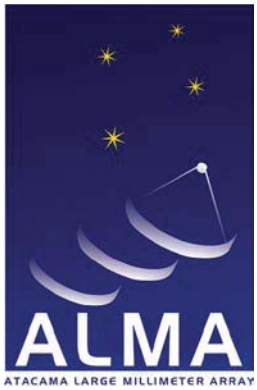

Atacama
Large
Millimeter
Array

ALMA Phasing Project
Product Assurance Plan

ALMA-05.11.10.01.0002-A-PLA

2013-05-17

Prepared by:	**Organization:**	**Signature and Date:**
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Change Record

Version	Date	Affected section(s)	Reason/Initiation/Remarks
A.1	2013-03-22	All	Initial draft
A.2	2013-04-03	All	Merged Mike H. comments
A.3	2013-04-04	Sec 1,3,&4	Merged Rich L. comments
A.4	2013-04-19	Title page	Add doc number
A	2013-05-17	4.4	Add comment on need for ALMA CCB approval regarding RfWs applicable to system level issues

Table of Contents

1. Description

1.1. Purpose of Document

The ALMA Phasing Project (APP) is a development project that will upgrade the ALMA telescope to operate in a phased array configuration. The APP is supported by contributions from multiple international institutions, under direction of the Project Management Office (PMO) seated at Haystack Observatory. Product Assurance is a work package under the PMO. Ultimately, the goal of Product Assurance is to see that all the deliverables meet their requirements. This plan establishes the role that Product Assurance will play across the APP in order to meet that goal.

1.2. Approach to PA

The APP PA Plan shall establish processes, identify best practices, itemize events, and define milestones in accordance with ALMA policies and requirements. This plan draws on a variety of sources to establish an APP PA Plan that will assure all stated requirements are met. Items addressed in this plan follow:

- Performance and requirements verification
- Documentation and configuration control
- Quality and reliability of parts and materials
- Issue tracking and risk management
- Shipping, Storage, and Logistics
- Safety Compliance
- ALMA system interfaces
- ALMA design and acceptance reviews
- Impact on ALMA operations and ALMA critical components
- Compliance with ALMA PA

Since the APP is relatively small in comparison to the ALMA Construction IPTs, some of the required documents and reviews normally encountered during construction will be consolidated in order to reduce the documentation load and make better use of meeting time. A second consequence of the scale of APP is that development is often concurrent with reviews and documentation, meaning (a) that reviews will not always precede initiation of activities and (b) some specification documents will be replaced by design documents

Each partner APP institution will identify a PA point of contact responsible for implementation of the provisions of this project-wide plan at their site. In all other respects, APP partner institutions are responsible for their own product assurance, and are not required to report on their internal processes, which are typically informal and undocumented.

2. Referenced Documents

2.1. Documents

[RD 01] ALMA Phasing Project Plan
[RD 02] ALMA Product Assurance Requirements
ALMA-80.11.00.00-001-C-GEN
[RD 03] ALMA Reviews Definitions, Guidelines and Procedure
ALMA-80.09.00.00-001-C-PLA

3. Abbreviations and Acronyms

ALMA	Atacama Large Millimeter Array
APP	ALMA Phasing Project
CDR	Critical Design Review
CIDL	Configuration Item Data List
COTS	Commercial Off The Shelf
CRE	Change Request (for Engineering)
FIT	Failures In Time
FMEA	Failure Modes and Effects Analysis
ICD	Interface Control Document
IPT	Integrated Product Team
JAO	Joint Alma Observatory
LRU	Line Replaceable Unit
MPIfR	Max Planck Institute for Radio Astronomy
MTBF	Mean Time Between Failure
NAOJ	National Astronomical Observatory of Japan
NCR	Non-Conformance Report
NRAO	National Radio Astronomy Observatory
PA	Product Assurance
PAI	Preliminary Acceptance in House
PAS	Preliminary Acceptance on Site
PDL	Polarization Dependent Loss
PDR	Preliminary Design Review
PMO	Project Management Office
QA	Quality Assurance
RD	Reference Document
RfW	Request for Waiver
RID	Review Item Discrepancy
SE	System Engineering
SPA	Software Product Assurance

TRR	Test Readiness Review
VLBI	Very Long Baseline Interferometry

4. Primary Provisions of the APP PA Plan

4.1. Performance and Requirements Verification

APP requirements were reviewed at the Preliminary Design Review (PDR) and are under configuration control. The Verification Plan for those requirements will be reviewed at the Critical Design Review (CDR), and test or analysis procedures will be reviewed at the Test Readiness Review (TRR). In addition:

- Outstanding issues from reviews, as well as non-conformances, shall be tracked from the point they are identified through closure. All items shall be closed prior to final acceptance.
- The requirements change and waiver process shall include both APP and ALMA personnel.
- The APP Test and Verification Plan (part of the CDR review package) shall consist of a verification matrix that captures requirements from all relevant documents including: Functional and environmental requirements documents; ICDs; safety plans; design documents, electrical or civil code, etc. Each requirement in the matrix is assigned one or more verification methods, chosen from test, inspection, analysis, and review of design. The verification may be reviewed at PAI, PAS, or both and may apply to only one article, to a sampled subset, or the entire delivery lot. Prior to the TRR, a complete Test Procedures document shall be prepared for review.
- APP shall summarize the results of their verification activities in a compliance matrix confirming that the delivered capability is compliant, partially compliant, or non-complaint with each requirement. Any entries that are non-compliant must be accompanied by an approved waiver. In some cases, the requirements may have been modified through the change request process prior to completion of the matrix. The Compliance Matrix (and sometimes the verification matrix) provides links and pointers to supporting documents that are used for evidence of compliance or requests to waive or change a requirement. A compliance matrix shall be the final checklist that brings acceptance to closure.

4.2. Documentation and Configuration Control

- Documents shall be divided into three categories by common agreement between APP and JAO: Internal APP (e.g. detailed schedule and budget), documents to be delivered to ALMA (e.g. review packages), and documents to be approved by ALMA (e.g. interface definitions, test plans).

- Document formatting shall be at the discretion of APP. Documents delivered to ALMA shall include numbering and cover pages that conform to JAO practice.
- All APP documents shall be subject to version control.
- Deliverable items that have assembly options, periodic hardware and/or firmware updates, calibration requirements, design evolutions, multiple versions in use, etc. shall be under configuration control.
- A document archive shall be maintained by APP and accessible to JAO personnel as needed for the purpose of conducting reviews, monitoring APP progress, and obtaining operational, test, and maintenance documentation prior to handover.
- A Configuration Item Data List (CIDL) shall be maintained and eventually delivered. This list will track the version, status, location, and due dates of all deliverable documents.

4.3. Quality and Reliability of Parts and Materials

- Procurements shall:
  - Include clear specifications where the item plays a critical role in meeting system requirements.
  - Specify inclusion of certificates of compliance where the item plays a critical role in meeting system requirements.
  - Specify MTBF or FIT to meet the 5 year MTBF requirement for LRUs purchased as COTS assemblies
  - Take necessary precautions against infiltration of counterfeit parts.
- Industry standards shall be specified for procurement of components, contracted assembly work, and other items that play a critical role in meeting system requirements. (i.e. UL or CE Safety, IPC for assembled electronics, ISO 9000 for general quality standards, ANSI, etc.)
- APP sites shall establish procurement, incoming inspection, acceptance testing, and recordkeeping protocols that can verify quality of received components, track and resolve quality issues, and retain vendor certificates of compliance when furnished.
- With all else equal, vendors performing contracted work shall be given consideration based on their ISO-9000 compliance or other quality certifications as applicable. In the absence of vendor certification, each APP site shall be responsible for a quality assessment of their suppliers.
- LRUs designed and built in-house or by contracted assembly shall exhibit no less than five year MTBF as demonstrated by life test, analysis, or other methods acceptable to the APP PA Lead.

4.4. Issue Tracking and Risk Management

The APP PMO and PA are collectively responsible for maintaining the following records in a format of their choosing:

- A history of changes to formal Requirements, ICDs, and other controlled documents.
- A history of RIDs and Action Items from Reviews, identifying at a minimum the source of the item and the resolution by the APP. These are to be presented as part of the review package at subsequent reviews.
- An internal problem log (i.e. non-conformances), to be maintained during development and test, tracking items that need to be repaired, updated, or brought into conformance for some other reason.
- Any waivers applicable to system level requirements (e.g. ICDs) or -performance, so with a potential impact on ALMA equipment or operations, should be reviewed/approved by the ALMA CCB.
- A Risk Register, identifying and ranking risk that could threaten the budget, schedule, or performance requirements.
- Monthly Management Review packages of the member institutions, as well as minutes of weekly teleconferences and other formal meetings
- Internal APP issues and actions (generally not reported to ALMA).

4.5. Shipping, Storage, and Logistics

Shipping to and from ALMA as well as storage and logistics at ALMA will be performed in compliance to ALMA standards. Shipping, storage, and logistics at other APP facilities will require approval of the APP PA Lead.

4.6. Safety Compliance

In order to assure compliance with ALMA safety requirements, a hazard analysis will be performed and submitted, along with a plan for corrective action or mitigation.

4.7. ALMA System Interfaces

The APP and ALMA JAO shall jointly agree on all interfaces that need to be defined in order to integrate the APP into the ALMA telescope. Documents that define these interfaces will be subject to ALMA documentation standards, version control, and approval as defined by APP and JAO management.

4.8. ALMA Design and Acceptance Reviews

- At the time of this writing, some milestones that typically involve PA have already transpired or will not be scheduled:
    - Project Plan vetted and submitted
    - Project conditionally approved by the ALMA Board

  - Preliminary Design Review passed
  - Procurement of some COTs, ROACH2, maser, Fiber Optic transceivers, and other items.
  - Hardware design is in assembly, first articles received and in test
  - There will be no separate Pre-Production Readiness or Manufacturing Readiness Review. The current status of custom and COTs procurements will be reviewed at CDR, and may include FMEA, manufacturing drawings, prototype and first article test reports, supplier's documentation of their QA credentials, component and LRU level test procedures, and related items
- Events that remain where reviews are expected:
  - A Critical Design Review is scheduled and a plan tailored for the APP has been signed. Provisions in the plan are taken from RD03.
  - Test Readiness Review – to gain approval for the test plan and procedures
  - Preliminary Acceptance In house (PAI), following established ALMA procedures
  - Preliminary Acceptance on Site (PAS), following established ALMA procedures
  - Final Science Commissioning and Issuance of acceptance certificate by ALMA Director

4.9. Impact on ALMA Operations and ALMA Critical Components

The APP PA lead will coordinate with JAO counterparts to ensure that APP installation and operation does not compromise ALMA critical components and operations.

4.10. Compliance with ALMA PA

The APP Product Assurance Manager shall work primarily with the JAO Development Project Coordinator to ensure a compliant delivery of the APP subsystem and components. These two parties are primarily responsible for resolving Product Assurance issues or discrepancies that arise between the APP and the JAO.

5. Optional PA activities

The following PA actions and activities will be pursued to the extent permitted by time and resources:

5.1. Capturing past events

An attempt will be made to capture relevant APP activities prior to establishment of a formal PA plan. This may include compilation of compliance certificates or review of already closed issue and action items.

5.2. Lessons Learned

APP will attempt to provide feedback to ALMA pertaining to the experience of an outside consortium providing an augmentation to ALMA capabilities. In addition, Lessons Learned will address the unusual circumstance of VLBI requiring coordination with external observatories.