



Document No.	GIS 34-103
Applicability	Group
Date	26 December 2005

Guidance on Industry Standard for ISO 13631 Packaged Reciprocating Gas Compressors (Formerly API 11P)

GIS 34-103

BP GROUP
ENGINEERING TECHNICAL PRACTICES

Foreword

This is the first issue of Engineering Technical Practice (ETP) BP GIS 34-103. This Guidance on Industry Standard (GIS) is based on parts of heritage documents from the merged BP companies as follows:

Amoco

- | | |
|-----------------|---|
| A RE-COMP-11P-P | Rotating Equipment—Compressors—API 11P—Procurement Specification. |
| A RE-COMP-HS-G | Rotating Equipment—Compressors—High Speed Reciprocating—Guide. |

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Introduction

- a. Guidance for high speed compressors is based on International Organization for Standardization (ISO) Standard 13631, “Petroleum and natural gas industries—Packaged reciprocating gas compressors”, First Edition, August 2002.
- b. Guidance statements of this GIS are modifications ISO 13631.
- c. Modifications to ISO 13631 are identified as Add, Modify to Read, or Delete.
- d. Clause numbers in this GIS correspond to ISO 13631.
- e. Clauses of ISO 13631 that are not revised remain applicable.



1 Scope

Add to First Clause

This standard defines minimum requirements for design, materials, fabrication, inspection, testing, and documentation of high speed reciprocating gas compressors with maximum power rating of 1 860 kW (2 500 hp).

Add to Third Clause

Air compressors and compressors for hydrogen rich gases (gases with molecular weight less than 12) are excluded.

Overall system responsibility for adequate sizing and interaction of components shall be with Vendor.

There are three types of compressor service:

- *Least demanding is standby compressor that is only operated if abnormal conditions exist (such as during failure or maintenance of primary equipment).*
- *Next higher level of service is compressor that is used for production. However, equipment is either spared or has multiple units to make up required capacity. Failure or shutdown of such equipment may or may not cause reduction in production. Frequency of maintenance contributes to overall operating cost of production facility.*
- *Most critical service is if a shutdown of compressor would result in either significant or total loss of production. Unscheduled shutdown may also require extended restarts of process or cause damage to facility. This type of service can be avoided by using multiple units and spares to reduce criticality of shutdown.*

Reciprocating gas compressors should be lubricated unless they discharge into process areas where oil carryover may be harmful. Process application should be checked to determine whether lubricated compressor is acceptable.

Add

1.1 Data sheets

- a. Compressor package, operating conditions, and compressor material requirements will be specified by BP on compressor data sheet.
- b. Data sheets from other applicable specifications will be used by BP to specify driver, cooler, exchanger, and control panel.
- c. Complete listing of specific exemptions (if any) to BP specifications shall be supplied by Packager on data sheet or other suitable document.
- d. Data sheet changes are not sufficient to be considered an exception.

Before inquiry, preliminary design that includes number of units, compressor configuration, number of stages, driver type, cooling methods, capacity control methods, and Vendor scope of supply needs to be established. If these decisions are left to Vendors, there is high probability that proposals will not be for equivalent equipment and rebids may be necessary.

There are only a few manufacturers of reciprocating compressors. There are, however, many packagers who design and assemble the entire unit. Selection of acceptable packagers should be based on preliminary investigation of experience with similar equipment and designs. If compressor manufacturer acts as packager, there is usually single source of responsibility and better technical capability.



2 Normative references

Add

BP

GIS 12-201	Guidance on Industry Standard for Low Voltage Induction Motors (IEC).
GIS 12-202	Guidance on Industry Standard for Low Voltage Induction Motors (IEEE 841).
GIS 12-203	Guidance on Industry Standard for High Voltage Induction Motors (IEC).
GIS 12-204	Guidance on Industry Standard for High Voltage Induction Motors (API 541).
GIS 12-205	Guidance on Industry Standard for IEC Synchronous Motors.
GIS 12-206	Guidance on Industry Standard for Synchronous Motors (API 546).
GIS 34-306	Guidance on Industry Standard for Gas Engines.
GP 06-20	Guidance on Practice for Materials for Sour Service.
GP 06-60	Guidance on Practice for Paints and Coatings (A CP-COAT-00-C or BP GS 106-2).
GP 12-45	Guidance on Practice for Electrical for Packaged Equipment.
GP 12-60	Guidance on Practice for Hazardous Area Electrical Installations.
GP 30-65	Guidance on Practice for Control Panels.
GP 30-70	Guidance on Practice for Control and Instrumentation in Vendor Packaged Equipment.
GP 36-10	Guidance on Practice for Materials Selection.
GP 44-60	Guidance on Practice for API RP 500 Area Classification.
GP 44-65	Guidance on Practice for IP 15 Area Classification.

5 General package requirements

5.1 Compressor package performance curves

Add

- Performance curves shall present values of dependent variables (compressor capacity, compressor shaft power, stage discharge temperatures, and combined rod loads and gas loads) on ordinate and shall show line plots for each of several constant compressor discharge pressures (kPag (psig)) as parameters.
- Values of inlet pressure (kPag ((psig)) that are common to all curves shall be shown on abscissa.
- Separate curves to same scale for various discharge pressures are acceptable.

Control method and number of steps required should be specified. This is important from both performance and hardware scope definition standpoints. Compressor performance, interstage pressures, rod loads, and frame loads should be checked during unloaded and partial load conditions. Partial load conditions may have significant effect on initial design.

5.5 Electrical area classification

Modify to Read

- Electrical installations shall comply with GP 12-60.
- Locations will be classified by BP in accordance with GP 44-60 or GP 44-65.



5.6 Package installation

Modify to Read

Site conditions will be specified in compressor data sheet.

Site location, service, number of compressors, lubrication type, and drive type should be specified on compressor data sheet. If required, preliminary information can be obtained from Vendor or Vendor catalogues.

It is important to carefully state impurities and trace contaminants in gas analysis section of data sheet so Vendor can recommend proper inlet treatment and liquid separation. Special conditions in remarks section for gas analysis should be included.

Process requirements and startup conditions should be thoroughly investigated. Often, gas plant services start up on gas composition that is very different from normal operating condition or with off design pressure requirements. Also, compressors may need to run on air for drying lines during commissioning. Compressor manufacturer should consider these conditions during initial design.

Compression of rich gas generates significant condensates which drop out between stages resulting in less gas capacity in each stage. Process simulation may be required when compressing rich gases in order to correctly select the right cylinder diameter and predict interstage pressures on multi-stage units. Failure to take liquid losses into account (i.e. assuming the same throughput on all stages) may produce unacceptable operating problems (i.e. high discharge temperatures).

5.7 Torsional analysis

Add

Package design shall ensure that torsional natural frequencies reside minimum of 20% above all specified operating speeds.

It is recommended that Torsional Analysis are carried out in accordance with “[Recommended Practice for Control of Torsional Vibrations for High Speed Separable Reciprocating Compressors](#)”. This document was prepared by a joint industry consortium on “Enhanced Torsional Modelling of High Speed Compressor Installations” and is published by Southwest Research Institute, May 2002.

This published document contains information on when a torsional analysis should be performed; the risks involved in not performing a torsional analysis; what should be included in the mass-elastic model; what should be predicted with the model; the torsional excitations which should be considered; the interpretation of and criteria for torsional natural frequencies and torsional vibration response levels; and the role of transient torsional analysis.

Add

5.8 Conflicting requirements

In case of conflicts, order of precedence shall be:

- Local codes and standards.
- Purchase order/requisition/contract.
- Project data sheet/drawings.
- This GIS.
- Referenced BP documents.



- f. Referenced standards.

6 Compressor

6.1 General

6.1.1 Manufacturer's rated capacity

Modify First Sentence to Read

Compressor shall be sized to handle quoted capacity with gas analysis, suction pressures, suction temperatures, discharge pressures, and site conditions specified on data sheets.

6.1.2 Performance calculations

Modify Second Sentence to Read

Compressor packager shall indicate values on data sheet, provide them with quotation, and use them to calculate performance data.

Initial inlet pressure and temperature and final pressure must be specified. If multiple stages are required, number of stages can be specified, but interstage conditions should not be set because this may significantly affect Vendor selection. Rated inlet capacity must be specified. This value should be indicated in kg (pounds) per hour (wet or dry weight) to minimise conversion variations. Most Vendor performance guarantees are based on $\pm 3\%$ tolerances. If service is critical and requires zero negative tolerance, rated capacity should be increased by 3%.

6.1.4 Forces and couples

Modify to Read

- Values for unbalance primary and secondary forces and couples in horizontal and vertical planes for quoted compressor shall be provided.
- Method used to calculate these quantities shall be provided.

6.2 Allowable speeds

Modify to Read

Maximum allowable compressor RPM and maximum compressor power that may be used at a given RPM is shown in the following tables:

Lubricated cylinders			
Compressor stroke length mm (in)	RPM	kW (Horsepower)	
		Per compressor throw	Max per frame
76 (3)	1 800	37 (50)	150 (200)
89 (3.5)	1 400	56 (75)	225 (300)
102 to 114 (4 to 4.5)	1 200	150 (200)	600 (800)
127 to 140 (5 to 5.5)	1 000	225 (300)	900 (1 200)
152 (6)	900	466 (625)	1 860 (2 500)
178 (7)	775	466 (625)	1 860 (2 500)
203 (8)	675	466 (625)	1 860 (2 500)
Note: Maximum average compressor piston speed for lubricated compressor cylinders shall be 4,6 compressor piston m/s (900 compressor piston ft/min).			

