

Engineering Standard

SAES-K-403

31 July 2005

Reciprocating Compressors

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Saudi Aramco DeskTop Standards

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1 Scope

This Standard covers the minimum mandatory requirements governing the design and installation of reciprocating compressors. This Standard may not be attached to or made a part of Purchase Orders. This Standard is **not applicable** to compressors handling breathing air.

2 Conflicts and Deviations

- 2.1 Any conflicts between this Standard and other applicable Saudi Aramco Engineering Standards (SAESs), Materials System Specifications (SAMSSs), Standard Drawings (SASDs) or industry standards, codes and forms shall be resolved in writing by the Company or Buyer Representative through the Manager, Consulting Services Department, Saudi Aramco, Dhahran.
- 2.2 Direct all requests to deviate from this Standard in writing to the Company or Buyer Representative, who shall follow internal company procedure [SAEP-302](#) and forward such requests to the Manager, Consulting Services Department, Saudi Aramco, Dhahran.

3 References

Material or equipment supplied to this Specification shall also comply with applicable sections of the latest edition of the references listed below or in the body of this document.

3.1 Saudi Aramco Standards

Saudi Aramco Engineering Procedure

[SAEP-302](#)

*Instructions for Obtaining a Waiver of a
Mandatory Saudi Aramco Engineering
Requirement*

Saudi Aramco Engineering Standards

[SAES-B-058](#)

*Emergency Isolation, Shutdown and De-
Pressurizing*

[SAES-J-901](#)

Instrument Air Supply Systems

[SAES-L-350](#)

Construction of Plant Piping

Saudi Aramco Materials System Specifications

[01-SAMSS-017](#)

Auxiliary Piping for Mechanical Equipment

[31-SAMSS-002](#)

Packaged Reciprocating Plant and Instrument Air Compressors

[31-SAMSS-003](#)

Reciprocating Compressors for Process Air or Gas Service

3.2 Industry Codes and Standards

American Petroleum Institute

API STD 618

Reciprocating Compressors for Petroleum, Chemical and Gas Industry Services

4 Design

4.1 General

4.1.1 Reciprocating compressors for plant or instrument air service having capacities of less than 140 SCFM may be manufacturer's standard units. However, the Vendor shall provide a list of previous installations of proposed compressors, including User's location and contact names, to demonstrate experience and enable verification of satisfactory field operation.

In addition, piston speeds of air-cooled compressors shall not exceed 3 m/sec (590 ft/min). Splash lubrication may be used for compressors which are not in instrument air service and have a capacity less than 140 SCFM.

4.1.2 Reciprocating compressors for plant or instrument air service with capacity equal to or exceeding 140 SCFM shall be in accordance with [31-SAMSS-002](#).

4.1.3 Reciprocating compressors for process air or gas service shall be in accordance with [31-SAMSS-003](#).

4.1.4 For compressors which are expected to be of the multistage type requiring interstage cooling and when the interstage pressures do not directly affect the process, only the first stage suction gas conditions and the final discharge pressure required shall be specified. The compressor Vendor will provide the interstage pressure, temperature and gas composition for the remaining stages.

4.1.5 Plant or Instrument air compressors shall be protected (e.g., with sunshades) from additional heat load due to solar radiation.

4.2 Compressor Cylinders

4.2.1 Direct seawater cooling of the compressor is not acceptable.

The Data Sheet section covering utilities must be completed with sufficient data to enable Vendors to determine whether API STD 618 cooling plan C or D is required. The information provided must indicate if the plant design includes a treated, tempered water system for cooling purposes. Information regarding pressures, temperatures and available quantities must also be provided.

4.2.2 The coolant inlet temperature shall exceed the gas inlet temperature by a minimum of 6°C at all times. The same coolant shall also be used for the pressure packing, if required.

4.2.3 Provision for cylinder pressure measurement is required on compressors specified to [31-SAMSS-003](#).

4.3 Cylinder and Packing Lubrication

For process gas compressors with lubricated cylinders, the lubricant used shall be specified or accepted by the process licensor. The oil type and brand name shall be stated in the Data Sheets.

5 Accessories

5.1 Control and Instrumentation

Controls and instrumentation shall be adequate to control and protect the compressor and process at all specified operating conditions. The control method shall be specified by the process engineers on the basis of process requirements, expected variations and any special startup considerations.

5.1.1 For compressors furnished to [31-SAMSS-002](#), the following applies:

- a) The unload set-point shall be at plant design air pressure;
 - b) The load set-point shall be 138 kPa gauge (20 psig) above the plant low air pressure ESD shutdown;
 - c) The control system shall start the standby compressor on "low low" air pressure when the air receiver pressure drops to 69 kPa gauge (10 psig) above the plant low air pressure ESD shutdown.
 - d) Two-step loading control (0% or 100% capacity output) shall be used for plant and instrument air compressors, except where demand is intermittent, in which case start/stop may be considered.
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- 5.1.2 For compressors furnished to [31-SAMSS-003](#), the following applies:
- a) Capacity control shall be accomplished by the use of suction valve unloaders and/or clearance volume pockets. The process licensor and Saudi Aramco shall specify the capacity control requirements and if unloaders shall load or unload the compressor upon failure of unloader control signal/pressure.
 - b) Recycling, as a means of control, shall be avoided. However, when recycle is required by the process, the recycled gas should be cooled before arriving back to the compressor suction.
 - c) Variable compressor speed control may be used for up to 30% variations in capacity and may be combined with unloading control to accommodate larger capacity variations.

6 Installation

- 6.1 Air compressors shall be located in non-classified areas whenever possible. Special arrangements such as elevated inlets must be investigated when compressors are located within classified areas. Long intake ducting to the compressor intake is not recommended as it can cause overheating, loss of capacity and vibration.
 - 6.2 Process piping shall be in accordance with [SAES-L-350](#), and auxiliary piping shall be in accordance with [01-SAMSS-017](#). Any auxiliary pipe welded to process piping between the suction and discharge header block valves shall be gusseted to the main pipe in two planes, 90° apart. On pulsation dampener vessels, flanged connections NPS 1 and smaller may use long weld neck nozzles in lieu of gussetting.
 - 6.3 All reciprocating compressor cylinders operating at or within 5°C of the saturated gas conditions at the compressor cylinder suction pressure shall take suction from a suction knock out drum. The knock out drum design shall include an all stainless steel demister pad designed to limit liquid droplets at the outlet to 10 microns. The knock out drum design shall also include automatic liquid drains, with bypass, and separate high and high-high level sensing instruments for alarm and shutdown. The liquid drains shall incorporate stainless steel internals.
 - 6.4 For process gas compressors, emergency shutdown and isolation systems shall be provided in accordance with [SAES-B-058](#). If power operated emergency isolation block valves are required, they shall be interlocked with the compressor shutdown logic such that they close only after the compressor has safely shut down.
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- 6.5 Suction piping downstream of the suction drums and pulsation suppression devices of compressors operating at or within 5°C of the gas saturation temperature shall be heat traced and insulated to ensure that condensation of liquids does not occur.
 - 6.6 All piping, piping components and pulsation suppression equipment between the compressor cylinder suction flange up to and including the cylinder suction block valve shall be rated for the compressor discharge pressure.
 - 6.7 If plant nitrogen is available, process gas compressors shall be provided with a permanently connected nitrogen supply to each cylinder suction and discharge lines at a location adjacent to and on the cylinder side of the cylinder isolation valves. The nitrogen supply piping shall be furnished with a check valve located between the supply line block valve and the connection to the process line. If plant nitrogen is not available, then nitrogen purge connections should be installed so that nitrogen bottles can be connected for purging purposes.
 - 6.8 All process gas compressors shall be provided with vent piping on the suction and discharge sides between pulsation suppression devices and cylinder connections unless a self venting design is provided. These vents shall be permanently connected to the flare header and shall include a check valve.
 - 6.9 A permanent spool-mounted stainless steel conical strainer 920 micron (20 mesh) of adequate strength shall be installed in all compressor cylinder inlet lines. A differential pressure gauge shall be installed to measure the differential pressure across the strainer.
 - 6.10 Where multiple compressors take suction from a common piping header, the piping shall be designed to equalize the pressure loss to the suction of each compressor cylinder.
 - 6.11 A single internally damped non-slam piston type check valve, specifically designed for pulsating flow, shall be installed in the common discharge header downstream of all compressors.
 - 6.12 A spectacle blind shall be installed in each compressor cylinder suction and discharge line at a location adjacent to and on the cylinder side of the cylinder isolation valves.
 - 6.13 Each cylinder suction block valve shall be furnished with a ¼ inch bypass line complete with a globe valve and spectacle blind to allow the compressor to be pressurized slowly.
 - 6.14 For hydrogen service (molecular weight less than 12), all block valves shall be of the double block arrangement.
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- 6.15 For compressors in hydrogen service (molecular weight less than 12), the suction and discharge piping serving each cylinder shall use double block and bleed arrangements. The valves adjacent to the header shall be of manufacture approved by the process licensor, specifically designed for sealing hydrogen (e.g., "Orbit" valves). "Orbit" or equivalent valves shall be specified for any service handling iron sulfide and iron chloride particulates. The other valve of the double block arrangement shall be a conventional gate valve. A piping spool shall be used between these valves and shall be permanently piped to the flare header using a double block valve.
- 6.16 All suction piping between each compressor cylinder pulsation suppression device and the first upstream vessel shall be chemically cleaned and neutralized, or cleaned by high pressure hydrojetting. Cleaning procedures shall be conducted after hydrotesting is complete.
- 6.17 All vent lines to flare shall include a check valve to prevent the possibility of reverse flow from the flare header.
- 6.18 All auxiliary piping and equipment shall be located to permit adequate maintenance access on both sides of the compressor.
- 6.19 All reciprocating compressors not furnished with a baseplate and all compressors supplied to [31-SAMSS-003](#) shall be grouted using epoxy grout. Baseplates, rails, soleplates and compressor frame surfaces which will be epoxy grouted shall first be prepared according to the epoxy grout manufacturer's instructions.
- 6.20 For compressors above 500 hp, the installation shall include an overhead rail mounted crane with two axis directional control, capable of lifting either the heaviest component for maintenance, the largest cylinder or the motor's rotor (only if a single bearing synchronous motor driver is used), whichever is heaviest. The crane shall overrun an adequately sized vehicle loading area. For a compressor size of 1000 hp and greater, a motorized crane shall be installed.

7 Inspection and Tests

- 7.1 For process air and gas compressors, hydrostatic tests, mechanical running test, crankshaft web deflection and bar over tests shall be witnessed, as a minimum, in accordance with [31-SAMSS-003](#).
 - 7.2 For compressors supplied in accordance with [31-SAMSS-002](#), a performance test shall be required for any air compressor model not previously supplied to Saudi Aramco. Unless there is evidence of a malfunction during the test, dismantling after testing should not be requested.
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31 July 2005 **Revision Summary**
Major revision.