

GP 10-03-01	Axial and Centrifugal Compressors and Expander-Compressors	February 2005
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Axial and Centrifugal Compressors and Expander-Compressors

GP 10-03-01

Scope

- 1) [I] This Global Practice (GP) refers to API STD 617, Seventh Edition, July 2002, which is a part of this GP.
- 2) [I] This GP covers special purpose centrifugal, axial compressors and integrally geared compressors.
- 3) [I] [GP 10-03-02](#) should be used for packaged integrally geared centrifugal air compressors.
- 4) [I] All requirement specified in this GP are additions to those of API STD 617 unless specifically noted as exceptions. Paragraph numbers in this GP which do not appear in API STD 617 are new paragraphs.
- 5) [I] An asterisk (*) indicates that a decision by the Purchaser is required, or that additional information is furnished by Purchaser.

Note: A Bullet (•) is shown in API STD 617 indicating that a Purchaser's decision is required.

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GP 10-03-01	Axial and Centrifugal Compressors and Expander-Compressors	February 2005
-------------	--	---------------

Table of Contents

1. Required References	4
1.1. Global Practices–ExxonMobil Engineering Practices	4
1.2. API–American Petroleum Institute	4
1.3. ASME–American Society of Mechanical Engineers	4
1.4. NACE–National Association of Corrosion Engineers	4
2. Additional Requirements	5
2.1. Global Practices–ExxonMobil Engineering Practices	5
2.2. ASME–American Society of Mechanical Engineers	5
2.3. ASTM–American Society for Testing and Materials	5
3. Revisions to API Standard 617	6
Modifications to Chapter 1–General Requirements	6
Modifications to Section 1: General.....	6
Modifications to Section 2: Basic Design	7
Modifications to Section 3: Accessories	15
Modifications to Section 4: Inspection, Testing, and Preparation for Shipment...19	19
Modifications to Section 5: Vendor's Data	20
Modifications to Annex 1D: Testing of Gas Seals in Seal Vendor's Shop	21
Modifications to Chapter 2–Centrifugal and Axial Compressors	22
Modifications to Section 2: Basic Design	22
Modifications to Section 3: Accessories	25
Modifications to Section 4: Inspection, Testing, and Preparation for Shipment...26	26
Modifications to Annex 2B: Centrifugal and Axial Compressor Vendor Drawing and Data Requirements.....	28
Modifications to Annex 2D: Inspector's Checklist	28
Modifications to Chapter 3–Integrally Geared Compressors	29

DNST, CHEM, DIOL	For ExxonMobil Use Only	Version 2.0.0
Page 2 of 28	©ExxonMobil Development Company	



Documents

Document Sharing Hub

GP 10-03-01	Axial and Centrifugal Compressors and Expander-Compressors	February 2005
-------------	--	---------------

Modifications to Section 2: Basic Design	29
Modifications to Section 3: Accessories	29
Modifications to Section 4: Inspection, Testing, and Preparation for Shipment...30	
Modifications to Annex 3B: Integrally Geared Compressor Vendor Drawing and Data Requirements	30
Addition	30
Modifications to Chapter 4—Expander-Compressors	31
Modifications to Section 2: Basic Design	31
Modifications to Annex 4B: Expander-Compressor Vendor Drawing and Data Requirements	33
Record of Change	34
Attachment: Purpose Codes Definitions	35

DNST, CHEM, DIOL	For ExxonMobil Use Only	Version 2.0.0
Page 3 of 28	©ExxonMobil Development Company	



Documents

Document Sharing Hub

GP 10-03-01	Axial and Centrifugal Compressors and Expander-Compressors	February 2005
-------------	--	---------------

1. Required References

[I] This Section lists Practices and Standards that are generically referenced and assumed to be a part of this document. Unless otherwise specified herein, use the latest edition.

1.1. Global Practices–ExxonMobil Engineering Practices

GP 02-01-01	Plant Noise Design Criteria
GP 03-03-03	Flushing and Drain Piping for Centrifugal and Rotary Gas Compressors
GP 03-06-01	Piping for Instruments
GP 03-16-01	Flanged Joints, Gaskets, and Bolting
GP 10-11-01	Sizing of Drivers and Transmissions for Compressors, Fans, and Pumps
GP 10-12-01	Vibration, Axial-Position, and Bearing-Temperature Monitoring Systems for Compressors and Drivers
GP 10-14-01	Lube and Seal Oil Systems for Machinery
GP 18-03-04	Pressure Casting Quality and Inspection
GP 18-10-01	Additional Requirements for Materials
GP 18-12-01	Positive Material Identification
GP 20-01-01	Inspection of Equipment and Materials

1.2. API–American Petroleum Institute

API STD 616	Gas Turbines for Petroleum, Chemical, and Gas Industry Services
API STD 617	Axial and Centrifugal Compressors and Expander-Compressors for Petroleum, Chemical and Gas Industries Seventh Edition; Errata: June 1, 2003

1.3. ASME–American Society of Mechanical Engineers

ASME PTC 10	Performance Test Code on Compressors and Exhausters (Performance Test Codes)
ASME SEC VIII D1	BPVC Section VIII - Rules for Construction of Pressure Vessels - Division 1

1.4. NACE–National Association of Corrosion Engineers

NACE MR0175	Petroleum and Natural Gas Industries Materials for Use in H2S-Containing Environments in Oil and Gas Production
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DNST, CHEM, DIOL	For ExxonMobil Use Only	Version 2.0.0
Page 4 of 28	©ExxonMobil Development Company	



Documents

Document Sharing Hub

GP 10-03-01	Axial and Centrifugal Compressors and Expander-Compressors	February 2005
-------------	--	---------------

2. Additional Requirements

* [I] The following Practices and Standards shall be used with this GP as specified by the Owner's Engineer.

2.1. Global Practices–ExxonMobil Engineering Practices

GP 03-09-01	Winterizing and Protection Against Ambient Temperatures
GP 04-10-02	Grouting for Machinery
GP 10-07-02	Special Purpose Steam Turbines
GP 10-08-01	Combustion Gas Turbines
GP 10-10-01	Special Purpose Gear Units
GP 15-01-02	Instrumentation for Compressors and Drivers
GP 15-07-01	Electric Power Branch Circuit Design for Instrumentation
GP 15-07-02	Protective Systems
GP 15-11-01	Instrument Control Panels
GP 16-09-01	Low Voltage AC Motors Up to 200 HP (150 kW)
GP 16-09-02	AC Motors: Medium Voltage and Low Voltage Over 200 HP (150 kW)
GP 18-10-01	Additional Requirements for Materials

2.2. ASME–American Society of Mechanical Engineers

ASME SEC VIII D1 B PT UW	Part UW Requirements for Pressure Vessels Fabricated by Welding
ASME SEC VIII D1 C PT UHA	Part UHA Requirements for Pressure Vessels Constructed of High Alloy Steel
ASME SEC VIII D1 C PT UCS	Part UCS Requirements for Pressure Vessels Constructed of Carbon and Low Alloy Steels
ASME Publication 87- GT-10	Influence of the Reynolds Number on the Performance of Centrifugal Compressors.

2.3. ASTM–American Society for Testing and Materials

ASTM A 488/A 488M	Standard Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel
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DNST, CHEM, DIOL	For ExxonMobil Use Only	Version 2.0.0
Page 5 of 28	©ExxonMobil Development Company	



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3. Revisions to API Standard 617

[I] All headings contained herein correspond to paragraph numbering within API STD 617 and reflect additions, substitutions, modifications, and deletions. All provisions not modified or deleted remain in force.

Modifications to Chapter 1—General Requirements

Modifications to Section 1: General

1.2. Addition: Alternative Designs

- a. [O], [R] Qualified Vendors with experience in manufacturing the units proposed shall supply the compressor systems. To qualify, Vendor must have manufactured at the proposed point of manufacture, at least two compressors of comparable speed, power rating, and discharge pressure. These compressors must have been in service for at least one year and be performing satisfactorily. Alternatively, Vendor may satisfy this experience requirement on an individual component and service condition basis. Experience need not be concentrated in a single compressor, but may be spread through several operating compressors. To qualify, each of these compressors shall have been in service for at least one year and be performing satisfactorily.
- b. Alternatively, Vendor may satisfy this experience requirement on an individual component and service condition basis. Experience need not be concentrated in a single compressor, but may be spread through several operating compressors. To qualify, each of these compressors must have been in service for at least one year and be performing satisfactorily.
- c. The critical areas relative to service conditions, which must be demonstrated to the satisfaction of the Owner's Engineer, include but are not limited to the following:
 - i. Pressure
 - ii. Volumetric capacity
 - iii. Power rating
 - iv. Speed
 - v. Temperature
- d. The critical areas relative to mechanical design, which must be demonstrated to the satisfaction of the Owner's Engineer, include but are not limited to the following:
 - i. Sealing system
 - ii. Bearing design and loading
 - iii. Number of stages and staging arrangement
 - iv. Casing size and design
 - v. Casing joint design

DNST, CHEM, DIOL	For ExxonMobil Use Only	Version 2.0.0
Page 6 of 28	©ExxonMobil Development Company	



GP 10-03-01	Axial and Centrifugal Compressors and Expander-Compressors	February 2005
-------------	--	---------------

- vi. Rotor dynamics
- vii. Blade and disk mechanical design and performance
- viii. Material selection
- ix. Power transmission components—design and arrangement
- e. In the area of component mechanical design, Vendor shall show that each component has operated under the same conditions as those of the proposed compressor.
- f. Compressors manufactured under a license agreement shall carry the Licensor's written guarantee.
- g. Where Vendor qualification requirement of Item 1.2a) above prevents the application of the latest technology, Vendor shall submit a second alternative proposal incorporating such features for evaluation by the Owner's Engineer. Such proposal shall specifically identify the undemonstrated features and state their advantages.

1.3. Rationale

Modifications to Section 2: Basic Design

2.1.1.3. Addition: General

- h. [O], [C] Compressors shall be guaranteed for head, capacity, and satisfactory performance at all specified operating points and further shall be guaranteed for power at the normal operating point (see API STD 617 Figure 2.1-1a).
- i. See Chapter 2 Sections 4.3.3.1.4 and 4.3.3.1.6 in this GP for constant speed compressors and compressors with sideloads or two or more process stages (sections).

2.1.8. Addition: Basic Design

* [I], [R] Compressors and auxiliaries shall be suitable for outdoor installation and shall be winterized for the climatic zone specified, as per [GP 03-09-01](#).

2.1.9. Addition: Noise Data

[E], [I] Compressor vendors shall submit noise emission data for the quoted machine with their proposal per [GP 02-01-01](#).

2.1.10. Rationale

2.1.13 Rationale

2.1.16. Addition: General

[O] Compressors shall be run-in on air. Vendor shall provide air performance curves, operating guidelines, and any additional features required for this "run-in."

2.1.17. Addition: Basic Design

[R] The following spare parts shall be furnished for and delivered with each compressor:

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Page 7 of 28	©ExxonMobil Development Company	



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GP 10-03-01	Axial and Centrifugal Compressors and Expander-Compressors	February 2005
-------------	--	---------------

- a. Rotor.
 - b. Set of stator blades for axial compressors. Blades to be installed in carriers if such design is available.
 - c. A fully instrumented set of bearings (radial and thrust).
 - d. Shaft seals.
 - e. Renewable labyrinths and other seal types for all internal close clearance points.
- Note: If two or more compressors are duplicates, a single set of spares will suffice.

2.2.1.6. Rationale

2.2.1.15.5. Exception: Low Temperature

* [S], [R] Material selection and impact requirements for low temperature service shall be governed by [GP 18-10-01](#). Critical Exposure Temperature (CET) shall be specified.

2.3.1.11.6. Addition: Pressure-Containing Casings

* [R] PWHT is required for all carbon and ferritic alloy steel pressure containing components that are welded and/or weld repaired, when the weldment is exposed to a process environment containing wet H₂S. The PWHT procedure outlined in the ASME SEC VIII D1 B PT UW Paragraphs 40 and 49, ASME SEC VIII D1 C PT UHA 32, and ASME SEC VIII D1 C PT UCS 56 shall be followed, except that notes in Tables UHA 32 and UCS 56 do not apply. All welds, regardless of type or size, that are exposed to wet H₂S shall be PWHT at a minimum temperature of 1150°F (620°C). External attachments or seal welded threaded connections on P-1 Group 1 and 2 materials do not require PWHT.

2.3.1.12.2.1. Addition: Material Inspection of Pressure-containing Parts

[R] All butt welds not requiring 100 percent radiography shall be spot radiographed per Section VIII, Division 1, UW-52 (ASME SEC VIII D1 B PT UW Paragraph 52).

2.3.2.1.6. Addition: Casing/Stage Drains

[I] Casing and stage drains and injection nozzles shall be done in accordance with [GP 03-03-03](#).

2.3.2.1.7. Addition: Pressure Casing Connections

* [I] If stage flushing (to individual impellers) is specified, the compressor Vendor shall provide the following:

- a. Individual stage drains.
- b. Flanged liquid injection connections with recessed spray nozzle seats to each stage (individual impellers).

2.3.2.2.2. Exception: Main Process Connections

[O], [R] Flanges shall be per [GP 03-16-01](#).

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Page 8 of 28	©ExxonMobil Development Company	



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Document Sharing Hub

GP 10-03-01	Axial and Centrifugal Compressors and Expander-Compressors	February 2005
-------------	--	---------------

2.5.1. Addition: Rotating Elements

[I], [R] Coupling hubs shall be removable and non-keyed (tapered bore, hydraulically fitted).

2.5.10.8. Addition: Impellers

[R] Impellers shall be designed to limit the maximum stress at maximum continuous speed to a value of 70 percent of the material yield strength.

2.5.10.9. Addition: Impellers

* [R] When flushing is specified, the impeller gas passage width at the periphery shall be $\frac{3}{8}$ in. (10 mm) minimum.

2.5.10.10. Addition: Impellers

[O], [R] For impellers with welded joints in wet H₂S service (see Section 2.11.1.7), the welding procedure shall specify any heat treatment used after completion of welding to achieve acceptable hardness values. Manufacturer shall verify that the maximum allowable hardness has not been exceeded. A mock-up weldment is acceptable for this purpose. This mock-up shall be prepared using the maximum thickness and same grade of materials to be joined for impeller construction. Joint details, welding process, filler metal and heat treatment shall be identical to that used for the construction of the impellers. The joint shall be cross-sectioned transversely, and a traverse made over the cross section to determine hardness of the base metal, weld metal and heat affected zone. This traverse shall be made $\frac{1}{16}$ in. (1.5 mm) from the top and parallel to the face of the weld. It is not necessary to repeat this test provided that the welding and heat treatment procedures are not changed.

2.5.10.11. Addition: Impellers

[O], [R] Manufacturer shall qualify a welding procedure for impellers with welded construction for each material P-number used.

2.5.10.12. Addition: Impellers

[O], [R] Manufacturer shall submit a brazing procedure for impellers with brazed construction.

2.6.2.6. Addition: Lateral Analysis

[R] Vendor shall perform a train lateral analysis on machinery trains with rigid couplings.

2.6.2.9. Exception: Lateral Analysis

[O], [R] The unbalance weights shall be added at positions mutually agreed to by Vendor, Purchaser and Owner's Engineer.

2.6.4. Exception: Additional Testing

[O], [R] Failure to meet the separation margins or vibration amplitudes of 2.6.3.2 shall be corrected as mutually agreed upon by Vendor, Purchaser, and Owner's Engineer.

2.6.7.6. Addition: Torsional Analysis

[I], [R] The Vendor shall perform a transient analysis for variable frequency motor driven trains. The transient analysis shall be performed after final electrical system characteristics are defined.

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