of protection of the function test facilities shall be agreed with the Principal.

5.4.5 Instrumentation and Control Panels

5.4.5.3 *Add to this clause*

Alternatively wiring can be installed in cable trays

5.4.6 Electrical systems

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 21 of 35

5.4.6.2 Add to this Clause:

The vendor has to prove that the number of air changes is sufficient to meet zone 2 (Class I, Group D, Div. 2) area classification requirements.

5.4.6.3 Add to this clause:

The Vendor shall state in the bid the maximum temperature the cabling can reach under all conditions, including heat soak on shutdown due to loss of AC power, and the temperature rating of the cable.

5.4.7 Instrumentation

5.4.7.1 General

Add to this clause:

If instrumentation is bought in for non-proprietary functions i.e. those functions where the instrument characteristics are not critical to the proprietary nature of the Vendor's control and safeguarding of the gas turbine, or where there are elements of extended scope in the Vendor's supply, discrete, direct mounted, field switches for alarm and instrumented protective functions are not allowed. A combination of signal transmitter with switch and/or trip amplifier shall be used.

Add new clauses:

5.4.7.1.1 With regard to the gas flow path, instrumentation shall be provided to monitor flow path temperature at the following locations:

1. Air compressor inlet;
2. Air compressor outlet;
3. Power turbine nozzle inlet, where applicable;
4. Power turbine exhaust diffuser.

At least two temperature detectors shall be provided for each of the locations 2, 3 and 4. At location 4 there shall be sufficient detectors to monitor the temperature distribution in the circumference of the exhaust plenum and give an indication of the performance of the individual combustion chambers.



5.4.7.1.2 Pressure indication shall be provided at the following locations:

1. Air compressor inlet;
2. Air compressor outlet;
3. Exhaust outlet.

Air compressor inlet pressure shall be measured in the bell mouth to allow signal use in flow measurement.

All the above sensors shall have transmitters, if not otherwise agreed.

The signal from each transmitter shall display the corresponding pressure on the control panel.

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 22 of 35

5.4.7.2 Tachometers

5.4.7.2.1 *Replace this clause by:*

Separate speed pick-ups shall be used for over-speed trip devices (2 out of 3).

5.4.7.2.2 *Replace this clause by:*

Unless otherwise specified, the range shall be from 0 to 125 percent of the maximum continuous speed (in revolutions per minute). Speed measurement shall be by noncontacting, electronic pick-up(s).

5.4.7.3 Temperature Gauges

5.4.7.3.1 *Replace the words “or mercury filled” by the words “with a stem diameter of 6 mm (¼ in)”*

5.4.7.4 *Replace the words ”Type 300” by “316”* 5.4.7.5 *Delete the words “When specified...”.*

Add to this clause:

The indicators for multiple detection points shall record the average temperature of all locations and allow interrogation of the maximum temperature spread and of the deviation at any point. The indicator shall provide an alarm and shutdown at pre-set average temperature deviation and maximum spread of temperature.

5.4.7.8.2 *Delete from this clause the words*

When specified

5.4.7.8.4 *Add to this clause:*



For rolling element bearings or where the mounting of a probe is such as to make it inaccessible for calibration and maintenance without dismantling any part of the gas turbine, case mounted accelerometers shall be used. Brackets shall be designed to accept accelerometers for measurement in the radial, longitudinal and tangential planes, and shall be mounted in accessible positions giving a satisfactory response to rotor vibration. Each bracket shall have space for attachment of a calibration accelerometer. The natural frequency of response of any bracket shall exceed twice the highest blade passing frequency.

Add new clauses:

5.4.7.9 Gauge board

5.4.7.9.1 Locally mounted gauge boards shall be furnished to provide indication of at least the following:

- a) Fuel pressure;
- b) Lubricant oil pressure;
- c) Control oil pressure;
- d) Hydraulic oil pressure;
- e) Differential pressure across the individual air filter stages;
- f) Driven equipment indicators (as agreed with Purchaser).

 I.O.O.C <i>Iranian Offshore Oil Co</i>	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C <i>Iranian Offshore Oil Co</i>				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 23 of 35

5.4.7.9.2 The gauge board may be part of the acoustic enclosure. Instruments shall comply with the area classification zone 2 (Class I, Group D, Div. 2). If there is no acoustic enclosure the gauge board shall be a free-standing steel panel mounted on the base plate at a location agreed with the Purchaser.

5.4.7.9.3 Local emergency shutdown buttons SHALL [PS] be fitted at strategic locations. The locations are to be agreed with the Principal to ensure consistency with the overall plant philosophy.

5.5 PIPING AND APPURTENANCES

5.5.1.3 *Add to this clause:*

Screwed and seal-welded connections or socket welding connections shall not be used.

5.5.2 Oil Piping

Add new clauses

5.5.2 Oil and fuel piping

Add new clauses

5.5.2.2 Lubricating oil, control oil and fuel oil piping around the gas turbine shall be arranged to prevent a hazardous situation developing from oil leaking or spraying onto hot turbine surfaces in the event of a pipe or pipe joint failure.

Where this requirement cannot be met by selected routing of the pipe work, appropriate baffle plates shall be installed to prevent a hazard as described from occurring.

5.5.2.3 All supply piping downstream of filters shall be seamless stainless steel AISI 316. Schedule 40S shall be used for sizes 3 in. and smaller, and schedule 10S shall be used for larger sizes.



Pressure piping downstream of filters shall be free from internal obstructions that could accumulate dirt, and shall be TIG welded.

All fittings downstream of filters shall be AISI 316, excluding the filter changeover valve and the bodies of isolation and control valves.

5.5.2.4 Common oil drains from bearing housings of aero-derivative gas turbines and the drains from their oil systems, shall be fitted with ½ in. NPT plugged connections for later installation of magnetic chip detectors by the Principal.

5.5.2.5 All fuel piping on the skid shall be fabricated by bending and welding. Connections to equipment shall be flanged. If tubing is used, connections shall be flanged.

5.5.2.7 Vent and drain connections from the fuel system shall be flanged and separately routed to the edge of the base plate.

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 24 of 35

5.6 INLET COOLERS

5.6.1.1 Delete section 5.6.1. Evaporative cooling shall not be applied

5.6.2 Inlet Air Cooler Heat Exchanger

5.7 INSULATION, WEATHERPROOFING, FIRE PROTECTION AND ACOUSTIC TREATMENT

5.7.1 Insulation

5.7.1.1 *Add to this clause:*

As far as is practical, insulation shall be in pre-formed sections, to facilitate installation and removal in the field.

Add new clause:

5.7.1.4 Insulating materials shall be non-combustible and shall not contain asbestos.

Add new clause:

5.7.1.5 Insulated surfaces shall be mechanically protected, preventing saturation of the insulation by inadvertent oil leaks or damage to the insulation material.

5.7.3 *Replace this clause by:*

5.7.3 Fire protection

5.7.3.1 General

5.7.3.3.1 *Add new clause*

The Vendor SHALL [PS] provide a fire detection and protection system of a type approved by the Principal.

5.7.3.1.2 *Add new clause*

Fixed automatic water deluge systems are not permitted on gas turbine installations. If the plant/location has a fire water ring main, only manually operated water monitors shall be used.

NOTE 1) Water mist systems are acceptable.

5.7.3.2 Flame detectors



5.7.3.3.2 *Add new clause*

Flame detectors shall be positioned strategically so that the combined fields of view of the detectors cover the entire gas turbine installation..

5.7.3.3.3 *Add new clause*

A minimum of two detectors shall be installed at each position with a dual-voting system for both the detector heads. Individual detectors may initiate an alarm. Coincident detection by two or more heads shall initiate:

- a) Fire alarm;
- b) Shutdown of the gas turbine;

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 25 of 35

- c) Shutdown of the ventilation system;
- d) Release of extinguishant into the enclosure;
- e) Initiation of the appropriate alarm.

Test facilities shall be provided to perform, either manually or automatically from the control panel, an integrity test and a functional test of not only the circuit, but also the detector head.

5.7.3.3 Compensated rate of heat rise fire detectors

5.7.3.3.4 Replace this clause by

Compensated rate of heat rise detectors shall be positioned close to the air outlet of the ventilation system.

Add new clause

Two compensated rate of heat rise detectors with dual voting system for both detector heads shall be positioned close to the air outlet of the ventilation system. Action following activation of the detector heads shall be in accordance with (5.7.3.3.3).

5.7.3.4 Flammable gas detectors

5.7.3.4.1 Add new clause

Three Gas detectors shall be installed in the outlet of the ventilation air system. The set point for alarm shall be at 20% of lower flammable level (LFL) and shutdown shall be at 40% LFL..

5.7.3.4.2 Extinguishant shall not be discharged upon gas detection within the enclosure.

5.7.3.6 Add new clause

When specified, the fire and gas detection system furnished for the gas turbine installation shall provide alarm signals into the Purchaser's overall fire and gas protection system on site. In this case the detection equipment shall be compatible with the Purchaser's supervisory equipment on site.

5.7.3.7 Add new clause



Unless otherwise specified, the Vendor shall furnish a freestanding fire and gas detection panel, to be located in the control room. This panel shall have facilities for testing the integrity of each detector circuit and for testing the functional integrity of each detector head, to be performed either manually or automatically.

5.7.3.8 Add new clause

To initiate the appropriate action upon activation of one or more detectors, facilities shall be provided for communicating the alarm and shutdown signals required by this specification to the gas turbine control panel.

5.7.3.9 Add new clause

Each compartment of the enclosure should have its own containers of extinguishant, each with its own release mechanism. Each release mechanism shall be suitable for automatic actuation (via the fire detection system),

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 26 of 35

for remote manual actuation by means of a push button in the control room, and for manual actuation by mechanical means from a position on the outside of the enclosure. A test valve shall be installed downstream of the release valves of each release mechanism.

If, after a fire is detected and extinguishant is discharged in a compartment, it proves necessary for an operator to discharge additional extinguishant into said compartment, the release piping for all compartments shall be interconnected via manually operated, normally closed, shutoff valves. In this way, extinguishant installed for another compartment can be directed manually to the compartment where the fire is located.

5.7.3.10 Add new clause

Upon detection of fire within the enclosure, the extinguishant in the compartment concerned shall be released only after a lapse of ten seconds after the sounding of the alarm. This allows time for personnel within the area to make their escape and for the ventilation system to shut down.

5.7.3.11 Add new clause

A 'two-shot' system shall be installed, whereby an initial charge of extinguishant is injected instantaneously into the compartment in order to inert the atmosphere as rapidly as possible, followed by the slow release of a second and equal quantity of extinguishant to maintain an inert atmosphere for a sufficient period to allow overheated components to cool below the auto-ignition temperature of the combustible material.

5.7.3.12 Add new clause

The release mechanism shall consist of two valves installed in parallel. The valves may be actuated by either a nitrogen or air-operated actuator signalled by a solenoid.

5.7.3.13 Add new clause

Means shall be provided for testing the quantity of extinguishant in each container and for testing the pressurizing medium.



5.7.3.14 Add new clause

Facilities shall be provided for testing the entire fire extinguishant system, both mechanically and electrically, without actual discharge of extinguishant into the protected enclosures.

5.7.3.15 Add new clause

Automatically actuated dampers or shutters in the ventilation system shall be of robust design and, where applicable, tropicalised.

5.7.3.16 Add new clause

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 27 of 35

All apertures in the base plate and any potential source of leakage of extinguishant through the lower part of the protected enclosure shall be positively sealed.

5.7.3.17 Add new clause

To ensure the safety of operation and maintenance personnel, the following requirements shall be met:



- Alarm lamps shall be provided on the outside of the enclosure and on the main control panel to indicate:
 - Extinguishant system normal (green);
 - Extinguishant release (flashing red);
 - Extinguishant electrically isolated (white);
- Additional flashing indicators and/or audible alarms shall be positioned in prominent positions within the protected area to signal extinguishant released and initiated by the actual release of the extinguishant;
- For each compartment, a two-position switch (lockable in each position) shall be provided on the outside of the enclosure and on the main control panel, the positions being marked:
 - Extinguishant release 'inhibited'
 - Extinguishant release 'auto';
- To permit personnel to enter compartments protected by automatic extinguishant release systems, a release inhibit switch shall be provided at the entrance to the compartment. Inhibition of the release system shall be annunciated on the main control panel. Should a compartment entrance be opened inadvertently without first inhibiting the release system, there shall be an annunciation on the main control panel and also an alarm shall sound at the entrance to the compartment.

5.7.5 Enclosures

5.7.5.1 Add to this clause:

Acoustic enclosures shall limit the noise emitted to meet the requirements of (4.1.10).

5.7.5.3.1 Replace the first sentence of this clause by:

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 28 of 35

Acoustic enclosures shall have hinged and removable doors or panels to provide access for maintenance. Where necessary for heavy maintenance the roof of the enclosure shall have removable panels, fitted with suitable lifting lugs. All openings in the roof shall be surrounded by a 25 mm (1 in) (minimum) raised edge. The roof shall be sloped so that water does not lie on the surface.

5.7.5.3.3 Add to this clause:

The layout and routing of cables, piping, tubing, etc. within the enclosure shall take into consideration the need for fast and efficient disassembly for maintenance. Layouts shall not require cutting of cables, piping, tubing etc. to permit disassembly of the enclosure or gas turbine.

Add new clause:

5.7.5.3.4 Escape doors shall be provided to allow the safe exit of personnel from within the enclosure in the event of an emergency. Such doors shall be fitted with an internal panic bar and shall be strategically placed to allow safe exit from any part of the enclosure.

Add new clause:

5.7.5.3.5 When maintenance of the gas turbine requires disassembly of the enclosure roof, or where the enclosure roof is designed to be disassembled, ancillary systems and equipment shall not be routed directly above, or mounted on, the enclosure roof.



Add new clause:

5.7.5.4.1 Enclosures surrounding equipment requiring operator attention shall be adequately lit to enable all operations to be safely undertaken. Emergency lighting shall be installed to allow the safe exit of operators within the enclosure in the event of main lighting failure. The emergency lighting shall be connected into the Purchaser's emergency lighting circuit.

5.7.5.6 Replace this clause by:

The enclosure shall be provided with two 100% duty ventilating fans, one running and one stand-by, to either pressurise or evacuate the acoustic enclosure in order to fulfil the area classification requirements specified in (5.4.6.1). The ventilation system shall be designed to provide the greater air flow required to meet the following criteria:

- Provide for a minimum of 20 air changes per hour;
- Ensure that the air temperature at the ventilation outlet does not exceed 20 °C (70F) above the maximum ambient temperature or 60 °C (140F), whichever is lower;
- Ensure that the air temperature does not exceed 80 °C (175F) at points within the

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 29 of 35

enclosure close to cables, instruments or potential work areas.

NOTE: This last requirement recognises that there are points within the enclosure where the air temperature will exceed 80 °C (175F), such as the near-casing air film local to the combustion casing, or near to the exhaust. These locations are not intended to be covered by this requirement.

The vendor shall confirm that the enclosure can withstand the worst case ventilation pressure when two fans are running and the compartment outlet dampers are closed.

5.7.5.6.1 *Replace the first sentence of this clause by:*

As a minimum, ventilating air shall be filtered by means of an inertial stage and a second renewable media filter stage.

Add new clause:

5.7.5.6.5 The arrangement for circulating the ventilating air within the enclosure shall prevent local overheating of components.

Add new clause:

5.7.5.6.6 Control equipment which requires setting or adjustment while the gas turbine is running shall be installed outside the acoustic enclosure.

All local instrument gauges and indicators shall be placed on an external auxiliary skid or be readable from outside the enclosure.

Lubrication and control oil filling points shall similarly be located outside the enclosure.

Add new clause:

5.7.5.6.6 The vendor to provide a safeguarding system that starts the second ventilation fan upon loss of flow. A running indication light shall be provided for each ventilation fan motor. The safeguard system shall shut down the gas turbine if ventilation air flow is not restored within 30 seconds.

5.8 FUEL SYSTEM

5.8.1 General



5.8.1.1 *Add to this clause:*

The Manufacturer shall state in his proposal if any treatment is considered necessary for the intended fuels. If a separate fuel is required for the combustion igniters, full details shall be included in the proposal.

5.8.1.2.1 *In item a), replace the words “A Y-type strainer” by the words “Twin de-mister/separators with both manual and automatic drain valves”*

5.8.1.2.4 *Delete this clause*

5.8.1.4.2 *Add to this clause:*

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 30 of 35

All necessary piping and components for flushing the fuel system with a light distillate fuel oil upon shutdown, and for use during starting if required, shall be included. The system shall be provided for safe control and subsequent draining of the liquid fuel from the fuel nozzles and liquid fuel manifold in the event of an emergency shutdown.

Add new clause:

5.8.1.4.6 The preferred method of atomisation of ASTM D 2880 Grade 3-GT and heavier liquid fuels is by means of an air blast. The system shall include an atomising air compressor.

5.8.1.5.1 *Delete the words “When specified” and delete the last sentence of this clause*

Add new clause:

5.8.1.5.4 Where the Vendor has no operating experience with the fuel specified by the Purchaser, a combustion test shall be undertaken before manufacture commences. For gas fuels with a lower heating value less than 30 MJ/m³ (805 Btu/ft³), a combustion test is mandatory.

The Vendor shall demonstrate satisfactory performance of the gas turbine on the contract fuel or a blend which simulates the properties of the contract fuel. Principal and vendor shall develop mutually, the acceptance criteria for the performance test.

The condition of the fuel nozzles and the hot path shall be inspected after the combustion test.

5.8.2 Gaseous fuel

5.8.2.1 *Add to this clause:*

The Manufacturer shall state the maximum variation which can be accepted in composition, heating value, Wobbe index, hydrocarbon and water dew points, and in pressure and temperature for the fuel intended.



The Manufacturer of the gas turbine shall state clearly the definition of Wobbe Index used and specify the variations in Wobbe Index acceptable both as an absolute variation and also as a rate of change. This is of particular importance where the design includes a facility for switching from one fuel gas type to another (e.g. a back-up supply).

5.8.3 Liquid fuel

5.8.4 Emission Suppression Systems

5.8.4.4 *Add to this clause:*

The Manufacturer shall clearly state the impact of the wet suppression system on the maintenance requirements of the gas turbine and the repair intervals of affected components. The Manufacturer shall also state whether firing temperature correction is applied to water injection systems.

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 31 of 35

6. INSPECTION AND TESTS

6.1 INSPECTION

6.2.1.1a *Add to this clause:*

Inspection certificates in accordance with ISO 10474, type 3.1B shall be provided for pressure containing parts, including any associated fasteners.

Certificates of compliance in accordance with ISO 10474, type 2.1 shall be provided for other parts.

6.2.1.3 *Replace this clause by:*

In addition to the requirements of 4.10.4.1 the Vendor shall propose, for the approval of the Principal, which parts shall be subjected to which methods of non-destructive examination.

6.2 TESTING

6.3.3 Mechanical Running Test

Add new clause:

6.3.3.1.13 The baseline data for the on-stream monitoring of the health and performance of the gas turbine and its auxiliaries, see (5.4.1), shall be obtained from the data recorded by the Manufacturer during the testing of the equipment. Details of the precise information required, which shall include temperature, pressure and flow profiles, vibration spectra and alignment data, shall be agreed with the Purchaser.

The Vendor shall be responsible for collecting all the baseline data required, and for presenting it in a separate volume of the operating manuals. The data shall also be collected in electronic format for subsequent loading into the Purchaser's system. This baseline data shall also be obtained and data collected during a complete unit test if such a test is specified.

Add new clause:



6.3.3.2.6 During a string test, the gas turbine shall run for at least 30 minutes at the minimum lubricating oil temperature and for 30 minutes at the maximum lubricating oil temperature as dictated by the climatic conditions given in the requisition. During the tests, the performance of the gas turbine shall be monitored, especially for vibration and maintenance of the specified lubricating oil pressures and temperatures.

6.3.3.4 *Replace the words "requirements of 6.3.3.4.1 through 6.3.3.4.2" by the words "requirements of 6.3.3.4.1 through (6.3.3.4.3)"*

Add new clause:

6.3.3.4.3 Wherever possible, a non-intrusive inspection using flexible, fibre optics shall be made after testing. Photographic records shall be made of all inspected components, and provided to the Principal.

Add new clause:

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 32 of 35

6.3.3.5 Response tests

For gas turbines driving alternators, tests shall be carried out to demonstrate the governor and turbine response at acceptance and rejection of load in 25, 50, 70 and 100% load steps.

6.3.4 Optional Tests

Add new clause:

6.3.4.12 Air filter tests

The mechanical and electrical operation of the air filter cleaning mechanism, if fitted, shall be demonstrated to the satisfaction of the Purchaser.

6.4 PREPARATION FOR SHIPMENT

6.4.3 Replace this clause by:

Preparation for shipment shall be in accordance with the requisition, the purchase order and variations thereto.

All packing and preservation shall provide suitable protection for storage on site for a period of 6 months under the ambient conditions specified without any further protection.

All instruments and delicate components shall be de-mounted, preserved and packed separately.

Aero-derivative engines shall be preserved and packed in accordance with the Manufacturer's instructions and shipped in the Manufacturer's original packing

APP. D LATERAL ROTOR DYNAMIC ANALYSIS FOR USE WITH MODIFIED ROTOR BEARING DESIGNS OR PROTOTYPE GAS TURBINES

D.1 LATERAL ANALYSIS



D.1.2 *In item c) of this clause, delete the words "if unique conditions exist"*

D.1.5 *Replace item b) of this clause by:*

b) If the amplification factor is between 2.5 and 4.01, the separation margin from all lateral modes shall be at least:

- 20 % above the maximum continuous speed; and
- 10 % below the minimum operating speed.

In item c) and item d) of this clause, replace "3.55" by "4.00"

 I.O.O.C <i>Iranian Offshore Oil Co</i>	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C <i>Iranian Offshore Oil Co</i>				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 33 of 35

PART IV REFERENCES

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



NOTES: 1. Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

AMERICAN STANDARDS

Special-purpose gear units for petroleum, chemical, and gas industry services	API 613
Lubrication, shaft-sealing and control oil systems for special-purpose applications	API 614
Gas turbines for the petroleum, chemical, and gas industry services	API 616 Fourth Edition, 1998
Vibration, axial position and bearing-temperature monitoring systems	API 670
Alloy steel and stainless steel bolting materials for high temperature service	ASTM A 193
Through-thickness tension testing of steel plates for special applications	ASTM A 770
Gas turbine fuel oils	ASTM D 2880
Quality standard for steel castings for valves, flanges and fittings and other piping components - visual method	MSS SP 55
Materials resistant to sulfide stress cracking in corrosive petroleum refining environments	NACE R0103
Petroleum and natural gas industries — Materials for use in H ₂ S-containing environments in oil and gas production	NACE R0175



INTERNATIONAL STANDARDS

Steel and steel products - inspection documents	ISO 10474
Petroleum and natural gas industries — Materials for use in H ₂ S-containing environments in oil and gas production	ISO 15156

 I.O.O.C Iranian Offshore Oil Co	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C Iranian Offshore Oil Co				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 34 of 35

APPENDIX 1 CONTROL AND INSTRUMENTATION FUNCTIONS

Function (1)	Local Display (2)	Remote Display	Alarm	Normal Shut down	GT ESD (8)
1. Flow Fuel(s)		I,R			
2. Level Lube oil tank(s) Fuel gas scrubber	I I		L H	HH	
3. Pressure Air filter ΔP Air compressor inlet Air compressor discharge Exhaust plenum Gas fuel Liquid fuel supply Liquid fuel to nozzles Atomising air Lube oil Hydraulic oil Lube oil filter ΔP Instrument air	I (3) I I I I I I I I I I I I	I I (9) I I	H L L L L L (4) L (6) H	LL LL LL	
4. Temperature Air compressor intake Air compressor discharge Power turbine 1 st stage nozzle inlet Gas turbine exhaust Gas turbine exhaust spread Fuel supply Lube oil tank Lube oil after cooler Each journal bearing Each thrust bearing Acoustic enclosure vent. air exhaust.	I I I I I	I (10) I (10) I,R (10) I,R (10) I I I I I	 H H L H	HH HH HH HH	
5. Vibration & axial displacement Proximity probes, X, Y each jrnl. brg. Accelerometers, six channels Axial Displacement		I I I	H H H	HH(7) HH(7) HH	
6. Speed Gas producer Power turbine		I I,R		HH HH	
7. Flame Present Failure		B	X	X	
8. Fire & gas Fire detection Gas detection Manual ESD(6)		X I X	X H X	HH	X(5) X
9. Miscellaneous Starting clutch failure to disengage			X	X	

 I.O.O.C <i>Iranian Offshore Oil Co</i>	GENERAL SPECIFICATION OF IRANIAN OFFSHORE OIL COMPANY ENGINEERING DEPARTMENT	 I.O.O.C <i>Iranian Offshore Oil Co</i>				
Document Title	Document Number					Page Number
SPECIFICATION FOR GAS TURBINE	AREA	DIS	DOC	SCOPE	SEQ	REV
		ENG	ME	DC	005	B0
						Page: 35 of 35

- Notes:**
- (1) The listed functions are to be considered as minimum requirements.
 - (2) Local Display means the information is available at a suitable and accessible location in the vicinity of the GT. It may be located on a free stand or a gauge board. Local panels are strongly discouraged.
 - (3) Local indication across each stage; remote indication and alarm for the total ΔP over the filter.
 - (4) Start aux. lube oil pump
 - (5) The emergency lube oil pump shall remain in operation
 - (6) Start aux. hydraulic oil pump
 - (7) Depending on GT, vibration protection may be by accelerometers or proximity probes.
 - (8) The ESD system shall be capable of accepting push buttons and an ESD command from the Purchaser's control system
 - (9) Air compressor inlet pressure shall be measured in the bell mouth (5.4.7.1.2)
 - (10) See (5.4.7.1.1) for numbers of temperature detectors to be supplied.

Nomenclature for alarm and shutdown functions:

- ESD Unit emergency shutdown
- I Indication of measured value
- B Status indication
- R (Permanent) Recording of measured value
- H High
- HH High-High
- L Low-Low
- LL Unacceptably low
- X Indicates that this function is required as described in the specification.
See text of specification for detailed requirements.