

Engineering Standard

SAES-J-005

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Instrumentation Drawings and Forms

Instrumentation Standards Committee Members

Al-Awami, L.H., Chairman

Tuin, R.R., Vice Chairman

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Grainger, J.F.

Jumah, Y.A.

Mahmood, B.

Qarni, M.A.

Trembley, R.J.

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Primary contact: Ralph A. Hartman on phone 873-2858

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1 Scope

- 1.1 This standard defines the minimum mandatory requirements governing the design of Saudi Aramco instrumentation drawings and forms.
- 1.2 The following drawings and forms are required for representation of instrumentation in Saudi Aramco plant design.
- 1.3 The drawings and forms described in this standard are required for representation of instrumentation in Saudi Aramco plant design. They shall be prepared and submitted according to the requirements set forth in this document, [SAES-A-202](#) and [SAEP-334](#).
- 1.3 Saudi Aramco Engineering Procedure [SAEP-127](#) shall be followed to maintain security and control of Saudi Aramco engineering data. This procedure covers the handling, control, transmission, confidentiality, security, storage, protection against unauthorized disclosure; modification; reproduction and eventual destruction of Saudi Aramco Engineering Data while they are created or modified by (work-in-progress), or while in the custody of Saudi Aramco organizations and personnel.

2 Conflicts and Deviations

- 2.1 All 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 and 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 and 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 Procedures

[SAEP-127](#)

*Security and Control of Saudi Aramco
Engineering Data*

[SAEP-302](#) *Instructions for Obtaining a Waiver of a
Mandatory Saudi Aramco Engineering
Requirement*

[SAEP-318](#) *Pressure Relief Valve Program Authorization for
Installation, Deletion and Changes*

[SAEP-334](#) *Retrieval, Certification and Submittal of Saudi
Aramco Engineering Drawings*

Saudi Aramco Engineering Standards

[SAES-A-202](#) *Saudi Aramco Engineering Drawing Preparation*

[SAES-J-001](#) *Instrumentation Index*

[SAES-J-004](#) *Instrumentation Symbols and Identification*

[SAES-J-903](#) *Intrinsically Safe Systems*

Saudi Aramco Standard Drawings

[AD-036491](#) *In-Line Instrument Symbols for ILDs*

[AB-036492](#) *Local Instrument Symbols for ILDs*

[AB-036493](#) *Panel Instrument Symbols for ILDs*

Saudi Aramco Library Drawing

[DB-950025](#) *Nameplate Details for Instrument Boards*

3.2 Industry Codes and Standards

Instrument Society of America

[ANSI/ISA 5.2](#) *Binary Logic Diagrams for Process Operations*

[ANSI/ISA RP12.2.02](#) *Recommendations for the Preparation, Content,
and Organization of Intrinsic Safety Control
Drawings*

4 Required Plant Design Drawings

4.1 Process Flow Diagram (PFD)

4.1.1 Only one circle symbol shall be used for each control loop, regardless of how many items of equipment eventually are required for the complete control loop. The identification letters shall be selected in accordance with [SAES-J-004](#).

4.1.2 The illustration of instrumentation other than controlling instruments is at the discretion of the Project, Process and Instrument Engineers.

4.2 Piping and Instrument Diagram (P&ID)

All instruments and accessory items as well as interconnecting pneumatic and electrical lines shall be shown in accordance with [SAES-J-004](#).

4.2.1 P&ID Additional Information

Additional information may be required outside of each instrument circle on the P&ID depending upon the type of instrument. Below are listed some common types of instruments followed by examples of the desired information.

- a) Orifices - The orifice flange size in inches and ANSI class rating, (e.g., 8"-600#).
- b) Control Valves - The valve size in inches, ANSI rating Class, air action, and air failure action, (e.g., 3"-300# AO/AFC).
- c) Safety Relief Valves - The inlet and outlet size in inches, orifice letter and set pressure in PSIG, (e.g., 6Q8, set at 100 PSIG).
- d) Gauge Glasses - The visible glass length in inches.
- e) Electric or Pneumatic Switches - Switch point in units of the process variable and actuation with respect to the measured variable, (e.g., 'H' for high, 'LL' for low low).
- f) Recorders or Indicators (Direct Process Connected) - Chart or scale range, except that a 0 to 10 square root scale for flow meters shall not be shown. For receiving instruments no notation is required.
- g) Nonstandard Air Supply - Supply pressure of instrument air other than 20 PSIG, (e.g., for use with shut down systems or similar special requirements).
- h) Other information which will assist in reading and checking the design, calibration and operation of the instrumentation may be added.

4.2.2 An example of such information is units of measurement when pressure measurements are less than atmospheric pressure. Both PSIA, and gauge (vacuum) units, inches of water vacuum, should be given.

4.3 Reference Drawings

The following drawings from index "A" of the drawing control should always be checked by the instrument engineering group responsible for the project.

- a) Process Flow Diagram(s)
- b) Piping and Instrument Diagram(s)

5 Required Instrumentation Documents

Following is a complete list of instrumentation documents which are to be prepared, as required, in the design stage of any plant. This list should be used for the preparation of the "J" section in the drawing control.

Standard forms and drawings shall be used as listed in this standard and [SAES-J-001](#). There shall be no modifications to the standard forms unless it is approved in writing by the Administrator, Engineering Drawings Services Division.

- 5.1 Instrument Installation Schedules. (Section 6.1)
- 5.2 Instrument Specification Sheets. (Section 6.2)
- 5.3 Instrument Calculation Sheets. (Section 6.3)
- 5.4 Orifice Plate Details. (Section 6.4)
- 5.5 Meter Reading Tables. (Section 6.5)
- 5.6 'Relief Valve Schedule' and 'Authorization and Test Report Record'. (Section 6.6)
- 5.7 Layout Drawings. (Section 6.7)
- 5.8 Instrument Interconnection Wiring Diagrams. (Section 6.8)
- 5.9 Panel Instrument Schedule. (Section 6.9)
- 5.10 List of Nameplates for Instruments. (Section 6.10)
- 5.11 Instrument Piping Details. (Section 6.11)
- 5.12 Instrument Mounting Details. (Section 6.12)
- 5.13 Layout of Instrument Points and Lines. (Section 6.13)
- 5.14 Emergency Shutdown System Drawings. (Section 6.14)

- 5.15 Equipment Protection System Drawings. (Section 6.15)
- 5.16 System Block (Architect) Diagram. (Section 6.16).
- 5.17 Special Drawings. (Section 6.17)
- 5.18 Cause and Effect Diagrams. (Section 6.18)
- 5.19 Instrument Loop Diagrams. (Section 6.19)
- 5.20 Instrument Segment Diagrams. (Section 6.20)
- 5.21 Decommissioning Documents. (Section 6.21)
- 5.22 Logic Diagrams. (Section 7)

6 Preparation of Instrumentation Documents

- 6.1 Instrument Installation Schedule (IIS), Forms 2781-ENG, 2799-ENG, and 7076-ENG
 - 6.1.1 These forms are used as the primary instrument index and material control sheet. Each instrument item shall be listed on one of these forms. Within each group, all instruments having the same numerical loop identifier shall be grouped together. Sorting within this subgroup may be done alphanumerically or by physical order in the loop, from primary to final element.
 - 6.1.2 Instruments shall be grouped on separate sheets as follows:
 - a) Pressure (2781A)
 - b) Temperature (2781B)
 - c) Flow (2781C)
 - d) Level (2781D)
 - e) Miscellaneous Instruments (2781E)
 - f) MOV/AOV/HOV/GOV; (7076)
 - g) Relief Valves (2799)

Commentary Note:

Analyzers and Annunciators are part of the miscellaneous instrument category and are to be listed together with other miscellaneous instruments on form 2781E.

6.1.3 Headings for the columns are self explanatory. The following clarification's are provided to assist the user.

- a) Installation Piping Details - This shall be a Library Drawing, showing the hook-up detail of the instrument, with its detail number as applicable. If no Library Drawing is available for this application, then the drawing number of the applicable installation piping drawings should be indicated. One line shall be used for each drawing to be specified.
- b) Installation Mounting Details - This shall be a Library Drawing showing the mounting detail of the instrument, with its detail number as applicable. If no Library Drawing is available for this application, then the drawing number of the applicable mounting drawing should be indicated. For instruments which do not require a special mounting detail, such as thermowells (TW) and pressure relief valves (PZV), reference shall be made to the piping drawing on which they appear.

6.2 Instrument Specification Sheets (ISS)

6.2.1 Each instrument item is to be detailed on a suitable Saudi Aramco specification form. A list of available standard forms is in [SAES-J-001](#). Where possible, the ISSs should be issued with the requisition to minimize duplication of information.

Commentary Note:

Packaged unit instruments shall also be specified on standard forms.

6.2.2 All instrument specifications shall be on standard Saudi Aramco forms. If no form is available for a special instrument application, a new form shall be made. The new form is to follow the same pattern as the standard instrument specification sheets.

6.3 Instrument Calculation Sheets

These forms are designed to be used as work sheets for the calculations of pitot tube meters, orifices, control valves and relief valves. They also serve as a record of the conditions on which the calculation was based. A list of available forms is in [SAES-J-001](#).

Commentary Note:

Calculation sheet(s) generated from workstation or vendor software packages are acceptable in lieu of Saudi Aramco Instrument Calculation Sheet form(s), provided that equivalent process and calculation information is shown.

6.4 Orifice Plate Details

These forms shall be completed for construction purposes. Up to 4 orifice plates may be specified on one single sheet.

- a) Form 3175-ENG - Orifice Plate Detail
- b) Form 3176-ENG - Orifice Plate Detail - Segmental
- c) Form 3176A-ENG - Orifice Plate Detail - Restriction
- d) Form 3177-ENG - Orifice Plate Detail - Quadrant Edge

6.5 Meter Reading Tables (Form 3188-ENG)

6.5.1 This form is designed for the preparation of the flow meter reading tables, which are normally put inside the flow recorder housings.

6.5.2 The number of digits shall be kept to a minimum by selecting a proper multiple of flow units, such as readings in MSCFH.

6.5.3 The following units should be used;

- a) Water - GPM
- b) Oil and all process liquids - BPH or BPD
- c) Steam, steam condensate - LB/H
- d) Gas - SCFM, SCFH or SCFD
- e) GOSP crude production - BPD
- f) GOSP gas production - SCFD

6.5.4 The final meter reading tables shall be reproduced to 50 mm x 100 mm for all miniature instruments.

6.6 Relief Valve Schedule (Form 2799-ENG)

6.6.1 This form is used as the relief valve index and material control sheet. All relief valves shall be listed on this form in numerical sequence.

6.6.2 Headings for the columns are self explanatory. The following clarifications are provided to assist the user.

- a) Installation Drawing - This shall be the process or piping isometric or vessel drawing. These drawings shall indicate the exact location of the relief valve.

- b) Relief Valve Authorization and Test Report Record (Form 3099A-ENG) - This form shall be completed for each relief valve.

6.6.3 For instructions which define the approval and authorization procedures, responsibilities, valve identification, in-kind replacements, and the references used to control and maintain pressure relieving valves, refer to [SAEP-318](#).

6.7 Layout Drawings

6.7.1 Control room layout drawings shall show in plan view the location of consoles, panels, control racks, computer racks and peripherals, logic racks, termination racks and boxes.

6.7.2 Remote building (Process Interface Buildings, Analyzer House, etc.) layout drawings shall show the position of each item of major equipment.

6.7.3 Layout of Control Room Console, Panel, Cabinets, and/or Local Panel - Normally these drawings serve only as a guide for the vendor. Therefore, neither construction details nor exact dimensions are required on these drawings. Only the overall dimensions, location of instrument items, shape, graphic layout and general layout are required, and should be in accordance with the applicable SAMSS's. The detailed layout provided by the vendor shall be approved by Saudi Aramco before fabrication of the console or panel is started.

Commentary Note:

In case the panelboard is to be field fabricated, and the instruments to be field mounted, complete lay-out and construction details are required.

6.7.4 Front of Control Room Console, Panel and/or Local Panel - Besides the basic information as specified in 6.7.3, the layout of the panelboard front should also indicate the cut-out dimensions and mounting details for all instrument items.

6.7.5 Back of Control Room Console, Panel and/or Local Panel - In addition to the basic information as specified in 6.7.3, the layout of the panelboard back shall indicate:

- a) Exact location where signal cabling, data highway cabling, and electrical power wiring enters the console or panelboard. Instrument air supply and pneumatic tubing must also be shown as applicable to each installation.
 - b) Panel illumination.
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- c) Location and designation number of terminal strips or electrical junction boxes.
- d) Main air supply header, if required.
- e) Schematic layout of pneumatic tubing runs, when applicable.

6.7.6 Front and Back of Cabinet/Rack Layout - As a minimum shall show dimensions, equipment location, wiring raceway, cable entries and terminal strips.

6.7.7 The Vendor's final drawings should be used for record purposes. Drawings which are likely to be changed later, as front of console or panelboard, back of console or panelboard and terminal layout drawings, shall comply with Saudi Aramco's drafting requirements for engineering drawings.

6.8 Instrument Interconnection Wiring Diagrams

6.8.1 An instrument interconnection wiring diagram(s) shall be prepared for each of the following enclosures:

- a) Field junction box's and field control panels.
- b) Marshalling cabinets.
- c) All instrument console/panels, cabinet/racks, junction box's, located in Process Interface Buildings (PIBs), substations, control rooms, etc.

6.8.2 The purpose of this drawing is to show the individual wiring between devices (e.g., terminal blocks, indicating lights, switches, I/O modules), and to identify cable numbers, wire tagging, terminal identification, fuse sizes, etc. All spare termination points are to be shown on this drawing.

6.9 Panel Instrument Schedule

This schedule shall be prepared to inform the panel vendor about the types, sources, installation, etc., of the instruments that are shown on the different panel drawings.

6.10 List of Nameplates for Instruments (Form 2504-ENG)

6.10.1 Separate drawings shall be prepared in accordance with Library Drawing DB-950025 to cover nameplates required for instruments as follows:

- a) Control room panel mounted instruments
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- b) Rack mounted instruments
- c) Local panel mounted instruments
- d) Local mounted instruments
- e) Annunciator

6.10.2 Instruments mounted in Control Room Console, Panel, Rack or Local Panel - Panel mounted instruments shall be provided with two nameplates, one on the front and one on the back; rack mounted instruments shall have front mounted nameplates only. The front nameplate shall show service description and tag (mark) number including plant and instrument number. In case of multipoint instruments, this information shall be shown for each point.

6.10.3 Nameplates shall be attached to RTD/thermocouple head chain and show tag (mark) number only.

6.11 Instrument Piping Details

The standard and library drawings indicated in [SAES-J-001](#) should be used whenever possible. Only in those cases where the standard or library drawings do not cover the special requirements of the piping of an instrument is a new instrument piping detail drawing to be made. This drawing shall follow the same pattern as the standard drawings of [SAES-J-001](#).

6.12 Instrument Mounting Details

Same requirements apply as the instrument piping details, reference Section 6.11.

6.13 Layout of Instrument Points and Lines

6.13.1 The purpose of this drawing is to physically locate field mounted instruments, junction boxes and accessory devices with their connection taps. For instruments located more than five foot above grade, the elevation shall be shown next to the instrument bubble.

6.13.2 The drawing is a plot plan with buildings, columns, tanks, and other major equipment shown in outline. In large plants the separation into sections should follow the same pattern as the piping drawings, or if this is not desirable, a logical system which groups identical equipment (e.g., trap area, spheroid area, etc.).

6.13.3 The point and line drawing shall also show the routings for tubing bundles, cables, air supplies, or electrical supplies as appropriate.

6.13.4 Only the location of the RTD or thermocouple shall be shown on the point and line.

6.14 Emergency Shutdown System Drawings

Details of Emergency Shutdown Systems shall consist of the following:

- a) Cause and Effect Diagram/Matrix supporting Emergency Shutdown System Actions: The cause and effect matrix should be arranged such that abnormal process conditions result in either shutdown or isolation of process equipment. (e.g., If HH level in compressor suction K.O. drum, then shutdown compressor driver and close isolation valves)
- b) Logic Diagrams for Emergency Shutdown System: Logic drawings are to be prepared which transform the cause and effect matrix into a diagram from which ESD logic and interactions can be developed. Logic diagram requirements are defined in Section 7.
- c) Narrative explaining Emergency Shutdown Logic shown in Logic Diagrams: A narrative is to be developed which explains the cause and effect actions shown in the logic diagram. This narrative serves as a guideline for embedding comments in logic and ladder diagrams network which are generated from the logic diagram.
- d) Ladder Diagram / Application Program Documentation (Reference Section 7.4).

6.15 Equipment Protection System Drawings

Details of Equipment Protection System shall consist of the following:

- a) Logic Diagrams for Equipment Protection Systems.
- b) Narrative explaining Equipment Protection System Logic shown in Logic Diagrams.
- c) Ladder Diagram / Application Program Documentation (Reference Section 7.4).

6.16 System Block (Architectural Layout) Diagram

This drawing(s) will show in a block diagram format all major control systems components, including routers, switches, gateways, servers, subsystems, etc. The drawing shall identify where all components are physically located, (e.g., Central Control Room, Substation, Utilities Control Building, etc.) The overall cable/wiring connection philosophy shall also be shown. The cable/wiring

details shall specify the media (i.e., fiber, coax, twisted pair, etc.), speed of communication link, protocol, and whether the link is redundant.

Commentary Note:

Block diagrams are typically drawn showing the DCS architecture, including all connected auxiliary systems, (e.g., Emergency Shutdown, Vibration Monitoring, Compressor Control, Printers, etc.). Block diagrams can also be drawn showing the conceptual layout of auxiliary systems or any other system that needs to be clearly defined, (e.g., complex metering systems, combustible and toxic gas monitoring systems, cable routing and junction box layout, etc.).

6.17 Special Drawings

- 6.17.1 To facilitate testing, a separate drawing shall be made for each discrete (non-DCS) annunciator showing annunciator and panel-terminals with reference to the tag (mark) numbers of the actuating devices. Each loop, comprising switch and annunciator shall also be shown on an individual loop diagram.
- 6.17.2 Motor Operated Valves (MOV) which have an associated ILD (reference 6.19.2) shall also have an associated elementary (schematic) diagram. The elementary diagram shall be a separate drawing.
- 6.17.3 The engineering/design contractor is responsible to generate any special drawings (e.g., hook-up of non-standard instruments) which are required to enable the construction contractor to complete a project.
- 6.17.4 When Intrinsic Safety is used to protect instrumentation within Hazardous Areas a "System Control Drawing" shall be generated per [SAES-J-903](#) and ISA-RP12.2.02. The 'system control drawing' shall reference the applicable Instrument Loop Diagram (ILD) or Instrument Segment Diagram (ISD).

Commentary:

A 'system control drawing' is a drawing of an intrinsically safe system in which both the intrinsically safe apparatus and the associated apparatus are identified by manufacturer, model number, and entity parameters (reference [SAES-J-903](#) and ISA-RP12.2.02)

6.18 Cause and Effect (or Conditions Diagram)

- 6.18.1 A Cause and Effect diagram is a chart showing ESD or regulatory control system output reactions in response to abnormal input changes, giving details of process alarms or trip points in response to process parameters or operating conditions.

- 6.18.2 A Cause and Effect conditions diagram will be required for all permitted modes of plant operation. The conditions diagram does not detail all the logic decisions which take place and cannot therefore, replace the logic diagram.

6.19 Instrument Loop Diagrams (ILDs), Form 7460-ENG

- 6.19.1 Instrument loop diagrams shall be prepared for every design package to detail interconnections of control system components and to facilitate testing of each loop during construction and maintenance.

- 6.19.2 Individual drawings shall be made for each single loop.

Exceptions:

ILDs shall not be generated for Foundation Fieldbus (FF) segments, reference section 6.20.

ILDs are generally not required for motor operated valves (MOV). However, ILDs shall be generated for MOV's that are remotely operated from the instrument panel/console or connected to a control or shutdown system.

- 6.19.3 The symbols used for the instruments on the loop diagrams shall be in accordance with symbols shown on standard drawings [AD-036491](#), AB-036492 and AB-036493.
- 6.19.4 On each ILD, all drawings associated with the ILD shall be referenced, (e.g., P&ID, instrument installation schedule, junction boxes, marshalling cabinets, logic diagram, system cabinet, etc.).
- 6.19.5 Complicated loops may be shown on more than one drawing. In such cases one of the drawings shall give an overall presentation of the loop with all missing sections shown in a block diagram format with the function of each block identified along with associated ILD/drawing reference numbers.
- 6.19.6 The loop diagram drawings shall be divided into separate sections, showing field mounted instruments, junction boxes (with terminal number, cable number and pair/triad identification); marshaling cabinet(s), control systems panel/cabinet/rack terminals, and operators console or display panel instruments.
- 6.19.7 Connections of the instrument loop to process equipment shall be shown and the service, line size and number or equipment tag (mark) numbers stated.

- 6.19.8 Where an instrument loop is connected to a separate control system, like a shutdown system or a pump control system, a so-called reference box may be shown on the loop diagram, giving the function of this box, tag (mark) number, incoming and outgoing terminals and reference drawings. If the function or logic contained in this reference box is relatively simple, the logic should be shown in an abbreviated manner.
- 6.19.9 All actual cabinet, rack, chassis, slot, port and terminal designations, I/O addresses, junction box numbers, cable numbers, etc., shall be shown on the drawings.
- 6.19.10 The following information shall be given in a block next to the applicable instruments: Instrument tag (mark) number; process variable range versus calibrated range and elevation or suppression for transmitters; range, process and signal set points on switches; air signal range and air failure action on control valves; bore diameter of orifices; mounting of seismic type vibration switches.
- 6.19.11 The block shall also contain the manufacturers name and model number when this information is not provided on the instrument installation schedule for the device.
- 6.19.12 Control valves shall be shown complete with accessories such as actuators, positioners, boosters, limit switches, solenoid or trip valves, lock up valves, and pressure reducers.
- 6.19.13 All solenoid operated valves, relays, and switches shall be shown in the de-energized state.

The following note shall be added to the drawings:

"Solenoid operated valves, relays, and switches are shown in the de-energized state, with no process input being applied to the switch."

- 6.19.14 When loop diagrams are prepared by a panel vendor or systems engineering house, the drawings shall comply with Saudi Aramco's drafting requirements for engineering drawings.

6.20 Instrument Segment Diagrams (ISD)

The Instrument Segment Diagram (ISD) shall replace the Instrument Loop Diagram (ILD) for all Foundation Fieldbus segments (networks). For details reference section 10.3 in SAES-J-904.

6.21 Decommissioning Documents

For a revamp job, decommissioning documents are required to show the instrumentation to be decommissioned. These documents shall show which instrumentation, cabling, support structure, etc., is to be removed and which is to be abandoned in place.

7 Logic Diagrams

A logic diagram is a Representative drawing in symbolic form of two state plant control systems. The symbols used are abstract representations of the logic functions performed. Logic diagrams shall be prepared for all two state control systems including emergency shutdown system logic, startup or shutdown logic for rotating equipment or for any batch or sequential operating system. Logic diagrams shall meet requirements for symbols, functions and types as described below. The requirements shall also be followed by control equipment vendors when they are responsible for developing control systems logic and documentation as well as providing systems engineering (e.g., logic diagrams, narratives, etc.).

Commentary Notes:

If the Saudi Aramco Project Management Team elects to generate the logic diagrams using a third party software tool in lieu of drafting the logic diagrams in Intergraph Microstation, then this software package shall be approved, in writing, by the Manager, Process and Control Systems Department and the Proponent Organization.

Logic diagrams are typically used to transfer operational information from the Owner to the party responsible for generating the application program.

7.1 Symbols and Functions

7.1.1 The symbols for logic diagrams shall be as shown in ANSI/ISA 5.2 unless otherwise shown in the drawing legend of the drafting document furnished by Saudi Aramco. Vendor's standard logic symbols may be applied when approved by the Manager, Process and Control Systems Department, and when truth tables for these symbols are provided on the drawings which present them.

7.1.2 A open circuit switch or an open circuit connection and all alarm, stop and shutdown signals shall always be considered to be a logical '0' and the following definition shall be added to the 'Notes' section of all drawings: "This drawing assumes all stop, shutdown, and abnormal process conditions to be a logical '0'."

7.1.3 The "positive" logic convention shall be used for all logic diagrams, and the following definition shall be added to the 'Notes' section of all

drawings: "This drawing assumes the positive logic convention, i.e., the higher (more positive) voltage signal level is the logical '1' state."

Example:

During normal process operation, field switches are treated as closed sets of contacts with a corresponding logical '1' state and which change to a logical '0' state when they open in reaction to an abnormal HH or LL process variable. The representation of these signals in positive logic means that a healthy signal input or condition (e.g., closed field contact) results in a positive (voltage or current) input on a corresponding set of input terminals.

- 7.1.4 To avoid undue redundancy the following rule shall be applied: the output of an AND gate shall not feed another AND gate unless it also feeds another type of gate; similarly the output of an OR gate shall not feed another OR gate unless it also feeds another type of gate.

7.2 Logic Diagram Format

7.2.1 A logic diagram shall contain the following information:

- a) The complete control logic using the symbols and function as defined in Section 7.1.
- b) The externally connected actuating devices.
- c) Tag (mark) numbers of all control devices.
- d) Input and output channels and I/O addresses.
- e) All bypass switches and associated logic.
- f) Annunciator logic and connection points.
- g) Event log/histogram logic and connection points.
- h) Time delays and their settings.
- i) Trip set points of input devices; supply pressure and/or voltage to input/output devices.
- j) Failure mode of final field device or control element.
- k) Low and/or high limit test and validation logic for analog inputs which are used as logical elements.

7.2.2 The logic diagram will be prepared by the responsible engineering design office.

7.2.3 Logic diagrams shall show the status of inputs when the plant is in shut down conditions with ambient temperature, atmospheric pressure, no speed, no level, no flow, no vibration, and no electrical, pneumatic or hydraulic power. MOV's and maintained position (spring-less) valves, shall be shown in the design shutdown position. These conventions shall be noted on each drawing.

7.2.4 Signal Lines

7.2.4.1 The normal direction of flow for signal lines shall be from left to right. When a signal output is unavoidably to the right of its next logical input, the two points shall be connected by the cross reference system.

7.2.4.2 When signal lines cross, one line shall break on each side of the other signal line. If required, a signal line may be interrupted using the cross reference system.

7.2.4.3 Signal line junctions shall be tee junction denoted by a dot at the point of intersection.

7.2.4.4 Vertical and horizontal signal lines shall only have an arrow indicating direction of signal flow when required to eliminate signal flow confusion.

7.2.5 Functional Names

A functional name shall be given to each signal line at any signal line interruption, major decision point, entrance, or exit to the control logic. Examples of a functional name are as follow; A1, B1, AA, AZ, etc.

7.2.6 Cross Reference System

Horizontal signal lines which are interrupted shall have the functional name and a coordinate reference at each end of the break and be shown as follows:

- a) If the signal line continues on a different drawing, then the continuation block shall contain the 'functional name', 'cross reference coordinates', and the 'continuation drawing and sheet number'. The continuation block shall include an angle arrow head to indicate signal flow direction.
 - b) If the signal line continues on the same drawing, then the continuation block shall contain the 'functional name', and the 'cross reference coordinates'.
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7.3 Narrative explaining Logic Diagrams

A narrative shall be developed for all logic diagrams. This narrative is a written description of the operation of the logic system. The narrative shall include instrument tag (mark) numbers, process line or vessel identification numbers, and shutdown/alarm/interlock set points.

7.4 Ladder Diagram / Application Program Documentation

7.4.1 Logic system vendors who translate logic diagrams into an application program (i.e., relay ladder logic and/or function block diagram) suitable for programmable controllers, shall ensure that all required logic functionality is satisfied. These application programs shall be generated by the program development workstation software tools, and shall be transmitted to Saudi Aramco in hard (printout) and soft (diskette) format.

7.4.2 Logic system vendors implementing a discrete relay based logic system shall develop ladder diagrams based on the logic diagrams.

Commentary Note:

Ladder diagrams are diagrammatic representations of logic diagrams which have been translated into industrial relay ladder logic (i.e., where logic elements are shown as switches, relay and timer elements and associated contacts).

7.4.3 Ladder diagrams are not required for solid state logic systems.

Revision Summary

29 February, 2004

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