



**Atacama
Large
Millimeter /
submillimeter
Array**

ALMA Development Projects Implementation Plan

ALMA-10.04.00.00-0025-A-PLA

2019-04-22

Prepared and Approved by:	Organization Role:	Date and Signature:
S. Corder	ALMA Deputy Director	
L. Testi	EU ALMA Operations Manager	
A. González	EA ALMA Operations Manager	
P. Jewell	NA ALMA Operations Manager	
Released by:	Organization Role:	Date and Signature:
S. Dougherty	ALMA Director	



**ALMA Development Projects
Implementation Plan**

Doc #: ALMA-10.04.00.00-0025-A-PLA
Date: 2019-04-22
Page: 2 of 26

Change Record

Version	Date	Affected Section(s)	Author	Reason/Initiation/Remarks
1.0	2015-08-07	ALL	S. Corder & A. Voigt	First Draft - Template
2.0	2018-11-13	ALL	AMT	Revised Template (4)
3.0	2019-01-24	ALL	AMT & A. Voigt	First complete draft
4.0	2019-03-12	ALL	AMT	Revised draft (f-2-f)
5.0	2019-03-25	ALL	A. González	Revision and clarifications
6.0	2019-04-01	ALL	P. Jewell	New sections, edits and flow clarifications
7.0	2019-04-02	ALL	S. Corder & A. Voigt	Final revision, edits and clarifications
8.0	2019-04-22	ALL	S. Corder, A. Voigt & B. Lopez	Comments from IxTs incorporated

Table of Contents

1. Purpose and Scope 3

2. Applicable Documents 4

3. Reference Documents 4

4. Definitions and Acronyms..... 4

5. Development Project Framework 5

6. Development Projects Workflow..... 6

7. Planning and Proposal Phase 9

 7.1 Science Motivation..... 10

 7.2 Potential collaborations 10

 7.3 Project concept..... 10

 7.4 Specifications..... 11

 7.5 Technical Readiness Status..... 11

 7.6 Operations and Colateral Development Input into Planning..... 11

 7.7 Proposal Submission Timeline 12

 7.8 Project Implementation Cost Responsibilities 12

 7.9 Proposal Content Requirements..... 12

8. AMT Recommendation 14

9. Approval 15

 9.1 Small Projects 15

 9.2 Full-scale Projects 15

9.3 Projects up to PDR..... 16

10. Execution and Oversight Phase 16

10.1 Detailed Design and Manufacturing Reviews 16

10.2 Oversight..... 17

 a. Deliverables 18

 b. Acceptance..... 18



**ALMA Development Projects
Implementation Plan**

Doc #: ALMA-10.04.00.00-0025-A-PLA
Date: 2019-04-22
Page: 3 of 26

10.3 Delivery Requirements.....	18
11. Commissioning.....	19
APPENDIX: Project Proposal Template.....	20
10.1 Offerer’s Staffing.....	21
10.2 External Staffing (<i>if applicable</i>).....	22
11.1 Offerer’s Cost.....	22
11.2 Collaborating Institution / Subcontractor Cost.....	23
11.3 Total Project Cost.....	23
11.4 Total Project Value.....	23
13.1 Systems/Configuration Control.....	24
a. Systems Requirement and Specification Control.....	24
b. Documentation Control.....	24
c. Product & Quality Assurance Control.....	24
13.2 Performance to Schedule.....	24
13.3 Performance to Budget.....	25
13.4 Measures of Success.....	25
13.5 Risk Management.....	25
13.6 Communication Plan and Progress Reporting.....	25

1. Purpose and Scope

Continuing hardware and software developments and infrastructure enhancements are essential to maintain ALMA as the state-of-the-art and world leading facility for millimeter/submillimeter astronomy over the course of its projected life of 30+ years [AD04]. The ALMA Development Program consists of a single, coherent vision [AD05] which is implemented by projects (full-scale and small) and studies [AD04].

This document focuses on ALMA Development Projects, which aim to deliver tangible improvements to ALMA for a particular aim with defined deliverables [AD04], and describes the fundamental processes for the proposal and approval of the Development Projects that are in force and currently executed by the different stakeholders. It also outlines the basic management structures and processes workflow, providing a summary of how the approved Principles of the ALMA Development Program [AD04] are implemented throughout the Regions and the JAO.

The processes of collection of community input and final execution of the development projects remains under the discretion of the individual Executive, respecting regional differences. The development projects shall be funded from budgets under the control of the Executives, and each Executive shall provide leadership to the regional projects, within a unified system, which is outlined here.

The details of community interaction on the establishment and execution of the science priorities, and the proposal/coordination processes are outlined in:

- The Development Science Vision, which is developed and maintained by the ALMA Director, with input from the AMT and the IST and in coordination with the ASAC, and



ALMA Development Projects Implementation Plan

Doc #: ALMA-10.04.00.00-0025-A-PLA
Date: 2019-04-22
Page: 4 of 26

approved by the ALMA Board, according to Article 4.1 of the Principles of the ALMA Development Program [AD04].

- The ALMA Support Centers Implementation Plans, which detail the interaction with the community on the establishment of science priorities at a regional level and the way these are executed.

2. Applicable Documents

Appl.	Document Title	ALMA Doc. Number
[AD01]	Trilateral Agreement	N/A
[AD02]	ALMA Management Agreement	N/A
[AD03]	Principles of ALMA Operations	ALMA-10.00.00.00-0020-A-PLA
[AD04]	Principles for ALMA Development Program	AEDM 2018-061-O
[AD05]	Development Roadmap	AEDM 2018-017-O
[AD06]	ALMA Maintenance Principles	AEDM 2014-027-O

3. Reference Documents

Ref.	Document Title	ALMA Doc. Number
[RD01]	ALMA Operations Management Plan	ALMA-10.00.00.00-0034-A-GEN
[RD02]	ALMA Management Team Charter	ALMA-10.00.00.00-0035-A-GEN
[RD03]	IST Implementation Plan	SCID-00.00.00.00-0124-A-GEN
[RD04]	IET Implementation Plan	ALMA-10.00.00.00-0024-A-PLA
[RD05]	ICT Implementation Plan	COMP-70.05.00.00-0025-D-PLA
[RD06]	ISOpT Implementation Plan	ALMA-90.00.00.00-0027-A-PLA
[RD07]	ALMA Product Assurance Requirements	ALMA-80.11.00.00-001-D-GEN
[RD08]	ALMA Warranty Policy	ALMA-10.00.00.00-0016-A-PLA
[RD09]	ALMA Design Reviews Definitions, Guidelines and Procedure	ALMA-80.09.00.00-001-D-PLA

4. Definitions and Acronyms

All acronyms and abbreviations used within this document are given at the [ALMA Acronym Finder](#) web page. In addition, the following acronyms are used in this document:

- **ALMA Director:** AD [AD01,AD02]
- **ALMA Science Advisory Committee:** ASAC [AD01]
- **ALMA Regional Support Center:** ASC [AD01, AD02, RD01]
- **ALMA Management Team:** AMT [AD02, RD01, RD02]
- **Director's Council:** DC [AD01,AD02]
- **Integrated Computing Team:** ICT [RD01, RD05]
- **Integrated Engineering Team:** IET [RD01, RD04]



- **Integrated Science Team:** IST [RD01, RD03]
- **Integrated Science Operations Team:** ISOpT [RD01, RD06]
- **Integrated Teams:** IXT [RD01]
- **Joint ALMA Observatory:** JAO [AD01, AD02]
- **Operations Manager:** OM [RD01]

5. Development Project Framework

ALMA development projects progress through several stages, from initial concept to final acceptance. With each stage, a project will increase in maturity and technical readiness. A typical, but not unique or required progression is described here as context. The remainder of this document is concerned with steps that require ALMA Director or Board approval to proceed.

Most ALMA projects originate as a Study Program. Studies are funded by, managed, and at the discretion of the regional Executives. They are designed and intended to allow an initial exploration of a concept that may be of interest to ALMA Development, in the near or long terms. The Study may or may not lead directly to an ALMA deliverable; however, if that is the intended next step, a useful, but optional, way to validate the approach is to review the results at a Conceptual Design Review (CoDR). The primary purpose of the CoDR is to present the performance of new capabilities and/or improvements of the alternative design choices, considering the science objectives and the organization's long-term development strategy, to discuss how those design alternatives are going to be evaluated, and to determine whether the details of early design activities for the project, resulting in the selection of the baseline design, are realistic. This review, if deemed beneficial, would be conducted under the auspices of the AMT and chaired by the Observatory Systems Engineer (OSE). If successful, the project might then proceed to a Preliminary Design Phase. If additional specifications are necessary, or existing requirements need to be changed, a (Sub-)System Requirements Review should be held (see section 7.4.), which aims at reviewing the changes of the science- and system level requirements as a result of the new development, as well as to ensure that applicable requirements have been duly identified, are correct and complete.

The Preliminary Design Phase is the phase where multiple solutions or concepts which meet the specified requirements are identified and explored, where critical technologies are identified and their feasibility analyzed, where selected solutions and concepts are refined and validated through extensive tradeoff studies and analyses, and where the top level performance requirements for the subsystem are analyzed to ensure they are complete, documented and well understood. The designs may be iterative, and alternatives, including secondary options from the concept stage, might be adopted in the end. For hardware projects, the Preliminary Design Phase may produce a functioning prototype to demonstrate performance. The endpoint of the Preliminary Design Phase is a Preliminary Design Review (PDR). The objectives of a PDR are, typically, to ensure that requirements and external interfaces are complete and validated, to demonstrate that the proposed design can meet these requirements, to demonstrate that all major risks have been identified and mitigated, and that overall, the project is ready to proceed to detailed (critical) design. Unless receiving an exemption from the AMT and the ALMA Director, major ALMA development projects are expected to pass a PDR before being approved for full construction. Preliminary Design Phase projects are eligible for ALMA Development funding and should follow the development approval steps outlined in this document.



The Detailed (or Critical) Design Phase is the period when the subsystem is designed and the design is verified analytically and/or by tests performed on prototypes. This phase concludes with Critical Design Review (CDR), which seeks to verify that the detailed design satisfies the specified requirements, that the design is duly documented, to assess risk areas of the design and, as applicable, to assess the results of producibility analyses, review preliminary hardware product specifications, evaluate preliminary test planning, and evaluate the adequacy of preliminary integration, operation and support documents.

The last stage of project development is the production phase. This phase includes a Manufacturing Readiness Review (MRR), which seeks to demonstrate the overall production readiness and to assure that the items to be manufactured will meet the corresponding requirements. If a pre-production phase was executed, then the results of that work are also reviewed during the MRR to further optimize the full production manufacturing process.

The project typically concludes with a series of incremental acceptance reviews, which seek to ensure that all technical requirements have been verified prior to proceeding to the next integration step or, ultimately, to commissioning.

The plan for the Detailed Design and Manufacturing phases may be submitted as a stand-alone proposal, or as part of a two-phase proposal and approval process, whereby the Detailed Design Phase is approved and proceeds as Phase 1, and if successful (including passing its gate review [CDR]), seeks approval from the Board before proceeding with Phase 2 (production, including passing its gate review [MRR]). In either case, the submitted proposal should follow the steps outlined in this document.

6. Development Projects Workflow

As it will be detailed in this document, Development projects [AD04] originate in the Executives. In general, projects are guided by the priorities of the ALMA Development Roadmap [AD05], while allowing scope for new ideas and innovation. Proposals are initially presented to the AMT for operational and technical impact assessment, and if recommended by the AMT, they will be considered for approval by the ALMA Director, in the case of small projects, or proposed by the ALMA Director to the ALMA Board for approval, in the case of full-scale projects [AD01, RD01, RD02].

The following is the general workflow for a Development Project:

- The Executives, under guidance of their IST member and in close coordination with the regional Development Manager, will start the processes particular to each region to initiate new development projects. This process may include workshops, development studies, and open calls for proposals, and can include the participation of Executives from other regions. This process will gather input, among others, from the regional SAC in terms of prioritization and science case of particular projects, and the regional ICT, IET, and ISOpT representatives in terms of operational impact, which will be coordinated through the AMT members. Each region is responsible for its own down-selection process for projects to be presented to the AMT.
- Project proposals will be presented by the Executives to the AMT who will conduct operational impact and technical readiness assessments, in coordination with the Observatory Scientist and the Observatory Systems Engineer, and that includes input from



ALMA Development Projects Implementation Plan

Doc #: ALMA-10.04.00.00-0025-A-PLA
Date: 2019-04-22
Page: 7 of 26

the IET, ICT, and ISOpT (see sections 7.5 and 7.6). The outcome of this assessment and the AMT's final recommendation will be forwarded to the ALMA Director.

- The ALMA Director will, concurrently, take into account advice from ASAC [AD01] with regard to the scientific objectives of the project, such as the ability and role of the project in meeting ALMA key scientific objectives, including those of the Development Roadmap [AD05]. Based on the recommendations of the AMT and the advice of the ASAC, the ALMA Director will recommend, or not, that the project be approved. The ALMA Director can directly approve small projects.
- Consistent with the ALMA Agreement [AD01], the ALMA Director will submit projects to the DC for concurrence prior to submission for approval to the Board (for full-scale projects), or for their information only, before proceeding, for small projects [AD04].
- After the project approval by the ALMA Board or the ALMA Director, depending on the size of the project [AD04], the regional Development Program Managers will coordinate with the project team and with the related IET or ICT groups for the implementation of the project, and keep the AMT informed about the progress. The AMT, in its role of project oversight, will transmit requests to the project teams as necessary through the corresponding Development Program Manager.
- After completion, a project will typically undergo an acceptance review before it is released for commissioning. The ALMA Director, as foreseen in the Development Principles [AD04], will be the acceptance authority for completed development projects, based on the recommendations from an appropriate Acceptance review process.

The Workflow of each development Project is as follows:

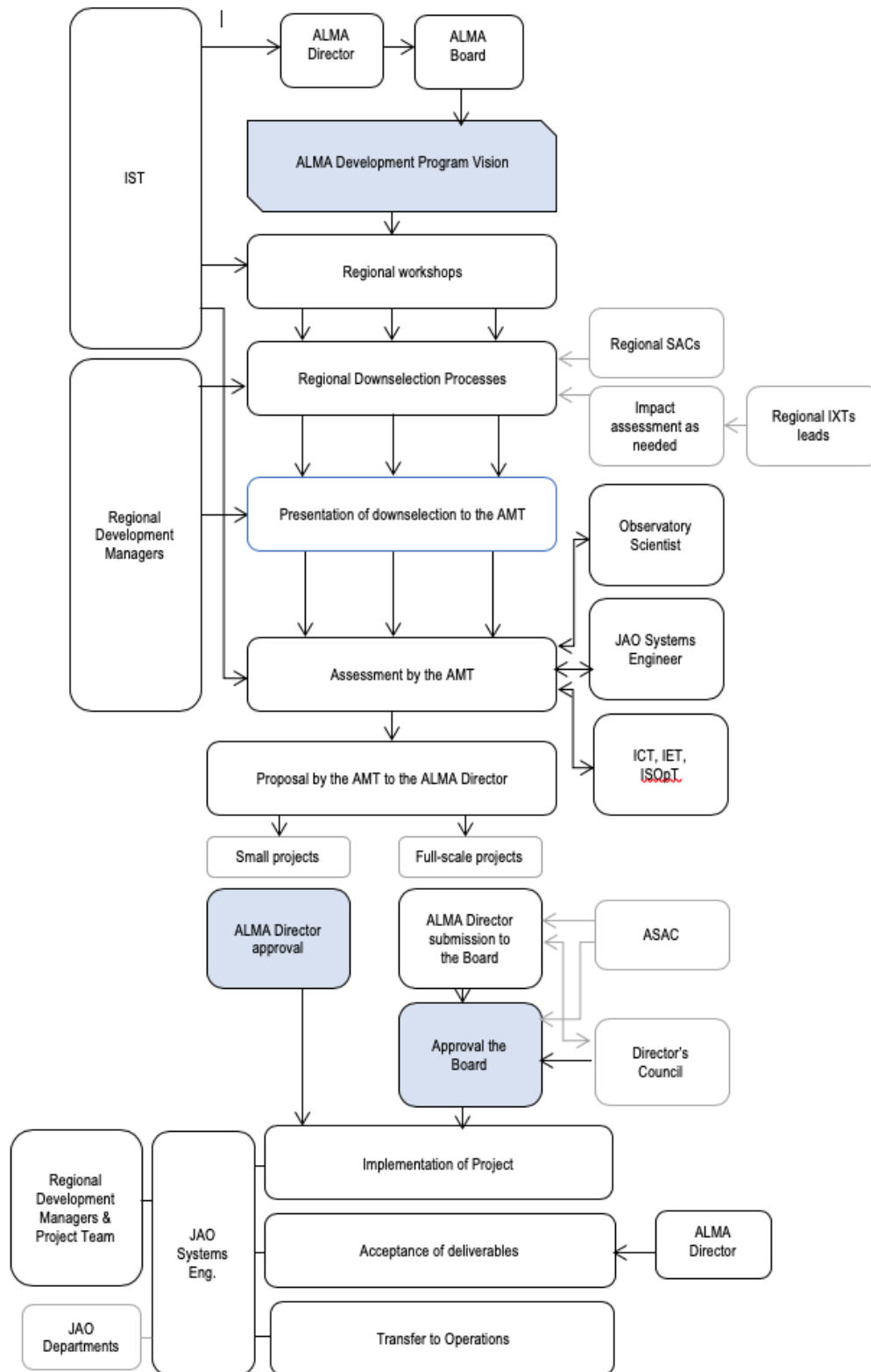


Figure 1: Development Projects Workflow



7. Planning and Proposal Phase

This section describes the initial stages of an ALMA Development Project proposal, from its preparation phase to demonstration of technical readiness, in preparation for consideration for approval by the ALMA Director or the ALMA Board, depending on the proposed budget [AD04].

Development Project proposals are initiated regionally in EA, EU, and NA following different processes which are particular to each region and are initiated and administered by NAOJ, ESO and NRAO, respectively. Therefore, the Executives shall, in possible collaboration with other institutes, choose and carry out development of new hardware, software, or infrastructure in accordance with the development principles [AD04].

The regional ASCs shall provide centralized management of the development process at the Executives, including gathering of information and coordination of community proposals. Each ASC manages the activities for upgrades and development/modification in cooperation with the regional ALMA Program Scientist, the regional Development Program Manager, and other technical experts within the ASC. Given the different frameworks under which the Executives operate, there is no shared and single implementation of the ASC from Executive to Executive. However, the AMT is responsible for ensuring the necessary coordination and unified projects proposal that are finally submitted by each ASC for consideration into the ALMA Development Program.

The initial planning must be driven by a clear science motivation [AD04]¹, and must try to exploit regional expertise as much as possible, in order to reduce risks and costs. Development project proposals must follow the unified ALMA Vision and provide deliverables which enhance the science capabilities and/or performance of the array, or which can be used as the initial stage for a new development project that would eventually introduce the same.

The IST and its members from each ASC are responsible for fostering high-level community input and interfacing with the scientific community to gauge interest and raise potential avenues of development for consideration. The IST is also responsible for coordinating the regional proposal processes to include relevant information regarding the overall vision and/or specific avenues of development and is responsible for all the scientific aspects of the ALMA Development Program, from formulation of requirements through design and construction to commissioning and science verification. Its inputs are conveyed to the AMT through the Observatory Scientist, to advise the ALMA Director on the overall scientific priorities of the ALMA Development Program. This process is informed through scientific/technical workshops and Studies funded regionally and defined under the leadership of the regional IST Heads. The IST can also foster and promote internal Studies and development proposals.

Development Project proposals in different regions will be coordinated by the Development Program Manager of the corresponding Executive. Development Program Managers will be the points of contacts with regional and cross-regional IET/ICT groups, the JAO and the AMT, and

¹ As described in [AD04], the ALMA Development Program shall achieve its goal of enhanced scientific capabilities by means of: delivery of new equipment or capabilities; improvement, enhancement or increased availability of existing equipment or capabilities; reduced costs or risks for Operations; or improved efficiency.



inform them and request input as necessary before the submission of the proposal for approval. The AMT will coordinate the necessary input from the IXTs.

If down-selection of competing proposals in the same or different regions is required, priority will be given to the scientific justification, budget considerations, and technical readiness and expertise. Down-selection processes shall be defined for each case by the AMT, with the input of the Observatory Scientist and the Observatory Systems Engineer.

7.1 Science Motivation

ALMA Development Project proposals must be driven by a strong science motivation in line with the ALMA Vision and largely consistent with the latest version of the Development Roadmap. Proposals not directly related to the Development Roadmap could also be considered if its implementation would lead to tangible scientific, operational, or maintenance improvements.

The science motivation of a Development Project proposal and its coherence with the ALMA Vision shall be assessed by the ASAC prior to submission for approval. In this regard, the ASAC provides scientific advice to the ALMA Board and ALMA Director regarding proposed priorities for development projects, and the suitability of specific projects in meeting stated ALMA scientific objectives. The prospective projects and priorities for the ALMA Development Program from the regional science advisory committees (ESAC, ANASAC, EASAC) will be made available to the ASAC which will provide a synthesis of that input in its advice to the ALMA Board and ALMA Director.

The scientific merit given the specifications should be highlighted by the IST, elaborating on the broad and specific benefits of the proposed Project. New science areas should be explicitly identified. Improvements to performance over existing telescope performance should be quantified into the space of the fundamental performance metrics for ALMA, namely improvement in speed/efficiency, accuracy and/or cost.

7.2 Potential collaborations

Development project proposals should explore possibilities of collaboration among the Executives, JAO, Institutes, Universities and Industry in order to reduce budgets and risks, exploit expertise and synergies of different groups, and provide a wider vision which strengthens the value of the proposal. Development Program Managers are responsible to coordinate different regional and cross-regional efforts and to keep the AMT properly and regularly informed.

7.3 Project concept

A Development Project proposal must clearly address the scope/scale and planned method of the Project, describing objectives, assumptions, working theories, and approaches that will be used, and state hypothesis, including the scientific rationale for the proposed Project and its significance to ALMA. Specifically, the projects shall follow the minimum proposal content requirements indicated in Section 7.9.



7.4 Specifications

A Development Project proposal must be consistent with the latest applicable ALMA system and corresponding sub-system level requirements. If additional specifications are necessary, or existing requirements need to be changed, this will be part of the initial project proposal package and will be subject to a (Sub-)System Requirements Review coordinated by the corresponding Development Program Manager, led by the Observatory Systems Engineer and with the participation of the IST. This (Sub-)System Requirements Review shall be completed before the proposal is submitted for approval. The approved specifications will be part of the assessment of Technical Readiness described in 7.5, and all additional or modified requirements must be approved by the ALMA Change Control Board (CCB) by the critical design phase (and no later than the project's CDR).

7.5 Technical Readiness Status

Before a Development Project proposal is submitted to the ALMA Director or the ALMA Board for approval, it must have reached proper technical readiness. Technical readiness will be assessed by comparison of performance of existing prototype hardware and/or software with the latest applicable ALMA requirements, including those approved by a (Sub-)System Requirements Review. In addition, the technical readiness assessment will also require consideration of readiness of implementation, e.g. fabrication methods, feasibility of mass production, ALMA interfaces, and possible impacts on ALMA facilities and maintenance and operation plans.

7.6 Operations and Colateral Development Input into Planning

Input regarding the potential impact of a development project on operations or further development is an important part of the consideration of any potential Development Project. If provided at a sufficiently early stage, this input can ensure that implementation measures are incorporated in the project from the outset, and that unexpected, late-stage impact costs are avoided. The Executives are responsible for gathering this input and providing it in a timely manner to potential Development Projects. This implementation planning process should typically occur after regional down-selection but before the proposal is submitted to ALMA for approval.

The regional Development Program Managers should keep the Observatory System Engineer informed of potential submissions of Development Projects. When, through this coordination, a Development Proposal is deemed sufficiently mature, the Observatory System Engineer will inform the ALMA Deputy Director of this status. The Observatory System Engineer, with support from the Performance and Quality Manager and from the relevant regional Development Program Manager (or their delegated point of contact), will assess what areas of upgrade to the ALMA System are required or what aspects of operations may be impacted, either financially or in performance. Following this initial assessment, the Observatory System Engineer will request further detailed input from JAO Department Heads and/or IXT Leads, who will give the performance or budgetary impact of such upgrade or operations input. The duration of this study will depend on the scope of the Project in question; the typical length is about four weeks and it shall not exceed eight weeks. This timescale will be informed to the relevant regional Development Program Manager. It is anticipated that this input will require broad participation from the regional offices and that collaboration between the IXT Lead and the heads in the regions which are responsible for the



components requiring upgrade/development will be vital. The final, collated input will be returned to the regional Development Program Manager for inclusion in the Project Proposal.

7.7 Proposal Submission Timeline

Proposals must be submitted sufficiently far in advance of the Board meeting at which approval is being sought to allow the required input and preliminary approvals to be obtained. A summary package with essential information – technical overview, budget and schedule estimates, and listing of major system impacts – must be received 16 weeks prior to the relevant Board meeting so that the evaluation and approval process can begin. The final proposal package must be received no less than ten weeks prior to the intended approval date. The AMT+OSE+OS would then have four weeks to review, discuss and potentially request clarification on the proposal before finally making any recommendation to the ALMA Director. The recommendation from the AMT to the ALMA Director must come at least six weeks prior to the ALMA Board meeting (or approval date, if done by the Board’s Written Procedure) at which the decision would be made in order to allow sufficient time for the approval process, considering that any submission to the Board has to be done at least two weeks in advance of the decision-making date. Input from the ASAC can be gained in parallel, especially considering the ASAC face-to-face meeting is typically only eight weeks prior to the ALMA Board.

In summary, these are the submission deadlines for ALMA Board evaluation of a Project Proposal:

- T-16 weeks: Summary package (technical overview, budget and schedule estimates, and listing of major system impacts)
- T-10 weeks: Final proposal package
- T-6 weeks: AMT+OSE+OS recommendation to the ALMA Director
- T-2 weeks: Final documentation package for the ALMA Board

7.8 Project Implementation Cost Responsibilities

All onsite upgrade costs (rough order of magnitude [ROM]) must be included in the assessment sent to the ALMA Director by the AMT+OSE+OS. Collateral development costs may either be included in the Project proposal, highlighted as coming as in-kind contributions from operations with corresponding risks to operations, or sought through a separate proposal to the Development Program. Upgrades to the infrastructure at the JAO should be included in the Development Project proposal as implementation costs. This may include upgrades to buildings, connectivity, archives, etc. The costs of AIV activities should be included in the proposal. Development of these estimates would be done prior to submission for approval by collaboration between the JAO, the submitting region and the Executives responsible for the modifications to JAO or other Executives’ infrastructure (e.g., buildings, archive).

7.9 Proposal Content Requirements



An ALMA Development Proposal shall contain the following standard elements, according to the template included in an appendix of this document. Some variation to accommodate differences or from region to region may be required.

- **Co-Is and Collaborating Institutions:** The proposal should include a table listing all co-investigators, together with their institutional affiliation and email and telephone contact information.
- **Sub-contractors:** The proposal should also list the name(s) and address(es) of any external contractors and a brief description of the parts or services they are providing to the project.
- **Science Case:** This section should describe the key science benefits to ALMA of the proposed project. A clear description of the science motivation for the project will be essential to the proposal's success.
- **Project Scope:** This section of the proposal should include a brief statement of the scope of the project: i.e., the overall intent of the project, what the project includes, and relevant or related items that it may exclude, if that should be clarified. For example, this section should include the extent of the design and development activity, the major components or modules to be constructed or the software to be written.
- **Project Deliverables:** This proposal section (and subsections, as required), should clearly describe and identify all the major deliverables for the project. This should specifically include:
 - Hardware
 - Software
 - Services, and
 - Documentation. The documentation deliverables should typically include:
 - Monthly Progress Reports
 - Specifications
 - Hardware design documentation
 - Software/firmware design documentation
 - Interface Control Documents (ICDs)
 - Technical manuals and procedures
 - Quality Assurance procedures
 - Safety procedures
 - Acceptance Test Procedures and Reports
 - Closeout Report
- **Interfaces to ALMA:** The project must indicate how its deliverables will interface and operate with other ALMA systems. This section might typically describe or list the major subsystems being constructed, the ALMA systems and subsystems being impacted, and the actions, in broad terms, that must be taken to address the impacts. The detailed integration plan may be developed in later impact assessments, described below.
- **Period of Performance:** This section of the proposal provides the expected period of performance (project start and end date).
- **Project Staffing:** This section lists the key personnel for the project by name, function, FTE allocation over the length of the project, and duration of the engagement. FTE totals for the project should be provided.
- **Project Cost:** The project proposal must contain a cost breakdown by WBS element. Contract costs should be listed as separate line items or described in separate sub-sections.



A table of total project costs including contingencies should be provided. Finally, a cost distribution (cash flow) table should be provided listing the project expenditures for each year of the project.

- **Project Schedule:** The proposal should provide an execution timeline. This is typically a Gantt Chart (or similar), organized by major work breakdown task elements, or in other a comparable project management format.
- **Project Management:** This section describes the management methods that will be employed in the project to ensure orderly execution and adherence to budget and schedule. Elements typically included are:
 - Systems/Configuration Control
 - Systems Requirements & Specification Control
 - Documentation Control
 - Product & Quality Assurance Control
 - Performance to Schedule
 - Performance to Budget
 - Measures of Success
 - Risk Management
 - Communication Plan and Progress Reporting
- **ALMA Implementation, Impact, and Commissioning Plans:** This section describes the plans for implementation, assessment of impact, and for commissioning, which can be developed with the assistance of the ALMA staff. The regional Development Program Manager is the contact point for this interaction.
- **Project Closeout:** At the conclusion of the project, the responsible Executive will typically require a closeout report from the PI to verify that the work has been completed, in compliance with the proposal requirements. The necessary contents of this report will be specified by the responsible Executive.
- **Operational Impact Assessment and Colateral Development Input:** see section 7.6
- **Commitment Statement:** This section is a statement by the PI agreeing to the terms of submission and these standard ALMA guidelines and to carry out the project as proposed.

8. AMT Recommendation

Upon receipt of a proposal from an Executive, the AMT will oversee the approval process. The AMT shall ensure that approval procedures are followed, that process and review decisions are timely, and that issues arising are resolved transparently and expeditiously. In this regard, the AMT, with the input of the Observatory Scientist and the Observatory Systems Engineer, will advise the ALMA Director on the projects that are ready for being submitted for approval and to be funded and implemented, based on:

- The science case and its relevance for the vision [AD05] and aims of the ALMA Development Program;
- The Operational Impact and the total estimated life-cycle cost of the Project (reduction or increase) including operation, maintenance and decommissioning, and telescope time;
- The Technical Readiness of the Project;
- The development capabilities in the individual regions so that ALMA enhancements and renewal can be sustained in the long-term.



- The proper consideration of possible collaborations to reduce costs and maximize the science impact of the Project.

9. Approval

The approval process will depend on the cost of the project, as defined in the Principles of the ALMA Development Program [AD04].

Currently, Full-scale Projects are those with estimated overall costs of more than 250 kEUR, 250 kUSD or 30 MJPY²; Small-Scale Projects are those with estimated costs below or equal to the above amount. The ultimate authority for approving Development Projects to be implemented is, in general, the ALMA Board, but the ALMA Board has delegated the authority to approve small projects to the ALMA Director.

The approval of a Project shall include approval of the overall costs of the Project for the purpose of balancing Party contributions to the ALMA Development Program.

For any changes made in the Development (DEV) budget, the corresponding ASC Operations Manager will inform the ALMA Director and AMT. Changes larger than 10% of an Executives' annual DEV budget need to be approved by the Board (for full-scale projects) or by the ALMA Director (for studies and small projects).

9.1 Small Projects

Small Projects (below the threshold specified in the Development Principles [AD04]) are recommended by the AMT, with a cover document including a summary of the motivation and the outcomes of the assessment conducted by the scientific and technical teams. The ALMA Director shall consider the approval of these projects after consulting with the ASAC through the Observatory Scientist. The AMT will propose the resolution to be passed by the ALMA Director, including the total cost of the project that is being submitted for approval and the implementation aspects. The ALMA Director shall keep the DC informed about the small projects being approved and/or consult for advice, if deemed necessary.

9.2 Full-scale Projects

Full-scale Projects (above the threshold specified in the Principles) are approved by the ALMA Board, upon recommendation by the ALMA Director, with the concurrence of the DC, due to their budgetary implications [AD01].

The ALMA Board would then approve these projects, considering relevant input from the ASAC.

The ALMA Director, as recommended by the AMT, will propose the resolution to be passed by the ALMA Board, including the total cost of the project that is being approved and the implementation aspects.

² Note that these values could change, please refer to [AD04] for the amounts as approved by the ALMA Board.



9.3 Projects up to PDR

Depending on the scale of a development project, a specific goal may be to get to a Preliminary Design Review through the ALMA Development Program.

At this stage the project team should demonstrate that viable technical options are available to achieve the project goals. For some development projects, achieving PDR level may be the end-goal of the project.

10. Execution and Oversight Phase

In general, the AMT provides the centralized steering of the overall Development Program and will oversee its delivery. The AMT will also monitor the progress towards the delivery of development projects already approved (short-range view – implementation) and will report to both the ALMA Director and the Board.

In particular, the execution and oversight of approved ALMA Development Projects are responsibilities of the proposing Executive. In case of collaborative projects across multiple Executives, the roles, responsibilities and interfaces for the execution phase will need to be detailed in the project structure and planning documents. One Executive will lead the overall project and will be directly responsible for providing the overall coordination of the activities, including tracking the general schedule and progress of the activities. Each Executive will remain responsible for the execution of the workpackages under its leadership, schedule and performance. Issues that cannot be resolved and agreed within the project partners (to be defined by the AMT for each project) will be escalated to the AMT for discussion and resolution.

Each Executive will follow its internal guidelines for Execution and Oversight of ALMA Development Projects. Oversight procedures for major milestones and Reviews (e.g., but not limited to PDR, CDR, MRR, etc.) shall adhere to common ALMA practices, as detailed in the ALMA Product Assurance Requirements [RD07], in order to ensure that all components of the ALMA system are delivered with a consistent high level of quality in their design, fabrication, performance, reliability and documentation.

The same principles of ownership, warranty, and maintenance responsibility will apply to the deliverables resulting from the ALMA Development Program as apply to those resulting from the construction phase of ALMA [AD06, RD08, RD09].

10.1 Detailed Design and Manufacturing Reviews

An approved development project would need to conduct a Critical Design Review (CDR) and a Manufacturing Readiness Review (MRR), which may be combined, depending on the scale and context of the project.



- Critical Design Review (CDR) is meant to verify that the detailed design of the configuration items satisfy specified requirements; to establish the compatibility among the configuration items and other items of equipment, facilities, software, and personnel; to assess risk areas for each configuration item; and, as applicable, to assess the results of producibility analyses, review preliminary hardware product specifications, evaluate preliminary test planning, and evaluate the adequacy of preliminary operation and support documents [RD09]. The Critical Design Review Data Package is the deliverables to be furnished by the contractor/ALMA partner(s) before the CDR in accordance with the timelines defined. The CDR will be conducted on the basis of the examination of these deliverables [RD09].
- MRR shall be held prior to the start of production or manufacturing to evaluate the maturity of the manufacturer's documentation and production processes and to highlight areas of risk that need to be monitored during production. Another key component of the MRR is to verify that all critical design issues have been resolved or sufficiently mitigated to the satisfaction of the review panel [RD09].

10.2 Oversight

Each Development Project shall have a project management team which shall be composed by at least a Project Manager (PM), and a technical/scientific leader. The PM shall be responsible for the execution of the project according to the agreed schedule and budget. The technical/scientific leader shall be responsible of ensuring that the deliverables of the projects meet the project science requirements. Where applicable, the technical/scientific leader will also be responsible to define and execute the Commissioning and Science Verification plan.

In case of Development Projects carried out by Institutes external to the ALMA Executives, the sponsoring Executive remains ultimately responsible for the execution of the Project. In such a situation, the sponsoring Executive shall nominate a project management team to track the execution of the Project and will be responsible towards the ALMA Partnership in a similar fashion as for an internal Project.

During the execution of an ALMA Development Project, the project team is responsible to produce regular project updates following the practices in place in each Executive. These updates will form the basis of the progress reports to the AMT, ALMA Board and the ASAC. It is expected that the relevant Executive Operations Manager will be responsible for keeping updated the AMT and ALMA Board on the milestones schedule and financial performance of the project, while the Executive Program Scientist will be responsible to provide updates to the ASAC.

If an ALMA Development Project deviates from the schedule or budget profile, the relevant Executive Operations Manager has the responsibility to take appropriate corrective actions and to keep the AMT informed of the schedule and financial risks of the project. Deviations from the planned schedule and budget profiles will be monitored by the AMT to evaluate the impact on delivering capabilities to the users and potential impact on other development activities. Deviations from budget beyond the thresholds defined in [AD04] will be dealt following the prescriptions in that document, as detailed in section 8 above.



a. Deliverables

Deliverables of ALMA Development Projects need to be clearly listed in the project proposal and must include all activities related to AIV and CSV, if appropriate (see section 7.9 – Proposal requirements). Unless differently agreed, the development project deliverables will become part of the ALMA Observatory, once formally accepted. The delivering Executive will be responsible for warranty [RD08] and maintenance of the deliveries, unless arranged otherwise.

b. Acceptance

The Development Project is responsible for defining and coordinating the execution of acceptance procedures of the deliverables according to the procedures outlined in the ALMA Product Assurance Requirements [RD07]. The corresponding acceptance plan and procedures are scrutinized at the CDR (preliminary versions) and MRR (final versions) gate reviews. An incremental acceptance approach is used:

- 1) Preliminary Acceptance In-House (PAI): full acceptance verification in-house, if passed the subsystem is authorized to be shipped to the site.
- 2) Provisional Acceptance on-Site (PAS): health check that the components have survived the shipping and transport process, if passed the subsystem is authorized to be integrated at the site.
- 3) Acceptance Review (ACRV): acceptance verification of the fully integrated system, if passed the subsystem is authorized to be commissioned. At this point all subsystem-level requirements shall be duly verified.

Projects may have two or more full-scale reviews as identified in the project management plan. The outcomes of these reviews will be included in the regular updates to the AMT and the Board. In some cases, as defined by the AMT, the reviews may result in the termination of the project.

10.3 Delivery Requirements

The formal owner of the deliverable shall be responsible for maintaining the integrity of the item and the accuracy of the controlled and released Configuration Item Data List (CIDL), which includes all work products that are intended to be handed over to the observatory including, but not limited to all documentation, hardware and software. The latter considers controlling the replacement of any hardware component, modification of marking or installation of any software upgrade or patch and the delivery of an update. As detailed in the ALMA Product Assurance Requirements [RD07], after an item has passed its formal acceptance process, JAO will take over the operation and maintenance of the deliverable.

Documentation shall accompany each configuration item and shall contain a list of all components (including, if applicable, serial numbers) that comprise the overall item. The accompanying documentation shall maintain a history of all equipment and/or component changes which occurred prior to the current version.



ALMA Development Projects Implementation Plan

Doc #: ALMA-10.04.00.00-0025-A-PLA
Date: 2019-04-22
Page: 19 of 26

The documentation supplied in the Acceptance Data Package shall reflect the “as-built” version of the delivered equipment and shall contain sufficient information for the installation, operation and maintenance of this equipment. This documentation is detailed in the ALMA Product Assurance Requirements [RD07] and includes Compliance matrix, relevant safety documents, manuals, as built drawings, etc.

All deliverables will include two years of spare parts, based on the results of the corresponding reliability analysis.

11. Commissioning

The commissioning plan should be delivered by time of a CDR. At that point, the JAO, regional centers, and any institutes participating in the program should agree on a resourcing and commissioning work estimate. After a successful Project is approved, the ALMA Deputy Director and the OS will include the capability in the Obsmode process (reference) for final roll out. At this point, the Deputy Director is responsible for informing if the commissioning process becomes stalled or blocked, escalating to the AMT for resource reconsideration or delay of the capability.

It is noted that for pure Software deliverables a more iterative and gradual commissioning approach might be suitable, in order to allow related staff to get involved at an early stage of the activities. Nevertheless, also here there needs to be a first-instance commissioning outline, including rollout and tasks list, which does allow for a preliminary agreement on resourcing and commissioning work estimate, as mentioned above.



APPENDIX: Project Proposal Template

**Development Upgrades of the Atacama Large
Millimeter/submillimeter Array (ALMA)**

*Insert **TITLE** here*

Principal Investigator:

Institution:

Address:

PI Contact Information:

Telephone Number

Email Address

1. Abstract

Present a one-page (or less) description of the work scope and objectives of the proposed project with emphasis on your project’s scientific merits. If applicable, please include a description of prototype hardware and/or software.

Contents

2. Co-Investigator(s) and Collaborating Institution(s)

Complete Table 1.0, below. Insert/delete rows as needed.

Table 1.0: Co-Investigator(s) and Collaborating Institution(s).

NAME	INSTITUTION	EMAIL	TELEPHONE

3. Subcontractors

Obtain Company and/or Institution authorization to be proposed as a subcontractor prior to completion and sign-off of this Proposal.

2.1 Company/Institution:

Address:

Subcontracted parts and/or services:

4. Science Case



Present the scientific rationale for the proposed Project and its significance to ALMA. Specifically, please explain how the science case is aligned with the current Development Roadmap priorities.

5. Project Scope

Insert an explanation of the scope/scale and planned method of the Project. Describe Project objectives, assumptions, working theories, and approaches that will be used, and state hypothesis.

6. Project Deliverables

Describe the products that will be delivered at the conclusion of the proposed Project (if applicable.)

6.1 Hardware

6.2 Software

6.3 Services

6.4 Documents

- Monthly Progress Reports
- Final Report

7. Interfaces to ALMA

Note the ALMA hardware and/or software control interfaces that may be affected if the proposed design or control scheme is implemented.

8. Site Location Impact Statement (if applicable)

Describe any new facilities, significant modifications to existing facilities, or use of [Executive] facilities that are required. Also indicate when these facilities and/or modification are required.

9. Period of Performance

Define the anticipated period of performance.

10. Staffing

*Estimate the level of effort (unit of measure = **F**ull **T**ime **E**quivalent) to be deployed. Include Collaborating Institutions/Subcontractors until completion of the proposed Project, as well as the corresponding total cost to be incurred. Identify essential (key) personnel required to ensure success. If two, or more, persons of equivalent labor grade are capable of performing any given task, leave the corresponding Key Personnel cell blank and note the FTE level of effort only.*

10.1 Offerer's Staffing



**ALMA Development Projects
Implementation Plan**

Doc #: ALMA-10.04.00.00-0025-A-PLA
Date: 2019-04-22
Page: 22 of 26

Complete Table 2.0, below. Insert/delete rows as needed.

Table 2.0: Labor Estimate.

TITLE (EXAMPLES)	KEY PERSONNEL	FTE	DURATION (MONTHS)
Principle Investigator			
Scientific Lead			
Engineering Lead			
Research Engineer			
Senior Engineer			
Engineer 1			
Technician 1			
Machinist			
Other			
TOTALS		0.00	0.00

10.2 External Staffing *(if applicable)*

Complete Table 3.0, below. Insert/delete rows as needed.

Table 3.0: External Staffing and Contact Information.

TITLE	NAME	INSTITUTION	EMAIL	TELEPHONE
Co-Investigator				
Vendor Point of Contact				
Customer Point of Contact				

11. Cost Breakdown

11.1 Offerer's Cost

Complete Table 4.0, below. Work Breakdown Structure (WBS) Number should correspond to Level 1 tasks/activities in the Project Schedule. Insert rows as needed.

Table 4.0: Offerer's Cost Breakdown.

WBS No.	TASK DESCRIPTION	LABOR (\$)	MATERIALS & SERVICES (\$)	TRAVEL (\$)
1.0				



**ALMA Development Projects
Implementation Plan**

Doc #: ALMA-10.04.00.00-0025-A-PLA
Date: 2019-04-22
Page: 23 of 26

2.0				
n.0				
<i>SUBTOTALS (\$)</i>		0.00	0.00	0.00
<i>TOTAL OFFERER'S COST (\$)</i>				0.00

11.2 Collaborating Institution / Subcontractor Cost

Complete Table 5.0, below. Insert rows as needed. Note the value of any In-Kind Contributions.

Table 5.0: Collaborating Institution/Subcontractor Cost & In-Kind Contribution.

COLLABORATING INSTITUTION / SUBCONTRACTOR	USD (\$)	IN-KIND CONTRIBUTION VALUE IN USD (\$)
<i>TOTAL COST (\$)</i>	0.00	
<i>TOTAL VALUE OF IN-KIND CONTRIBUTIONS (\$)</i>		0.00

11.3 Total Project Cost

Complete Table 6.0, below.

Table 6.0: Total Project Cost.

PROJECT COST ELEMENTS	USD (\$)
Total Offerer's Cost (Table 4.0)	
Collaborating Institution / Contractor Total Cost (Table 5.0)	
Project Contingency (requires a supporting Risk Mitigation Plan, Table 9.0)	
<i>TOTAL PROJECT COST (\$)</i>	0.00

11.4 Total Project Value

Complete Table 8.0, below.

Table 8.0: Total Project Value.

PROJECT ELEMENTS	USD (\$)
Total Offerer's Cost (Table 4.0)	
Collaborating Institution / Contractor Total In-Kind Contributions (Table 5.0)	



<i>TOTAL PROJECT VALUE (\$)</i>	0.00
--	-------------

12. Project Schedule

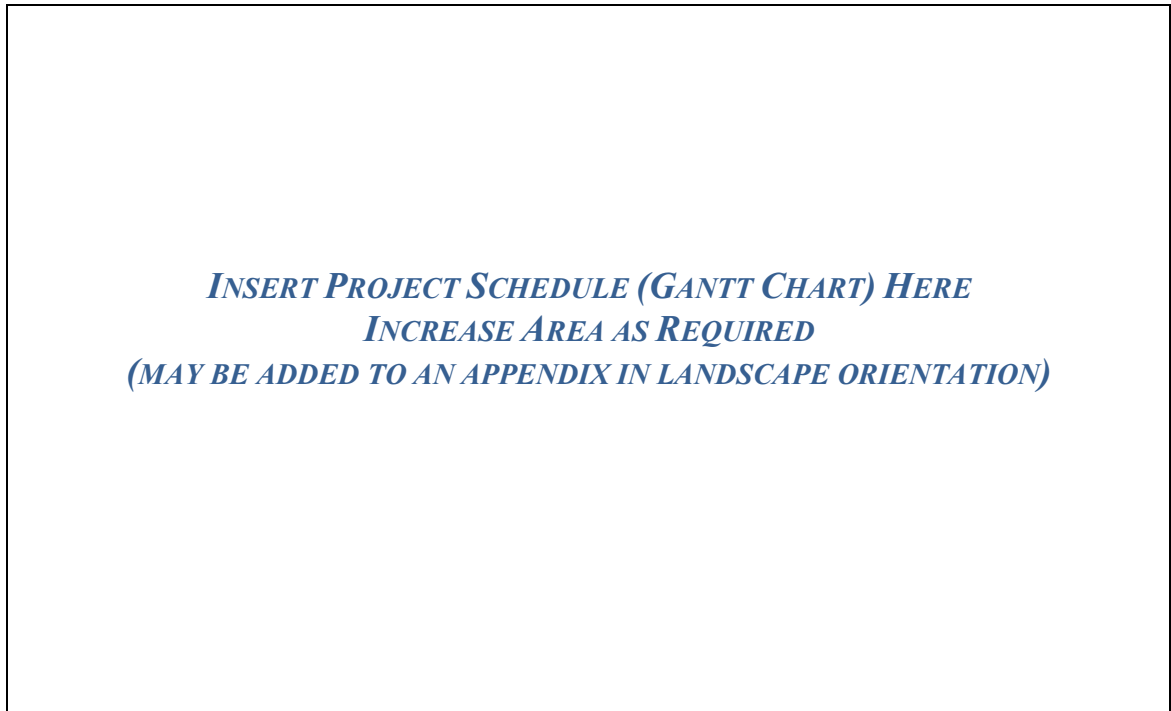


Figure 1.0: Project Schedule.

13. Project Management

13.1 Systems/Configuration Control

a. Systems Requirement and Specification Control

Refer to [RD1].

Development engineering and design activities shall be conducted in accordance with established Systems Engineering policies, practices and procedures.

b. Documentation Control

All shared documents shall be dated and bear a revision level number.

c. Product & Quality Assurance Control

Refer to [RD2]. A unique Product Assurance Plan is unnecessary.

Development engineering and design activities shall be conducted in accordance with established ALMA PA/QA policies, practices and procedures.

13.2 Performance to Schedule



The Principal Investigator has primary responsibility for schedule development and performance to schedule. The [Region] ALMA Development Program Manager will, if requested, provide support to the PI in establishment of a revision-controlled Project Schedule and monthly preparation of performance to schedule status. In the event of a schedule variance, the PI and the [Region] ALMA Development Program Manager will assess the impact and develop the appropriate recovery action(s).

13.3 Performance to Budget

The Principal Investigator has primary responsibility for intra-Project budget allocation and cost performance. The [Region] ALMA Development Program Manager, if requested, will provide support to the PI in establishment of cost accounts, budget load, and the preparation of a revision-controlled, monthly Budget Status Report. In the event of a cost variance, the PI and the [Region] ALMA Development Program Manager will assess the impact and develop the appropriate recovery action(s).

13.4 Measures of Success

Describe the measures of success (performance metrics and outcomes) for this Project. Describe the process that will be used to address experiment prioritization, evaluate experiment results, and to modify the approach/redirect experiments. Include an assessment of the likelihood that the proposed method and approach to the Project will further the state of the art.

13.5 Risk Management

Identify the primary areas of uncertainty (risk) foreseen at the outset of the Project. Estimate the probability of occurrence and associated cost impact of each identified risk. Also, briefly note the means by which each primary risk may be mitigated or retired altogether. Add/delete rows as needed.

Table 9.0: Project Risk Assessment.

NO.	PRIMARY RISK(S)	PROB. (%)	IMPACT (\$)	MITIGATION
1				
2				
3				
TOTAL PROJECT CONTINGENCY (\$)			0.00	

13.6 Communication Plan and Progress Reporting

A monthly Progress Report shall be prepared by the Principal Investigator in accordance with [Executive] Program Management practices and procedures. Informal reviews will be conducted by the [Region] ALMA Development Program Manager upon the completion of project milestones.



14. Project Closeout

Upon conclusion of this Project, the [Region] ALMA Development Program Office will coordinate the orderly closeout of activities; or, the transition of activities to a continuing Study or Project.

15. Commitment

Having read all documents listed in, and having assessed the situation and the nature and difficulties of the proposed services, the undersigned hereby offers the “*insert Project Title here*” in accordance with the provisions of the present Development Project Proposals and, if awarded the Agreement, undertakes to carry out the work required according to best trade practices, within the prescribed time limits, and at the price set out in this Proposal.

Name: _____

Institution: _____

Signature: _____

Date: _____

ANNEX A - REFERENCE DOCUMENTS

ANNEX B – CURRICULUM VITAE OF KEY PERSONNEL