

Engineering Standard

SAES-J-901

30 June, 2003

Instrument Air Supply Systems

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1 Scope

This Standard defines the minimum mandatory requirements governing the design and installation of instrument air supply systems.

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, Process & Control Systems Department of 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, Process & Control Systems Department of Saudi Aramco, Dhahran.

3 References

The selection of material and equipment, and the design, construction, maintenance, and repair of equipment and facilities covered by this standard shall comply with the latest edition of the references listed below, unless otherwise noted.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedure

[SAEP-302](#)

Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirements

Saudi Aramco Engineering Standards

[SAES-A-112](#)

Environmental and Seismic Design Criteria

[SAES-D-001](#)

Design Criteria of Pressure Vessels

[SAES-H-002](#)

Internal and External Coatings for Steel Pipelines and Piping

[SAES-H-100](#)

Painting Requirements for Industrial Facilities

[SAES-H-101](#)

Approved Protective Coating Systems

[SAES-J-003](#)

Instrumentation – Basic Design Criteria

[SAES-J-600](#)

Safety Relief Systems

[SAES-J-601](#)

Emergency Shutdown Systems

SAES-L-032

Material Selection of Piping Systems

SAES-L-056

Pressure Testing of Plant Piping and Pipelines

Saudi Aramco Materials System Specifications

[31-SAMSS-002](#)

*Packaged Reciprocating Plant and Instrument Air
Compressors*

[31-SAMSS-006](#)

*Packaged Integrally Geared Centrifugal Air
Compressors*

[34-SAMSS-821](#)

Instrument Control Cabinets – Outdoor

[34-SAMSS-831](#)

Instrumentation for Packaged Units

3.2 Industry Codes and Standards

Process Industry Practices (Reference only)

[PCCIA001](#)

Instrument Air Systems Criteria

4 Design

4.1 General

- 4.1.1 Instrument air supply systems shall provide dry, oil-free air to pneumatic instrumentation, valve actuators, and other services requiring instrument-quality air.
 - 4.1.2 No cross-connections between plant or utility air services shall be made to the instrument air distribution system downstream of the air dryer inlet filters. A valve at the tie-in from the instrument air compressor(s) discharge to the utility air distribution system shall automatically close to isolate the two systems upon low instrument air system pressure.
 - 4.1.3 The following pressure criteria shall be used to design the instrument air system.
 - a. Relief valve setting: Equipment MAWP
 - b. High pressure alarm: Between 125 psig and MAWP
 - c. Maximum normal operating pressure: 125 psig
 - d. Minimum normal operating pressure: 80 psig
 - e. Start standby compressor(s): 70 psig*
 - f. Activate emergency shutdown: 60 psig
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* *Typical. Actual value to be determined based on system design and capacity.*

4.1.4 All equipment of the air system shall be capable of being isolated by block valves.

4.2 Environmental Conditions

Unless otherwise specified, equipment will be installed outdoors in a desert area, with required relative humidity and temperature ratings as specified in [SAES-J-003](#). Other criteria stated in [SAES-J-003](#) shall also apply. Site specific meteorological and seismic data as specified in [SAES-A-112](#) shall be used for equipment design.

4.3 Instrument Air Compressors

4.3.1 Compressors shall not use oil in any parts exposed to the compressed air (oil-free).

4.3.2 Centrifugal compressors are preferred for capacities above 17 standard cubic meters per minute (600 scfm).

4.3.3 New air compressor systems shall be designed to provide 100% backup capacity via one or more standby compressor(s). Two compressors, one main and the other standby, sized to individually provide 100% capacity are preferred. Compressors shall have both automatic and manual start capabilities. A manual switch shall be provided to permit selection of either of the compressors as the duty compressor.

4.3.4 When an existing instrument air system is being expanded, backup compression equal to the capacity of the largest primary system compressor shall be provided.

4.3.5 A check valve shall be provided between each compressor discharge and the first block valve.

4.3.6 Centrifugal Compressors

4.3.6.1 Centrifugal compressors, when specified, shall be supplied in accordance with [31-SAMSS-006](#).

4.3.6.2 Compressor controls and instrumentation shall be in accordance with [31-SAMSS-006](#), Paragraph 3.4.

4.3.6.3 Centrifugal compressors shall be controlled to maintain constant discharge pressure. Multiple compressors operating in parallel shall be controlled to balance the load between them.

4.3.7 Reciprocating Compressors

- 4.3.7.1 Reciprocating compressors, when specified, shall be supplied in accordance with [31-SAMSS-002](#).
- 4.3.7.2 Reciprocating compressors shall operate continuously. Gap action control, using an unloader system which senses the pressure in the receiver, shall load or unload the compressor as required.
- 4.3.7.3 Compressor controls and instrumentation shall be in accordance with [31-SAMSS-002](#), Paragraph 4.6.

4.3.8 The intake air filter(s) shall be located away from sources of dirt, moisture, and toxic, corrosive or flammable gases. The air intake filter(s) shall be installed at a height to avoid ground level dust and debris.

4.4 Instrument Air Receiver

- 4.4.1 An instrument air receiver shall be provided to damp out system fluctuations and to provide surge capacity in the event of duty compressor shutdown. The receiver should be sized to provide adequate time to permit startup of the standby compressor(s), as well as sufficient capacity to allow a safe shutdown. Typical residence time is 1.5 minutes of the rated compressor capacity.
- 4.4.2 The air receiver shall be provided with an automatic and a manual drain for liquid removal.
- 4.4.3 The air receiver shall be designed and built in accordance with [SAES-D-001](#), and be provided with a pressure gauge and safety relief valve.
- 4.4.4 The air receiver shall be internally prepared and coated in accordance with [SAES-H-100](#) and [SAES-H-101](#), APCS-2A.

4.5 Instrument Air Dryer

- 4.5.1 An instrument air dryer shall be supplied to deliver air at a maximum dew point of -15°C at system pressure, unless the process requires a lower dew point. In addition, the following inlet conditions shall be clearly stated to vendors for correct sizing of desiccant chambers: maximum temperature, maximum flowrate, maximum moisture saturation, and minimum and maximum pressures.

- 4.5.2 A regenerative desiccant dryer shall be used. Refrigeration dryers are not permitted.
 - 4.5.3 The air dryer shall utilize two desiccant chambers, allowing one chamber to regenerate while the other chamber is in service. Regeneration shall consume less than 20% of the total air capacity. This consumption shall be included in the system air requirements.
 - 4.5.4 An inline continuous moisture indicator shall be provided in the dryer discharge.
 - 4.5.5 The desiccant shall be a type that does not disintegrate upon contact with water. Activated Alumina, SAMS stock number 26-126-418 or 26-126-465, is preferred.
 - 4.6 Instrument Air Filters
 - 4.6.1 A coalescing prefilter shall be provided upstream of the air dryer. The filter shall be capable of removing entrained droplets of oil or water, and dust or other foreign matter. Filters are to be fitted with automatic drains.
 - 4.6.2 A 3-micron afterfilter shall be installed downstream of all desiccant dryers to prevent desiccant fines from entering the downstream system.
 - 4.6.3 The pressure drop caused by the drying and filtering equipment when it is clean shall not exceed 35 kPa (5 psi) at the maximum design flowrate.
 - 4.7 Instrumentation and Controls
 - 4.7.1 Compressor Controls

Instrument air compressors shall be furnished with the manufacturer's standard control system.

 - 4.7.1.1 Centrifugal compressor control requirements are detailed in [31-SAMSS-006](#), Paragraph 3.4.
 - 4.7.1.2 Reciprocating compressor control requirements are detailed in [31-SAMSS-002](#), paragraph 4.6, with the following addition. A microprocessor-based control system may be used provided that details of the design and operation are submitted to the Company or Buyer Representative for the review and approval of the General Supervisor, Process Instrumentation Division, P&CSD. If the microprocessor is to be mounted outdoors, it must be capable of withstanding the environmental conditions
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detailed in Paragraph 4.2 of this Standard. The control system must, as a minimum, be capable of interfacing with a DCS system for data monitoring and retrieval or as specified in the Purchase Order.

4.7.2 Standby Compressor Controls

4.7.2.1 The standby compressor shall start upon any one or more of the following events:

- a) Failure of the duty compressor
- b) Low pressure in the air receiver. A pressure transmitter is the preferred field instrument. The setpoint shall be in accordance with Paragraph 4.1.3.5
- c) Operation of any one of the manual start switch(es)

4.7.2.2 Starting upon events "a" and "b" shall be automatic. Starting of the stand-by compressor shall not automatically stop the duty compressor(s).

4.7.3 Air Dryer Controls

4.7.3.1 Dryer controls shall be manufacturer's standard design, with preference given to programmable controller (PLC) systems.

4.7.3.2 The local control panel and all components contained therein shall meet the requirements of [34-SAMSS-821](#), unless the air dryer is supplied as a package unit for which [34-SAMSS-831](#) will apply.

4.7.3.3 Solenoid valves used for controlling dryer regeneration and duty cycles shall be capable of operating with air containing desiccant fines without sticking or clogging.

4.7.4 Instrument Air System Alarms

4.7.4.1 The following alarms shall be provided. For attended plants these alarms shall be in the appropriate control room. For unattended plants they shall be local with a high-visibility indication (flag).

- a) High pressure in the instrument air receiver.
 - b) High liquid level in the instrument air receiver.
 - c) Shutdown of any operating (duty) compressor for any reason.
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- d) Starting of the stand-by compressor for any reason.
- e) Change in selection of the stand-by compressor (change-over).
- f) Low air header pressure alarm.

4.7.4.2 Other alarms may be provided as engineering judgement dictates for various situations.

4.7.5 Plant Shutdown

4.7.5.1 A low-low instrument air pressure signal shall be provided to the plant emergency shutdown (ESD) system to initiate a shutdown at 60 psig, decreasing.

4.7.5.2 The pressure transmitter or switch(es) generating the low-low instrument air pressure signal shall be installed per the requirements of [SAES-J-601](#), downstream of all drying and filtering facilities.

4.7.6 Safety Relief Valves

4.7.6.1 Safety relief valves shall comply with [SAES-J-600](#).

4.7.6.2 All safety relief valves for instrument air service shall be equipped with a lifting device.

4.7.6.3 Safety relief valves shall be installed on the air receiver and air dryer, and on any other equipment requiring overpressure protection.

4.8 Instrument Air Distribution System

4.8.1 General Requirements

4.8.1.1 Piping material shall be selected in accordance with SAES-L-032. The selection of alternative piping material requires the approval of the Coordinator, Mechanical and Civil Engineering Division/CSD.

4.8.1.2 All main and branch headers shall be sloped {minimum 64 mm per 30 m (2.5 inches per 100 feet)} and provided with low point drains.

4.8.1.3 All headers shall terminate with a line-size valve, blind, or plug to facilitate cleaning and plant expansions.

- 4.8.1.4 Each branch header shall connect to the top of the main header through a branch-line-size, full-bore isolation valve.
- 4.8.1.5 Where there is a general distribution system for more than one plant, the piping shall be connected in a loop to provide two directions of supply to each plant. Isolation valves shall be provided to enable isolation of each plant.
- 4.8.1.6 Supply takeoffs to individual instruments (a line serving up to a maximum of four devices) shall connect to the top of the branch header through a takeoff-line-size, full-bore isolation valve.
 - 4.8.1.6.1 The minimum size of supply takeoffs is ½-inch.
 - 4.8.1.6.2 Twenty percent (20%) spare takeoff fittings and block valves shall be installed on the branch header.
- 4.8.1.7 Instrument air piping shall not be pocketed (i.e., shall not contain, U-sections). Instrument air piping shall not be installed underground.

Exception:

Instrument air branch connections may be buried to cross beneath roadways or fences where there is no existing overhead rack and where the aboveground support would interfere with crane or emergency vehicle movement. Prior approval from the General Supervisor, Process Instrumentation Division, P&CSD is required. Buried branch lines shall have low point drains, stainless steel construction and external coating per [SAES-H-002](#).

4.8.2 Header and Takeoff Sizing

- 4.8.2.1 The pressure drop for piping between the dryer afterfilter outlet and the most remotely located user shall not exceed 35 kPa (5 psi) under maximum service flowrate.
- 4.8.2.2 For installations in which the instrument air consumers are located more than 600 m (2000 ft) from the instrument air compressor; pipe sizes should be calculated to keep pressure drops within the above limit. Below 600 m (2000 ft) instrument air header pipe size should be selected from Table 2.

Table 2

Number of Users	Pipe Size
1 - 4	½ inch
5 - 9	¾ inch
10 - 15	1 inch
16 - 80	1½ inch
81 - 150	2 inch
151 - 300	3 inch

4.9 Instrument Air System Capacity

4.9.1 Steady State Consumption

4.9.1.1 The capacity of the instrument air supply system shall be based on the total requirements of all connected loads, assuming all instruments are in steady state operation.

Comment:

Saudi Aramco facilities typically take plant and utility air from the instrument air system upstream of the dryers. This intermittent demand is not considered when calculating steady state operation.

4.9.1.2 Consumption figures for each instrument should be obtained from the manufacturer's literature. When this is not available, default values from the Table 3 shall be used.

Default Air Consumption Values for Various Instruments

Table 3 - Air-Consumption Per Instrument

	m ³ /hour (std)	SCFM
Control Panel Mounted Instruments (including pneumatic relays, etc.)	0.85	0.50
Field Mounted Instruments	0.85	0.50
Control Valve with Diaphragm Actuator and Positioner	1.275	0.75
Control Valve with Piston Actuator and Positioner	8.50	5.00

4.9.1.3 For capacity requirement purposes it shall be assumed that air-operated valves (AOVs) will operate once every eight hours and that when emergency shutdown valves (ZVs) operate, the instrument air system will be capable of returning the ZV

storage tanks from 0 kPa (ga) to 700 kPa (ga) (100 psig) within one hour maximum. Shorter times may be specified when operating conditions so require.

4.9.1.4 In systems in which AOVs are designed to operate on a defined schedule (e.g., process dryer switching, or water deionization unit switching) their actual consumption shall be determined.

4.9.1.5 Purge consumption rates shall be the maximum flow of the purge rotameter.

4.9.2 Additional Capacity

4.9.2.1 To compensate for system leaks and allow for plant expansion, 20% of the steady state consumption shall be added.

4.9.2.2 To account for air dryer regeneration usage, 20% of the sum of steady state consumption plus the additional capacity of Paragraph 4.9.2.1 shall be added.

4.9.2.3 For reciprocating instrument air compressors, 20% of the sum of steady state consumption plus additional capacities calculated in Paragraphs 4.9.2.1 and 4.9.2.2, shall be added to compensate for wear and loss of efficiency.

Note:

Centrifugal compressors do not require wear and efficiency compensation.

4.9.3 Total Instrument Air Compressor System Capacity

The sums of the capacities in Paragraphs 4.9.1 and 4.9.2 are as follows.

Centrifugal compressors: 1.44 times instrument air steady state consumption

Reciprocating compressors: 1.73 times instrument air steady state consumption

5 Testing

Pressure testing of supply system and distribution system per SAES-L-056, using dry instrument air or inert gas is required. Hydrostatic testing of instrument air piping is not permitted.

Revision Summary

30 June, 2003

Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with minor changes.