

Engineering Standard

SAES-J-003

31 May, 2004

Instrumentation – Basic Design Criteria

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Table of Contents

1	Scope.....	2
2	Conflicts and Deviations.....	2
3	References.....	2
4	General.....	2
5	Measurement Units.....	3
6	Gas as an Instrument Supply.....	5
7	Signal Ranges and Communications Protocols.....	5
8	Environmental Conditions.....	5

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Revised paragraphs are indicated in the right margin

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Page 1 of 6

1 Scope

This Engineering Standard covers the basic requirements for the selection, design, and application of process instrumentation and control systems.

This entire standard may be attached to and made a part of purchase orders.

2 Conflicts and Deviations

2.1 Any conflicts between this standard and other Saudi Aramco Engineering Standards (SAESs), Saudi Aramco Materials System Specifications (SAMSSs), Industry Standards, codes, forms, and Saudi Aramco Standard Drawings (SASDs) shall be resolved by the Manager, Process & Control Systems Department of Saudi Aramco, Dhahran.

2.2 Direct all requests to deviate from this specification 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 below, unless otherwise noted.

Saudi Aramco Engineering Procedures

[SAEP-103](#)

Metric Units of Weights and Measures

[SAEP-302](#)

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

Saudi Aramco Engineering Standards

[SAES-A-105](#)

Noise Control

[SAES-A-112](#)

Meteorological and Seismic Design Data

[SAES-J-700](#)

Control Valves

[SAES-J-904](#)

FOUNDATION™ Fieldbus (FF) Systems

4 General

All continuous measurement electronic field instruments, and control valve positioners, shall be smart.

The design requirements for each type of instrument are covered by the individual standards and specifications.

The design and selection of process control and instrumentation systems should include consideration of the following:

- Application suitability
- Reliability
- Quality
- Accuracy
- Repeatability
- Life cycle cost
- Previous acceptance as a stock item (i.e., savings on spares)
- Availability of spares beyond the end of the production run of the respective item
- Compatibility with existing equipment (i.e., a Plant Expansion)
- Flexibility of use
- Compatibility with the environment (climatic and electrical classification)
- Ease of maintenance (reduction of down-time)
- Ease of operation (confidence and familiarity of the operator)

Commentary Note:

The priority of the above aspects will depend on the application and equipment under consideration.

5 Measurement Units

All new facilities shall be designed for operation in English units with the following exception. Operating Departments which have historically utilized operating units other than English units shall determine whether these units or English units will be used for new facilities under their jurisdiction. Upgrades or modifications to existing facilities shall retain existing operating units unless otherwise specified in project documentation.

Subject	Fluid	SI Unit	English Unit
Length	N/A	M	ft
Mass	All	Kg	lb
Temperature	All	°C	°F
Flow (Note 2) (Note 3) (Note 3)	Water Oil and in-plant process liquids Steam and steam condensate Gas (except GOSP Gas) GOSP Gas GOSP Crude Production	m ³ /h, m ³ /d m ³ /h, m ³ /d kg/h m ³ /h, m ³ /d m ³ /d m ³ /d	GPM (US), BPD BPH, BPD LB/H SCFM, SCFH, SCFD SCFD BPD
Level	All	mm, cm, m, % of range	in, ft, % of range
Pressure	All	kPa	Psig, psia
Vacuum	All	Pa, kPa	inches of H ₂ O inches of Hg
Pressure, Differential	All	kPa	psi inches of H ₂ O
Vibration	All	Micrometer	mil (0.001 inch)
Concentration	All	mole %, ppm, %w, %v kg/m ³	mole %, ppm, %w, %v PTB (Pounds per thousand barrels)
Viscosity, Kinematic Dynamic	All	m ² /s Pa.s	CST (centistoke) CP (centipoise)
Density	All	g/cm ³ , g/liter, kg/m ³	lb/ft ³

Notes:

- SI Units shall conform to [SAEP-103](#), Metric Units of Weight & Measures.
- Flowrate given in units per day is based on operating day, e.g., BPOD. This is to be differentiated from flow rate per calendar day, e.g., BPCD, which is used for plant design, and takes into account the operating factor (less than unity) of the plant. Thus, BPCD = BPOD * (operating factor).
- Saudi Aramco-defined standard conditions for process flow measurement are as follows:

	SI Unit	English Unit
Pressure	101.325 kPa (abs)	14.73 psia
Temperature	15°C	60°F

Standard conditions for custody metering are as follows:

	SI Unit	English Unit
Pressure	101.325 kPa (abs)	14.696 psia
Temperature	15.00°C	60°F

6 Gas as an Instrument Supply

Sour gas shall not be used in lieu of instrument air. Gas with less than 10 ppm H₂O, 10 ppm CO₂ and 5 ppm H₂S may be used with prior written approval by the Supervisor, Instrumentation Unit, Process Instrumentation Division, Process & Control Systems Department.

7 Signal Ranges and Communications Protocols

Acceptable field transmission signals are 3-15 psi, 4-20 mA, and vendor specific digital protocols (when used between their controllers and their respective field devices). In the context of this standard, field transmission signals are defined as signals from field transmitters, or signals from a control system to field devices. Analog input signals to control systems may include, but are not limited to, the above signal types.

HART communication protocol is acceptable provided that the superimposed digital signal is not used for plant control. FOUNDATION™ Fieldbus based instrumentation and control systems are acceptable pursuant to requirements specified in [SAES-J-904](#).

Use of any other communication protocol requires prior written approval of the General Supervisor, Process Instrumentation Division, Process & Control Systems Department

8 Environmental Conditions

8.1 Temperature

Instruments and control systems shall operate continuously under the following ambient air temperatures without any degradation of the manufacturer's guaranteed performance:

	Indoor Air Conditioned ⁽²⁾	Outdoor Sheltered ⁽¹⁾⁽²⁾⁽³⁾	Outdoor Unsheltered ⁽²⁾⁽³⁾
Maximum	35°C (95°F)	55°C (131°F)	65°C (149°F)
Minimum	10°C (50°F)	0°C (32°F)	0°C (32°F)

Notes:

- 1) "Sheltered" refers to permanent, ventilated enclosures or buildings, or permanently fixed sunshades with a top and three sides.
- 2) For instruments which dissipate internal heat and are installed in custom engineered enclosures (e.g., enclosures not included in the original manufacturer's temperature certification), an additional 15°C shall be added to the above maximum temperatures. An example, for "indoor air conditioned" installation, the equipment must perform at 35 + 15 = 50°C. Similarly, for the "outdoor unsheltered" case, the equipment shall be designed for a maximum operating temperature of 65 + 15 = 80°C.
- 3) For the outdoor installations only, the designer can take credit for forced or passive cooling to eliminate or reduce the 15°C heat rise. For example, if vortex coolers are used, the heat removal capacity of the coolers may be subtracted from the generated heat. No more than 15°C reduction in temperature will be given as credit. The designer shall substantiate his claim by providing the support data and calculations.

8.2 Contaminants

Installations shall be designed for operation in an environment with contaminant levels as defined in the Ambient Air Quality Section of [SAES-A-112](#).

8.3 Humidity

Indoor humidity design basis shall be 20% to 80% relative humidity.

Outdoor design basis shall be 5% to 95% relative humidity (non-condensing).

8.4 Noise

Instruments that generate noise shall be selected so that the effect on the environment is limited in accordance with [SAES-A-105](#).

Control valve installations shall meet the noise requirements specified in [SAES-J-700](#).

8.5 Offshore and Nearshore Environment

Equipment which is not enclosed or hermetically sealed, but is situated offshore or nearshore, shall be protected against corrosion and operational failure due to wind-borne sea water spray and the accumulation of wetted salt (NaCl).

Nearshore is defined as any outdoor, onshore location within one kilometer from the shoreline of the Arabian Gulf; all of the Ras Tanura Refinery and Terminal; and within three kilometers from the shoreline of the Red Sea.

Revision Summary

30 July, 2003	Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with minor/editorial revision.
31 May, 2004	Editorial revision to add 2 nd paragraph in Section 1.