

Engineering Procedure

SAEP-16

31 May, 2003

Project Execution Guide for Process Automation Systems

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Saudi Aramco DeskTop Standards

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1 Scope

This Saudi Aramco Engineering Procedure (SAEP) defines the procedures and responsibilities for the execution of Process Automation Systems (PAS) projects with the exception of royalty custody metering facilities. Royalty custody metering facilities project execution is governed by [SAEP-21](#) and [SAEP-50](#). SAEP-16 is applicable to all Saudi Aramco capital projects ([SAEP-1020](#)) and BI-1900 projects which include process automation systems, and where the overall cost of the PAS portion is at least \$1,000,000. The cost shall include all direct Saudi Aramco costs to design, procure, install and commission the system.

In the event that some or all of the steps are executed by contractors or vendors, the project management team (PMT) shall ensure that the project is executed within the framework of this procedure.

2 Applicable Documents

Saudi Aramco Engineering Procedures

SAEP-11	<i>Authorization for Expenditure</i>
SAEP-12	<i>Project Execution Plan</i>
SAEP-14	<i>Project Proposals</i>
SAEP-21	<i>Royalty/Custody Metering Facilities Execution Guide</i>
SAEP-50	<i>Third Party Royalty/Custody Metering Facilities Execution Guide</i>
SAEP-200	<i>Engineering Study Program</i>
SAEP-302	<i>Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement</i>
SAEP-303	<i>Engineering Reviews of Project Proposal and Detail Design Documentation</i>
SAEP-1020	<i>Capital & Non Capital Programs Planning</i>
SAEP-1610	<i>Preparation of Functional Specification Documents</i>
SAEP-1620	<i>Bid Slate Development</i>
SAEP-1622	<i>Preparation of Technical Bid Evaluation Plan</i>
SAEP-1624	<i>Preparation of System Design Document</i>
SAEP-1626	<i>Configuration and Graphics Guidelines</i>
SAEP-1628	<i>Integration Specifications Document</i>

<u>SAEP-1630</u>	<i>Integration Test Procedures</i>
<u>SAEP-1634</u>	<i>Factory Acceptance Test</i>
<u>SAEP-1636</u>	<i>Installation and Checkout Plan</i>
<u>SAEP-1638</u>	<i>Site Acceptance Test</i>
<u>SAEP-1640</u>	<i>Operating Instructions for PAS</i>
<u>SAEP-1642</u>	<i>Maintenance Instructions for PAS</i>

Saudi Aramco General Instructions

<i>GI-0002.710</i>	<i>Mechanical Completion & Performance Acceptance of Plant/Unit</i>
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<i>GI-0020.500</i>	<i>Expenditure Control</i>
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Saudi Aramco Worldwide Purchasing Manual

Saudi Aramco Contracting Manual

Saudi Aramco Engineering Reports

<u>SAER-5437</u>	<i>Guidelines for Conducting HAZOP Studies</i>
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3 Definitions

3.1 Acronyms

CDR	Critical Design Review
DBSP	Design Basis Scoping Paper
DCS	Distributed Control System
ER	Expenditure Request
ERA	Expenditure Request Approval
E&OS	Engineering & Operations Services
EPI	Engineering Program Item
ESD	Emergency Shutdown System
FAT	Factory Acceptance Test
FPD	Facilities Planning Department
FSD	Functional Specifications Document
GI	General Instructions
HVAC	Heating, Ventilation, and Air Conditioning
ID	Inspection Department
I/O	Input/Output

IT	Integration Test
LPD	Loss Prevention Department
MCC	Mechanical Completion Certificate
MIS	Management Information System
MSAER	Mandatory Saudi Aramco Engineering Requirements
NCR	Non-Conformance Report
NMR	Non-Material Requirements
OO	Operating Organization
PAC	Performance Acceptance Certificate
PAS	Process Automation System
PAT	Performance Acceptance Test
PC	Personal Computer
P&CSD	Process and Control Systems Department
PDR	Preliminary Design Review
PEP	Project Execution Plan
PLC	Programmable Logic Controller
PMCC	Partial Mechanical Completion Certificate
PMT	Project Management Team
PO	Procurement Organization (Contracting Dept. or Purchasing Dept.)
PRB	Project Review Board
PS&CD	Project Support & Control Department
SAEP	Saudi Aramco Engineering Procedure
SAMSS	Saudi Aramco Materials System Specification
SAT	Site Acceptance Test
SCADA	Supervisory Control and Data Acquisition
SDD	System Design Document
SDP	System Development Plan
SRC	Services Review Committee

3.2 Terms

Bid Package: The package of documentation supplied to a bidder to quote the job. A Bid Package includes Instructions to Bidders, Pro Forma Contract, Job

Specifications, Functional Specifications Document, relevant SAMSS specifications, and other documents as applicable.

Bid Evaluation Team: A team that reviews the contractor's or vendor's bids and prepare technical and commercial recommendations. Refer to the Contracting Manual for additional information.

Bid Slate: A list of qualified contractors or vendors to bid on the project.

Field Proven: A software and/or hardware which has been in successful operation at a field installation for six months or more excluding beta testing.

Integration Specifications Document: A document prepared by the PAS integrator that provides the technical specifications for all the different systems and sub-systems' hardware interfaces, applications interfaces, data communications requirements, and testing procedures. This document is only required if the project is comprised of multiple systems linked via a common backbone or a wide-area network. **Examples are:** DCS/MIS, SCADA/MIS, DCS/SCADA or DCS/SCADA/MIS. Systems connected by serial interfaces do not fall under this category.

Job Specification: The scope of the work to be performed pursuant to a contract. It describes or refers to the applicable drawings, standards, specifications as well as the administrative, procedural, and technical requirements that the contractor shall satisfy or adhere to in accomplishing the work.

Non-Conformance Report: A report issued by Inspection Department to highlight any deviation from the standards and specifications.

Non-Material Requirements: The complete set of documentation required from the vendor and/or the contractor during the design and development phase of the project. There are three categories of NMRs:

- | | |
|----------|--|
| 601 NMRs | Preliminary drawings for review and approval |
| 602 NMRs | Certified drawings, literature, photographs, and spare parts data/requirements |
| 603 NMRs | Operations, maintenance manuals, installation instructions, test certificates. |

Operating Organization: The organization responsible for operating the facility.

Process Automation System: A network of computer-based or microprocessor-based electronic equipment whose primary purpose is process automation. The functions may include process control, safety, data acquisition, advanced control and optimization, historical archiving, and decision support.

Examples of process automation systems are either stand-alone or integrated systems such as DCS, SCADA, MIS, ESD, PC and PLC-based systems.

PAS Integrator: The party responsible for the design and integration of the PAS. The integrator may be a vendor, a contractor, or a Saudi Aramco organization.

Project Execution Plan: A document prepared by the PMT upon approval of the DBSP to define the objectives, plans, requirements, and related information necessary for optimum project execution.

Project Management Team: The team assigned the responsibility of managing the project. An E&OS organization or the operating organization may serve as the PMT. For projects classified by FPD as "engineered", PS&CD decides on the organization responsible for the project management. For "non-engineered" projects, the proponent organization decides whether to take the responsibility or make a request that this function be performed by an E&OS organization.

System Design Document: A document prepared by the vendor and/or the design contractor that contains the design narratives and the key design issues of the system.

System Development Plan: A document prepared by the vendor and/or the design contractor to outline the development steps, project schedules and major milestones. This document should be constantly updated throughout the development phase.

Waiver: The formal approval to waive one or more specified Mandatory Saudi Aramco Engineering Requirements (MSAERs) on a project basis.

4 Instructions

4.1 Project Execution Steps

The following steps are to be executed for each PAS Project.

4.1.1 Project Conception

Once the need for the project is identified, viable approaches are developed, and recommendations are made. PAS Feasibility Study should be completed by a team from P&CSD, FPD and Operating Organization to determine the best value control system architecture and technology for the proposed project.

DELIVERABLES: PAS Feasibility Study
EPI (if applicable, refer to SAEP-200)

4.1.2 Scope Definition

A brief description of what needs to be achieved and a synopsis of how the requirements are to be accomplished are defined in the DBSP. The

Feasibility Study should be an integral part of the DBSP. The DBSP constitutes an agreement between the proponent organization, PMT, and FPD on the project scope and schedule. At the time of DBSP approval, conceptual cost estimates ($\pm 40\%$) and preliminary economic analysis are performed.

DELIVERABLES: DBSP

4.1.3 Project Proposal

During this stage, the detailed project scope, cost estimate basis, schedule, and quality system are established. This includes the proposed facility size and general layout and the appropriate functional and performance specifications. Waiver approval is obtained for any MSAER that will not be met according to the Project Proposal (refer to [SAEP-302](#)). In addition, the bid slate for process automation vendors is developed and potential contracting alternatives are examined. P&CSD shall conduct one formal review of the Project Proposal Package per [SAEP-303](#) requirements.

Conduct Process Hazardous Analysis (PHA) at the Project Proposal stage as required by project scope or applicable standards

DELIVERABLES: PEP (if applicable, refer to [SAEP-12](#))
Project Proposal Package (refer to [SAEP-14](#))
FSD (refer to [SAEP-1610](#))
PHA Report

4.1.4 Expenditure Request Approval (ERA)

At this stage, detailed project economics are developed and presented to management for approval. Refer to GI-0020.500 for more details.

DELIVERABLE: ER Package

4.1.5 Bid Period

Upon finalization of the contracting plan, the bid package is prepared and sent out to the bidders on the bid slate. When bid responses are received, technical and commercial evaluations are conducted by the bid evaluation team. Refer to Saudi Aramco Contracting Manual Chapter VII or Saudi Aramco Worldwide Purchasing Manual for more details on this phase of the project.

DELIVERABLES: Bid Slate (refer to SAEP-1620)
Bid Package
Technical Evaluation (refer to [SAEP-1622](#))
Commercial Evaluation

Award Recommendation (Form SA-4535)
Procurement Document (Contract or Purchase
Order)

4.1.6 Detailed Design

During the detailed engineering phase of the project, the PAS design is reviewed at two milestones: Preliminary Design Review and Critical Design Review. Waiver approval is obtained for any additional MSAER that will not be met (beyond those approved at Project Proposal). P&CSD shall conduct one formal review of the Detail Design Package per [SAEP-303](#) requirements

Conduct Process Hazard and Operability (HAZOP) study at the Detail Design stage of the project as required by project scope or applicable standards

DELIVERABLE: HAZOP Study Report ([SAER-5437](#))

4.1.6.1 Preliminary Design Review (PDR)

This initial review of the PAS design takes place when the design is at 30% to 50% complete. It consists of a thorough walk-through and analysis of the 601 NMRs, with emphasis on assuring that the design will meet the functional specifications and Saudi Aramco standards. Saudi Aramco approval on these NMRs is required prior to any fabrication. The PDR serves as the basis for finalizing the hardware design.

Appendix B includes a recommended list of the 601 NMRs that are normally required at this stage.

DELIVERABLES: Approved 601 NMRs

4.1.6.2 Critical Design Review (CDR)

This complete review of the design, implementation, documentation and testing plans/procedures normally takes place when the design is 80% to 90% complete. The review consists of a thorough walk-through and analysis of the 602 NMRs, with emphasis on assuring that the design, implementation, documentation and testing plan/procedures will meet the contractual requirements. The CDR shall serve as the basis for complete PAS design prior to FAT.

Appendix B includes a recommended list of 602 NMRs that are normally required at this stage.

DELIVERABLES: Approved 602 NMRs

4.1.7 Integration

When the CDR review is completed, the PAS is manufactured and staged for configuration and testing. P&CSD shall be consulted on the PAS Integration Specification Document.

A review of the 603 NMRs is required at this stage. Appendix B includes a recommended list.

DELIVERABLES: Approved 603 NMRs
PAS Integration Specification ([SAEP-1628](#))

4.1.8 Factory Acceptance Test (FAT)

The approved FAT procedure (see [SAEP-1634](#)) shall be used to test the integrated hardware/software functionality, system performance, and to confirm conformance to all project specifications. Un-configured functionality of the system is not required to be tested. A minimum of 10% of the system I/O points shall be tested during the FAT, with at least one point tested on each physical I/O card.

If a project is considered "high risk" and a PRB has been established then a 100% test of hardware, software and application packages are required.

A technical representative from P&CSD shall be invited to participate in the FAT for all PAS projects. P&CSD will assess the extent of its participation on a project by project basis.

DELIVERABLES: FAT Report

4.1.9 Integration Test

This test is only required if the project is delivering multiple systems that are required to be integrated.

The approved Integration Test procedure (see [SAEP-1630](#)) shall be used to demonstrate the seamless integration of the PAS. The focus of the Integration Test shall be to verify a) the proper functioning of the required interfaces and b) the data transfer rates among the different components of the PAS.

DELIVERABLES: Integration Test Report

4.1.10 Packing and Shipping

Upon successful completion of the prior tests, the PAS is packed and shipped to the job site for installation.

If the test reports has been approved but with exception items and/or outstanding NCRs, the PMT representative may choose to ship the system and close these items in the field prior to the SAT.

DELIVERABLES: Packing List

4.1.11 Installation and Checkout

When the PAS is received at the job site, it shall be inspected for physical damage and the packing list shall be verified.

The PAS is then installed and checked out to verify compliance with applicable electrical and safety codes and standards (see [SAEP-1636](#)).

DELIVERABLES: Material Receiving Report
Physical Damage Report

4.1.12 Site Acceptance Test (SAT)

The approved SAT procedure (see [SAEP-1638](#)) is used to test the installed PAS at its final location. The focus of the SAT shall be to verify that no damage occurred during shipping or installation and to verify the integrity and functionality of the system after it is powered up. I/O checks are typically limited from the operator consoles to marshalling cabinet terminations since field connections are not yet made.

The SAT shall include any integration tests that were not tested during FAT.

DELIVERABLES: SAT Report

4.1.13 Pre-Commissioning

A commissioning plan shall be developed by the Operating Organization and supported by the Project Management Team. P&CSD shall be consulted on as needed basis during this stage of the project. Complete loop testing from the sensing element(s) to the final control element(s) is performed. This test will verify the instruments, the wiring, the I/O cards, and the I/O configuration.

DELIVERABLES: Commissioning Plan
Loop Acceptance Sheets

4.1.14 Mechanical Completion Certificate (MCC)

MCC is signed off when all "yes" items (items required for start-up) are resolved, all engineering drawings are marked-up and issued by the PMT to the OO to "As-Built" status, and system documentation is revised to reflect the actual system. The system is then turned over to the operating organization.

It is PMT's responsibility to update the red-lined drawings and turn over to the OO within a reasonable period of time, normally not exceeding six months.

A Project Feedback form on the PAS shall be completed after MCC completion by SAPMT and OO. This Feedback will cover lessons learned, problems and resolutions, etc. in order to improve the quality of future PAS projects. The form shall be returned to Process & Control Systems Department, Attention, Process Control Standards Chairman.

DELIVERABLES: MCC Form A-7213
Feedback Form (Appendix C)

4.1.15 Start-up and Commissioning

The operating organization with the assistance of the PMT commissions the facilities. Final loop tuning may be required to set the process automation system to the optimum operating conditions.

DELIVERABLES: None

4.1.16 Performance Acceptance Test (PAT)

For performance acceptance criteria, refer to GI-0002.710, "Mechanical Completion and Performance Acceptance of Facilities".

DELIVERABLES: PAC Form A-7214

4.2 Project Review Board (PRB)

4.2.1 PRB Criteria

When deemed necessary by the PMT, a Project Review Board shall be established for projects which are considered as high risks.

A project is considered to be of high risk if all or part of the system requires:

- a. New technology or first-time application within Saudi Aramco;
- b. Custom development or modification to standard package(s), provided that the cost of the development is \$500,000 or more.

It is Saudi Aramco's objective to procure standard off-the-shelf field proven hardware, software and application packages. Customized one-of-a-kind hardware and software are strongly discouraged.

4.2.2 PRB Timing

Projects shall be evaluated:

- a. During DBSP stage.
- b. Before the final placement of contracts or purchase orders with the vendor.

4.2.3 PRB Objectives

The objective of the Project Review Board is to reduce the risk of a project by ensuring:

- a. That Management is aware of the project scope, progress, development, and execution problems;
- b. That appropriate and timely management assistance to the operating organization, project management and other organizations involved in the development and execution of the project are available.

4.2.4 PRB Makeup

The Project Review Board shall consist of the following:

- a. Chairman - to be appointed by the Vice President, Project Management, concurred by the Vice President of the Operating Organization and the Vice President, Engineering Services.
- b. PMT technical representative
- c. OO technical representative
- d. P&CSD technical representative

5 Responsibilities

5.1 Execution Responsibilities

Step	Activity	Perform	Consult	Approve
4.1.1	Project Conception	OO/FPD	P&CSD	
Deliv.	Feasibility Study EPI	FPD/P&CSD/OO		OO See SAEP-200
4.1.2	Scope Definition	FPD	OO/P&CSD	
Deliv. ***	DBSP PRB First Checkpoint	FPD	PMT/P&CSD	FPD/OO/PMT*
4.1.3	Project Proposal	PMT	OO/P&CSD	
Deliv.	PEP Proposal Package FSD			See SAEP-12 See SAEP-14 See SAEP-1610
4.1.4	ERA	PMT/FPD	PSCD	
Deliv.	ER Package			See SAEP-11
4.1.5	Bid Period	PMT/PO	OO/P&CSD	
Deliv.	Bid Slate Bid Package Technical Evaluation Commercial Evaluation Award Recommendation	PMT/P&CSD PMT/PO PMT/OO/P&CSD PMT/PO		See SAEP-1620 See Contract Manual See Contract Manual See Contract Manual See Contract Manual
***	PRB Second Checkpoint	PMT	P&CSD	
4.1.6	Detailed Design	PMT		
Deliv.	601 NMRs 602 NMRs			PMT/OO PMT/OO

4.1.7	Integration	PMT	ID	
Deliv.	603 NMRs			PMT/OO
4.1.8	FAT	PMT/OO/P&CSD	P&CSD	
Deliv.	FAT Report			PMT/OO/P&CSD
4.1.9	Integration Test (If Req'd.)	PMT/OO/P&CSD	P&CSD	
Deliv.	IT Report			PMT/OO/ P&CSD
4.1.10	Packing and Shipping	PMT	ID	PMT
Deliv.	Packing List			
4.1.11	Installation and Checkout	PMT	ID	
Deliv.	None			
4.1.12	SAT	PMT/OO	P&CSD	
Deliv.	SAT Report			PMT/OO
4.1.13	Pre-Commissioning	OO/PMT	P&CSD	
Deliv.	Loop Acceptance Sheets Commissioning Plan			PMT/OO PMT/OO
4.1.14	MCC Feedback Form	PMT PMT/OO	OO	
Deliv.	MCC Form (SA-7213) PAS Form			
4.1.15	Start-up and Commissioning	OO	PMT	
Deliv.	None			
4.1.16	PAT	OO/PMT	P&CSD	
Deliv.	PAC Form (SA-7214)			PMT/OO

* PMT approves schedule only

** P&CSD participation for high risk projects as defined in section 4.2.1

*** Time flag see section 4.2.2

5.2 Project Review Board Responsibilities

The responsibilities of the PRB for a process automation system project include, but not limited to:

- Monitoring cost, schedule, and quality of the PAS development.
- Conducting "in-depth" reviews with the project manager and the senior operations representative. Quarterly review cycles are recommended; however, the PRB may adopt an alternate schedule.
- Resolving technical and business-related issues, and providing appropriate guidance to the operating organization and project manager based on resolution of these issues.
- Advising executive and corporate business line management, as appropriate, on the project status and potential problems/changes impacting system quality, cost and schedule.

6 Approval, Deviation and Exceptions

6.1 Deviations and Exceptions

Deviations and exceptions to one or more requirements in this procedure can be requested on the basis of economical benefit or unique project requirements. All deviations and exceptions must be approved by the signing parties of this procedure.

6.2 Document Approval

This document was approved by:

Vice President, Engineering Services

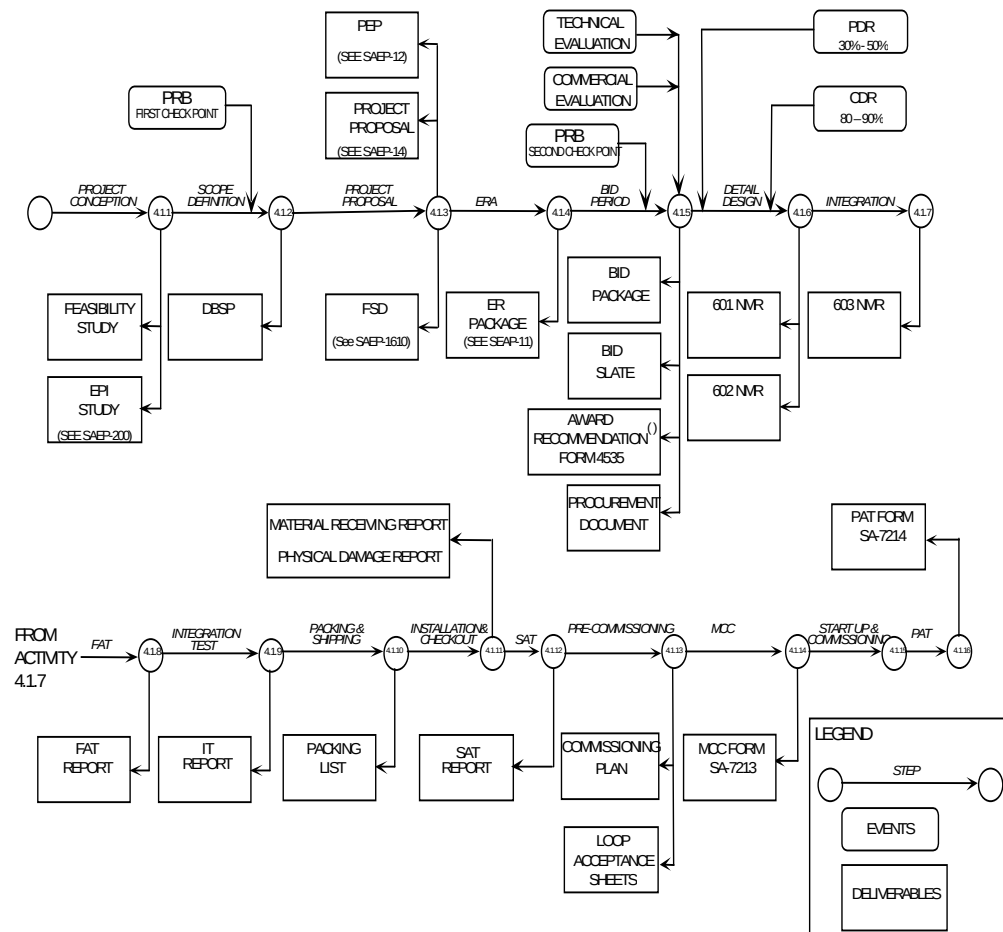
Vice President, Project Management

Senior Vice President, E&OS

Revision Summary

31 May, 2003 Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with minor revision to optimize project execution cycle and improve cost effectiveness.

Appendix A – Project Life Cycle Chart



Appendix B – Non-Material Requirements

It is Saudi Aramco's intent to maximize the use of standard vendor diagrams and documentation, especially in electronic format. However, the vendors should be instructed to provide a narrative explicitly referencing specific sections of their standard documentation for each specific project requirements.

B.1 601 NMRS

Saudi Aramco's approval of these preliminary documents is required prior to any fabrications. The following list is recommended. It may be revised as necessary

- 601.1 System Development Plan
- 601.2 System Design Document (refer to [SAEP-1624](#))
- 601.3 Integration Specifications Document (refer to [SAEP-1628](#))
- 601.4 Bill of Materials
- 601.5 Dimensional Outline Diagrams
- 601.6 Panel Front and Back Layout Diagrams
- 601.7 Electric Power Distribution Diagram
- 601.8 Factory Acceptance Test Plan
- 601.9 Integration Test Plan
- 601.10 Site Acceptance Test Plan
- 601.11 Configuration and Graphics Guidelines (refer to [SAEP-1626](#))
- 601.12 Power Requirements
- 601.13 HVAC Requirements
- 601.14 Air Purity Requirements
- 601.15 Required Floor Loading
- 601.16 Composite Engineering, Manufacturing and Testing Schedule

B.2 602 NMRS

These certified drawings, parts data and documents should be marked as final. The following list is recommended. It may be revised as necessary.

- 602.1 System Development Plan (Revised)
 - 602.2 System Design Document (Revised)
 - 602.3 Integration Specifications Document (Revised)
 - 602.4 Bill of Materials (Revised)
-

- 602.5 Dimensional Outline Diagrams (Revised)
- 602.6 Panel Front and Back Layout Diagrams (Revised)
- 602.7 Electric Power Distribution Diagram (Revised)
- 602.8 Factory Acceptance Test Procedure
- 602.9 Integration Test Procedure (Revised)
- 602.10 Site Acceptance Test Procedure
- 602.11 Configuration and Graphics Guidelines (Revised)
- 602.12 Installation/ Check-out Plan
- 602.13 System Performance Specifications
- 602.14 List of all deviations from Purchase Requisition with Suggested Alternatives
- 602.15 List of Special Tools, Devices, and Test Equipment Required for Installation
- 602.16 Functional Test Certificates

B.3 603 NMRS

The following list is recommended. It may be revised as necessary.

- 603.1 System Performance Specifications
- 603.2 Installation Instructions
- 603.3 Operating Instructions (refer to [SAEP-1640](#))
- 603.4 Maintenance Manuals (refer to [SAEP-1642](#))
- 603.5 Certified Test Reports, and Certificates

Appendix C – PAS Project Execution Feedback Form

BI#:

Project Title:

PAS Vendor Name/Product Line:

List in the table below the major problems encountered in the execution of this PAS project and the final resolutions:

No	PROBLEM	RESOLUTION

List suggested improvement items for future PAS projects execution:

Name: _____	Date: _____
Telephone #: _____	
E-mail Address: _____	

Notes:

1. PMT/OO can use this typical form or any other free formatted form to provide the above information
2. Fill out a separate form for each PAS vendor/product.