

Engineering Procedure

SAEP-1610

28 February 2005

Preparation of Functional Specification Documents

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1 Scope

1.1 Introduction

This Saudi Aramco Engineering Procedure (SAEP) provides instructions for the development and approval of a Functional Specification Document (FSD).

1.2 Definition

The FSD is a document that clearly and concisely describes the functional requirements and design constraints for a process automation system (PAS) which is proposed to be procured via a Saudi Aramco project.

1.3 Purpose

The FSD formally establishes the functional requirements which form the basis for the PAS portion of the project. The FSD is a logical extension of the Design Basis Scoping Paper (DBSP). The contents of an FSD shall never conflict with the DBSP.

The FSD is part of the basis for the ER estimate which is generated after Project Proposal completion.

The FSD is part of the Invitation for Proposal or Request for Quotation issued to solicit bids for the PAS. It is normally the bidders' only detailed source of information on the site specific requirements of the system.

The FSD, in addition to the applicable SAEPs, SAESs and SAMSSs, forms the basis for testing the PAS to verify that it meets project requirements.

1.4 Timing

Per [SAEP-16](#), the FSD is a deliverable required at the end of the Project Proposal phase.

Since the FSD is used as the basis for factory acceptance testing (FAT), a revised FSD (or a letter documenting changes) may be needed at the time procurement documents are finalized so as to reflect any changes established as a result of evaluation of bids. The revision shall be signed by the same three organizations which signed the original FSD.

1.5 Application

An FSD is required for all projects which fall under [SAEP-16](#). Specifically, this means projects in which:

- a) a process automation system is included and
- b) overall cost of the PAS is at least \$2,000,000

Projects might be divided into two or more sub-projects each of which would require its own FSD. Example: A project that includes a DCS and an ESD

could be separated into two distinct FSDs, one for the DCS and one for the ESD. Each document would follow the procedures contained in this SAEP.

2 Conflicts and Deviations

- 2.1 Any conflicts between this Procedure and other applicable Saudi Aramco Engineering Procedures (SAEPs), Saudi Aramco Engineering Standards (SAESs), Saudi Aramco Materials System Specifications (SAMSSs), Saudi Aramco 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 Procedure 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 Applicable Documents, Acronyms and Definitions

3.1 Applicable Documents

SAEP-16	<i>Project Execution Guide for Process Automation Systems</i>
SAEP-302	<i>Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement</i>
SAES-Z-001	<i>Process Control Systems</i>
23-SAMSS-010	<i>Saudi Aramco Material System Specifications, Distributed Control Systems</i>

3.2 Acronyms

DBSP	- Design Basis Scoping Paper
DCS	- Distributed Control System
ESD	- Emergency Shutdown System
FSD	- Functional Specification Document
ILD	- Instrument Loop Diagram
MIS	- Management Information System
P&CSD	- Process and Control Systems Dept.
P&ID	- Piping and Instrument Diagram
PIB	- Process Interface Building

- SAEP - Saudi Aramco Engineering Procedure
- SAMSS - Saudi Aramco Materials System Specification
- SAPMT - Saudi Aramco Project Management Team

3.3 Definitions

Abnormal Procedure: Operating procedure to be followed when equipment, units or processes are not running normally. These procedures are usually associated with alarm conditions. The key to an effective abnormal procedure is an awareness of the possible process upsets that could occur, and the corrective action required to resolve them.

Auxiliary System: A control and/or monitoring system that is stand-alone, performs a specialized task, and communicates to the main control system for monitoring and operator control. Examples are ESD, Compressor Control, Rotating Machinery protection, process analyzers network.

Control Procedures: Procedure to be followed while operating and controlling equipment, units or processes. Control procedures are typically classified as Normal, Abnormal, ESD, Start-up and Shut-Down.

Context Diagram: A schematic representation of the scope of the system.

ESD Procedure: Operating procedure to be followed in emergency shut down situations. A special case of an abnormal procedure.

Normal Procedure: Operating procedure to be followed during normal operation of equipment, units or processes.

Operating Organization: The department responsible for operating the facility, sometimes called Proponent.

Operator Interface: The set of Man Machine Interface, such as, CRT, keyboard, touch screen, track ball, annunciator panel, etc., used by the operator to operate the process.

Responsible Organizations: Organizations within Saudi Aramco responsible for the approval of an FSD; Operating Organization, P&CSD and SAPMT.

4 Responsibilities

Per [SAEP-16](#), the SAPMT has overall responsibility for the FSD. The Operating Organization identifies requirements which are specific to the project and not already required by the applicable standards. P&CSD assists both SAPMT and the Operating Organization on a consultancy basis. Department Managers of all three organizations approve the final document.

If a contractor is retained to write the FSD, this procedure shall be used and the above organizations shall retain approval rights.

4.1 Saudi Aramco Project Management Team (SAPMT)

Responsibilities include:

- a. Maintain overall responsibility for the FSD.
- b. Initiate formal reviews of the FSD with Operating Organization and with P&CSD.
- c. Review and approve the final FSD document.

4.2 Operating Organization

Responsibilities include:

- a. Assign one or more responsible engineer(s) to supply the detailed information required for the FSD.
- b. Identify the functional requirements to be included in the FSD.
- c. Participate in periodic reviews of the FSD.
- d. Review and approve the final FSD document.

4.3 Process Control Division, Process & Control Systems Department, Engineering Services

Responsibilities include:

- a. Consult with the Operating Organization responsible engineer as requested to define the functions that the Operating Organization requires.
- b. Consult with SAPMT as requested to answer questions as they arise.
- c. Participate in periodic reviews of the FSD.
- d. Review and approve the final FSD document.

4.4 Contractor (if applicable)

When employed by SAPMT to prepare the FSD, contractor shall:

- a. Be responsible to the SAPMT.
- b. Consult with the SAPMT, Operating Organization and P&CSD in the preparation of the FSD.
- c. Use the procedures in this SAEP in the preparation of the FSD.

5 Instructions

5.1 Format and Content

[23-SAMSS-010](#) provides the minimum technical specifications for Saudi Aramco's distributed control systems. Include technical requirements more stringent than those provided in [23-SAMSS-010](#) within the appropriate sections of the FSD. Do not duplicate specifications in [23-SAMSS-010](#).

Appendix 1 provides the guidelines for the format and contents of an FSD. Material shown in double quotation marks ("...") shall be used in the FSD as written. Other descriptions are suggested contents. Material enclosed by square brackets [*____*], is required material and should be added where marked.

The table of contents shall start on the first substantive page of the FSD. It shall include the paragraph and all titled subparagraph numbers and their corresponding page number. Show at least two levels of paragraph headings and page numbers.

- a) Each functional requirement shall be uniquely identified with only one requirement stated per paragraph.
- b) Use the word "shall" when stating a requirement (e.g., The system shall...). The use of the word "shall" places a demand on the vendor and the vendor is **required** to respond to the requirement.
- c) It shall be possible to test each requirement to demonstrate that the system conforms to the requirement. These might be related to deliverables (hardware or software) or performance (control, reliability, accuracy).

Example: "The system shall continuously monitor the status of MOVs and ZVs." The word "shall" places a demand on the supplier to provide the function of continuously monitoring the status, with the system. However, the function might be difficult to test. An additional function might be required, such as: "The status of MOVs and ZVs shall be displayed as a tabular graphic." Both functions can be easily tested by changing the status of individual valves and observing the results on the graphic.

- d) Each requirement shall be clearly and concisely stated. Avoid ambiguous words or statements.
- e) Sufficient information shall be provided to enable a bidder (or estimator) to prepare a realistic bid (or estimate).
- f) Slang, undefined acronyms or expressions difficult to define shall be avoided. The term "totally integrated" for instance, is difficult to define and should be avoided.
- g) Consistent format, writing style and terminology shall be used throughout the FSD.
- h) Flow charts, control loop diagrams and other visual aids shall be used to supplement and/or clarify the text.
- i) Words such as "all", "never", "whenever" or "always" shall be avoided unless they really apply.

5.2 Training, Maintenance and Spare Parts

Training, required by the SAPMT, contractor or P&CSD personnel, is not within the scope of the FSD. The responsible engineers should identify project training requirements, document them and advise the SAPMT. The SAPMT can include the project training in the invitation for proposal (IFP) or the request for quotation (RFQ).

Start-up spares are not within the scope of the FSD.

Class room training of personnel for post project support, on-going maintenance contracts and operational spare parts are not within the scope of a capital expenditure project. These items are provided by Operating Expenses or Maintenance Expenses. They can be specified separately and procured through separate contracts or purchase orders.

5.3 Training/Simulation Equipment

Hardware and software for a permanent training or simulation system shall be included as part of the FSD, if required.

5.4 Miscellaneous

FSDs are organized to match the procurement approach. Multiple FSDs may be required, each targeting the requirements of a single vendor's deliverables.

The following items are not within the scope of the control system, therefore, they should not be in the FSD, however, they should appear in the Project Proposal where applicable:

- a. Control building and Process Interface Building (PIB) sizing
- b. Uninterruptable Power Supply (UPS)
- c. Heating, Ventilating and Air Conditioning (HVAC)
- d. Halon System
- e. Communications equipment for operators; Sound-powered telephones, radios, telephones
- f) Project Training Requirements.

Revision Summary

28 February 2005

Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with no other changes.

Appendix 1 – Functional Specification Document, Example Based on DCS

1. Introduction

1.1 Purpose

Include the following statement in every FSD. "The purpose of this Functional Specification Document is to describe the functional and technical requirements for the [* insert project title *]."

1.2 Plant Overview

This section describes the plant, its location, feed stocks, products, and major process units. Use the description in the DBSP and expand on it as required.

Descriptions should be in sufficient detail to support the scoping of the control function sections. Keep the descriptions brief and be sure to include everything that was in the DBSP.

Include a description of existing measurement and control instrumentation.

Include plot plans and process flow diagrams in the appropriate appendix. Reference the appendix to support descriptions in this section.

Control buildings and PIBs, if they are required, are to be shown on the plot plans. Proposed cable runs must be shown. The plot plan must be to scale to allow the vendor to determine cable lengths. Alternatively, distances between buildings can be stated.

2. Scope

The scope of work for the PAS represents what the vendor and/or contract engineering firm will be required to provide. This includes hardware, firmware, software and engineering.

The scope of the project shall be the same as that defined in the DBSP. However, the level of detail of the scope must be expanded for the FSD. It is important to identify which auxiliary equipment falls within the scope, and therefore, requiring hardware and software configuration and application functions. An example of this is an emergency shutdown system (ESD).

Include the following within the description of the project scope:

- a. All process plants and operational units that require process control or data management functions.
- b. Which facilities are new, to be upgraded, demothballed, etc.

- c. Define the interactions with other systems that are not within the scope of the project. An onshore facility might not be within the scope of an offshore GOSP project. But, the onshore control system might need to know the product flows which affect its operation. This interaction must be defined. Interface to the disaster control center is required.
- d. Communication requirements for external systems such as OSPAS.
- e. New or upgraded control rooms and/or PIBs.
- f. How the existing facility operates. Discuss how the Operations Organization wishes to operate the plant. This will be a determining factor on how many operator workstations are required.

2.1 Context Diagram

The context diagram defines the boundaries of the control system. Include the diagram with the text or add it as an appendix. Figure [1] is an example of a context diagram for a hypothetical DCS project involving two plants. Entities represented by the circles and the interconnecting lines lie within the scope of the project. Those represented by rectangles lie outside the scope of the project.

In the example shown the DCS for both Plant #1 and Plant #2 are within the scope of the project. Also, the ESD for Plant #1 is within the DCS but the ESD for Plant #2 is not. The Operating Organization will use the existing ESD system in Plant #2. Only the interface between the existing ESD system for Plant #2 and the DCS is within the scope of the project. The process equipment, referred to in the diagram as the Plant Physical Facilities, is not within the scope, but the interfaces between the pieces of process equipment and their respective DCSs are.

The 'Operator' rectangles represent the plant operators who are themselves outside the scope of the control system. The hardware and software required by the man machine interface are, however, within the scope. The compressor controls for Plant #1 and the ESD systems for Plant #2 are outside the scope of the project. This means that the hardware and application packages for these auxiliary systems either already exist or are to be provided by others.

2.2 Control Rooms

Provide a layout drawing in Appendix F. Describe the layout as required. Cover the following:

- a. Physical Layout of the rooms in which equipment will be installed, including dimensions and any constraints on equipment positioning;
 - b. Electrical power availability;
-

- c. Constraints on utilization of the facility.

2.3 Process Interface Buildings

Provide a PIB layout drawing in Appendix G and describe the layout as required. If existing control rooms are to be used, then include that information in this section. Cover the following:

- a. Physical Layout, including dimensions; (See notes in 2.2.a above).
- b. Electrical power availability;
- c. Constraints on utilization of the facility.

3. Definitions

Place the following statement in the FSD:

- a) 'Shall' is used in an imperative sense;
- b) 'May' is used in a permissive sense to state authority or permission to do the act prescribed or provide the function being defined in the prescribed manner, and the words 'no person may...' or 'a person may not...' mean that no person is required, authorized, or permitted to do the act prescribed, and the words 'a ... may not ...' mean that the item being described is not required, authorized, or permitted in the prescribed manner; and
- c) 'Includes' means 'includes but not limited to'."

3.1 Acronyms

Place the following statement in the FSD. "See Appendix A for acronyms used in this document."

3.2 Terms

Place the following statement in the FSD. "See Appendix A for terms used in this document."

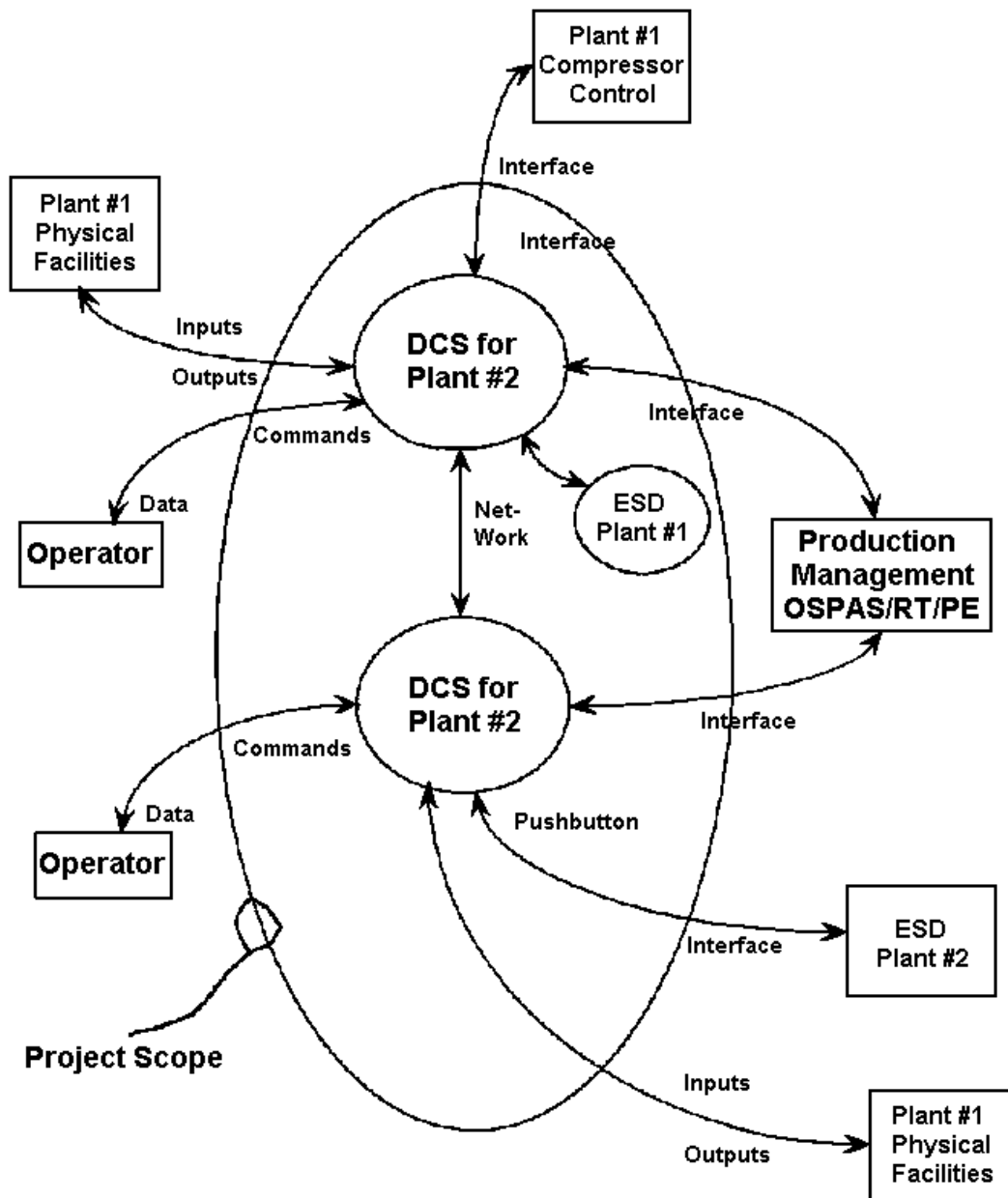


Figure 1 – Context Diagram

4. Applicable Documents

Place the following statement in the FSD. "See Appendix B for a list of applicable documents."

5. Process Control Procedures

The control procedures described in this section are the procedures that will be implemented within the control system to operate and control equipment, units or processes. The control procedures should be logically segregated by physical facilities (equipment dependent) or by functionality. A producing plant might best be subdivided into process units. Transportation processes like oil movement or well production might best be divided by functions, i.e., 'filling', 'transferring', 'testing', 'purging', etc. The responsible engineer, in cooperation with the Operating Organization should determine the best way to describe the process.

Identifying control procedures and getting good definitions is often a difficult and time consuming task. The responsible engineers should provide as much information as is available at the time the FSD is prepared. It must be recognized that incomplete procedures will have to be completed during the design phase of the project and might therefore require project change orders.

In order to reflect the process unit functions, the outline for this section shall be consistent with the organization of the facility as shown in process flow diagrams and P&IDs. Process areas will be major headings and unit operations minor headings. If the subdivision is by functionality the outline should be consistent with the functional requirements defined by the Operating Department.

It is not necessary to define a procedure for each unit or function if there are common units or multiple applications of the same function. It is important to identify the number of units for which the procedure will apply. For example, only one control procedure is required for a gas compressor if there are three identical gas compressors within the scope. The procedure, when implemented, will use the appropriate tags. Or, only one procedure is required for the 'filling' operation in a tank farm even though multiple 'fillings' are possible. Each procedure will be implemented with the proper tags and valve line-ups.

Control procedure information might be found in written procedures or in P&IDs, ILDs, logic diagrams, etc. Add appropriate diagrams to the appendix. Available information is dependent upon the type of project, grassroots vs. addition to existing facilities vs. revamp of existing facilities.

Sub-paragraphs can be used to explain the control procedures required for each process unit within a plant. Process units should be clearly defined in P&IDs. When control procedures are organized by functions, sub-paragraphs can be

used for procedures within functions. For example, when a well test function is 'testing' two procedures can be written: one procedure for the 'stabilizing' function and one for the 'test' function.

The sections to follow represent a suggested division of procedures for a plant unit dependent system.

5.1 Process Unit #1 Control Procedures

Describe the procedure for the control of the process unit, including constraints or limits of control to be implemented in the control system.

An example is, 'It shall be possible during a blending operation to simultaneously add all components to a mixing tank'. This prevents the control system vendor from supplying a system that limits blending by pumping only one component at a time.

5.1.1 Normal Procedures

These are the procedures that the operator would normally follow when operating a unit.

5.1.2 Abnormal Procedures

These procedures describe what must be done when certain alarms are exceeded. Abnormal procedures are usually associated with machinery or unit 'protection systems', first-out, and/or sequence of events recording. Emergency shutdown procedures are a separate class of abnormal procedures and would appear as ESD Procedures.

5.1.3 ESD Procedures

If ESD is within the scope of the project insert the ESD procedures in this section.

5.1.4 Start-up Procedures

Insert start-up procedures in this section.

5.1.5 Shut-Down Procedures

Insert shut-down procedures in this section.

5.2 Process Unit #2 Control Procedures. See Section 5.1.

5.2.1 Normal Procedures

5.2.2 Abnormal Procedures

5.2.3 ESD Procedures

5.2.4 Start-up Procedures

5.2.5 Shut-Down Procedures

6. Auxiliary Systems

Auxiliary systems are stand-alone systems that are integrated into the control system for monitoring and operator control. Auxiliary systems might be included within the scope of the project, or they might lie outside of the scope of the project, i.e., only the interface to the control system is required. If they lie inside the scope of the project the FSD must define the functions to be provided by the auxiliary system as well as the interface between the system and the control system. If they lie outside the scope of the project the FSD, only the interface to the control system needs to be defined.

The functional requirements of an auxiliary system is typically provided in a separate FSD for the auxiliary system vendor. When separate FSDs go to separate vendors, it is vital that the interface between the two is clearly defined in both FSDs, and that primary responsibility for proper operation of the interface is well understood. Part of each interface requirement is the need for synchronization between the main control system and each auxiliary system.

The following is a partial list of auxiliary systems that commonly interface with a control system. Include only those that apply to the current job.

- a) Emergency Shutdown Systems (ESD)
- b) Rotating Equipment Machinery Protection Systems
- c) Compressor control can be performed by auxiliary systems. However, the control system can perform compressor control provided the required response time is not faster than the response time of the control system. This requirement will have to be analyzed on a system by system basis.
- d) Fire Protection Instrumentation System (FPIS)
- e) Weather Stations
- f) Laboratory Systems
- g) Tank Gauging systems
- h) Metering Systems
- i) Process Analyzers (e.g., GCs, moisture, H₂S, color, gravity, etc.)

7. Communications with Other Systems

Provide information on the needs of voice and data (non-voice) communications such as locations and distances.

Examples:

- a. Radio communication; number of frequencies, multiplexing, etc.
 - b. Modem communication; dedicated telephone lines, dial up security modems, etc.
-

c. OSPAS computer to computer communication.

8. Reports/Historical Data Collection/Trends

This section describes information requirements in detail. Daily logs, Operator action logs, Crude Flow Reports, etc.

8.1 Reports

Identify the reports required. In Appendix N, provide detailed descriptions of the form and content of each report including the source of included data. An example printout of each report should be given.

Some types of reports follow:

- a. Operator reports
- b. Production reports
- c. Management reports.
- d. Shift reports
- e. Morning reports

8.2 Historical Data Collection

Identify the quantity and kinds of data that are required for long term storage and retrieval.

8.2.1 Discrete History

Provide the number of each of the following events to be stored on-line for each PLANT SECTION.

Alarm History	_____
Operator Actions	_____
Operator Message History	_____
System Alarm History	_____
Sequence of Events	_____ (if applicable)

8.2.2 Continuous History

Provide the number of days each of the following histories to be stored on-line.

X-minute snapshot for	_____	days
Hourly averages for	_____	days
Shift averages for	_____	days
Daily Averages for	_____	days

Monthly averages for _____ days

8.3 Trends

State-of-the-art control systems have trending capability based on user configured parameters. What is required in this section is to determine the number of points that are to be configured for trending and the maximum number that will be trended at any given time. List all known trending points in Appendix Q.

8.4 Graphics

List the number and types of graphics required to operate the facility. Provide sketches of the graphics, including dynamic update points and points on the graphic that call up other graphics, in Appendix M. Also, identify the source and/or destination for each point.

9. Management Information System (MIS)

MIS considers the facility as a whole, providing facility control and information management. Facility models forecast performance based on real-time, historical, and operator-entered data. Facility-level performance can be optimized and scheduled for economics, specific product yield and energy and material usage. Examples of production management applications are:

- a. inventory control
- b. modeling
- c. optimization
- d. scheduling
- e. data and mass balance reconciliation
- f. information capture, development, archiving and presentation
- g. quality assurance and quality control
- h. maintenance management.

This section will address these topics if they apply to the system. Details shall be included in Appendix R.

10. Appendices

The following appendices will normally be included in an FSD.

A. Definitions

Review the document thoroughly and define all acronyms and abbreviations used. Spell out the complete description the first time it is used and show the acronym in parentheses. Avoid using acronyms or abbreviations that appear only once in the document. Define any words or

terms that are not clearly understood and that do not appear in Section 3 of [23-SAMSS-010](#).

B. Applicable Documents

Review the FSD thoroughly and list all referenced documents in this section. Do not reference non-Saudi Aramco standards without full knowledge of their contents.

C. Plot Plan

D. Process Flow Diagrams

E. Context Diagrams

Provide one or more diagrams such as Figure 1.

F. Control Room Layout

G. Pib Layout

H. Piping and Instrument Diagrams

I. Control Algorithms

Describe complex control strategies built from standard algorithms (See [23-SAMSS-010](#) for standard list) in this section. Refer to appropriate ILDs.

J. Reports

Attach a copy of each type of report identified.

- a. Specify the number of reports to be provided.
- b. Provide sketches of the formatted report.
- c. Define update field types including calculations and historical data and identify the source of the data.
- d. Specify who or what initiates each report or report type and where its destination is (printer, screen, etc.).
- e) Specify the retention time of reports in the system. (? Days).

K. Alarm system

Alarm systems are complex and the specifications must conform to the particular process facility. In this appendix, specify the following:

a. Alarm Design Philosophy and Configuration

Too many alarms make an alarm system inoperable. Alarms shall only be provided to alert the operator to take some action. Events that occur routinely and require no operator intervention shall not be alarmed. Alarms that are not relevant in the current context shall be

suppressed where it is practical to do so. Examples include alarms from shut down equipment, and alarms that always occur immediately as a direct consequence of an equipment trip. Control system alarms shall be distinct from process alarms.

b. Alarm priorities

Alarm priority shall be based upon the time the operator has to respond and the consequence if no response action is taken.

Typically 3 or 4 bands are established for each consequence level and for response times. The consequences typically include Safety, Environmental, and Economic Loss, each of which is rated separately, the most severe being selected. The alarm priority can then be determined from a matrix such as the following example. Four priorities (numbers 1-4) are established in this example.

Safety:	Any potential injury	-	-	-
Environmental:	Extreme	Major	Medium	Low
Economic:	Major plant damage	Site shutdown or loss > \$1M	Train shutdown or loss \$100k - \$1M	Equipment shutdown or loss \$10k - \$100k
Time to respond:				
< 30 mins	1	2	3	4
30 – 60 mins	1	2	4	4
> 60 mins	2	3	4	4

Define attributes to be used to indicate alarms audibly and visually, based upon priority. These should be consistent with those in use already by the operating Department or Admin Area.

L. History

List the points to be collected per time interval, how long it is to be stored, when it is to be retrieved and by whom. Specify archive functions required for archiving and retrieving history data.

M. Trending Points List

List the points to be trended.

N. Management Information System (MIS)

Include the specifications of the Management Information System in this appendix.

O. Auxiliary System Specifications

Include in this appendix the specifications for auxiliary equipment. If the auxiliary equipment supplier is a different vendor, specify only the interface requirements.

Appendix 2 – FSD Approval Page

Project Title: _____

APPROVAL

Manager, Process & Control Systems Dept.

Date

Manager, [Operating Organization]

Date

Manager, SAPMT

Date