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## Revision Memo

**12/97**    Page 3: API and IP titles updated.  
Page 8: Reference to **IP 3-3-4** deleted as IP no longer exists.  
**Tables 1, 2 and 3** updated to match paragraph references of latest API Editions.

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## SCOPE

This subsection presents procedures for designing and specifying compression services. Only the general aspects of design which are common to the various compressor types are covered. Details relating to specific types of compressors, drivers, auxiliary systems, and specialized aspects of compression service design are presented in other subsections.<sup>(1)</sup>

## REFERENCES

### DESIGN PRACTICES (BESIDES SUBSECTIONS OF SECTION XI)

|               |                                                      |
|---------------|------------------------------------------------------|
| Section V     | Drums                                                |
| Section XII   | Instrumentation                                      |
| Section XV    | Safety in Plant Design                               |
| Section XVIII | Guidelines and Considerations for Industrial Hygiene |

### INTERNATIONAL PRACTICES

|             |                                                                      |
|-------------|----------------------------------------------------------------------|
| IP 3-3-3    | Flushing and Drain Piping For Centrifugal And Rotary Gas Compressors |
| IP 3-9-1    | Winterizing and Protection Against Ambient Temperatures              |
| IP 10-3-1   | Special Purpose Centrifugal Compressors                              |
| IP 10-3-3   | Rotary Screw Compressors                                             |
| ♦ IP 10-3-4 | Axial Compressors for Air Service                                    |
| IP 10-4-1   | Reciprocating Process Compressors                                    |
| IP 10-7-2   | Special Purpose Steam Turbines                                       |
| IP 10-8-1   | Combustion Gas Turbines                                              |
| IP 10-10-1  | High Speed Special Purpose Gear Units                                |
| IP 10-14-1  | Lube and Seal Oil Systems for Machinery                              |
| ♦ IP 16-9-1 | Low Voltage A-C Motors Up To 200 HP (150 kW)                         |
| ♦ IP 16-9-2 | AC Motors: Medium Voltage and Low Voltage Over 200 HP(150 kW)        |
| IP 16-14-1  | Variable Frequency Drives                                            |
| IP 18-10-1  | Additional Requirements for Materials                                |

### OTHER REFERENCES

Computer Program CompCalc Version 2.1, CPEE 41

ER&E R&D Report No. EE.16E.87 Mitigating the Effects of Fouling of Turbomachinery

|           |                                                                                   |
|-----------|-----------------------------------------------------------------------------------|
| ♦ API-612 | Special Purpose Steam Turbines for Petroleum, Chemical, and Gas Industry Services |
| API-613   | Special Purpose Gear Units for Petroleum, Chemical, and Gas Industry Services     |
| ♦ API-616 | Gas Turbines for Refinery Services Petroleum, Chemical, and Gas Industry Services |
| ♦ API-617 | Centrifugal Compressors for Petroleum, Chemical, and Gas Industry Services        |
| ♦ API-618 | Reciprocating Compressors for Petroleum, Chemical, and Gas Industry Services      |
| ♦ API-619 | Rotary-Type Positive Displacement Compressors for General Refinery Services       |

#### Note:

- (1) API compressor data sheets specify pressure in psi, bar, and kPa. In this subsection, bar is the metric unit used for pressure.

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## BACKGROUND

### GENERAL

The application of compression equipment is accomplished in three major phases:

1. Compression service design and specification.
2. Compressor vendor and model selection.
3. Detailed compressor and installation design.

Compression service design and specification, including compressor and driver type selection, are part of the overall process design effort. The choice of a specific compressor vendor and model is done by machinery specialists during the detail engineering phase of a project. Compressor and driver design are vendor responsibilities, while installation design is left to the detail engineering contractor.

### TYPES OF COMPRESSORS

**Section XI-B** provides a summary of the various types of commercially available compressors. The four commonly used types are conventional centrifugal, axial, reciprocating, and high pressure helical screw compressors. Design and International Practice coverage for these types is extensive.

Certain compressor types are infrequently applied; therefore, they are not extensively covered in this Design Practice or the International Practices. Machinery specialist assistance should be used in the selection and specification of the following infrequently used compressor types:

1. High speed single stage centrifugal compressors.
2. Axial compressors for other than air service.
3. High pressure reciprocating compressors (over 6000 psi) (415 bar).
4. Diaphragm compressors.
5. Rotary compressors other than high pressure helical screw type.
6. Fans for gas service.
7. Liquid ring compressors.

### JOB SPECIFICATION INFORMATION LOCATIONS

Compressor service design and specification information is generally located in the following job specification documents:

1. The General Instructions and Information (**GII**) section of the Design Specifications.
2. The Design Specification for the process unit in which the compressor is located. This includes Design Flow Plans.
3. International Practices.

### INTERNATIONAL PRACTICE COVERAGE

The applicable International Practices for the four commonly applied compressor types are **IP 10-3-1** for centrifugal compressors, **IP 10-3-4** for axial air compressors, **IP 10-4-1** for reciprocating process compressors, and **IP 10-3-3** for the high pressure helical screw machine. The compressor International Practices include the requirements of the applicable API Standards. They are API-617 for centrifugals and axials, API-618 for reciprocating compressors, and API-619 for the helical screw machine.

There are also International Practices covering the various types of compressor drivers, namely, electric motors, gearing, and steam and gas turbines. They are **IP 16-9-1**, **IP 16-9-2**, and **IP 16-14-1** for motors, **IP 10-10-1** for gears, **IP 10-7-2** for steam turbines, and **IP 10-8-1** for gas turbines. The gear, steam turbine, and gas turbine International Practices also include the requirements of API-613 for gears, API-612 for steam turbines, and API-616 for gas turbines.

The International Practices, including API Standards, cover many aspects of compressor, driver, and auxiliary system design. However, there are many International Practice issues which require that the purchaser make a decision or furnish additional information. The International Practices define the purchaser as the party originating the technical requirements for inclusion in an inquiry or direct purchase order. If a job is contracted, the Contractor is considered to be the purchaser; however, there are still some job specific issues which are best addressed by the process designer in the Design Specification.

Many of the issues to be addressed pertain to all four types of commonly used compressors, while some, of course, are peculiar to certain types. This section directly addresses the issues pertaining to all four compressor types. For issues peculiar to a compressor type, the appropriate Design Practice references are provided.

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## BACKGROUND (Cont)

### DESIGN SPECIFICATION CHECKLISTS AND SAMPLE SPECIFICATIONS

Included as **Tables 1** through **4** are **Design Specification Checklists** for each compressor type. The checklists show the items to be specified by the process designer. The API Standard or International Practice paragraph which is the source of each requirement is noted where applicable. The item description gives guidance on where the item is discussed in the Design Practices. **Appendices A and B** are **Sample Design Specifications** for a reciprocating and a centrifugal compressor.

In preparing the checklists, it was necessary to decide which issues to address in the Design Specification and which to appropriately leave to the detail engineering contractor. The reader is encouraged to review the International Practice requirements and become familiar with all of the technical issues associated with the preparation of an inquiry or direct purchase order. Please note that each Checklist references the edition of the API and International Practices used in its formulation.

## BASIC DESIGN CONSIDERATIONS

### EQUIPMENT TYPE SELECTION

**Compressors** - See [Design Practice XI Section B](#)

**Drivers** - See [Design Practice XI Section K](#)

### GENERAL INSTRUCTIONS AND INFORMATION (GII) CONTENT

The **GII** should include the following information which is assumed to relate generally to all compressors on a given project:

**System of Measurement** - The system of measurement to be used in preparing Design Specifications and doing the detail engineering, e.g., MKS System.

**Noise and Industrial Hygiene** - Facility industrial hygiene considerations including any special noise level requirements.

**Characteristics of Utilities** - Provide the characteristics of the cooling water, steam, instrument and utility air, inert gases, fuels, and electric power available. Utilities cost are required to permit evaluation of operating costs in the equipment selection phase.

**Meteorological Data** - This includes site temperatures, relative humidity, wind speeds and direction, rainfall, site altitude, and winterizing area class.

**Critical Exposure Temperature (CET)** - Casing or cylinder CET must be specified for all compressor types. CET is defined in [IP 18-10-1](#), Additional Requirements for Materials. It may be given in the GII, when the same value applies to all compressors or on the compressor data sheet, if service specific.

**Environmental Conditions** - For all compression trains, unusual amounts of airborne dust, such as catalyst fines and sand, can have an adverse effect on exposed parts like valve stems and mechanical linkages. In addition, the quality of the air in the vicinity of air intakes to compressors and engines affects filtering requirements. The presence of sea spray, salty ocean mists, and chemical fumes also must be specified. Marine or tropical environments should be identified. These conditions may be reported in the individual compressor Design Specification or in the GII.

**Equipment General Information** - General instructions and information relating to the design of heat exchange equipment, pumps, compression machinery, instrumentation, vessels, and safety facilities .

### INDIVIDUAL COMPRESSOR DESIGN SPECIFICATION CONTENT

The compressor individual Design Specification including the compressor data sheet should cover the following requirements:

**Item Number and Service Name** - The compression machinery data sheet should show compressor item number(s) and service name.

**Type of Compressor** - Give the type of compressor as centrifugal, axial, reciprocating, or rotary screw type. For reciprocating compressors indicate if machine is lubricated or non lubricated.

**Number of Units, Operating and Spares** - The number of compressor units required and the number of operating and spare units should be specified. Sparing will be determined during compressor type selection referring to [Design Practice XI Section B and C](#).

**Service Class** - Advise the service class (Continuous or Intermittent).

**Driver Type And Estimated Rating** - Designate driver type and provide estimated driver rating in HP or kW.

|                        |                 |                                                                                                                               |                                                   |
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## BASIC DESIGN CONSIDERATIONS (Cont)

The power requirements of compression services must be estimated during compression service design so that utility systems can be specified and operating costs estimated. See [Design Practice XI Section D, Compressor Calculations](#), for recommended compressor power and performance calculation methods.

**Installation Characteristics** - It is a requirement of the International Practices that compressors be suitable for outdoor installation in the climatic zone specified. Climate zone information should be provided in the GII and noted in the compressor data sheet **Winterization Requirements**. Any requirements for shelters and cranes should be included in the compressor Design Specification. See [Design Practice XI Section P, Shelters and Cranes](#).

## OPERATING CONDITIONS

- **General** - Operating conditions should be provided on a per unit (each machine basis). From all of the possible operating conditions, one point should be designated as the Normal point. All the rest should be shown as alternate operating points on the data sheet. These include starting and equipment run in conditions.

For all compressor types, the Normal operating point is defined by the API Standards as the point at which usual operation is expected, and optimum efficiency is desired. This is usually the point at which the vendor certifies that performance is within International Practice and API tolerances. If performance at any of the specified alternate conditions is critical, it should be noted in the Design Specification for review with the prospective vendors.

- **Fluid Property Data Sources** - Fluid properties such as molecular weight, compressibility factor, and specific heat ratio should be determined by the use of Exxon Data Library (EDL) information or the **PC Program for Compressor Network Simulation- CompCalc**. For definitive design, flash calculations to predict vapor-liquid equilibrium in separator drums and intercoolers should be done using programs which access EDL thermodynamic data. CompCalc flash calculations may be used for screening studies.

- **Process Staging** - The number of "process compression stages" and the operating conditions for each stage are required.

High pressure ratio compression services are commonly separated into multiple "process compression stages" and almost always include coolers between the stages to remove the heat of compression. A "process compression stage" is defined as the compression step between two adjacent pressure levels in a process system. It may consist of one or more "compressor stages." Some reasons for providing process compression staging are as follows:

- To limit the discharge temperature of each stage to acceptable levels from the standpoints of both compressor design restraints and the fouling tendency of the compressed gas. One example is steam cracker cracked gas service where intercooling is used to limit stage discharge temperatures and avoid fouling. It is also necessary to divide high compression ratio reciprocating compressors into multiple compression stages to keep discharge temperature levels low enough to ensure proper cylinder lubrication.
- To make sidestreams available in the compression sequence at intermediate pressure levels such as in process refrigeration systems.
- To reduce "compressor stage" inlet temperatures thereby reducing the amount of work (head) required to achieve a given pressure ratio. This can also reduce the number of compressor stages required and allow more compact, lower cost compressor designs. Centrifugal air compressors are frequently intercooled to minimize power consumption.
- To satisfy differential pressure and pressure ratio limits of various compressor types, e.g., axial thrust load limitations for centrifugals and axials, piston rod stress limits in reciprocating compressors, and rotor lateral deflection and axial thrust in screw compressors.

A "compressor stage" is an assembly of compressor flow path elements designed to achieve all or part of a process compression stage duty. Compressor stages are employed singly, in series, and in parallel within a compressor. Examples of a compressor stage are:

- The inlet guidevane, impeller, diffuser, and return channel combination of a centrifugal compressor.
- Each rotating blade row and the following stationary blade row in an axial compressor.
- For reciprocating compressors, each cylinder or set of cylinders arranged for parallel flow.
- For rotary compressors, most casings including the rotor set make up a single stage.

It is the process compression stage information that is included in the Design Specification. For more information on process compression staging, see [Design Practice XI Sections E, F, H, and I covering staging and casing arrangements](#) for each of the compressor types.

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### BASIC DESIGN CONSIDERATIONS (Cont)

- **Gas Composition** - The Design Specification compressor data sheet must provide a complete analysis of the gas to be compressed for each operating condition. All changes in gas composition due to feedstock or processing changes must be evaluated and a comprehensive range of operating conditions provided. Constituents should be named and their flow rates given in pound moles or kg moles per hour. High molecular weight components, i.e., hexane or heavier, should be individually identified if in total they constitute more than two mole percent of the gas stream. Otherwise, they may be grouped and specified as hexane and heavier. An individual component may be identified by name or by specifying its normal boiling point and molecular weight.

The gas composition data is used to determine gas stream volume flow rate at conditions, molecular weight, compressibility factor, and specific heat ratio. These factors determine the sizing of compressor flow path elements, set allowable gas path velocities based on sonic velocity, and determine the head requirement of the service.

Head is the amount of energy per unit mass required to achieve a desired pressure increase. The head required for a given service is affected by fluid molecular weight, compressibility factor, specific heat ratio, inlet temperature and efficiency. Failure to define the complete range of operating conditions can lead to the underestimation of service head requirements and the purchase of inoperable equipment.

- **Effect of Recycle on Gas Mixture Properties** - If condensate is removed following cooling of a compressed gas stream and the stream is then recycled to the compressor inlet, the properties of the gas at the compressor inlet are changed. This change in properties can significantly raise the head requirements of the service and, for centrifugal and axial compressors, will require the addition of head generating capability. The change in properties is especially critical in hydrogen rich reformer recycle and cat plant light ends services because condensate removal can have a significant effect on molecular weight. The molecular weight reduction is especially significant when there are two or more process compression stages involving multiple coolings and liquid separations.

For centrifugal and axial compressors, the preferred recycle line arrangement returns uncooled compressed discharge gas to the inlet system upstream of a cooler (or condenser). This avoids further liquid separation and attendant changes in gas properties. Designing the compressor and driver for an alternate operating point at reduced molecular weight is costly and recommended only if other approaches are impractical. In cases where multiple process compression stages with separations are used, individual recycles should be provided around each process stage to minimize or eliminate any reduction in molecular weight.

Positive displacement compressors, such as the reciprocating and screw types, are not as sensitive as centrifugals and axials to gas property changes; therefore, no special design is required for their recycle system. However, the effects of recycle on gas composition must be considered as it may affect the number of compressor or process compression stages required.

For all types of compressors any operating condition where gas properties are affected by recycle must be noted as an alternate operating point on the compressor data sheet.

- **Molecular Weight** - The molecular weight of the gas should be provided for each operating condition.
- **Flow Rate** - Data sheet should give the compressor actual inlet volumetric flow (at inlet conditions) and the mass flow rate required. For air compressors, water content in the air should be considered in determining flow rates.
- **Inlet Pressure** - The inlet pressure must be specified as the lowest value for which the compressor is expected to meet guarantee performance. Variations in inlet pressure which can occur in normal operation are to be specified.

Air compressors should have an allowance of 0.3 psi (.02 bar) for pressure drop across the inlet hood, screen, filter, and piping.

The specified inlet pressure is the pressure immediately upstream of the compressor inlet flange. When inlet throttling is used for capacity control, the pressure given is that on the compressor side of the throttling valve with the valve in its controlling position, i.e., with the valve taking some pressure drop. For reciprocating and rotary compressors, the specification should note that the inlet pressure specified is upstream of the pulsation suppression device for reciprocating compressors and upstream of the inlet silencing device on rotary compressors. Pulsation suppression and silencing devices are engineered by the detail engineering contractor or compressor vendor, and their maximum allowable pressure drops are specified in the API Standards.

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## BASIC DESIGN CONSIDERATIONS (Cont)

During Design Specification preparation, the actual inlet pressure and inlet volumetric flow are known for only the normal operating point of inlet throttled centrifugal and axial compressors. The inlet pressure and volumetric flows at the alternate operating points are determined by the shape of the compressor performance curve, i.e., the amount of inlet throttling required to achieve the required change in compressor mass flow. This is not known exactly, until a compressor is selected. For these alternate points, the designer should note that the inlet pressure given is upstream of the throttle valve, and the compressor manufacturer is to advise the conditions at the compressor inlet flange.

This same approach applies when specifying the discharge pressure of discharge throttled centrifugal and axial compressors, i.e., the discharge pressure specified is downstream of the discharge throttle valve and the compressor manufacturer is to advise the conditions at the compressor discharge flange.

If it is intended to start a compressor at a higher than normal inlet pressure, the starting condition inlet pressure should be specified. Such a situation might occur after a compressor trip when the system pressures settle out, and it is not intended that the system be vented prior to compressor restart.

The use of the term "inlet" is preferred over "suction" for compressor design terminology.

- **Discharge Pressure** - The discharge pressure specified is at the discharge flange for centrifugal and axial compressors. For reciprocating and rotary compressors, the specification should note that the discharge pressure specified is downstream of the pulsation suppression device for reciprocating compressors and downstream of the discharge silencing device on rotary compressors. These devices are engineered by the detail engineering contractor or compressor vendor, and their maximum allowable pressure drops are specified in the API Standards.
- **Inlet Temperature** - Inlet temperature affects the volume flow rate, compression service head requirements, and required power. The full range of inlet temperatures should be specified.

When heat exchangers are located in compressor inlet lines, the compressor performance is affected by exchanger performance. This should be considered when establishing possible compressor alternate operating points since both inlet temperature and gas composition can be affected.

- **Discharge Temperature** - Compressor discharge temperature is influenced by the inlet temperature, pressure ratio, gas specific heat values, and the efficiency of compression. It is important in determining compressor mechanical design, gas fouling tendency, process compression stage selection, and cooler and piping design.

Discharge temperature can only be estimated during the compressor service design phase since the efficiency of the compressor can only be estimated. Methods for estimating discharge temperatures are found in [Design Practice XI Section D, Compression Calculations](#) and information on the discharge temperature limits for the various types of compressors can be found in [Design Practice XI Sections E, F, H, and I](#).

During the detail compressor installation design phase, after compressor selection, all items that have their design affected by discharge temperature, such as coolers, should be checked using the actual compressor discharge temperature.

- **Compressibility Factor and Specific Heat Ratio** - Provide the compressibility factor and specific heat ratio ( $C_p/C_v$ ) at the inlet and discharge for all operating conditions. The discharge value is estimated for the discharge since the compression efficiency is estimated.
- **Corrosiveness** - Corrosive gas stream constituents must be identified for all operating conditions including transients. The most common and important corrosive substance in refinery streams is hydrogen sulphide; however, ammonium chloride, sulphur dioxide, ammonia, hydrogen chloride, carbon dioxide, and water can all be significant in gas and air services. Wet  $H_2S$  is of particular concern in compression service since it can cause stress corrosion cracking of high strength materials. International Practices provide definitive requirements for the materials of compressors in gas services containing  $H_2S$ . Even trace amounts of corrosives should be reported.
- **Fouling Tendency** - The compressor Design Specification should describe the fouling tendency of the gas and specify compressor flushing facilities if required.

The prediction of service fouling tendency is based largely on prior pilot plant and commercial process operating experience. Fouling of compressor internals can occur as the result of fine solids carryover and gas polymerization. The solid particles most often encountered in operation are coke, catalyst fines, desiccant fines, and corrosion products such as iron oxide, iron chloride, ammonium chloride, and iron sulphide. The hydrocarbons most susceptible to polymerization are acetylene, diolefins such as butadiene, and higher olefins such as propylene or heavier. The services most susceptible are steam cracker process gas, coker overhead gas, and cat plant fractionator overhead gas. The temperature at which gas polymerization fouling begins is generally in the range of 210 to 250°F (100 to 120°C) with the rate doubling for each 20°F (11°C) increment above 250°F (120°C). Staging and intercooling are conventionally designed to keep discharge temperatures at or below 250°F (120°C) in potential polymer fouling services.

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## BASIC DESIGN CONSIDERATIONS (Cont)

- The Design Specification should specify if flushing facilities are required per [IP 3-3-3, Flushing And Drain Piping For Centrifugal And Rotary Gas Compressors](#). The source of flushing fluid must be specified, and the fluid must be provided at a suitable pressure. Flushing fluid is injected at the inlet of the compressors; however, for centrifugal compressors, it may also be injected at the individual impellers. If individual impeller flushing is required, it must be specified. See [IP 3-3-3](#). Also see [Section XI-O, Compressor Flushing Systems](#).
- Liquid in Gas Streams** - Liquid in the gas stream is generally harmful to compressors and should be avoided by proper inlet system design. Where liquids are present, compressor inlet and interstages should be provided with liquid separators (See [Design Practice V Section A, Drums](#)) and heat tracing and insulation of compressor inlet lines should be provided when ambient temperature is below the dew point of the gas at the compressor inlet or when handling hydrocarbon gas components heavier than ethane. See [IP 3-9-1, Winterizing and Protection Against Ambient Temperatures](#).
- Hazard of Air Circulation** - See [Design Practice XV Section B, Minimizing the Risks of Fire, Explosion, or Accident](#).

**Flexibility for Expansion** - Long range planning and manufacturing facilities investment strategy occasionally justify pre-investment in plant equipment to allow future capacity expansion at low cost. Compressor services along with other unit operations can be initially specified to have the desired degree of expansion flexibility. Simply leaving plot area for an additional compressor to operate in parallel is seldom practical since it is usually uneconomical from the standpoint of plant layout.

The better way to provide for expansion, in most cases, is to specify the future operating conditions along with the initial conditions. It can then be specified that the compressor, driver, and major installation facilities (e.g., separator drums, piping, auxiliary systems etc.) be pre engineered to reduce the cost of the future capacity increase.

## CASINGS AND CYLINDERS

- Maximum Allowable Working Pressure** - Compressor data sheet mechanical design information requires the specification of a casing or cylinder maximum allowable working pressure (MAWP).

API Standards define MAWP as the maximum continuous pressure for which the manufacturer has designed the equipment (or any part to which the term is referred) when it is operating at the maximum allowable temperature. In the Design Specification, we are specifying a minimum acceptable value for MAWP. The compressor vendor must provide a compressor with an MAWP equal to or greater than the specified value.

For centrifugal and axial compressors, the casing MAWP is computed by adding the maximum inlet pressure to the maximum differential pressure that the compressor can develop at the most severe combination of conditions. The maximum differential pressure must be calculated using the highest operating speed, the highest head point on the compressor curve at the highest operating speed, and the gas composition which yields the highest pressure rise. A safety valve at the compressor discharge, set at a lower pressure than the computed maximum, is normally desirable to limit the design pressure requirements of downstream piping and equipment. When a safety valve is provided, its setting determines the specified minimum acceptable value of MAWP. When a safety valve is not provided, the compressor and discharge circuit must be suitable for the computed maximum discharge pressure.

The International Practices do not permit, without purchaser approval, casings designed for more than one MAWP. This possibility of having a casing with more than one MAWP arises when two or more process compression stages at different pressure levels are contained in a single casing. The Design Specification should provide just one MAWP based on the highest operating pressure.

In estimating the casing MAWP for **constant speed** centrifugal and axial compressors, the designer should add 5 percent to the compressor head. International Practices allow the manufacturer to exceed compressor quoted head by 5 percent for constant speed centrifugal and axial compressors.

For all centrifugal and axial compressors, it is necessary to recheck the Design Specification calculated MAWP and safety valve settings based on the performance curve of the compressor as quoted and later as performance tested.

For reciprocating compressor cylinders and screw compressor casings, the MAWP should exceed the rated discharge pressure by 10 percent or 25 psi (1.7 bar), whichever is greater. Rated discharge pressure is defined as the highest pressure required to meet the conditions specified by the purchaser for the intended service. The designer need only take the highest discharge pressure specified under operating conditions and add 10 percent or 25 psi (1.7 bar), whichever is greater, to determine the minimum acceptable value of MAWP.

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## BASIC DESIGN CONSIDERATIONS (Cont)

- **Maximum Allowable Temperature** - Compressor data sheet mechanical design information requires the specification of a casing or cylinder maximum allowable temperature.

API Standards define the maximum allowable temperature as the maximum continuous temperature for which the manufacturer has designed the equipment (or any part to which the term is referred) when handling the specified fluid at the specified pressure. In the Design Specification, we are specifying a minimum acceptable value for the maximum allowable temperature. The compressor vendor must provide a compressor having a maximum allowable temperature equal to or greater than the specified value.

For centrifugal and axial compressors, the specified maximum allowable temperature should be the maximum discharge temperature anticipated over the compressor speed and capacity range and include a margin of approximately 50°F (28°C). Factors that can raise discharge temperatures above those expected are internal compressor wear, fouling, and deterioration of intercooler performance. Higher temperatures that might occur due to a complete loss of cooling water in intercoolers would force compressor shutdown and should not be considered in setting the specified maximum allowable temperature.

For reciprocating compressor cylinders and screw compressor casings, the specified maximum allowable temperature should exceed the rated discharge temperature by 50°F (28°C). The rated discharge temperature is the highest predicted operating temperature resulting from any specified operating condition. The designer need only take the highest discharge temperature specified under operating conditions and add 50°F (28°C) to determine the maximum allowable temperature.

- **Settling Out Pressure** - The settling out pressure must be specified. The settling out pressure is the maximum pressure level which can be reached in the compressor following a compressor trip out and before the pressure is manually vented. It is important to compressor design because it usually represents the highest pressure to which the shaft seals and the inlet side of the compressor casing are ever exposed. It is normally somewhat higher than any operating inlet pressure and lower than discharge pressure and is limited either by a safety valve on the inlet side of the compressor or by the equilibrium pressure of the gas when it reaches ambient temperature during a shutdown. Note that it can be significantly higher than compressor inlet pressure in refrigeration compressors when refrigerant temperatures reach ambient temperature after prolonged shutdown. If it is necessary to restart the compressor without venting the system, settling out pressure may affect driver sizing.
- **Piping Flanges and Ratings** - The Design Specification should indicate the connected process piping line size, flange rating, and facing for all compressor inlet and discharge lines.
- **Main Process Connection Orientation** - The orientation of the main process connections should be specified for centrifugal, axial, and rotary screw compressors. See [Design Practice XI Section P, Foundations](#), for discussion of connection orientation. For reciprocating compressors, API mandates bottom discharge for all horizontal cylinders so specification of cylinder inlet and outlet connection orientation is not required. See [Design Practice XI Section H, Sensitivity to Liquids](#), for information on reciprocating compressor connection orientation.

**Shaft and Piston Rod Sealing** - The type of shaft or piston rod seal and supporting auxiliary systems must be specified. See [Shaft Seals, Design Practice XI Sections E, F & I](#), and [Distance Pieces, Packing Cases, and Pressure Packing, Design Practice XI Section H](#), for the Design Specification requirements of specific types of compressors.

**Lube Oil and Seal Oil Systems** - [IP 10-14-1](#) covers many required features of lube and seal oil systems for centrifugal, axial, and rotary screw compressors. However, it is required that the Design Specification provide information on certain aspects of system design. See [Lube Oil and Seal Oil Systems, Design Practice XI Section E, F, & I](#) for the specification requirements of centrifugal, axial, and screw compressors. See [Frame and Cylinder and Packing Lubrication, Design Practice XI Section H](#) for reciprocating compressor lubrication system specification requirements.

## MATERIALS

- **General** - Material specifications for compressors and drivers are contained in the International Practices and companion API Standards; therefore, they need not be specified under normal circumstances. See **Corrosivity** under heading **Operating Conditions** of this section guidance in specifying corrosive constituents in the gas.

In Design Specifications, the use of the term "vendor's standard" should be avoided, since it implies the acceptability of standard materials in what may be a severe or non-standard service environment.

- **Critical Exposure Temperature (CET)** - Casing or cylinder CET must be specified for all compressor types. CET is defined in [IP 18-10-1](#), Additional Requirements For Materials. It may be given in the GII, when the same value applies to all compressors or in the compressor Design Specification if service specific.

**Drivers** - See [Design Practice XI Section L, M, & N](#) for specification requirements of various driver types.