Liquid Ring Vacuum Pumps and Compressors for Petroleum, Chemical, and Gas Industry Services

API STANDARD 681
FIRST EDITION, FEBRUARY 1996

REAFFIRMED, NOVEMBER 2010

AMERICAN PETROLEUM INSTITUTE

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Manufacturing, Distribution and Marketing Department

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FOREWORD

This standard requires the purchaser to specify certain details and features. Although it is recognized that the purchaser may desire to modify, delete, or amplify sections of the standard, it is strongly recommended that such modifications, deletions, and amplifications be made by supplementing this standard rather than by rewriting or incorporating sections of this standard into another complete standard.

Suggested revisions are invited and should be submitted to the director of the Manufacturing, Distribution and Marketing Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

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Liquid Ring Vacuum Pumps and Compressors for Petroleum, Chemical, and Gas Industry Services

SECTION 1—GENERAL

1.1 Scope

1.1.1 This standard covers the minimum requirements for liquid ring vacuum pump and compressor systems for service in the petroleum, chemical, and gas industries. This includes both vacuum pump and compressor design and system design.

1.1.2 The design of the system is critical to the successful operation of the liquid ring vacuum pump or compressor. Close attention must be paid not only to the design of the ring liquid system but also to how it is integrated into the user's process.

1.1.3 Although this standard covers minimum requirements appropriate for petroleum refinery service, purchasers may wish to consider pumps, compressors, and systems that do not meet all the requirements of this standard, based on specific nonflammable, nontoxic service conditions.

Note: A bullet (●) at the beginning of a paragraph indicates that a decision by the purchaser is required. These decisions should be indicated on the data sheet (see Appendix A); otherwise, they should be stated in the quotation request or in the order.

1.2 Alternative Designs

The vendor may offer alternative designs. Equivalent metric dimensions, fasteners, and flanges may be substituted as mutually agreed upon by the purchaser and the vendor.

1.3 Conflicting Requirements

In case of conflict between this standard and the inquiry, or order, the information included in the order shall govern.

1.4 Definition of Terms

Terms used in this standard are defined in 1.4.1 through 1.4.26 (refer to Figure 1).

1.4.1 The *alarm point* is a preset value of a parameter at which an alarm is actuated to warn of a condition that requires corrective action.

1.4.2 The *compressor rated point* is the point on the 100 percent speed curve at the highest capacity of any specified.

1.4.3 *Hydrodynamic bearings* are bearings that use the principles of hydrodynamic lubrication. Their surfaces are oriented so that relative motion forms an oil wedge to support the load without journal-to-bearing contact.

1.4.4 *Inlet cubic feet per minute* (ICFM) refers to the flow rate determined at the conditions of pressure, temperature, compressibility, and gas composition, including moisture, at the compressor inlet flange. *Actual cubic feet per minute* (ACFM) may be used to refer to flow at a number of locations and should therefore not be used interchangeably with inlet cubic feet per minute.

1.4.5 A *liquid ring vacuum pump, or compressor,* is a rotary positive-displacement machine in which gas compression is achieved by the action of a radially bladed impeller mounted in an eccentric or elliptical casing which is partially filled with liquid.

1.4.6 *Maximum allowable differential pressure* is the maximum differential pressure for which the manufacturer has designed the equipment for continuous operation.

1.4.7 *Maximum allowable speed* (revolutions per minute) is the highest speed at which the manufacturer's design will permit continuous operation.

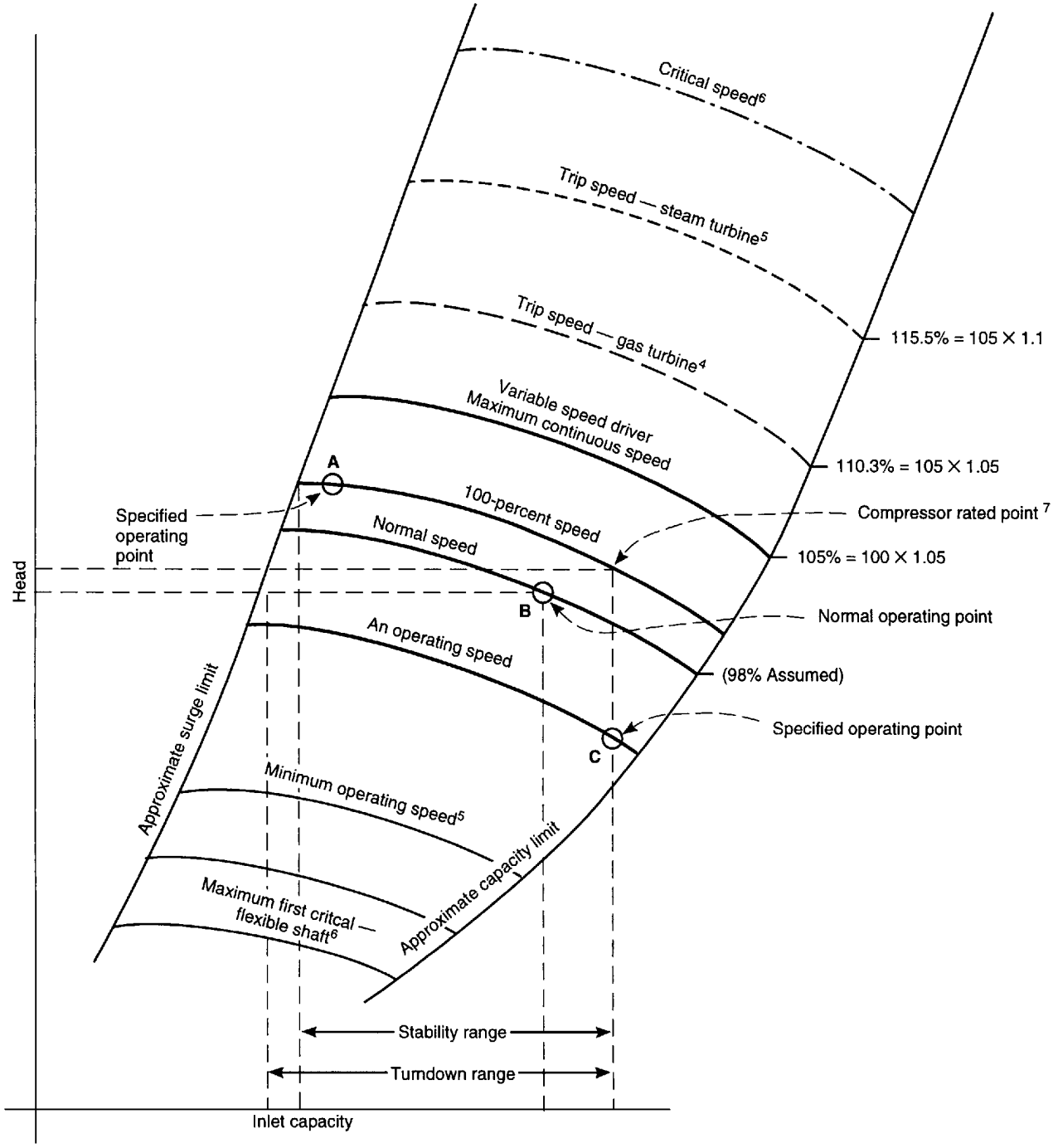
1.4.8 *Maximum allowable temperature* is the maximum continuous temperature for which the manufacturer has designed the equipment (or any part to which the term is referred) when handling the specified fluid at the specified pressure.

1.4.9 *Maximum allowable vacuum* is the maximum vacuum (minimum suction pressure) for which the manufacturer has designed the equipment, corrected for the vapor pressure of the seal liquid at the operating temperature.

1.4.10 *Maximum allowable working pressure* is the maximum continuous pressure 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 temperature.

1.4.11 *Maximum continuous speed* (revolutions per minute) is the speed at least equal to 105 percent of the rated speed. Maximum continuous speed for constant-speed drivers shall be equal to the 100-percent speed.

1.4.12 *Maximum differential pressure* is the maximum discharge pressure minus the minimum suction pressure that the pump is able to develop when operating at the specified speed, specific gravity, and pumping temperature.



Notes:
1. Except where specific numerical relationships are stated, the relative values implied in this figure are assumed values for illustration only.
2. The 100 percent speed curve is determined from the operating point requiring the highest head; point A in the illustration.
3. The compressor rated point (CRP) is the intersection on the 100 percent speed line corresponding to the highest flow of any operating point; point C in the illustration.
4. The head-capacity curve at 100 percent speed shall extend to at least 115 percent of the capacity of the CRP. Head-capacity curves at other speeds shall be extended to equivalent capacity at each speed. For example, the head-capacity curve at 105 percent speed shall be extended to at least 1.05 times 1.15 times the capacity of the CRP; the head-capacity curve at 90 percent speed shall be extended to at least 0.9 times 1.15 times capacity of the CRP; and so on. These points define the "approximate capacity limit" curve.
5. Refer to the applicable standard for the compressor driver such as API Standard 612 (Steam Turbine) or API Standard 616 (Gas Turbine) for trip speed and minimum operating speed limits.
6. Refer to 2.7 for allowable margins of critical speeds to operating speeds.
7. See 1.4.4.

Figure 1—Illustration of Terms

1.4.13 *Maximum discharge pressure* is the maximum suction pressure plus the maximum differential pressure that the pump is able to develop when operating at the specified speed, specific gravity, and pumping temperature.

1.4.14 *Maximum sealing pressure* is the highest pressure expected at the seals during any specified static or operating condition and during start-up and shutdown.

1.4.15 *Minimum allowable temperature* is the minimum continuous temperature for which the manufacturer has designed the equipment (or any part to which the term is referred).

1.4.16 *Normal operating point* is the point at which usual operation is expected and optimum efficiency is desired.

1.4.17 The *casing* is the composite of all stationary pressure-containing parts of the unit, including all nozzles, seal glands, and other attached parts but excluding the stationary and rotating members of mechanical seals (see Figure E-1, Appendix E).

1.4.18 *Radially split* refers to casing joints that are transverse to the shaft centerline.

1.4.19 *Rated discharge pressure* is the highest pressure required to meet the conditions specified by the purchaser for the intended service.

1.4.20 The *rated operating point* is the point at which the vendor certifies that performance is within the tolerances stated in this standard. Performance includes the following factors: capacity, power, efficiency, rotative speed, and rated suction and discharge pressures.

1.4.21 The *shutdown point* is a preset value of a parameter at which automatic or manual shutdown of the system is required.

1.4.22 *Standard flow* is the flow rate expressed in volume flow rate. ISO standard flow rate is cubic meters per hour or minute (m^3/h or m^3/min) at an absolute pressure of 1.013 bar [14.7 pounds per square inch (psi)] and a temperature of 0°C (32°F). Customary units are standard cubic feet per minute (SCFM) or million standard cubic feet per day (MMSCFD) at an absolute pressure of 14.7 pounds per square inch and a temperature of 60°F.

1.4.23 *Total indicated runout* (TIR), also known as total indicator reading, is the runout of a diameter or face determined by measurement with a dial indicator. The indicator reading implies an out-of-squareness equal to the reading or an eccentricity equal to half the reading.

1.4.24 *Trip speed* (revolutions per minute) is the speed at which the independent emergency overspeed device operates to shut down a variable speed prime mover (see Table 1).

Table 1—Driver Trip Speeds

Driver Type	Trip Speed (% of Maximum Continuous Speed)
Steam turbine	
NEMA Class A[a]	115
NEMA Classes B, C, D[a]	110
Gas turbine	105
Variable speed motor	110
Reciprocating engine	110

[a]Indicates governor class as specified in NEMA SM 23

1.4.25 *Unit responsibility* refers to the responsibility for coordinating the technical aspects of the equipment and all auxiliary systems included in the scope of the order. It includes responsibility for reviewing such factors as the power requirements, speed, rotation, general arrangement, couplings, dynamics, noise, lubrication, sealing system, material test reports, instrumentation, piping, and testing of components.

1.4.26 A *wet critical speed* is a rotor resonant frequency calculated considering the additional support and damping produced by the action of the pumped liquid within internal running clearances at the operating conditions and allowing for flexibility and damping within the bearings.

1.5 References

1.5.1 This standard makes reference to American standards; other international or national standards may be used as mutually agreed between purchaser and vendor provided it can be shown that these standards meet or exceed the American standards referenced.

1.5.2 The editions of the following standards, codes, and specifications that are in effect at the time of publication of this standard shall, to the extent specified herein, form a part of this standard. The applicability of changes in standards, codes, and specifications that occur after the inquiry shall be mutually agreed upon by the purchaser and the vendor.

AFBMA[1]

Std 7 *Shaft and Housing Fits for Metric Radial Ball and Roller Bearings (Except Tapered Roller Bearings) Conforming to Basic Boundary Plans*

Std 9 *Load Ratings and Fatigue Life for Ball Bearings*

Std 19 *Tapered Roller Bearings–Radial Inch Design*

[1] Anti-Friction Bearing Manufacturers Association, 1235 Jefferson Davis Highway, Arlington, Virginia 22202.