



LOADING & PENALTY CRITERIA (GAS TURBINE DRIVEN CENTRIFUGAL COMPRESSOR PACKAGE)

PROJECT : Installation of New GTC Compressor at Gandhar,
Gujarat,

OWNER : Gas Authority of India Limited

PMC : Engineers India Limited

JOB NO. : B240

A	16.04.19	ISSUED FOR COMMENTS	AS	NK	NK
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

1.0 SCOPE

This specification describes the Loading & Penalty criteria applicable for Gas Turbine driven centrifugal compressor package(s).

2.0 PERFORMANCE GUARANTEES

Loading and Penalty criteria shall be based on individual guaranteed performance of compressor and the gas turbine.

The parameter for loading shall be the **fuel consumption** of the Gas Turbine while generating the guaranteed compressor BkW (as per 2.1 below) with the Gas Turbine guaranteed heat rate (as per 2.3 below) at site conditions, corresponding to the process parameters of the **RATED/GUARANTTEE CASE** as indicated in the compressor datasheet.

Bidder shall furnish the guaranteed values for the following:

2.1 COMPRESSOR

Guaranteed BkW of compressor (**BKW_G**) including all losses (Compressor mechanical losses, Gear-box, transmission etc.) with zero per cent positive tolerance including errors in instruments and measurement, corresponding to the **RATED/GUARANTTEE CASE** specified in the compressor datasheet which shall be verified on test bed during compressor performance test PTC -10 Class-2 at Compressor vendor's shop.

2.2 GEAR-BOX (AS APPLICABLE)

Efficiency of Gear-Box while transmitting the guaranteed shaft power of Compressor. However, for loading purposes the maximum efficiency of Gear-Box shall be limited to 98%.

2.3 GAS TURBINE

2.3.1 Guaranteed Heat rate **H_G** (kcal/kw-hr) of gas turbine with zero percent positive tolerance including errors in instruments and measurement at the specified site rated temperature, Intake and Exhaust losses of 100 mm (4") of Water column, while generating at the Turbine output shaft, the guaranteed compressor **BKW_G** (as defined in 2.1) when operating with the **RATED/GUARANTTEE CASE** as specified in the compressor data sheet which shall be verified on test bed during gas Turbine performance test as per PTC-22 conducted at Gas turbine manufacturer's shop.

2.3.2 Guaranteed Site Rated shaft power **P_{GT}** developed by the Gas Turbine with zero percent negative tolerance including errors in instruments and measurement at the specified site rated temperature, Intake and Exhaust losses of 100 mm (4") of Water column when generating the guaranteed compressor **BKW_G** (as defined in 2.1) at the **RATED/GUARANTTEE CASE** as specified in the compressor data sheet.

Note: Please refer Job specification for Gas Turbine sizing criteria.

3.0 LOADING CRITERIA

3.1 TOTAL COST

The total cost of the GTC package for evaluation purposes shall be computed as under:

TOTAL COST OF THE PACKAGE FOR EVALUATION PURPOSES = A + B + C

Where,

- A** = Capital cost of GTC package including cost of mandatory spares, commissioning spares and special tools & tackles.
- B** = Differential operating cost as defined hereunder in Clause # 3.3.1 below
- C** = Cost of supervisory mandays for erection and commissioning of the GTC package.

3.2 FUEL COST LOADING CRITERIA

This shall be based on the compressor guaranteed **BKW_G** (as per 2.1) and guaranteed heat rate **H_G** (as per 2.3) furnished by the bidder in Annexure-1 alongwith the bid.

3.3 DIFFERENTIAL OPERATING COST

3.3.1 Differential operating cost, B is defined as under:

$$B \text{ (in Rupees)} = (F_E - F_R) \times C_F \times 8760 \times D_F$$

- F_E** = Fuel consumption as calculated for the bidder under evaluation as defined under 3.3.2.
F_R = Lowest fuel consumption (Amongst all technically acceptable bidders) as defined under 3.3.2.
C_F = Cost of fuel, **14.39** Rupees per Sm³ of fuel (Based on Rs. 320.34/MMBTU)
8760 = Number of operating hours per year.
D_F = Discounting factor to arrive at Net Present Value (NPV) based on number of operating years as defined under clause 3.3.3.

3.3.2 Guaranteed Fuel consumption (F_G) is defined as:

$$F_G(\text{Sm}^3/\text{hr}) = (\text{BKW}_G \times H_G) / \text{LHV}$$

Where,

- BKW_G** = Guaranteed BKW of compressor in kW as defined under 2.1.
H_G = Heat rate of gas turbine in kcal/kW-hr as defined under 2.3.
LHV = LHV value to be considered as **8834** kCal/Sm³.

3.3.3 Discounting factor (D_F) is defined as under:

$$D_F = \sum_{n=2}^{n=k+1} [1 \div \{1 + (X/100)\}^n]$$

where,

- k** = Number of operating years for which loading is to be done as specified i.e. **5 Years.**
X = Percentage rate of interest. i.e. **9.5 %.**
D_F = **3.5066.**

[The above formula considers one year time for start-up of operation]

3.4 The maximum loading to be applied however shall not exceed **15 %** of the total capital cost i.e. **[A]** as defined in 3.1.

4.0 PENALTY CRITERIA

In case the offered Compressor and/or the offered Gas Turbine fails to meet the declared guaranteed values (in Annexure-1) during the performance test at the Compressor and Gas Turbine manufacturer's works respectively, the following procedure shall be followed for levy of performance guarantees.

4.1 COMPRESSOR

4.1.1 In case during shop performance tests, the tested **BKW_T** (as per 4.1.3.) consumed by the compressor exceeds the bidder/supplier quoted guaranteed value **BKW_G** (as defined under 2.1), by upto 4%, penalty as defined in clause no. 4.1.3 shall be applied.

4.1.2 In case during shop performance test, the tested **BKW_T** consumed by the compressor exceeds the stipulated bidder/supplier quoted guaranteed **BKW_G** (as defined under clause 2.1), beyond 4%, the following methodology shall be adopted:

- (a). Equipment vendor/supplier/OEM shall carry out necessary shop performance re-tests after repair / rectification / modification / replacement at his own cost & time to prove bidder/supplier quoted guaranteed **BKW_G**. All such re-tests shall be conducted at the earliest, within the committed delivery dates as per contract.
- (b). However, if the guaranteed **BKW_G** is still not met, equipment vendor/supplier/OEM & owner will mutually agree on the method & possibilities of further rectification.
- (c). If the compressor is still not found capable of performing within the guaranteed **BKW_G**, it shall be owner/EIL's decision with respect to "rejection" (or) "acceptance with penalty upto a maximum four percent (4%) for excess power **ΔBKW** consumed over and above the bidder/supplier quoted guaranteed **BKW_G**", which shall be final & binding on the equipment vendor/supplier.
- (d). In case, owner/EIL exercises the acceptance with penalty option, for excess power **ΔBKW** consumed over and above the bidder/supplier quoted guaranteed **BKW_G** upto a maximum of four percent (4%), penalty as defined in Clause no. 4.1.3 shall be applied.

4.1.3 Penalty (**P_{CC}**) shall be worked out as under:

$$P_{CC} \text{ (in Rupees)} = [(BKW_T - BKW_G) \times H_G \times C_F \times 8760 \times D_F] / LHV$$

Where,

P_{CC} = Penalty for Compressor

BKW_T = Compressor **BKW** as obtained during shop Testing.

Note: All losses as per 2.1 shall also be considered in the shop tested value

BKW_G = Guaranteed Compressor **BKW** as per 2.1.

H_G = Guaranteed Heat Rate of Gas Turbine as per 2.3.

LHV = LHV to be considered as 8834 kCal/Sm³

C_F = Cost of fuel, **14.39** Rupees per Sm³ of fuel (Based on Rs. 320.34/MMBTU)

8760 = Number of operating hours per year.

D_F = Discounting factor to arrive at Net Present Value (NPV) based on number of operating years as defined under clause 3.3.3.

4.2 GAS TURBINE

4.2.1 OUTPUT POWER

In case during shop performance test of a gas turbine, the guaranteed site rated power **P_{GT}** as defined under 2.3 is not met, the subject gas turbine gets rejected.

4.2.2 HEAT RATE

In case during shop test, the tested heat rate **H_T** of the Gas Turbine exceeds the bidder/supplier quoted guaranteed value of heat rate **H_G** (as defined under 2.3), by upto 5%, penalty as defined in clause no. 4.2.4 shall be applied.

4.2.3 In case during shop performance test, the tested heat rate **H_T** of the Gas turbine exceeds the stipulated bidder/supplier quoted guaranteed heat rate **H_G** (as defined under 2.3), beyond 5%, the following methodology shall be adopted:

- (e). Equipment vendor/supplier/OEM shall carry out necessary shop re-tests after repair / rectification / modification / replacement at his own cost & time to prove bidder/supplier quoted guaranteed heat rate **H_G**. All such re-tests shall be conducted at the earliest, within the committed delivery dates as per contract.
- (f). However, if the guaranteed heat rate **H_G** is still not met, equipment vendor/supplier/OEM

& owner will mutually agree on the method & possibilities of further rectification.

- (g). If the Gas Turbine is still not found capable of performing within the guaranteed heat rate H_G , it shall be owner/EIL's decision with respect to "rejection" (or) "acceptance with penalty upto a maximum five percent (5%) for excess heat rate ΔH above the bidder/supplier quoted guaranteed heat rate H_G ", which shall be final & binding on the equipment vendor/supplier.
- (h). In case, owner/EIL exercises the acceptance with penalty option, for excess heat rate ΔH over and above the bidder/supplier quoted heat rate H_G upto a maximum of five percent (5%), penalty as defined in Clause no. 4.2.4 shall be applied.

4.2.4 Penalty (P_{CGT}) shall be worked out as under:

$$P_{CGT} \text{ (in Rupees)} = [(H_T - H_G) \times BKW_G \times C_F \times 8760 \times D_F] / LHV$$

Where,

- P_{CGT} = Penalty for Gas Turbine
- H_T = Heat Rate of Gas Turbine obtained during shop Testing.
- H_G = Guaranteed Heat Rate of Gas Turbine as per 2.3.
- BKW_G = Guaranteed Compressor BKW as per 2.1.
- LHV = LHV to be considered as 8834 kCal/Sm³
- C_F = Cost of fuel, 14.39 Rupees per Sm³ of fuel (Based on Rs. 320.34/MMBTU)
- 8760** = Number of operating hours per year.
- D_F = Discounting factor to arrive at Net Present Value (NPV) based on number of operating years as defined under clause 3.3.3.

4.2.5 Gas Turbine Correction Curves

The bidder shall furnish alongwith the bid, gas turbine correction curves to correct power and heat rate for the following:

- Site ambient temperature
- Site ambient pressure
- Humidity & Altitude
- Power Turbine Speed
- Actual Power Turbine Loading
- Conversion of heat rate and power from liquid fuel to gas fuel and vice versa.

These curves shall be used to estimate heat rate and power indicated by the Bidder in his bid and to convert test results to site conditions and to ISO conditions. No change in this shall be accepted after award of the contract. Bidder shall also furnish a set of sample hand calculations for conversion of test data to site conditions.

4.3 The maximum penalty to be charged for non conformance to guaranteed values during the shop performance test of compressor(s) & gas turbine(s) put together shall not exceed **15 %** of the total capital cost i.e. **[A]** as defined in 3.1.

This penalty shall be independent of any other penalties specified elsewhere in the bid/inquiry documents.

5.0 GUARANTEED VALUES

Bidder shall furnish the guaranteed values (Compressor and Gas Turbine) as per **ANNEXURE-1** attached.

Annexure-1 : Format for Guaranteed Compressor BKW and Gas Turbine heat rate

RFQ :

BIDDING DOCUMENT NO. :

NAME OF BIDDER :

GUARANTEED PARAMETER FOR COMPRESSOR (#)

SL. NO.	ITEM TAG NO. /EQUIPMENT	DESCRIPTION/ SERVICE	GUARANTEED PARAMETERS	REMARK
1	910-K-901	Centrifugal Compressor	BKW _G = _____ kW	(0% +ve Tol.)

(#)No change in guaranteed value is permitted post submission of bid. Bidder to note and comply with the following:

- In case of suo-moto increase in guaranteed Compressor **BKW_G** (without any change in operating condition), post submission of bid, bidder's bid/offer is liable to be **REJECTED**.
- In case of suo-moto decrease guaranteed Compressor BKW (without any change in operating condition), post submission of bid, the guaranteed figure as per original bid will be considered for the purpose of loading and reduced guaranteed figure will be considered for the penalty purpose.

In case of non-submission of guarantee values with the bid, the bid shall be summarily rejected.

GUARANTEED PARAMETER FOR GAS TURBINE (§)

SL. NO.	ITEM TAG NO./ EQUIPMENT	DESCRIPTION/ SERVICE	GUARANTEED PARAMETERS	REMARK
1	910-KT-901	Gas Turbine	F _G = _____ Sm ³ /hr	(0% +ve Tol.)
2			H _G = _____ kCal/kW-h	(0% +ve Tol.)
3			P _{GT} = _____ kW	(0% -ve Tol.)

(§)No change in guaranteed value is permitted post submission of bid. Bidder to note and comply with the following:

- In case of suo-moto increase in guaranteed fuel consumption value (without any change in operating condition), post submission of bid, bidder's bid/offer is liable to be **REJECTED**.
- In case of suo-moto increase in guaranteed heat rate value (without any change in operating condition), post submission of bid, bidder's bid/offer is liable to be **REJECTED**.
- In case of suo-moto decrease in guaranteed gas turbine site rated power value (without any change in operating condition), post submission of bid, bidder's bid/offer is liable to be **REJECTED**.
- In case of suo-moto decrease in guaranteed heat rate value (without any change in operating condition), post submission of bid, the guaranteed figure as per original bid will be considered for the purpose of loading and reduced guaranteed figure will be considered for the penalty purpose.

CAUTION: Technical bids without duly filled-in & signed/stamped Annexure-1 will be summarily rejected.