Foreword

This code is developed by Sinopec Shanghai Engineering Co., Ltd in cooperation with other involved organizations based on the requirements of Document JIANBIAO〔2009〕No. 88 issued by the Ministry of Housing and Urban-Rural Development of the People's Republic of China - Notice on Printing the Development and Revision Plan of National Engineering Construction Standards in 2009.

In preparing this code, the development team made special studies and extensive investigations, summarized the practices on the rotary machine design in recent ten years, solicited the comments from the designers, manufacturers, users and erectors, discussed the This code comprises 12 chapters and 1 appendix, and mainly covers general provisions, terms, basic requirements, pumps and hydraulic turbines, agitators, vacuum pumps, Compressors and Fans, steam turbines, expanders and gas turbines, centrifuges, accessories, inspection and testing, and painting, marking Packaging and shipment.

Ministry of Housing and Urban-Rural Development of the People's Republic of China is in charge of administration of this code. China Petroleum and Chemical Corporation is responsible for its routine management. Sinopec Shanghai Engineering Co., Ltd is tasked for explanation of specific technical contents. All relevant organizations are kindly requested to sum up your experiences in actual practices during the process of implementing this code. The relevant comments and information can be posted or passed on to Sinopec Shanghai Engineering Co., Ltd (Address: 769 Zhangyang Rd., Pudong New Area, Shanghai, Post code: 200120) as a reference for revising this code in the future.

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1 General Provisions

1.0.1 This code is developed for the purposes of ensuring the rotary machines for petrochemical service in long-term, stable and safe operation and satisfying energy conservation and environment protection requirements.

1.0.2 This code is applicable for the design of rotary machines for petrochemical service.

1.0.3 In addition to this code, the design of rotary machines for petrochemical service shall also comply with the current applicable national codes and standards.

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2 Terms

2.0.1 Rotary machines

Rotating equipment used in various process and utilities in petrochemical plants.

2.0.2 Pumps

Machines used for transferring or boosting liquids.

2.0.3 Hydraulic power recovery turbines

Machines used to recover the energy from liquid pressure drop in industrial production plants, also known as hydraulic power recovery turbines.

2.0.4 Mechanical agitators

Machines comprising agitating impellers, agitating shafts, shaft seal systems and driving equipment (drivers, gear units, frames and couplings).

2.0.5 Vacuum pumps

Machines used to draw vapor out of container, creating a vacuum inside.

2.0.6 Compressors

Fluid machines used to increase gas pressure energy and transfer gas with outlet pressure larger than 0.2MPa(G)or compression ratio larger than 3.

2.0.7 Fans

Fluid machines used to increase gas pressure and deliver the gas. The machines with outlet pressure less than or equal to 0.03MPa (G)or compression ratio less than or equal to 1.3 are defined as fans (including induced draft fans), and the machines with outlet pressure higher than 0.03MPa (G)but less than 0.2MPa (G)or compression ratio larger than 1.3 but less than or equal to 3 are defined as forced draft blowers.

2.0.8 Steam turbines

Machines using steam expansion to do work.

2.0.9 Expanders

Machines using gas expansion to do work for energy recovery.

2.0.10 Gas turbines

Machines using expansion of high temperature and high pressure gas generated from fuel combustion to do work.

2.0.11 Centrifuges

Machines using centrifuge force to separate liquid and solid particles or non-compatible liquids.

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3 Basic Requirements

3.1 General Requirements

3.1.1 The rotary machines used for petrochemical service shall be designed and constructed for a minimum service life of 20 years (excluding the wearing parts), and the uninterrupted operation cycles shall be no less than the service years indicated in Table 3.1.1.

Table 3.1.1 Uninterrupted Operation Cycle of Rotary Machines Used for Petrochemical Service

Category	Uninterrupted operation cycle (years)	Category	Uninterrupted operation cycle (years)
Pumps	3	Reciprocating compressors	3
Hydraulic power recovery turbines	3	Rotary compressors	3
Vacuum pumps	3	General-purposes team turbines	3
Agitators	2	Special purpose steam turbines	5
Centrifugal fans	3	Expanders	3
Instrument air centrifugal compressor	3	Gas turbines	3
Process centrifugal compressors	5	Roots blowers	3
Centrifuges	2	—	—

Note: in special conditions, the uninterrupted operation cycle of rotary machines may be mutually agreed.

3.1.2 The rotary machines shall be within the scope of their design and manufacture experience, and at least one same or similar model rotary machine have been running successfully under same or similar operating conditions for two years or more.

3.1.3 On-lines pares shall be provided for the pumps, medium- and small-size fans/blowers, instrument air centrifugal compressors and reciprocating compressors in continuous operation, one on-line spare shall be provided for the single pump (rotary machine), and at least one on-line spare shall be provided for several pumps (rotary machines) arranged in parallel operation. Off-line spare parts shall be provided for the agitators in continuous operation. On-line spares may not be provided for the large-size fans/blowers, centrifugal compressors and gas turbines, but long term parts should be provided as critical/capital spare parts for them.

3.1.4 When the medium contain H_2S, chloride or other components that may result in stress corrosion, or the medium contain any components that may be subject to reaction with copper or copper alloy, they shall be indicated in the datasheets or technical requisition documents. The construction materials of rotary machines shall be suitable for the requirements for these medium.

3.1.5 The complete unit of rotary machine shall include all equipment, pipes, valves, electrical, instrument and control systems within the scope of supply.

3.1.6 The design pressure of steam jacket and cooling water jacket shall be no less than the maximum working pressure of their respective external supply systems.

3.1.7 The minimum temperature rise at the water side of cooling system shall comply with the

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utilities conditions. When gas cooler is used, the minimum temperature rise shall be at least equal to 8℃, and when oil cooler is used, the minimum temperature rise shall be at least equal to 4℃.

3.1.8 The general design of rotary machines shall be easy for operation and maintenance, the construction design should allow easy dismantling of rotors without removing the process pipes on the casings, and the engineering design shall provide sufficient spaces and accesses and shall be easy for equipment and pipe maintenance, hot insulation, cold insulation and personnel protection insulation installation.

3.1.9 The rotary machines should be shipped as complete units. For oversize equipment, they may be shipped by segments. For fragile parts, they may be removed after test, and then shipped in separate, and the mating surfaces shall be marked. All fragile parts shall be specified in the installation manuals.

3.2 Allowable Working Pressure and Allowable Working Temperature of Rotary Machines

3.2.1 The allowable working pressure and allowable working temperature of rotary machines shall be determined based on the process operating conditions and design parameters of rotary machines.

3.2.2 The maximum allowable working pressure of pressure-containing casings shall conform to Table 3.2.2, and shall match with pressure ratings of adjacent flanges.

Table 3.2.2 Maximum Allowable Working Pressure of Pressure-containing Casing

Category	Maximum allowable working pressure
Rotary machines without pressure relief devices	⩾ the maximum outlet pressure plus 10% pressure difference between inlet and outlet
Rotary machines with pressure relief devices such as pressure relief valves	⩾110% of the release pressure of the pressure relief valve

Note: the release pressure of pressure relief valve is taken as 1.05—1.15 times maximum working pressure.

3.2.3 For the rotary machines installed indoors or hot (or cold) insulated, the maximum (or minimum) allowable working temperature of their pressure-containing casings shall be determined in accordance with Table 3.2.3.

Table 3.2.3 Maximum (or Minimum) Allowable Working Temperature(t) of Pressure-containing Casings

t_0 Medium Temperature, t_0	Max. (or Min.) Allowable Working Temperature
$t_0 \leqslant 0$	The minimum working temperature of the medium
$t_0 > 0$	The maximum expected working temperature or rated working temperature plus 10℃, whichever is higher

3.2.4 For the rotary machines installed outdoors without insulation, their minimum allowable working temperature shall be determined based on the minimum ambient temperature specified in utilities conditions.

3.3 Inlets, Outlets and Other Connections

3.3.1 The inlets, outlets and other connections of rotary machines shall be flanged, and the flange standards and pressure rating shall be specified in the inquiries or datasheets.

3.3.2 The connections within the rotary machines may use other flange standards beyond those specified in the inquiries or datasheets, the applicable standards and nominal pressure ratings for

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flanges may follow Appendix A of this code.

3.4 Materials

3.4.1 The construction materials of rotary machines shall comply with the following requirements:

1 The material requirements for the pressure-containing parts and other main components of rotary machines shall be specified in the inquiries or datasheets, final material selection shall be specified in the proposals of the manufacturers, and specific material codes shall be indicated in the datasheets.

2 Welded pressure-containing parts shall be subject to post weld heat treatment and nondestructive test.

3 Except for cast steel parts, repair welding shall not be made on all pressure-containing cast parts. If repair welding is required for cast steel parts, it shall comply with Article 11.2.3 of this code.

4 If the specified minimum design metal temperature is lower than −20℃, low temperature impact test shall be made for the base metal and welds of all pressure-containing steels except for austenitic stainless steel.

5 If chlorides are present in the medium, the component materials in contact with the medium should not be aluminum and austenitic stainless steel.

6 When the medium contact with copper and then generate explosive copper compounds, copper or copper alloy shall not be used to fabricate the parts.

7 The materials exposed in acid environment or wet H_2S-containing environment shall comply with the requirements specified in the current national standard GB/T 20972.1 *Petroleum and Natural Gas Industries-Materials for Use in H_2S-containing Environments in Oil and Gas Production-Part 1: General Principles for Selection of Cracking-resistant Materials*.

8 Gaskets and seal rings shall not contain any asbestos.

9 Hygroscopic materials shall not be used for sound insulation materials.

10 Material corrosion-resistant performance should not be enhanced by using surface plating and surface coating.

11 Materials for lube oil, seal oil, seal flushing and dry gas seal piping and fittings shall be 304 or 316 stainless steel.

12 For the welds that are impossible for inspection during fabrication or after fabrication, separate quality control methods shall be determined.

3.4.2 In addition to the requirements specified in Article 3.4.1 of this code, the construction materials of pumps shall also comply with the following the requirements:

1 Cast iron shall not be used for pressure-containing parts of pumps for toxic, flammable and explosive liquid services. Cast iron shall not be used for centrifugal pumps and rotary pumps for toxic, flammable and explosive liquid services, including seal less centrifugal pumps, and their bearing housings.

2 Unless otherwise specified, the corrosion allowance of pump casings shall be at least equal to 3.0mm.

3 The liners of canned pumps shall be made of nonmagnetic materials and shall have good corrosion resistance and high strength, stator liner should be Hastelloy alloy, its minimum thickness shall be 0.4mm and corrosion allowance shall be 0.15mm. The containment shell of magnetic drive pump shall be high-resistivity materials, Hastelloy alloy and titanium alloy should be selected, its

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minimum thickness shall be 1mm and its corrosion allowance shall be 0.4mm. For medium- and light-duty magnetic drive pumps used for medium service with temperature lower than 120℃, their containment shells may be non-metal materials such as plastics or ceramics.

4 For non-metal pumps, their allowable working temperature shall meet the special performance requirements such as material thermal expansion coefficient, high temperature "creep" of plastic materials and low temperature cracking. The maximum allowable working temperature of non-metal pumps shall be 60%–70% of the ultimate heat-resistant temperature of the materials.

5 The diaphragm materials of pneumatic diaphragm pumps shall have reliable chemical stability, and the working temperature shall be less than the ultimate heat-resistant temperature of the diaphragm materials.

3.4.3 In addition to the requirements specified in Article 3.4.1 of this code, the construction materials of agitators shall also comply with the following requirements:

1 The corrosion allowance of agitator shafts and impellers shall be at least equal to 1.0mm.

2 The agitator impellers and shafts contacting with mediums shall be not lower than materials grade of the vessels.

3 Lock nuts, spring washers, lock pins and metal lock wires shall be austenitic stainless steel or higher materials. The material grade of lock nuts and spring washers contacting with the medium shall be not lower than the agitator impellers. The metal lock wires contacting with the medium should be titanium.

3.4.4 In addition to the requirements specified in Article 3.4.1 of this code, the construction materials of compressors shall also comply with the following requirements:

1 The casing materials of centrifugal and rotary compressors for flammable and toxic gas services shall be at least carbon steel.

2 The casing materials of centrifugal compressors for air or non-flammable gas services may be ductile iron; however, the maximum outlet pressure of the compressors shall be less than or equal to the maximum allowable pressure of *PN*50 flanges at the delivered medium temperature.

3 The casing materials of rotary compressors for air or non-flammable gas services may be ductile iron; however, the maximum outlet pressure of the compressors shall be less than or equal to 1.0MPa, and the maximum outlet temperature shall be less than or equal to 250℃.

3.4.5 In addition to the requirements specified in Article 3.4.1 of this code, the construction materials of steam turbines shall also comply with the following requirements:

1 For steam pressure of greater than 0.52MPa (G) or steam temperature of higher than 230℃, all the pressure-containing parts shall be of steel.

2 For maximum steam temperature of higher than 410℃, all the pressure-containing parts shall be of alloy steel.

3 Material for turbine shafts and wheels shall be forged steel.

4 The nozzles, closing pieces, rotating and stationary blades, shrouding, and steam strainers should be of 11% to 13% chromium steel, titanium, or nickel-copper alloy.

3.4.6 In addition to the requirements specified in Article 3.4.1 of this code, the construction materials of expanders used in the following plants shall also comply with the following requirements:

1 For expanders used in air separation plants, the main shafts shall be alloy steel, the impellers shall be cast aluminum and wrought aluminum, and they shall be subject to anodic oxidation treatment

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after fabrication.

2 For expanders of flue gas energy recovery unit used in catalytic cracking plants, the materials of main parts of expanders at various inlet temperatures shall be selected in accordance with Table 3.4.6.

Table 3.4.6 Materials of Main Parts of Expander

Inlet flue gas temperature (℃)	Material of stator blade	Material of moving blade	Material of disc
500–600	K213	K213	20Cr3MoWV
601–650	K213	K213	GH2132
651–730	K213	864 alloy	864 alloy

3 If the fluid contains dust and particles, anti-erosion measures shall be provided to mitigate erosion to guide vanes and stator vanes.

4 480m/s. In air separation plants, if the expander impellers are aluminum, the linear speed shall be less than or equal to 270m/s, if the impellers are wrought aluminum, the linear speed shall be less than or equal to 480m/s.

3.4.7 In addition to the requirements specified in Article 3.4.1 of this code, the construction materials of gas turbines shall also comply with the following requirements:

1 The material of fuel gas pipes within gas turbine unit shall be at least 316L stainless steel, and pipe welds shall be 100% NDT tested.

2 The internals of fuel gas filters shall be of stainless steel.

3.5 Noises

3.5.1 Effective measures shall be taken for the main noise sources to control the noise to minimum levels. On the premise of meeting safety and process flow, provisions should be made for noise reduction such as noise absorption, noise elimination and vibration damping. Acoustic enclosures should not be used. When sound insulation hoods are used, ventilation devices shall be provided, and the design of ventilation devices shall be facilitate unit maintenance.

3.5.2 The overall noise level (A-weighted sound pressure level) measured at 1m from the unit shall not exceed the limit values shown in Table 3.5.2.

Table 3.5.2 Health Limits for Noise Levels in Workplaces

Daily noise exposure time, h	Health limit, dB(A)
8	85
4	88
2	91
1	94
0.5	97

Note: the data in this table is calculated by using the formula in the current industrial standard GB/T 189.8 *Measurement of Physical Agents in Workplace-Part 8: Noise* and in accordance with the current national standard GBZ 2.2 *Occupational Exposure Limits for Hazardous Agents in Workplace-Part2: Physical Agents, Article 11.2.*

3.6 Spare Parts

3.6.1 The spare parts shall be interchangeable.

3.6.2 Inspection, test and acceptance of spare parts shall be carried out in accordance with the

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corresponding technical requirements or specifications for the rotary machines.

3.6.3 The requirements and number of spare parts shall be determined based on the following principles:

1 The criticality and operation cases of rotary machines in the plant, and installed spare required or not;

2 The criticality of each part in rotary machine, the proportion of the price of expensive part out of the loss of plant shutdown due to damage of the part;

3 The interchangeability of wear parts of same or similar rotary machines or the rotary machines in one train;

4 The availability of the spare parts in the region or country where the contract plant is sited, and the procurement and the delivery time of the spare parts.

3.7 Special Tools

3.7.1 If special tools and fixtures are required to disassemble, assemble the unit, they shall be furnished as part of the initial supply of the machine attached with the list.

3.7.2 The special tools shall be separately packaged into metal boxes, and each tool shall be stamped or labeled to indicate its service.

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4 Pumps and Hydraulic Turbines

4.1 General Requirements

4.1.1 Pump types shall be determined based on operating parameters and medium characteristics, and may be determined based on the proven successful experience in similar cases.

4.1.2 When selecting pumps, centrifugal pumps should be preferably selected. When the medium viscosity is larger than or equals to 100MPa · s, displacement type pump should be selected.

4.1.3 When the operating parameters are low flow and high head, pumps should be selected in the following order:

1 High-speed centrifugal pump, pitot tube pump;

2 Rotary pump, reciprocating pump;

3 Multi-stage centrifugal pump;

4 Vortex pump may be selected with lower cavitations tendency.

4.1.4 If metering is required, metering pump shall be selected.

4.1.5 Centrifugal pump and rotary pump shall be equipped with cartridge mechanical seals. The seals and sealing systems shall be selected according to SH/T 3156 *Engineering Specification of Pump-shaft Seal Systems of Centrifugal and Rotary Pumps for Petrochemical Industry*.

4.2 Centrifugal Pumps

4.2.1 For centrifugal pumps handling non-hazardous fluids in petrochemical industry, when the following operating conditions are met, centrifugal pumps for medium- and light-duty services should be selected and shall conform to the current industrial standard SH/T 3140 *Technical Specification on Centrifugal Pumps for Medium- and Light-duty Services in Petrochemical Industry*, otherwise, centrifugal pumps for heavy-duty services should be selected and shall conform to the current industrial standard SH/T 3139 *Technical Specification on Centrifugal Pumps for Heavy-duty Services in Petrochemical Industry*.

1 Rated discharge pressure: ≤1.9 MPa (G).

2 Pumping temperature (liquid temperature): <225℃.

3 Rated rotated speed for motor-driven pumps: ≤3000r/min, the rated rotated speed may be increased by 5% for turbine-driven pumps.

4 Rated head: ≤120m.

5 Maximum suction pressure: ≤0.5MPa(G).

6 Maximum impeller diameter for overhung pumps: ≤330mm.

4.2.2 For centrifugal pumps handling hazardous fluids, centrifugal pumps with shaft seal for heavy-duty services or seal less sealless centrifugal pumps should be selected. Centrifugal pumps with shaft seal for heavy-duty services shall conform to the current industrial standard SH/T 3139 *Technical Specification on Centrifugal Pumps for Heavy-duty Services in Petrochemical Industry* and sealless centrifugal pumps shall conform to the current industrial standard SH/T 3148 *Technical Specification for Sealless Centrifugal Pumps in Petrochemical Industry*.

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4.2.3 If the fluid viscosity is larger than 20MPa · s, viscous fluid performance conversion shall be made for the centrifugal pumps.

4.2.4 Single volute casing may be used for the pump with discharge nozzle size of *DN*100 (4in) or less.

4.2.5 Except for high speed pump, inducershould not used for centrifugal pump.

4.2.6 In addition to the requirements specified in Article 3.2.2 of this code, the allowable working pressure of pump casings shall also comply with the following requirements:

1 For medium- and light-duty centrifugal pumps with shaft seal and sealless pumps, the allowable working pressure of pump casings shall be at least equal to the maximum allowable working pressure of *PN*16 flanges at the handling temperature.

2 The allowable working pressure of casings shall be not less than the maximum allowable working pressure of *PN*20 flanges at the operating temperature for between bearings, axially split, single stage or double stage centrifugal pumps or vertically suspended single casing pumps in heavy-duty services. And for other types of pumps, the allowable working pressure of casings shall be not less than the maximum allowable working pressure of *PN*50 flanges at the operating temperature.

4.2.7 The total indicated runout (TIR) of the single piece of shaft measured at any point shall comply with the following requirements:

1 For centrifugal pumps with shaft seal and sealless centrifugal pumps for medium-and light-duty services, TIR shall be ≤0.05mm;

2 For centrifugal pumps with shaft seal and sealless centrifugal pumps for heavy-duty services, TIR shall be ≤0.025mm.

4.2.8 Each rotating part of centrifugal pump shall be dynamically balanced in accordance with the current national standard GB/T 9239.1 *Mechanical Vibration-Balance Quality Requirements for Rotors in a Constant (Rigid) State-Part 1: Specification and Verification of Balance Tolerances*, and balance accuracy shall comply with the following requirements:

1 For centrifugal pumps with shaft seal and sealless centrifugal pumps for medium-and light-duty services, the impellers shall be dynamically balanced to G2.5;

2 For centrifugal pumps with shaft seal and sealless centrifugal pumps for heavy-duty services, the impellers, balancing drums and main similar rotating parts shall be dynamically balanced to G2.5;

3 The impellers, drums and main similar rotating parts of high speed centrifugal pumps or pitot tube pumps shall be dynamically balanced to G1.0.

4.3 Reciprocating Pumps, Metering Pumps and Rotary Pumps

4.3.1 Reciprocating pumps for petrochemical service shall conform to the current industrial standard SH/T 3141 *Technical Specification for Reciprocating Pumps in Petrochemical Industry.*

4.3.2 For metering pumps in petrochemical industry, hydraulic diaphragm type metering pump should be selected, and plunger type metering pump may be selected, and they shall conform to the current industrial standard SH/T 3142 *Technical Specification for Metering Pumps in Petrochemical Industry.*

4.3.3 When the metering pump is used to handle hazardous medium or when the handled streams and hydraulic oil are mixed and subject to reaction, hydraulic double-diaphragm metering pump shall be selected and shall be equipped with alarm device for indicating diaphragm broken.

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4.3.4 Rotary pumps for petrochemical service shall conform to the current industrial standard SH/T 3151 *Technical Specification for Rotary Pumps in Petrochemical Industry*. When rotary pump is used to handle the stream sensitive to shear force, or it is expected that the suspended substances or solids in the solution is not damaged, low shear force rotary pump shall be selected.

4.3.5 Relief valves shall be installed on the outlet piping of reciprocating pump, metering pump and rotary pump.

4.3.6 The reciprocating pump, metering pump and rotary pump shall be capable of continuous operation at the maximum allowable rotated speed and at the outlet pressure that is the setpoint of the Relief valves.

4.3.7 Elastic diaphragm or bladder type accumulators shall be provided at the inlet and outlet of reciprocating pump and metering pump.

4.3.8 The metering pump capacity shall be adjusted by changing the pump stroke or the rotated speed during operation. If required, the metering pump capacity shall be remotely or automatically adjusted.

4.3.9 If the outlet pressure of metering pump is close to inlet pressure, a back pressure valve shall be provided after the pump outlet buffer tank, and the pump outlet pressure shall be at least 0.1MPa higher than inlet pressure.

4.4 Pneumatic Diaphragm Pumps

4.4.1 When pneumatic diaphragm pumps are used to handle hazardous fluids, their working diaphragms shall be double diaphragm structure, and alarm devices shall be provided for indicating diaphragm broken.

4.4.2 For pneumatic diagram pumps intended for continuous operation, elastic diaphragm or bladder type accumulators shall be provided at the pump outlets.

4.4.3 The air motor of pneumatic diaphragm pump shall be non-lubricated type.

4.4.4 The inlet air piping of air motor shall be equipped with integral filter, control valve and pressure gauge module, and the vent shall be provided with a silencer.

4.4.5 Flexible pipes should be used for the inlet, outlet and air connections of pneumatic diaphragm pumps.

4.5 Hydraulic Power Recovery Turbines

4.5.1 If the liquids in higher flowrate and higher pressure in the plant is required for pressure reduction, hydraulic turbines should be used for energy recovery.

4.5.2 Tech-economic analysis shall be made for installation of hydraulic turbines, if the investment payback period is less than 5 years, hydraulic turbines should be provided.

4.5.3 Hydraulic turbines shall comply with the requirements specified in Articles 4.2.2 to 4.2.8 of this code and the applicable requirements specified in the current industrial standard SH/T 3139 *Technical Specification on Centrifugal Pumps for Heavy-duty Services in Petrochemical Industry*.

4.5.4 In the datasheets, it shall specify if vapor is contained in the liquid of hydraulic turbine inlet and outlet, and specify the components, density and volume percentage as well as the flashing temperature and pressure. If the hydraulic turbine inlet contains steam or gas, or vapor may separate out after pressure reduction in the turbines, the hydraulic turbines shall be applied to two phase flow design.

4.5.5 When hydraulic turbine is used, overspeed trip device shall be equipped, and the overspeed trip

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speed shall be 115%–120% of the rated rotated speed of hydraulic turbine.

4.5.6 When hydraulic turbine is used as auxiliary driver, the power of main electric motor or steam turbine should be calculated as a sole driver for the pump.

4.5.7 Hydraulic turbine shall be located at the end of the machine unit, and shall be provided with overspeed clutch to enable the hydraulic turbine disengaged from the machine unit while the pump running.

4.5.8 The flow control valve should be installed on inlet piping of hydraulic power recovery turbine.

4.5.9 Hydraulic turbine shall be equipped with a full flow bypass valve with regulating function.

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5 Agitators

5.0.1 Agitators for petrochemical service shall comply with the requirements specified in the current industrial standard SH/T 3150 *Engineering Specification of Agitators in Petrochemical Industry*, and the agitator blade type, size and agitating speed shall be determined based on the process flow, medium characteristics and operation experiences.

5.0.2 All removable parts within the agitator container such as agitating impeller and agitating shaft shall be disassembled and assembled through the manhole or erection opening.

5.0.3 Locking measures shall be taken for all the bolts and nuts that are used for connecting between rotating parts, between rotating parts and frame, and between frame and vessel.

5.0.4 When the agitator shaft is of rigid design, its rotated speed shall be less than or equal to 0.7 times of the first critical speed, and when agitator shaft is of flexible design, its rotated speed shall be larger 1.25 times of the first critical speed and less than 0.7 times of the second critical speed, and shall not be integral times of the first critical rotated speed.

5.0.5 Shaft seal should be mechanical seal. The volume of buffer liquid or barrier liquid tank of seal system shall comply with the following requirements:

1 For agitator in shaft diameter less than or equal to 80mm: ≥12L;

2 For agitator in shaft diameter larger than 80mm: ≥20L.

5.0.6 Leakage rate at the mechanical seal shall comply with the following requirements:

1 For wet type dull mechanical seals used for pressure less than or equal to 6.3MPa and linear speed less than or equal to 3m/s, if the outside diameter of the shaft or shaft sleeve is less than or equal to 80mm, the leakage rate of single seal face shall be less than or equal to 8ml/h, and if the outside diameter of the shaft or shaft sleeve is larger than 80mm, the leakage rate of single seal face shall be less than or equal to 10ml/h.

2 For mechanical seals used in other services and other types of mechanical seals, the leakage rate may be mutually agreed.

5.0.7 The intermediate bearing or base bearing should be replaceable sliding bearing, and the bearing should be replaced without removal of agitator shaft and impellers.

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6 Vacuum Pumps

6.1 General Requirements

6.1.1 The types of vacuum pumps shall be determined based on the operation parameters and medium characteristics.

6.1.2 Selection of vacuum pumps shall comply with the following requirements:

1 Pump with proper ultimate pressure shall be selected based on the vacuum degree required by the system. The ultimate pressure of pump shall be 0.5–1 order of magnitude higher than the ultimate pressure required by the system.

2 The vacuum pumps shall be selected based on the pressure range during system normal operation, types, compositions and impurities of pumped vapor and the limit requirements for contamination during system operation. If the system requires absolute no oil or working fluid, or the expenditure of working fluid storage and treatment is higher, dry type vacuum pumps should be selected.

3 The size of vacuum pump shall be determined based on the volume flowrate of vapour drew out from the system.

6.1.3 After the main vacuum pump is selected, it shall determine if backing pump is required. The backing pump shall comply with following requirements:

1 The backing pump shall satisfy the pre-vacuuming requirements required by the main vacuum pump.

2 The backing pump shall be at least equal to the maximum flowrate of the main vacuum pump.

3 The backing pump shall satisfy the pre-vacuuming period required at maximum working pressure of main vacuum pump inlet.

4 If oil-sealed vacuum pump is used as the backing pump, it should not be used to draw out hazardous medium, or gas that reacts with vacuum oil or contains dust and particles.

6.2 Reciprocating Vacuum Pumps

6.2.1 Reciprocating vacuum pumps should be used for the services with single stage ultimate pressure of 400Pa(A)–2600Pa(A).

6.2.2 The nominal pressure of inlet and outlet flanges for reciprocating vacuum pump shall not be less than 1.0MPa.

6.2.3 The temperature of draw out gas of reciprocating vacuum pump shall be less than or equal to 35℃.

6.2.4 The reciprocating vacuum pumps shall not be used for pumping corrosive gas or gas containing particles and dust. If the pumped gas contains dust, filter shall be installed at the pump inlet.

6.2.5 An oil barrier chamber shall be provided between the cylinder and the frame for the non-lubricated reciprocating vacuum pump, and the length of oil barrier chamber shall be larger than one piston stroke.

6.2.6 Self-lubrication materials shall be used to fabricate the piston rings and seal rings of non-

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lubricated vacuum pumps.

6.2.7 The types and basic parameters of Reciprocating Vacuum Pumps shall comply with the requirements specified in the current industrial standard JB/T 7675 *Reciprocating Vacuum Pump*.

6.3 Rotary Vane Vacuum Pumps

6.3.1 Lubricated rotary vane vacuum pumps should be used for the services with ultimate pressure at least equal to 6×10^{-2}Pa(A), and shall not be used for hazardous medium, or gas that reacts with vacuum oil or contains dust and particles.

6.3.2 The continuous operation time of rotary vane vacuum pumps at inlet pressure of 100kPa(A)–6kPa(A)shall be less than or equal to 3 minutes, and when the inlet is fully opened to suck in air, there shall be no oil spill within 1 minute.

6.3.3 After the rotary vane vacuum pumps are stopped, restart of the rotary vane vacuum pumps shall not be hampered due to back oil.

6.3.4 The minimum start-up temperature of rotary vane vacuum pump should be 12℃.

6.3.5 The rotary vane vacuum pumps used for pumping condensable gas shall be equipped with gas ballast devices.

6.3.6 The types and basic parameters of rotary vane vacuum pumps shall comply with the requirements specified in the current industrial standard JB/T 6533 *Rotary Vane Vacuum Pumps*.

6.4 Screw Vacuum Pumps

6.4.1 Single stage screw vacuum pumps should be used for the services with ultimate pressure at least equal to1Pa(A), and square thread screw vacuum pumps should be used for the services with ultimate pressure at least equal to 0.1Pa(A).

6.4.2 The casing of fixed pitch vacuum pump shall be provided with cooling jacket.

6.4.3 Mechanical seal should be provided at the discharge end, and double lip-type seal may be used at inlet side.

6.4.4 The screw shall be dynamically balanced to G2.5 as specified in the current national standard GB/T 9239.1 *Mechanical Vibration-Balance Quality Requirements for Rotors in a Constant (Rigid) State-Part 1: Specification and Verification of Balance Tolerances*.

6.4.5 The number of spiral turns shall be at least equal to 2.

6.4.6 Variable pitch vacuum pumps shall not be used for pumping condensable gas.

6.5 Roots Vacuum Pumps

6.5.1 Dry type Roots vacuum pumps directly venting into the air could be used for the services with ultimate pressure of 10000Pa(A)–20000Pa(A), and two pumps in tandem operation may be used for the services with ultimate pressure of 2000Pa(A)–3000Pa(A).

6.5.2 When the outlet pressure of Roots vacuum pump is below 4000Pa(A), the inlet pressure range should be within 0.1Pa(A)–1000Pa(A), and when the outlet pressure is below 1000Pa(A), the inlet pressure range should be within 1Pa(A)–100Pa(A).

6.5.3 Except for air-cooled Roots vacuum pumps, general-purpose Roots vacuum pumps or Roots vacuum pumps with overflow valves shall not be used individually, and backing pumps shall be provided.

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6.5.4 When the Roots vacuum pump directly vents into the air, its outlet shall be equipped with silencer.

6.5.5 Roots vacuum pumps should not be used for pumping light molecular weight gas.

6.5.6 The types and basic parameters of Roots vacuum pumps shall comply with the requirements specified in the current industrial standard JB/T 7674 *Roots Vacuum Pump*.

6.6 Liquid Ring Vacuum Pumps

6.6.1 Liquid ring vacuum pumps should be used for the services with ultimate pressure of 3000Pa(A) or higher, and suitable for pumping hazardous fluids.

6.6.2 Liquid ring vacuum pump for petrochemical service shall conform to the current industrial standard SH/T 3162 *Technical Specification for Liquid Ring Vacuum Pumps and Compressors in Petrochemical Industry*.

6.6.3 Liquid ring vacuum pump shall be provided with stable working fluid system, and the vaporization pressure of working fluid shall be lower than pump inlet pressure.

6.6.4 Under working conditions, the actual first lateral critical speed of the liquid ring pump rotor shall be at least equal to 120% of the maximum continuous speed.

6.6.5 The rotor of liquid vacuum pump shall be dynamically balanced to G2.5 as specified in the current national standard GB/T 9239.1 *Mechanical Vibration-Balance Quality Requirements for Rotors in a Constant (Rigid) State-Part 1: Specification and Verification of Balance Tolerances*.

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7 Compressors and Fans

7.1 General Requirements

7.1.1 Compressor types should be determined based on the compositions, flowrate and molecular weight of the fluid to be handled as well as the required energy head (or pressure ratio).

7.1.2 For the cases where the inlet flowrate is larger than 1200m^3/min, if the fluid is air or clean and non-corrosive gas, axial flow compressors may be selected. Flow of constant speed axial flow compressor should be controlled by adjusting the static blade angle.

7.1.3 If the outlet flowrate is larger than 5m^3/min, and the efficiency is acceptable, centrifugal compressors should be selected. Centrifugal compressors shall comply with the following requirements:

1 For the rotor with tandem impeller arrangement, the number of impellers of each cylinder of centrifugal compressor should not exceed 9, and for the rotor with back-to-back impeller arrangement, the number of impellers of each cylinder should not exceed 8. For large size impellers, the number of impellers of each cylinder shall be also determined based on the dynamic limits.

2 The shaft seals of process centrifugal compressors shall be selected in a precedence of dry gas seals, mechanical seals, oil-film seals and other types of seals. Tandem dry gas seal with intermediate buffer gas injection should be selected as the dry gas seal, and the buffer gas shall be inert gas, such as nitrogen. For the case where the process allows a small amount of separation gas (nitrogen) leak into the compressor, back to back dual dry gas seals with intermediate separation gas injection may be selected. If the fluid is air or nitrogen, or the fluid is non-toxic, non-flammable and non-explosive gas and the pressure is not high, labyrinth seals may be selected.

3 The flow of single-shaft centrifugal compressors should be controlled by speed governing system, the flow of integrally geared compressors should be controlled by inlet guide vane, and proper variable speed drivers shall be selected based on utilities conditions. When utilities conditions permit, steam turbines should be selected as the drivers.

7.1.4 For small flowrate and large pressure ratio cases, reciprocating compressors should be selected. Reciprocating compressors shall comply with the following requirements:

1 When internal combustion engines or variable frequency electric motors are used as the drivers, it shall guarantee to provide sufficient lubrication (for crankshaft driven pumps) and lubrication of the crosshead pins at rod reversal degree.

2 Steam turbine should not be selected as the driver for reciprocating compressor.

3 Reciprocating compressors should be non-lubricated type.

7.1.5 If reliable operation is proven for rotary compressors in similar services and rotary compressors have significant advantages compared with reciprocating compressors, rotary compressors may be selected. Rotary compressors shall comply with the following requirements:

1 Liquid ring vacuum compressors may be selected for vacuum systems. Oil jet screw compressors may be selected for refrigeration systems or pneumatic systems, and the service pressure shall be less than or equal to 2.5MPa. Light oil jet screw compressors may be selected for flare gas recovery systems. And screw compressors should be selected for the gas services where dust

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concentration is high.

2 For shaft seal systems, if the compressed gas is non-toxic and non-flammable and the operating pressure is not high, labyrinth seals shall be selected, if the compressed gas is non-corrosive hydrocarbons, mechanical seals shall be selected, and oil-film seals may be selected for other services. Shaft seals shall not be carbon ring seals. If demonstrated application experiences are available at the same conditions, shaft seal may be dry gas seal.

7.1.6 Selection of integrally geared centrifugal compressors shall comply with the following requirements:

1 For compressing non-hydrocarbon process gases that are non-toxic and non-harmful, integrally geared single-stage compressors may be used.

2 For compressing other process gases, integrally geared multi-stage compressors should not be selected.

3 Integrally geared multi-stage compressors should be the standard types of the manufacturers.

7.1.7 When the inlet pressure is atmospheric pressure or slightly less than atmospheric pressure, and outlet pressure is less than or equal to 0.2MPa, Centrifugal fans may be selected. Centrifugal fans shall comply with the following requirements:

1 When inlet flow is less than $200m^3/min$, overhung blowers should be selected; and if the flow is large, double-suction, between bearing fans may be selected.

2 For clean and non-corrosive gas services, inlet guide vane may be used for flow control, but inlet guide vane should not be used for other services.

3 If the compressed gas is non-flammable, non-explosive and non-corrosive gas, labyrinth seals may be used. If the process plant does not allow gas leak-out or air leak into process stream, additional inert gas seal systems shall be provided, and mechanical seals may be used.

7.1.8 When forced draft is required, Roots blowers should be selected, and shall comply with the following requirements:

1 Blower inlet gas temperature should not be higher than 40℃.

2 The content of solid particles in the gas shall be less than or equal to $100mg/m^3$, and the maximum particle size shall be less than or equal to the half of the minimum working clearance specified in the list of assembly clearances.

3 If the compressed gas is non-flammable, non-explosive and non-corrosive gas, labyrinth seals may be used. If the process plant does not allow gas leak-out or air leak into process stream, additional inert gas seal systems shall be provided, and mechanical seals may be used.

7.2 Centrifugal and Axial Flow Compressors

7.2.1 Single shaft centrifugal and axial flow compressors used in petrochemical industry shall comply with the current industrial standard SH/T 3144 *Technical Specification for Reciprocating Compressors in Petrochemical Industry*, they should be designed in horizontal type. The casings shall be horizontally or radially split, single cylinder or multi-cylinders may be used, and the split face shall be metal-to-metal joint.

7.2.2 Inter-stage diaphragms shall be suitable for all specified operating conditions as well as start-up, shutdown, trip-out, settling-out, and momentary surge.

7.2.3 Shafts shall be made of integral forged, heat treated alloy steel. The surface on the shaft

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possibly contacting or rubbing with other parts shall be polished.

7.2.4 Impellers may be closed, consisting of a hub, blades and a cover; or semi-open, consisting of a hub and blades. Impellers may be of welded, milled or cast construction.

7.2.5 Hydrodynamic radial and thrust bearings shall be provided.

7.2.6 Shaft seals shall be provided to restrict or prevent process gas leaks to the atmosphere or seal fluid leaks into the process gas stream over the range of specified operating conditions, including start-up and shutdown. Seals shall be suitable for specified variations in seal operating conditions during start-up, shutdown, settling out and during any other special operation cases specified. The maximum sealing pressure shall be at least equal to the settling-out pressure. Shaft end seals and seal system shall be designed to be in operation prior to process start-up and permit compressor safe pressurization and shall accommodate the rapid drop of operating pressure of the compressor. Shaft end seals and shaft sleeve shall be accessible for inspection and for replacement without removing the top half of the casing for an axially split compressor or the end covers of radially split compressor.

7.2.7 The compressor units shall be provided with controls, monitoring systems and anti-surge systems.

7.2.8 Compressor flow may be controlled by adjusting the speed, suction throttling and inlet guide vanes, and shall be suitable for all specified operating conditions, as well as start-up, shutdown, trip-out, and momentary surge. The method to adjust the variable inlet guide vanes or suction throttling to control the compressor flow should be used for the constant-speed compressors, and fixed inlet guide vanes may be used for the variable speed compressors.

7.2.9 The compressor shall be provided with independent sealing system and lubrication system, and the driven equipment and driver should share one common lubrication system.

7.3 Reciprocating Compressors

7.3.1 The reciprocating compressors may be divided into piston compressors (including plunger compressors) and diaphragm compressors. Except for high pressure and ultra-low flow services where diaphragm compressors may be used, piston compressors should be used for other services.

7.3.2 Piston type reciprocating compressor should be opposed-balanced type, and shall be in accordance with Articles 7.3.3-7.3.16 of this code.

7.3.3 Reciprocating compressors for petrochemical service shall conform to the current industrial standard SH/T 3143 *Technical Specification for Reciprocating Compressors in Petrochemical Industry.*

7.3.4 For air compressors, oxygen compressors and hydrocarbon gas compressors where regeneration with airis required, their cylinders and packings shall be operated non-lubricated.

7.3.5 If the compressed gas shall not contain any mineral or synthetical lubricant, the compressor cylinders and packings shall be operated non-lubricated.

7.3.6 For non-toxic gas and gas requiring accurate composition, labyrinth compressors should be used. Such compressors selected shall be in the scope of the standard types with successful operating experiences.

7.3.7 In case of cylinders are lubricated, the compressor speeds and the corresponding maximum allowable average piston speeds shall conform to Table 7.3.7.

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Table 7.3.7 Compressor Maximum Allowable Piston Average Speed

Compressor power, kW	Maximum crankshaft speed, r/min	Maximum average piston speed, m/s
25–150	500	5.0
150–250	428	5.0
≥250	375	4.0

7.3.8 When the reciprocating piston ring compressor handles hydrocarbon gases or the cylinders are not lubricated, its average piston speed shall be less than or equal to 3.6m/s.

7.3.9 For lubricated cylinders handling rich hydrogen gases with molecular weight less than 12, the predicted discharge temperature shall not exceed 135℃ at all specified operating points and load conditions. For non-lubricated cylinders handing at the pressure of 7 MPa gauge pressure or higher, the predicted discharge temperature shall not exceed 130℃ at all specified operating points and load conditions.

7.3.10 The cylinder cooling system provided shall be adequate to prevent gas condensing under all conditions including start-up from cold. Cooling water inlet temperature shall be at least 5℃ above the inlet gas temperature, and cooling water return temperature shall not be higher than 17℃ above gas inlet temperature.

7.3.11 For flammable, hazardous, toxic or wet gas services or for applications handling a concentration of 5 mol% or greater H_2S, the intermediate partition packing cases and cylinder pressure packing cases shall be purged with nitrogen.

7.3.12 For the unit having a nominal frame rating of 150kW or above, the vendor shall provide a motor driven auxiliary oil pump. When the oil pressure is low, the auxiliary oil pump shall be able to be automatically started, and when the compressor unit is shut down, the auxiliary oil pump shall provide sufficient lubrication.

7.3.13 Than 150kW, if the motor driven auxiliary oil pump is not provided, a hand pump shall be provided.

7.3.14 For critical service compressor without spare, the following requirements shall be met:

1 Oil pump should not be driven by the crankshaft.

2 The power supply for the two motor driven pumps shall be separate, or bladder type accumulator shall be provided.

3 Dual oil filters and oil coolers with continuous-flow transfer valves shall be provided.

7.3.15 When the power of motor is equal to or less than 600kW, induction motor should be used; when the power is larger than 600kW or the power grid does not permit use of the induction motor, brushless synchronous motors should be used.

7.3.16 Pulsation and vibration calculations of the reciprocating compressor train and mechanical stress analysis of the related pipes shall include all the pipes and appurtenances within the scope of the compressor train as well as the upstream and downstream vessels and supports adjacent to the compressor train.

7.3.17 For the compressor having a rated power equal to or less than 450kW and the compressor arranged in one throw or two throws with an allowable combined rod loading equal to or less than 160kN, a manual driven barring device is acceptable. For the compressor having a rated power larger than 450kW and an allowable combined rod loading larger than 160KN, or the compressor arranged in

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more than two throws, a pneumatically driven barring device or a motor driven barring device is acceptable.

7.4 Rotary Compressors

7.4.1 The rotary compressors for petrochemical service shall be timing gear driven twin-screw compressors, and shall comply with the current industrial standard SH/T 3157 *Technical Specification of Rotary-type Compressor for Petrochemical Industry*.

7.4.2 It shall specify the maximum allowable working pressure and temperature of the rotary compressors.

7.4.3 If the medium permits, liquid may be injected into the inlet of compressor to decrease the outlet temperature.

7.4.4 For variable speed driver, the allowable operating speed range of the machine unit shall be specified, and related safety protection system shall be provided. The speed governing range of variable speed driver should be from the maximum continuous speed to 90% of the minimum operating speed for all the cases or from the maximum continuous speed to 65% of the rated speed, whichever is larger.

7.4.5 The discharge temperature at any operating point plus 20℃ shall be less than or equal to the maximum allowable working temperature.

7.4.6 For wet gas services, the rotary compressors should be designed in top suction and bottom discharge.

7.4.7 Rotor stiffness shall be adequate to prevent contact between the rotor bodies and the casing and between gear-timed rotor bodies under the most severe operating conditions of minimum suction pressure and discharge pressure equal to the relief valve setting. The rotor bodies should be integral with the shaft, and if the rotor bodies are not integral with the shaft, structural welds on rotors shall be full-penetration continuous welds and shall be stress relieved。

7.4.8 Contact type mechanical seal should be used for flooded screw compressor.

7.4.9 When dry gas seal is used as the shaft seal, it shall be integral cartridge dry gas seal. An intermediate labyrinth shall be provided between the primary seal and the secondary seal of the tandem dry gas seal.

7.4.10 Rotors shall be of a stiff-shaft construction, and the first critical speed shall be at least 120% of the maximum allowable speed.

7.5 Centrifugal Fans

7.5.1 The Centrifugal fans for petrochemical service shall conform to the current industrial standard SH/T 3170 *Technical Specification of Centrifugal Fans in Petrochemical Engineering*.

7.5.2 Centrifugal fans should not be arranged in parallel operation or tandem operation.

7.5.3 High efficiency, low noise centrifugal fans shall be selected, provided that the flowrate and pressure requirements are met.

7.5.4 Centrifugal fans should be limited to the machines with maximum outlet pressure of 200kPa(G) and maximum single-stage pressure rise of 25kPa.

7.5.5 When any of the following conditions exists, the Centrifugal fan shall be arranged with fan wheel located between bearings and the bearings shall be mounted on independent supporting pedestals:

1 Impeller diameter greater than 1500mm;

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2 Driver rated power of 200kW or greater;

3 Speed greater than 1800r/min;

4 Design temperature of 220℃ or greater;

5 Service subject with fouling deposits that could cause rotor unbalance.

7.5.6 The surge point of Centrifugal fans should be less than 60% of the fan rated flow, and the surge point of Centrifugal blowers shall be less than 80% of the blower rated flow.

7.5.7 Under working conditions, the first lateral critical speed of the rotor shall be at least equal to 120% of the maximum operating speed.

7.5.8 The rotor of Centrifugal fan shall be dynamically balanced to G2.5 as specified in the current national standard GB/T 9239.1 *Mechanical Vibration-Balance Quality Requirements for Rotors in a Constant (Rigid)State-Part 1: Specification and Verification of Balance Tolerances.*

7.5.9 Minimum housing plate thickness shall be 4.75mm for forced draft fans, and 6.4mm for induced draft fans.

7.5.10 Impellers should have solid hubs. Impellers with hollow hubs may be used for the services where the fluid temperature is below 150℃ or the fan tip speed is less than 6000r/min.

7.5.11 When the fan shaft power is larger than 75kW, belt drives shall not be used.

7.6 Roots Blowers

7.6.1 Silencers should be installed at the inlet and outlet of Roots blower.

7.6.2 Flexible connection or bellows should be provided at the inlet and outlet of Roots blower.

7.6.3 The vibration speed at the bearings of Roots blower shall be less than or equal to 6.3mm/s.

7.6.4 The rotor of Roots fan shall be dynamically balanced to G6.3 as specified in the current national standard GB/T 9239.1 *Mechanical Vibration-Balance Quality Requirements for Rotors in a Constant (Rigid)State-Part 1: Specification and Verification of Balance Tolerances.*

7.6.5 Timing gear comprises gear ring and gear hub, and conic pin is used for positioning.

7.6.6 The accuracy of timing gear shall be higher or equal to Grade 10 as specified the current national standard GB/T 10095.1 *Cylindrical Gears-System of Accuracy-Part 1: Definitions and Allowable Values of Deviations Relevant to Corresponding Flanks of Gear Teeth.*

7.6.7 The gear ring shall be fabricated by using high strength abrasion resistant materials.

7.6.8 The minimum service factor of timing gear shall be 1.8.

7.6.9 The misalignment at the joints between the blower casing and wall and between the split casing and the wall shall be less than or equal to 5mm.

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8 Steam Turbines, Expanders and Gas Turbines

8.1 General Requirements

8.1.1 Steam turbines, expanders, gas turbines, hydraulic turbines, electric motors and fuel engines shall be selected as the driver or energy recovery unit based on plant utilities conditions (including electric load, steam balance, fuels and types of driven equipment).

8.1.2 When several options are available, the types of drivers shall be selected based on safety, reliability, environment protection and technically economic index factors.

8.2 Steam Turbines

8.2.1 If all the following conditions are met, general-purpose steam turbine should be selected and shall conform to the current industrial standard SH/T 3149 *Technical Specification for General-purpose Steam Turbines in Petrochemical Industry*. And if any one of the following conditions is not met, special purpose steam turbine should be selected and shall conform to the current industrial standard SH/T 3145 *Technical Specification for Special-purpose Steam Turbines in Petrochemical Industry*.

1 The driven equipment shall have standby unit.

2 The driven equipment is relatively small in size (power).

3 The driven equipment is of non-critical service.

4 Steam conditions no less than 4.8MPa(G) inlet pressure and 400℃ inlet temperature.

5 Steam turbine speed is not more than 6000r/min.

8.2.2 The steam turbine shaft power shall be not less than 110% of rated power in normal steam conditions.

8.2.3 Steam turbine shall be sized (rated) to deliver continuously not less than 104% of the rated power requirement of the driven equipment at the rated speed with coincident minimum inlet and maximum exhaust pressure and temperature, and this shaft power shall include various mechanical losses.

8.2.4 Electronic speed governor shall have two speed-sensing systems provided to ensure that the failure of the speed governor will not occur in the event that one sensing system failed.

8.2.5 Steam turbine casing and any other pressure-containing parts shall be designed for maximum allowable working pressure. The maximum allowable working pressure of the casing shall be at least equal to the specified relief valve setting. For condensing turbine, the maximum allowable working pressure of the exhaust casing shall be at least 0.07MPa (G), and shall be full vacuum.

8.2.6 Radially and axially split casings shall be a metal-to-metal joint that is tightly maintained by suitable bolting.

8.2.7 Rotor shall be capable of safe operation at momentary speed up to 121% of maximum continuous speed at any specified operating temperature.

8.2.8 When blade tip velocity exceeds 250m/s at the maximum continuous speed or when inlet steam temperature exceeds 440℃, integral hub shall be used.

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8.2.9 Major parts of the rotating element, such as the shaft, disk, coupling, gear and balancing drum, shall be dynamically balanced individually. They shall be dynamically balanced to G1.0 as specified in the current national standard GB/T 9239.1 *Mechanical Vibration-Balance Quality Requirements for Rotors in a Constant (Rigid)State-Part 1: Specification and Verification of Balance Tolerances.*

8.2.10 The steam turbines should be provided with independent mechanical or manual emergency trip devices.

8.2.11 Surface condenser provided for condensing turbine should use circulation water for cooling, and may use air for cooling.

8.3 Expanders

8.3.1 Expanders shall comply with the following requirements:

1 For expanders intended to recover cold energy, the power possibly recovered and investment of additional equipment necessary for power recovery shall govern if it is required to provide expanders.

2 For expanders intended to recover residual pressure and waste heat, if the recovered power is less than or equal to 75kW, expanders may not be provided.

3 When expander is used for driving compressor, the rotative speed of expander shall be well coordinated with that of compressor.

4 When the medium contains solid particles or liquid, separation equipment shall be provided before the expander, and when expansion ratio is larger and the fluid may be subject to icing at expander outlet, the fluid shall be heated up before the expander.

5 The expander shall be equipped with proper control systems, especially overspeed protection system.

6 When diaphragm type or diaphragm disc type coupling is used to couple the expander and its driver, it shall be coupling protected by backup gear teeth.

8.3.2 Selection of expanders shall comply with the following principles:

1 Expanders shall be selected based on the inlet flow and expansion ratio of expanders. In large-size industrial plants where energy recovery is the main purpose, axial flow type expanders should be selected, and in air separation plants, radial flow or axial flow expanders should be selected based on the sizes of air separation plants. Expanders may be selected in accordance with Table 8.3.2.

Table 8.3.2 Selection of expanders

Expansion ratio	Type of expander
≤40:1	Partial air intake axial flow type
≤30:1	Radial flow type or full air intake impulse axial flow type
≤5:1	Full air intake reaction axial flow type

2 When gas-liquid phase flow may be generated in the fluid expansion process in the expander, radial flow expander shall be used.

3 Axial flow expander should be reaction expander.

4 Proper types of bearings shall be selected based on rotated speeds of expanders. Small-size high speed expanders used in small-size air separation plants should use gas bearings, the expanders used for energy recovery in mid-and large-size air separation plants and industrial plants should use hydrodynamic bearings, and the expanders for special services such as natural gas expanders in oil fields should use

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magnetic bearings.

8.3.3 One or several of the following methods shall be used for flow control of expanders based on the specific operating cases:

1 Lower inlet pressure;

2 Controlled by nozzle block;

3 Controlled by adjustable nozzle;

4 Controlled by changing the height of nozzle.

8.4 Gas Turbines

8.4.1 Gas turbines shall be suitable for the fuel specified in the datasheets.

8.4.2 Single shaft gas turbines should be used for the services without load variation or with minor load variation, and double shaft or multiple shaft gas turbines should be used for the services with load variation.

8.4.3 The gas turbine compressor should be axial flow compressor or centrifugal compressor or a combination of both. The combustion chamber shall comply with the following principles:

1 High combustion efficiency;

2 Reliable firing and stable combustion;

3 Less pressure loss;

4 Uniform outlet temperature;

5 Strong combustion;

6 Less emissions;

7 Long service life.

8.4.4 Electric motor and steam turbine should be used as the starting or helper driver for gas turbine start up.

8.4.5 The design service life and uninterrupted operation of gas turbines shall comply with the requirements specified in paragraph 3.1.1 of this code. It is also recognized that inspection of hot section shall be required; however, the required interval between inspections shall be not more than 8000 operating hours.

8.4.6 The emission suppression system for gas turbine shall be provided to control NO_x, CO, and unburned hydrocarbons in the turbine's exhaust gas.

8.4.7 The noise level of the gas turbine and its driven equipment as a whole system shall comply with the requirements specified in paragraph 3.5.2 of this code.

8.4.8 Fuel nozzles should be removable without dismantling of the combustors. For liquid fuels, nozzles shall be designed for operation without erosion, plugging, and carbonization, scheduled maintenance intervals shall be shortened.

8.4.9 Locations to measure the inlet conditions and outlet conditions of gas turbines shall be specified.

8.4.10 The effects caused by ambient temperature, altitude and humidity as well as the losses of gear boxes and transmission equipment shall be specified for gas turbines.

8.4.11 The power of driving machinery for gas turbine shall be measured at the output shaft end of gas turbine.

8.4.12 The design of gas turbine shall permit hot restarting following any emergency shutdown. If this function is not achieved, pre-cooling device shall be provided between two times starting under any

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operating conditions.

8.4.13 Air inlet system shall comply with the following requirements:

1 For dry environment, the air filter system should be self-cleaning type, and for tropical environment, the air filter system should be static type.

2 Pressure gauge and pressure sensor shall be provided at the compressor inlet flange, and their signals shall be sent to the control system.

3 Corrosion protection is required for inlet silencer. If protective coating is required, zinc-free coating shall be used.

8.4.14 Fuel system shall comply with the following requirements:

1 The material of fuel gas pipes within gas turbine unit shall be at least 316L stainless steel, and pipe welds shall be 100% NDT tested.

2 Fuel gas filter with DP pressure gauge shall be provided, and the internals of this filter shall be stainless steel.

8.4.15 The control and protection systems for gas turbine and its driven equipment shall comply with the following requirements:

1 The control functions of gas turbine shall include startup, operation, shutdown, protection, detection and cleaning of the machine train.

2 The gas turbine shall be provided with overspeed protection, over-temperature protection, fire protection, and gas and H_2S detection system.

3 Besides the fuel control valve, the fuel control system shall include a individual block valve or a shutoff valve. For gas fuel, proper vent valve shall be used.

4 Individual overspeed regulator and overspeed trip device shall be provided for each shaft.

5 One additional overspeed protection may be provided for the double shaft or multiple shaft gas turbine or the gas turbine with heat exchanger.

6 Machine unit for the case when the gas turbine is extinguished.

7 The fuel control system shall include a limit control system.

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9 Centrifuges

9.1 General Requirements

9.1.1 Proper type of centrifuge shall be selected based on the suspension properties, separation requirements and operation methods.

9.1.2 When the concentration of solid phase in suspension is higher, the particles are rigid or crystal and the large, filtration centrifuge should be selected; when the concentration of solid phase in suspension is lower, the particles are plastic or fine, decanter centrifuge should be selected.

9.2 Filtration Centrifuges

9.2.1 Filtration centrifuge should be used for separation of liquid-solid phase suspension where the solid concentration is within 5%–80% and particle sizes are within 10μm–5mm.

9.2.2 Horizontal peeler centrifuge should be used for separation of the suspension where the solid concentration is within 25%–60%, the particle sizes are larger than 10μm, the viscosity of liquid is less than 0.1Pa · s, and the particles are allowed to be crushed. Peeler centrifuge shall be in accordance with the current industrial standard JB/T 7220 *Peeler Centrifuge*.

9.2.3 Pusher centrifuge should be used for separation of the suspension where the solid phase concentration is within 30%–60%, the particle sizes are within 0.1mm–3mm, the viscosity of liquid phase is less than 0.1Pa · s, the rigidity of filter cake is enough rigid, and the particles are not prone to be crushed. For the suspension where the rigidity of cake is not enough rigid, single-stage or multi-stage pusher centrifuges should not be selected. Pusher centrifuge shall be in accordance with the current industrial standard JB/T 447 *Pusher Centrifuge*.

9.3 Decanter Centrifuges

9.3.1 Decanter centrifuge may be used for separation of the suspension where the solid concentration is within 2%–70%, the particle sizes are larger than 5μm–5mm, and the viscosity of liquid is approximately 0.1Pa · s.

9.3.2 Scroll decanter centrifuge shall be in accordance with the current industrial standard JB/T 502 *Solid-bowl Scroll Discharge Centrifuge*.

9.3.3 Selection of scroll decanter centrifuge shall comply with the following requirements:

1 For the feed where solid concentration is low, particles are fine, the density differential between solid and liquid is small, and high calcification is required for the liquid, the centrifuge should be of concurrent flow with cylindrical or conical rotating bowl in a length to diameter ratio (L/D) of 3 or larger.

2 For the feed where solid concentration is higher, the density differential between solid and liquid is higher, high sludge produce and lower moisture content is required, the centrifuge should be of countercurrent flow with cylindrical or conical rotating bowl in a length to diameter ratio (L/D) of 2 or larger.

3 For large particle dewatering service, if it is required to have higher sludge produce and lower

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moisture content in the sludge, the centrifuge should be a combined type of screen and scroll.

9.3.4 Single helical scroll should be selected for the scroll decanter centrifuge. Where large feed treatment is required, and it is allowed with more solid in the clarified effluent and properly increased moisture in the sludge, double helical scrolls may be selected or differential speed and torque between the rotating bowl and the scroll may be increased.

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10 Accessories

10.1 Drivers

10.1.1 The motor rated power shall be at least equal to the rated shaft power of the rotary machine (including power transmission loss) multiplying the motor power allowance coefficient K. Motor power allowance coefficient, K, shall be selected from Table 10.1.1.

Table 10.1.1 Motor Power Allowance Coefficient, K

P_a(kW) motor nameplate power P_a(kW)	K power allowance coefficient (K)
<22	125%
$22 \leqslant P_a \leqslant 55$	115%
>55	110%

10.1.2 Electric motors should be capable to directly started at 80% of rated voltage.

10.1.3 For the machine unit driven by steam turbine, the power of steam turbine shall comply with the requirements specified in Article 8.2.2 and Article 8.2.3 of this code.

10.1.4 For variable speed driver such as steam turbine and gas turbine, it shall be designed for continuous operation at any speed within the governor's regulation region, and the governor's regulation range shall be determined based on the driven equipment.

10.2 Gear Units and Hydraulic Couplers

10.2.1 For power transmission equipment such as gear units and hydraulic couplers, their rated power shall be larger than the maximum output power of the drivers.

10.2.2 For rotary machines provided with spares or the rotary machines for non-critical services, general-purpose gear units should be used.

10.2.3 For centrifugal compressors, axial flow compressors and large-size Centrifugal fans without spares, special purpose gear units should be used.

10.3 Couplings and Guards

10.3.1 Couplings shall conform to the current industrial standard SH/T 3171 *Technical Specification for Flexible Couplings in Petrochemical Engineering*. The couplings shall be sized based on the driver rating multiplying 1.2, and all torque-transmitting components shall have a safety factor of no less than 1.15.

10.3.2 Belt drives should not be used. If belt drives are selected, anti-static treatment shall be made for the belts.

10.3.3 All external rotating parts including the couplings and driving wheels of rotary machines shall be equipped with fully enclosed removable safety guards. For rotary machines used in hazardous services, their coupling guards shall be made of non-spark materials.

10.4 Lube, Seal Oil and Oil-control Systems

10.4.1 For pumps equipped with hydrodynamic bearings, general-purpose steam turbines, reciprocating

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compressors or integrally geared centrifugal instrument air compressors, their oil systems shall be general-purpose oil systems for petroleum, chemical and natural gas services.

10.4.2 For centrifugal compressors, rotary compressors, special purpose steam turbines, expanders and gas turbines used in petrochemical industry, their oil systems shall be special purpose oil systems for petroleum, chemical and natural gas services.

10.4.3 The complete unit, including the driver, should share one common oil system.

10.5 Baseplates

10.5.1 A common baseplate shall be provided for the compressor and driver, and that shall be a single fabricated steel unit with edges, drains and equipped with lifting points and lugs. The baseplate shall be large enough to extend beyond the feet of compressor, driver and related equipment in longitudinal and lateral directions except the following parts.

1 Junction box of the motor;

2 Frame end of the motor equipped with grease lubricated bearing.

10.5.2 For large-size unit, if it is impossible to install the whole unit on one common baseplate, the rotary machine and main driver may be installed on their respective independent baseplates; however, other accessories should be installed on one common baseplate. The skids and equipment interconnected shall be assembled and tested in factory, mating faces shall be marked, and shall be assembled at site.

10.5.3 The baseplate shall be constructed with sufficient structural stiffness without grouting to meet the rotary machine alignment accuracy requirements and the allowable external forces and the moments on nozzle flanges.

10.5.4 Rotary machine and baseplate shall be bolt connected. The bolts shall withstand the nozzle reaction forces during startup and operation of rotary machines, and their size shall be at least equal to M12.

10.5.5 For pumps, if the driver mass is larger than 200kg, positioning jackscrews for transverse and axial alignment shall be provided. For compressor unit, axial, transverse and vertical alignment positioning jackscrews shall be provided. If the equipment is too heavy to use alignment positioning jackscrews, other means for alignment shall be provided.

10.5.6 Stainless shims shall be used to adjust the gap between the equipment support and baseplate, and the thickness of shim shall be within 3mm-13mm. All the shims shall straddle the fixing bolts and vertical alignment positioning jackscrews, and extend at least 5mm beyond the equipment outer edges.

10.5.7 Positioning jackscrews for horizontal alignment shall be equally spaced near to the anchor bolts around the baseplate, and the number of such positioning jackscrews shall be not less than 6.

10.5.8 The baseplate shall be provided with at least 4 lifting points and equipped with lifting lugs. When the baseplate installed with all equipment is lifted, it shall ensure the baseplate and the equipment installed on the baseplate without any permanent deformation or damage.

10.5.9 The anchor bolts shall sufficiently withstand the reaction forces of nozzles during starting and operation of rotary machines. Anchor bolts, nuts and pads should be supplied together with the machine unit.

10.5.10 The baseplates shall be provided with at least 2 earthing lugs at opposite positions.

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10.6 Controls and Instrument

10.6.1 The rotary machines shall be provided with two systems: instrument monitoring and control system and safety interlock system. And these two systems shall be provided based on the performance characteristics of rotary machines and their functions in process flows. The specific requirements are as follows:

1 Independent machinery monitoring system and safety interlock system may not be provided for reciprocating compressors, screw compressors, pumps, and electric motor driving centrifugal and axial flow compressors, the monitoring and control function may be performed by the plant distributed control system (DCS), and the safety interlock function may be performed by the plant safety interlock system (SIS).

2 Independent or shared machinery monitoring system and safety interlock system should be provided for large critical machine units, and the system selection and technical requirements shall be consistent with the requirements for the plants.

3 When specified, on-line state monitoring systems shall be provided for the large critical machine units.

10.6.2 Instrument signals for interlock protection should be two out of three "voting" type, and the signal should be the same signal from the same location.

10.6.3 For screw compressors, centrifugal or axial flow compressors and large-size centrifugal pumps with a rotated speed higher than 3000r/min and a power larger than 1000kW and equipped with hydrodynamic bearings, displacement detectors and phase detectors should be provided at X- and Y-directions to monitor the shaft vibration. For other machine units, the vibration velocity or acceleration of bearing housing may be monitored. And for reciprocating compressors, the frame vibration acceleration should be monitored.

10.6.4 Self-operated regulators should be used as the control valves for the forced lubrication system. If control valves provided with controllers are used, the controllers shall be capable of carrying out the required control algorithm within 100ms.

10.6.5 The instruments of forced lubrication systems should be locally installed. When specified, local open rack instrument panels may be provided, and junction boxes shall be installed for instrument wiring.

10.6.6 All instruments used to monitor the vibration, shaft displacement, phase, pressure, temperature and liquid level of rotary machine shall be wired to the junction boxes located at the edge of baseplate, and different junction boxes shall be provided per signal types.

10.6.7 The design, selection and installation of instruments within the unit packages shall comply with the plant technical specifications for instrument design.

10.7 Piping and Appurtenances

10.7.1 Cooling water, steam, vent, drain and other auxiliary piping systems, including all the accessories such as instruments and valves, shall be assembled and installed orderly, and completely cleaned and after hydraulic test, and then installed on the rotary machine or within the baseplate of the rotary machine. Piping and equipment shall be properly designed and arranged for easy removal and maintenance.

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10.7.2 The piping of the same kind in the unit shall be provided with only one inlet and one outlet, and routed on the edge of baseplate.

10.7.3 For cooling water piping system, globe valves shall be provided on the inlet and outlet connections of the system manifold and each branch line, and sight flow indicators shall be provided in each branch outlet line.

10.7.4 The piping shall also comply with the following requirements:

1 The corrosion allowance for carbon steel piping and low alloy steel piping shall be at least equal to 1mm, and the corrosion allowance for high alloy steel, austenitic stainless steel and nonferrous metal piping may be ignored.

2 The inlet and outlet flanges of the piping system shall be of the same pressure rating.

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11 Inspection and Testing

11.1 General Requirements

11.1.1 The inspection and testing items shall be specified in the technical documents, including the inspection and testing items required to be witnessed or observed, and inspection reports shall be provided. The inspection and test plan, detailed test procedures and acceptance criteria for the items required to be witnessed or observed shall be submitted in advance.

11.1.2 The items and contents that not specified in this code, referenced codes and standards and technical attachments to the contract or the reviewed datasheets shall be inspected and tested in accordance with vendor's standard procedures.

11.1.3 Pre-test may not be required before witness test.

11.2 Inspection

11.2.1 All the critical components of rotary machines and the pressure-containing parts of major accessories shall be supplied with material quality certificates. The contents of the certificates shall include chemical analysis, mechanical properties and heat treatment conditions of the materials, and shall comply with the applicable material standards.

11.2.2 All heat treatment measures shall be provided with documentary evidences to prove that all heat treatment activities have been properly carried out in the process of normal fabrication or as a part of repair procedures.

11.2.3 Repair of cast steel pressure-containing parts shall comply with the following requirements:

1 The general surface defects identified during inspection shall be removed, and the major defects shall be repaired, and then re-inspected to prove complete removal of the defects.

2 Prior to repair of major defects, repair sketches shall be drawn, clearly indicating the defects to be repaired, the locations of defects and the detailed defect repair procedures.

3 After the defects are repaired, all machined weld surfaces shall be MT or PT tested, and welds for major defects of pressure-containing castings shall be subject to stress relief, PWHT and RT.

11.2.4 The rotary machines shall be visually examined and comply with the following requirements:

1 The surface of each pressure-containing casting shall be free of any inclusion, porosities, scars, cracks and hot tear or other similar casting defects.

2 Welds shall be free of any cracks, undercuts or other harmful defects.

3 The roughness of all machined surfaces shall comply with the specified requirements.

4 The exterior and interior of casing shall be cleaned.

5 Oil leakage is not allowed during mechanical running test. If identified, proper troubleshooting shall be made immediately to eliminate the leakage.

11.2.5 The following items shall be checked in accordance with the reviewed and approved drawings and datasheets:

1 The rotating direction of rotary machine;

2 All information stamped or engraved on the nameplate;

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3 Nozzle orientation;

4 Arrangement of the piping;

5 Quantities of auxiliaries and spare parts.

11.2.6 Dimensional inspections shall include the following items:

1 Baseplate dimensions, including the dimensions and locations of anchor bolts;

2 Clearances and dimensions required for maintenance and assembly;

3 Outline dimensions necessary for connection or installation at the site, including flange sizes, types and locations;

4 The actual wall thickness of casing.

11.3 Testing

11.3.1 Testing items for rotary machines shall include hydraulic test, rotor dynamic balance test, overspeed test, performance test, mechanical running test, complete unit test and noise test etc.

11.3.2 Conventional test items for rotary machines shall include:

1 Pumps and hydraulic turbines: hydraulic test, rotor dynamic balance test, performance test and mechanical running test.

2 Agitators: mechanical running test.

3 Reciprocating compressors: hydraulic test and mechanical running test.

4 Rotary compressors: hydraulic test, rotor dynamic balance test and mechanical running test.

5 Centrifugal compressors, steam turbines, expanders and gas turbines: hydraulic test, rotor dynamic balance test, disc overspeed test and mechanical running test.

6 Lube oil stations: running test shall be made at the manufacturer workshop.

7 Dry gas seals: mechanical running test shall be performed with the rotary machines.

11.3.3 When required, the mechanical running test shall be performed with a complete unit including compressors, and auxiliaries and systems such as gears, drivers, seal systems and control systems, and etc.

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12 Painting, Marking, Packaging and Shipment

12.1 Painting

12.1.1 Except for the machined surfaces, exterior surfaces of the machines shall be coated with primer and finish in accordance with the current industrial standard SH 3043 *Specification for Surface Color and Identification of Equipment, Pipes and Steel Structures in Petrochemical Industry.*

12.1.2 The flanges mating faces of the machines and accessories shall not be applied with anti-corrosion paint.

12.1.3 Exterior machined surfaces shall be coated with a suitable rust preventer.

12.1.4 The interior of the machine shall be cleaned with applicable rust preventative that shall be removed by solvent. The rust preventive shall be filled while the rotor is being slowly rotated.

12.1.5 All the internals of bearing housing contacting with oil and the components of lubrication system, which are made of materials other than stainless steel, shall be coated with a suitable oil-soluble rust preventer.

12.2 Nameplates and Rotation Arrows

12.2.1 The nameplate of rotary machine shall be made of stainless steel, and securely attached at a readily visible location on the major component of the machine.

12.2.2 The words on the nameplates for the rotary machines fabricated in China should be stamped in Chinese, and the words on the nameplate the rotary machines fabricated abroad should be stamped in English. Unit of measurements shall be SI unit.

12.2.3 The nameplate shall include the following information:

1 Tag number and machine number.

2 Manufacturer's name.

3 Manufacturing serial numbe.

4 Model and size.

5 Main performance parameters.

6 Manufacturing date.

12.2.4 Rotation arrows shall be provided on the main machine, driver and gear unit as well as those for the lubrication system and cooling system. Rotation arrows should be casted or made of austenitic stainless steel, and shall be securely attached at readily visible locations on the machines.

12.3 Marking

12.3.1 Removable components, for which accurate restoration is required and misinstallation is potential, shall be pair marked.

12.3.2 All instruments, accessories, auxiliary equipment, components and spare parts that are shipped separately shall be attached with corresponding labels or marked with corresponding signs. The labels shall be stainless steel.

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12.4 Packaging and Shipment

12.4.1 All the flanged openings located on the machines and accessories shall be covered with metal enclosures provided with rubber gaskets and at least four bolts.

12.4.2 All the unflanged openings shall be blocked with suitable plugs.

12.4.3 All parts shall be properly cleaned, coated with rust preventive and provided with necessary protection measures to enable the machines capable of withstanding six months of outdoor storage from the time of shipment without any damages when no additional protection measures are taken.

12.4.4 The rotary machine should be packaged and shipped as a complete unit.

12.4.5 Each piece of equipment or material shall be properly packaged, securely fixed and moisture protected.

12.4.6 The brackets, supports and riggings to facilitate machine shipment and handling shall be supplied with the machine unit. Temporary brackets and supports shall be clearly marked or painted in yellow color to indicate that they shall be removed upon completion of permanent installation.

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Appendix A Applicable Standards and Pressure Ratings for Flanges

A.0.1 Applicable standards and pressure ratings for steel pipe flanges shall conform to Table A.0.1.

Table A.0.1 Applicable Standards and Pressure Ratings for Steel Pipe Flanges

		Nominal pressure rating							Applicable standard
America System	China	*PN*	20	50	110	150	260	420	GB/T 9112,HG/T 20615,SH/T 3406
	USA	Class	150	300	600	900	1500	2500	ASME B16.5(DN15–600) ASME B16.47 (DJV650–1500)A\B* ASME B16.47 (DJV650–1500)Series A\B*
Europe System	China	*PN*6,10,16,25,40,63,100,160,250							GB/T 9112,HG/T 20592
	Europe								EN 1092-1

A.0.2 Applicable standards and pressure ratings for grey cast iron pipe flanges shall conform to Table A.0.2.

Table A.0.2 Applicable Standards and Pressure Ratings for Grey Cast Iron Pipe Flanges

		Nominal pressure rating				Applicable standard
America System	China	*PN*	20	50	—	GB/T 17241
	USA	Class	125	250	800	ASME B16.1
Europe System	China	*PN*2.5,6,10,16,25,40				GB/T 17241
	Europe					EN 1092-2

A.0.3 Applicable standards and pressure ratings for ductile iron pipe flanges shall conform to Table A.0.3.

Table A.0.3 Applicable Standards and Pressure Ratings for Ductile Iron Pipe Flanges

		Nominal pressure rating			Applicable standard
America System	China	*PN*	20	50	GB/T 17241
	USA	Class	150	300	ASME B16.42
Europe System	China	*PN*6,10,16,25,40			GB/T 17241
	Europe				EN 1092-2

Notes:1 ASME B16.47 (*DN*650–1500) Series A,B correspond to Chinese standard HG/T 20623 (DN650–1500)Series A,B;

2 Figures after *PN* (nominal pressure)in the table correspond to the values expressed in bar;

3 GB/T 9112: Steel Pipe Flanges;

4 GB/T 17241: Cast Iron Pipe Flanges;

5 HG/T 20592: Steel Pipe Flanges (PN designated);

6 HG/T 20615: Steel Pipe Flanges (Class designated);

7 HG/T 20623: Large Diameter Steel Pipe Flanges (Class designated);

8 SH/T 3406: Steel Pipe Flanges for Petrochemical Industry;

9 ASME B16.1: Gray Iron Pipe Flanges and Flanged Fittings :Classes 25,125 and 250;

10 ASME B16.42: Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300;

11 ASME B16.47: Large Diameter Steel Flanges: NPS 26 through NPS 60;

12 ASME B16.5: Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24;

13 EN 1092-1: Flanges and Their Joints-Circular Flanges for Pipes, Valves, Fittings and Accessories-Part 1 Steel Flanges;

14 EN 1092-2: Flanges and Their Joints-Circular Flanges for Pipes, Valves, Fittings and Accessories-Part 2 Cast Iron Flanges.

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Explanation of Wording in This Code

1 Words used for different degrees of strictness are explained as follows in order to mark the differences in executing the requirements in this code:

1)Words denoting a very strict or mandatory requirement:

"Must" is used for affirmation,"must not" for negation.

2)Words denoting a strict requirement under normal conditions:

"Shall" is used for affirmation,"shall not" for negation.

3)Words denoting a permission of a slight choice or an indication of the most suitable choice when conditions permit:

"Should" is used for affirmation,"should not" for negation.

4)"May" is used to express the option available,sometimes with the conditional permit.

2 "Shall comply with..." or "Shall meet the requirements of..." is used in this code to indicate that it is necessary to comply with the requirements stipulated in other relative standards and codes.

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List of Quoted Standards

GB/T 9112 *Steel Pipe Flanges*

GB/T 9239.1 *Mechanical Vibration-Balance Quality Requirements for Rotors in a Constant (Rigid)State-Part 1 Specification and Verification of Balance Tolerances*

GB/T 17241 *Cast Iron Pipe Flanges*

GB/T 20972.1 *Petroleum and Natural Gas Industries-materials for Use in H_2S-containing Environments in Oil and Gas Production-Part 1: General Principles for Selection of Cracking-resistant Materials*

GB/T 10095.1 *Cylindrical Gears-System of Accuracy-Part 1: Definitions and Allowable Values of Deviations Relevant to Corresponding Flanks of Gear Teeth*

GBZ 2.2 *Occupational Exposure Limits for Hazardous Agents in Workplace-Part2: Physical Agents*

GB/T 189.8 *Measurement of Physical Agents in Workplace-Part 8: Noise*

SH/T 3043 *Specification for Surface Color and Mark on Equipment Pipe and Steel Structure in Petrochemical Industry*

SH/T 3139 *Technical Specification on Centrifugal Pumps for Heavy-duty Services in Petrochemical Industry*

SH/T 3140 *Technical Specification on Centrifugal Pumps for Medium-and Light-duty Services in Petrochemical Industry*

SH/T 3141 *Technical Specification for Reciprocating Pumps in Petrochemical Industry*

SH/T 3142 *Technical Specification for Metering Pumps in Petrochemical Industry*

SH/T 3143 *Technical Specification for Reciprocating Compressors in Petrochemical Industry*

SH/T 3144 *Technical Specification for Centrifugal and Axial Compressor in Petrochemical Industry*

SH/T 3145 *Technical Specification for Special-purpose Steam Turbines in Petrochemical Industry*

SH/T 3148 *Technical Specification of Sealless Centrifugal Pumps in Petrochemical Industry*

SH/T 3149 *Technical Specification for General-purpose Steam Turbines in Petrochemical Industry*

SH/T 3150 *Engineering Specification for Agitators in Petrochemical Industry*

SH/T 3151 *Technical Specification for Rotary Pumps in Petrochemical Industry*

SH/T 3156 *Engineering Specification of Pumpsshaft Seal Systems of Centrifugal and Rotary Pumps for Petrochemical Industry*

SH/T 3157 *Technical Specification of Rotary-type Compressor for Petrochemical Industry*

SH/T 3162 *Technical Specification of Liquid Ring Vacuum Pumps and Compressors in Petrochemical Industry*

SH/T 3170 *Technical Specification of Centrifugal Fans in Petrochemical Engineering*

SH/T 3171 *Technical Specification for Flexible Couplings in Petrochemical Engineering*

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SH/T 3406 *Steel Pipe Flanges for Petrochemical Industry*

HG/T 20592 *Steel Pipe Flanges (PN designated)*

HG/T 20615 *Steel Pipe Flanges (Class designated)*

HG/T 20623 *Large Diameter Steel Pipe Flanges (Class designated)*

JB/T 447 *Pusher Centrifuge*

JB/T 502 *Solid-bowl Scroll Discharge Centrifuge*

JB/T 6533 *Rotary Vane Vacuum Pump*

JB/T 7220 *Peeler Centrifuge*

JB/T 7674 *Roots Vacuum Pump*

JB/T 7675 *Reciprocating Vacuum Pump*

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