

**REQUEST FOR PROPOSALS (RFP) – Contract
ND1503C**

FOR

GEMINI NORTH ADAPTIVE OPTICS (GNAO)

“ADAPTIVE OPTICS BENCH (AOB)”

STATEMENT OF WORK

GNAO-AOB-RFP-001



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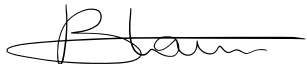


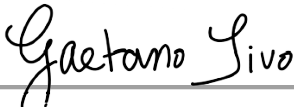



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Document Acceptance and Release Notice

The Statement of Work Document is a managed document. To identify changes, each page contains a release number and a page number. This document is authorized for release once all signatures have been obtained.

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Change Record

Version	Date	Description	Owner Name
A	1/15/2020	Approved for release	C. Blain



1 Applicable Documents

Applicable documents are binding to the contract to be signed.

Document #	Document ID	Revision	Title
[AD-01]	GNAO-AOB-RfP-002	A	GNAO AOB Specifications
[AD-02]	ICD 1.5.3/1.9	E	Instrument Support Structure to Science Instruments ICD
[AD-03]	ICD 1.9/5.0	D	Science and Facilities Instrument to Transport, Observatory and Operational Environment Interface Control Document
[AD-04]	ICD 1.5.3/1.8b	A	Instrument Support Structure (ISS) to Gemini North Adaptive Optics Bench (GN-AOB) Interface Control Document
[AD-05]	SPE-ASA-G0008	10	Gemini Electronic Design Specification

2 Reference Documents

Document #	Document ID	Revision	Title
[RD-01]	GNAO-CoD-07 (extract)	A	GNAO Conceptual Design Document EXTRACT
[RD-02]	GNAO-CoD-05	A	Concept of Operations Document
[RD-03]	GNAO-CoD-04	A	Science Case Document
[RD-04]	INST-REQ-0001	C	Science and Facility Instruments Common Requirements Specification
[RD-05]	GNAO-AOB-SIM-004	v2.1	Wavefront Sensor and Deformable Mirror Design Parameters for GNAO
[RD-06]	GNAO-AOB-SIM-002	v0.2	Distortion in Gemini MCAO Systems
[RD-07]	GNAO-AOB-SIM-003	v0.2	GNAO Laser Launch Telescope Location



3 Introduction

The Gemini Observatory is developing a new facility class Multi-Conjugate Adaptive Optics (MCAO) facility for the Gemini North Telescope. The Gemini North Adaptive Optics (GNAO) system, comprises four main products: (i) an Adaptive Optics Bench (AOB), (ii) a Real-time Controller (RTC), (iii) a Laser Guide Star Facility (LGSF) and (iv) a System Controller (SyCo). The AOB is an integral product of the GNAO facility, integrating closely with the other GNAO products, the telescope, and the science instrument(s). All GNAO products work together to reduce the optical aberrations introduced by the atmosphere.

This Statement of Work (SOW) identifies the general approach, deliverable items, and overall work required by the Contractor to design, implement, procure, integrate and conduct acceptance testing, packaging, transportation, delivery and warranty of the GNAO Adaptive Optics Bench. The SOW also provides programmatic and technical background. The SOW defines the scope of work to be performed, the tasks, the reports and reviews to be completed, and defines deliverables required from the contractor. Technical specifications are contained in the AOB Specifications Document [AD-01]. Specific contractual requirements are contained in the contract document.

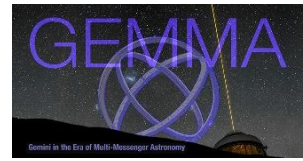
The Contractor is defined as the organization, or the representative of a group of organizations, selected to perform the work stated in this document.

The final deliverables of the system are summarized below and detailed in Sections 4 and 5:

- The optomechanical adaptive optics bench (and bench's support structure, interfacing with the ISS), with all optical and hardware elements, as described in the AOB Specification document [AD-01].
- Accompanying low-level electronics and software for controllable devices (deformable mirrors, wavefront sensors, etc.).
- Documentation including internal AOB requirements, design definition documents, fabrication drawings, schematics, manuals, procedures, maintenance, etc.

3.1 Program Background

The National Science Foundation awarded AURA funding for the Gemini in the Era of Multi-Messenger Astronomy (GEMMA) program. The GEMMA program has three component projects: (i) upgrade the Gemini North Adaptive Optics system, (ii) provide new rapid-response capabilities for time-domain astronomy and (iii) expand community engagement.



3.2 Technical Background

The GNAO facility instrument is a Multi-conjugate Adaptive Optics (MCAO) system for Gemini North. GNAO is a next-generation MCAO system designed for a wide range of science cases. The intention is to produce near diffraction-limited image quality for near-infrared observations, with stable image quality across a 2' diameter field, with a K-band Strehl ratio of between 0.3 (requirement) and 0.5 (goal) under median seeing conditions and nominal 3-NGS constellation. The AOB is the Adaptive Optics Bench of the GNAO facility. Its functionality is to correct the science field from the optical aberrations created by the Earth's atmosphere.

The proposed baseline configuration for the AOB consists of (i) three deformable mirrors (DM), (ii) a tip-tilt mirror (TTM), (iii) a natural guide star focal plane wavefront sensor (WFS) to sense the tip-tilt and correct the plate scale modes, and (iv) 5 laser guide stars WFSs; each collecting light from a laser guide star (generated by 2 Topica lasers, respectively split in 2 and 3 guide stars).

The AOB performs the wavefront correction over the science field by:

- simultaneously collecting the incoming light from the science target, the natural guide stars, and the laser guide stars
- optically decoupling the information relative to each of these entities and sending it for measurement toward the corresponding wavefront sensors
- sampling the wavefront and sending wavefront sensor data to the RTC, using it to generate correction signals for the TTM and DMs
- sending the corrected wavefront to the science instrument

4 Scope

The Contractor shall provide all materials and labor, either directly or through appropriate subcontractors, for the engineering design, integration, verification, validation, packaging, shipping, onsite installation, and onsite acceptance testing as necessary to provide an operational AOB product, according to the AOB Specification document [AD-01] and its associated compliance documents.

This effort includes design interactions between the GNAO Project Technical Representative and the Contractor, and development of plans and documentation to finalize and optimize interfaces between GNAO subsystems and other elements of the telescope system.

The Contractor shall demonstrate that the AOB performance budgets conform to the specifications (optical quality, distortions, WFE and phase reconstruction). This SOW includes all hardware, software, control systems, electronics, and sensors that are required to operate the AOB to required specifications. This SOW defines reports, reviews, and final deliverables.



The Contractor work shall culminate with the on-sky commissioning of the AOB, fully integrated within the GNAO system, at the Gemini North Telescope. The on-sky commissioning of the system is defined as sending the corrected incoming light from the GNAO system to the science instrument camera, with the AOB running in closed-loop. Due to the project's highly constrained schedule, the on-sky commissioning is not expected to be a full science demonstration. The follow-up on-sky science demonstration, dedicated to bring the system into full operation, will be the responsibility of Gemini Observatory.

4.1 AOB Conceptual Opto-Mechanical Baseline Configuration and Hardware

The GNAO team developed and studied two optomechanical concepts during the Conceptual Design Stage of the GNAO project. These designs are presented in the extract of the Conceptual Design Document (RD-01).

- Concept 1 is based on a 4 Off-Axis Parabolas (OAPs) optical design.
- Concept 2 is based on a modified Offner Relay optical design.

Concept 2 presents an improved distortion performance compared to Concept 1 and has been identified by the GNAO team as the preferred baseline configuration for the AOB.

The optical trade studies (done at a conceptual level) have determined that a fixed ADC shall be designed and implemented for the NGS path. For the science path, an ADC shall be retractable as its presence in the science path will be dependent on the type of science instrument used with the GNAO facility.

Simulations have been performed to suggest guidelines for the main parameters of the AO dimensioning regarding (for the deformable mirrors and the wavefront sensors). Results are presented in [RD-05] and [AD-01].

The current baseline configuration consists of:

- 3 DMs conjugated at 0 km, 5 km, and 12 km.
- 5 LGSs generated by 2 Topica lasers (one split in 2 and one split in 3).

For the LGS WFS detectors, the OCAM2 camera has been evaluated by the GNAO team and is suggested as the baseline for the AOB. For the DMs, the Contractor shall evaluate the off-the-shelf available DMs and propose options.



4.2 Interfaces

The Contractor shall provide all the necessary components to interface the AOB product with the entirety of the GNAO system, as defined in the associated Interface Control Documents (ICDs). During the preliminary design stage, the Contractor shall define the AOB external and internal interfaces to generate the respective AOB ICDs (External and Internal) during the critical design stage. The GNAO system is under development, therefore some of the related ICDs are not completely defined. These ICDs shall be developed by the Contractor in collaboration with the GNAO Technical Representative during the design phase of the AOB.

Although interfaces will be developed in collaboration between the AOB Contractor and GNAO Project Technical Representative, the Contractor shall have control over all internal interfaces of the AOB. The GNAO Project Technical Representative shall have control over all external interfaces between the AOB and other systems (see [AD-01] Section 12). Both the Contractor and the GNAO Project Technical Representative shall analyze all external interfaces.

4.3 Procurement

Commercial off-the-shelf (COTS) components shall be used wherever practical. High-priced and long lead items shall be identified in the proposal budget. They shall be confirmed during the particular project phase and reviewed by the GNAO Project Technical Representative prior to purchase.

4.4 Electronics, Cabling, and Controllers

The Contractor shall develop and provide all electronics, controllers, and cabling from their fixed locations to their terminations, as described in [AD-02], [AD-03], [AD-04] and [AD-05].

4.5 Enabling Products

The Contractor shall develop and provide all the equipment required to integrate, test, maintain and operate the AOB at Gemini North Observatory. This may include deliverables such as written operations manuals, and maintenance documentation and test reports of all the components. The list of documents to be provided, and their description, is presented in Appendix 10.2. The Contractor shall provide all plans, specifications, and procedures required to fabricate, assemble, integrate and test the AOB.

4.6 Factory Testing

The Contractor shall perform individual components, subsystems, and full system testing at their facility as required to verify and validate the system is built and operating in accordance with design specifications in order to reduce risks, minimize onsite integration schedule, support manufacture, integration, and overall system testing for operational optimization and onsite acceptance. With the exception of the Gemini-supplied AOB related System Controller and RTC,



the Contractor is required to furnish all equipment and supply all utilities required to operate the AOB during factory testing.

4.7 Packaging and Shipping

The Contractor shall provide appropriate packaging materials and devices required for safe transport of the entire product and shall provide shipping from the manufacturer's facility to the telescope site in Hilo, Hawai'i, as defined in [AD-03]. The final delivery location (Hilo Base Facility or Gemini Telescope at Maunakea summit) will be revised at the start of the Realization Phase.

4.8 Onsite Installation and Acceptance Testing

The Contractor shall provide supervision, labor, equipment, operators, and procedural support for onsite installation of the GNAO AOB at the telescope site on Maunakea, Hawai'i. The Contractor shall perform onsite acceptance testing of the AOB at the scheduled time to validate performance and facilitate final delivery.

4.9 Documentation

The Contractor shall provide to the GNAO Project Technical Representative all design documents, drawings, models, specifications, material certification, literature and manuals, as well as complete as-built design specifications and drawings of the product all in a common electronic format. A list of documentation deliverables is provided in Appendix 10.2. A description of the documentation deliverables is provided in Appendix 10.3. All documents shall be in English.

5 Contractor Work and Deliverables

The selected contractor must design and build the AOB to meet the requirements specified in [AD-01] and ensure the AOB provides all of the functionality and performance required to support the GNAO facility. **The final deliverable (the on-sky commissioning of the system) shall be no later than June 1st, 2024.** Table 1. lists the project deliverables:

Deliverables
Assessment of existing conceptual design
Project Management Plan
System Engineering Plan
Assessment of existing conceptual design report
Opto-mechanical design
Selection of HW components and electronics
Procurement
SW developments
Alignment procedure development
System implementation and Integration
System verification and performance evaluation (at Contractor site and Gemini North)
Maintenance plan development
Documentation and reporting
Installation at Gemini North
On-sky commissioning

Table 1. Project deliverables

5.1 Deliverable details

The Contractor shall provide the deliverables described below following completion of this contracted effort. Where designs or other information are proprietary, AURA will execute non-disclosure agreements with the Contractor, as required to support information transfer.



5.1.1 Assessment of the existing conceptual design

The Contractor shall provide in their proposal, a detailed analysis of the requirements and of the conceptual design developed by the GNAO team during the Conceptual Design Stage of the project. After analysis of the existing conceptual design, the Contractor shall propose to either continue with the existing conceptual design or propose an alternative design. Within the first 60 days after contract execution, during the Initial Planning and Evaluation Stage, the proposer will provide a final assessment of the GNAO-provided conceptual design.

5.1.2 Project Management Plan

The Contractor shall provide a detailed Project Management Plan (PMP) that describes the technical and management teams that will be responsible for the work and specify the key individuals, their responsibilities, and lines of reporting. The Management Plan shall provide identification of a single point of contact for the Contractor organization. Status, reviews, meetings, and daily technical issues will be coordinated with the technical point of contact.

The Contractor shall provide a Project Plan to include at a minimum the following:

1. Work Breakdown Structure (WBS) - with time allocation per activity limited to a maximum of 2 weeks.
2. Product Breakdown Structure (PBS)
3. Work Schedule and Milestones
4. Cost Management Plan (labor and materials)
5. Realization (Implementation, Integration, Verification and Validation) Plans
6. Factory Integration and Test Plans and Procedures
7. Onsite Integration and Acceptance Test Procedures
8. Payment Schedule
9. Final Delivery Date

The Contractor shall provide a detailed work schedule for all major activities and indicate the relevant work milestones. The work schedule shall identify target dates for review meetings (as defined in Section 6.3) and indicate timelines for all tasks with a minimum resolution of a 1-month duration. The Work Schedule shall be consistent with the contract payment milestones and is established to incorporate clear transition points from design and specification tasks to realization and custom purchases. Payments shall be made upon the successful completion of specific milestone activities identified in the Contractor Project Plan.



The Contractor shall include a Quality Assurance plan (see Section 7) which details quality processes and procedures to be used at the Contractor's facility and at Gemini facilities during the execution of this work.

The submitted Contractor's Project Management Plan will be subject to negotiation (schedule, budget, payment milestones, delivery dates, etc.) and final approval by the GNAO Project Technical Representative. The PMP shall be reviewed and finalized during the Initial Planning and Evaluation Stage, described in Section 5.1.2.

5.1.3 System Engineering Management Plan

The Contractor shall provide a Systems Engineering Management Plan (SEMP) that details the systems engineering design processes, build processes and procedures to be used in the Contractor's facility and at Gemini facilities during the execution of this work.

The System Engineering Management Plan shall include at a minimum the following:

- Systems Engineering methodology
- Design and development process
- Requirements management
- Interface management
- Configuration control
- Quality management
- Technical budget management
- Technical management processes

The SEMP shall be reviewed and finalized during the Initial Planning and Evaluation Stage, described in Section 5.1.3.

5.1.4 Optical, Hardware and Software Equipment

The Contractor shall deliver all the mechanical, optical and hardware elements (DMs, cameras, etc.), as well as computer hardware, electronics, cables, software, support equipment, and packaging required for delivery to the Gemini North site in Hilo, Hawai'i.

Whenever applicable, all licenses shall be registered to AURA. The Contractor shall deliver any software developed in source format and shall include the manuals to provide the documentation needed to support the operation of the product.



As mentioned in Sec 4.1, the need to include ADCs within the NGS path and the science path has been identified during the conceptual design. It should be noted that the Contractor shall analyze the ADC design the GNAO team has prepared and finalize the design and provide performance evaluation for both ADCs. The Contractor shall develop and integrate the ADC of the NGS path. The Contractor shall develop the retractable ADC assembly in the science path and integrate the optical component only if can fit in the budget.

5.1.5 Results of Design Analysis and Modeling

The Contractor shall provide results from all design notes, documents, calculations, analysis, and modeling conducted to support the product design and engineering effort. Where available, copies of the analyses shall be provided in computer media or via file transfer in native format, to enable additional analysis by the GNAO team.

5.1.6 Design Documentation and Models

The Contractor shall provide scientific and engineering-driven design documents to allow functional reviews of the Preliminary and Critical Design. All documents shall be provided in electronic formats and include title, date, author, and version number written in English.

The Contractor shall provide all engineering models, Zemax and CAD files, and computer media copies of designs, drawings, models. All shall be in native format (3D models, drawings) for future AURA use. CAD files shall be delivered in both their native format and in STEP format. STEP format files are only required for top-level assemblies (if more than one).

5.1.7 Drawings, and Specifications

The Contractor shall provide electronic versions of all drawings and specifications (pdf format acceptable) derived from this effort. Drawings shall have a drawing ID, title, author, date, version number and be updated to reflect any variation between the drawings and the as-built condition. These shall be delivered at the time of design review and at the delivery of the product respectively.

The Contractor shall follow the Gemini guidelines for the drawing ID definition. Gemini will provide a block of drawing numbers to be used by the Contractor as part of the Drawing ID definition. The drawings set(s) shall be delivered in native, .dwg, and .pdf formats, and shall include both assembly and detail (or fabrication) drawings.

5.1.8 Written Reports

The Contractor shall provide all written reports as specified in Section 6.2 and Section 6.3. Each review meeting requires both a written version and an actual presentation. All written reports shall have a title, author, date, and version number and be written in English.



5.1.9 Monthly Progress Reports

The Contractor shall provide progress reports via email by the 10th of each month as defined in Section 6.2.2. These reports are intended to aid the GNAO Project Technical Representative to monitor technical progress. Due dates shall be established in the contract document.

5.1.10 Reviews and Meetings Documents

The Contractor shall provide all materials presented during the specific meetings and reviews described in Section 6.3. Materials shall include presentations, analysis reports, and measurement summaries.

For each main stage review, the Contractor shall also provide the document listed in the documentation deliverable table provided in Appendix 10.2.

5.1.11 Interface Control Documentation

The Contractor shall provide all documentation showing the defined internal and external interfaces of the product, and describe the design for their implementation using Interface Control Documents of the interfaces between the product and other GNAO products. Specifically, this shall include external and internal interfaces described in [AD-01].

5.1.12 Acceptance Test Plan

The Contractor shall provide 2 Acceptance Test Plans (ATP):

- Factory Acceptance Test (FAT) Plan (during the Build Phase): At the Contractor site - to test the system compliance to the requirements, before shipping the instrument to Gemini North.
- Onsite Acceptance Test (OAT) Plan (during the Transition Phase): At the telescope - when the system has been delivered, re-assembled, tested and verified, to test the system readiness before the on-sky commissioning.

For every requirement that is to be verified, the ATPs shall contain sufficient information to plan verification, perform the verification, and to repeat the verification at a later date.

The ATP shall clearly state the success criteria and any test prerequisites, including specific software or hardware needed for each tested requirement.

The step-by-step procedure for each verification procedure shall be sufficiently detailed to allow the GNAO Project Technical Representative to both evaluate the appropriateness of each procedure (with respect to the requirements and success criteria) and to repeat the test independently of the Contractor.

For the OAT, the ATP shall include a test set-up section to describe any special set-up involving the facility (such as calibration sources or turbulence injectors). The OAT plan shall also include a subset of the pre-delivery tests that shall be performed post-delivery to demonstrate that nothing has changed during transportation or in changing environments. The ATPs do not include on-sky tests.

5.2 Project Stage Work

An overview of the requested project life cycle is presented in Fig. 1. The contractor can propose (and shall provide supporting descriptions) for an alternative project life cycle in their proposal.

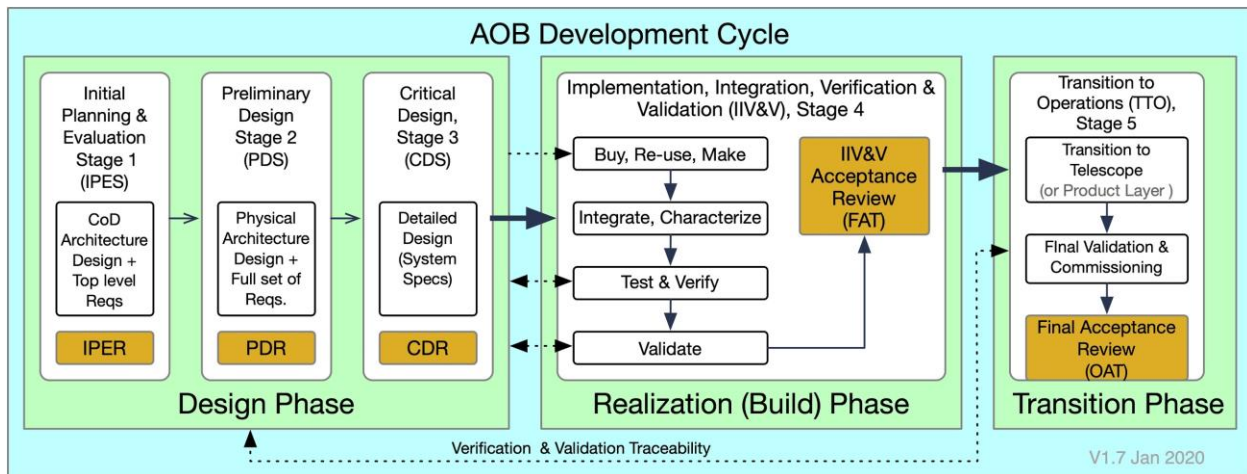


Figure 1: Requested phases and stages organization of the GNAO project.

5.2.1 Design Phase

5.2.1.1 Initial Planning and Evaluation Stage

This section of the SOW describes the Work to be conducted by the Contractor during the Initial Planning and Evaluation Stage of the project.

The Contractor shall present a complete Project Management Plan (PMP) and System Engineering Management Plan (SEMP) for the AOB, based on the work to be conducted.

The Contractor shall complete a detailed analysis of the top-level requirements and of the proposed conceptual design developed by the GNAO team during the Conceptual Design Stage of the project.

The Contractor shall propose to either continue with the proposed GNAO team conceptual design or propose an alternative design.

The GNAO team proposed conceptual design is presented in the following documents:



- AOB Specifications Document [AD-01]
- CoDR Conceptual Design Document Extract [RD-01]
- CoDR ConOps Document [RD-02]
- CoDR Science Case Document [RD-03]
- Wavefront Sensor and Deformable Mirror Design Parameters for GNAO report [RD-05]
- Distortion in Gemini MCAO Systems report [RD-06]
- GNAO laser Launch Telescope Location report [RD-07]

The Initial Planning and Evaluation Stage shall culminate with the IPER (Initial Planning and Evaluation Review), the Contractor shall:

- present an evaluation of the conceptual design proposed by the GNAO Team and an envisioned path forward to the final design, build and implementation of the AOB.
- review their compliance matrix to address all AOB requirements, identifying any stressing or critical risk requirements and present a risk register to include mitigation strategy and schedule.

The IPER (described in Section 5.2.1) is expected to be scheduled within 2 months of the Contractor start date.

5.2.1.2 Preliminary Design Stage

This section of the SOW describes the Work conducted by the Contractor during the Preliminary Design Stage of the project. The Contractor shall develop a preliminary design for the AOB, as described in the AOB Specification Document [AD-01], including optomechanics, electronics, thermal management, etc.

A detailed analysis and/or modeling necessary to verify and validate the performance of the AOB shall be provided. The Contractor shall confirm the AO dimensioning provided by the GNAO Team and provide a list of hardware that can meet the system performance requirements. All integration and test plans shall be developed during the Preliminary Design Stage.

The Contractor shall prepare a compliance matrix for the top-level GNAO-team-delivered requirements, which addresses all requirements and clearly identifies requirements:

- for which the contractor can completely meet.
- for which the Contractor is unable to fully or partially meet.



The matrix shall define how each requirement in the specification will be verified (i.e. analysis, test, inspection, demonstration).

During the Preliminary Design Stage, the Contractor shall identify all devices to be controlled and the associated low-level electronics/software chosen to meet the GNAO control system interfaces agreed with the GNAO Project Technical Representative during the Preliminary Design Stage.

All the external and internal interfaces shall be defined and documented in the Interface Definition Document (IDD).

As an integral part of the Preliminary Design, the Contractor shall prepare detailed error budgets for all critical system performance attributes illustrating the Preliminary Design will meet requirements. Any prototyping required to evaluate options shall be done during this stage to confirm that the chosen solution is fit for purpose.

The Contractor shall identify all long lead items and, if necessary, during the PDS, shall request approval from the GNAO Project Technical Representative.

The Preliminary Design Stage shall culminate in a Preliminary Design Review at the Contractor's facility, as defined in Section 6.3.1.3. This review will focus on the design as developed, critical risk areas, and required work or decisions by the GNAO Project Technical Representative and the Contractor to enable continued design work.

5.2.1.3 Critical Design Stage

This section of the SOW describes the Work conducted by the Contractor during the Critical Design Stage of the project.

Following the completion of the Preliminary Design Stage and approval from the GNAO Project Technical Representative, the Contractor shall proceed with the Critical Design Stage of the product and implementation. The Critical Design effort entails completion of all design work necessary for the Realization (Build) of the AOB. During the Critical Design Stage, the Contractor shall not deviate from the Preliminary Design without written approval from the GNAO Project Technical Representative.

Work performed by the Contractor in this stage shall include the completion of all analyses, modeling and test plans required to ensure the viability of the design as developed. Any outstanding issues regarding the definition of mechanical, electrical, utility, and software interfaces shall be completely resolved during the earliest phases of the Critical Design effort.

The Contractor shall prepare a compliance matrix for the AOB-level requirements defined by the Contractor, which addresses all requirements and clearly identify requirements:

- for which the contractor can completely meet.
- for which the Contractor is unable to fully or partially meet.



The matrix shall define how each requirement in the specification will be verified (i.e. analysis, test, inspection, demonstration).

The Contractor shall request approval to purchase, or request the purchase by the GNAO Project Technical Representative, of all long lead items, identified during the PDS, that have not already been procured.

Any sub-system testing needed to support analysis and modeling shall be finished in this stage.

The Contractor shall finalize all external AOB ICDs and develop an internal ICD for each interface between the major hardware and software components. These documents shall be provided to the GNAO Project Technical Representative for final approval.

The Critical Design Stage shall culminate in a Critical Design Review (CDR) as defined in Section 6.3.1.4. The CDR will focus on the assessment of the design as developed and documented, and identification of any remaining critical risk areas.

5.2.2 Realization (Build) Phase (Implementation, Integration, Verification and Validation Stage)

This section of the SOW describes the Work conducted by the Contractor during the Implementation, Integration, Verification and Validation Stage of the Realization Phase of the GNAO AOB.

Following the completion of the Critical Design Stage, the Contractor may acquire all remaining equipment, materials, and components to be used in the design approved at CDR.

The Contractor shall integrate and test the specified optomechanical interfaces and hardware using the GNAO team supplied device control system and RTC. The contractor may use stand-alone or manufacturer-supplied software to test basic device operations prior to integration with the GNAO Team control system. The Contractor shall integrate all components to develop a functional AOB.

During the Realization Phase, in order to allow the Contractor to characterize, test and verify the system, the GNAO Team will provide a version of the RTC System Controller, adequate to test interfaces and support the integration activities of the AOB with the RTC System software.

As identified in the Factory Acceptance Test (FAT), the Contractor shall begin system acceptance testing once the AOB is fully integrated and characterized.

The Factory Acceptance Test (FAT) plan, as defined in Section 5.1.12, shall be completed at the end of the Integration, Implementation, Verification, and Validation stage. The Contractor shall execute the FAT plan and confirm the AOB meets all of the requirements detailed in the AOB Specifications Document [AD-01]



The Contractor shall complete the Onsite Assembly and Installation (OAI) plan and On-site Acceptance Test (OAT) plan for the AOB under development. The OAT plan shall address and verify all items in the compliance matrix.

The Contractor shall create a Pre-Delivery Acceptance Test Report documenting the results of all of the tests described in the Acceptance Test Plan, including the completed compliance matrix, and documenting any revisions or changes to the ATP which were made during the integration and testing procedures.

The Integration, Implementation, Verification, and Validation Stage shall culminate in a Factory Acceptance Test Review (or IIV&V Acceptance Review) at the Contractor's facility, as described in Section 6.3.1.5. The FAT Review will focus on the verification and validation of the AOB performance through the execution of selected tests from the FAT. The suite of tests required to be passed for acceptance at FAT shall be agreed in advance between the Contractor and GNAO Project Technical Representative.

The Contractor OAI plan shall specify all required procedures, identify any specialized tooling and required handling equipment, and provide a detailed schedule of planned tasks. The Contractor shall supply supervision, labor, equipment, operators, and procedural support for assembly and installation of the AOB at the Gemini North Telescope facility.

Following successful completion of the FAT Review, the AOB shall be shipped to the Gemini Hilo base facility for the Transition to Operation Stage.

5.2.3 Transition Phase (Transition to Operations Stage)

This section of the SOW describes the Work conducted by the Contractor during the Transition to Operations Stage of the AOB.

Once the GNAO Project Technical Representative approves shipment, the Contractor shall package the GNAO AOB in a manner that shall protect it from harm during transit in accordance with the specifications contained in [AD-03], and shall then ship the instrument to the Gemini North facility in Hilo, Hawai'i.

The Contractor shall perform on-site assembly and installation of the product as defined in the Onsite Assembly and Installation (OAI) plan. The Contractor shall perform onsite acceptance testing as defined in the Onsite Acceptance Test (OAT) plan. The results of the OAT stage shall be presented at the OAT Final Acceptance Review (described in Section 6.3.1.6).

The Contractor shall demonstrate all maintenance procedures during the onsite acceptance tests. Where necessary, the Contractor shall provide Gemini personnel training activities required for operations or maintenance. The Transition Phase shall culminate by the on-sky commissioning of the AOB (AOB operating in closed-loop and light being sent to the science instrument), fully integrated within the GNAO Facility.



6 Communication, Reports, and Reviews

6.1 Communications

No aspect of the Work may be modified by verbal or informal email communications. In order to be binding on the parties, a modification to the Work must be executed by the AURA Contracts Officer (CO), after preliminary approval of the GNAO Project Technical Representative, as provided in the Contract.

When the Contractor requires technical information from AURA, the GNAO Technical Representative will provide the information using a standard signed Technical Directive form. All Technical Directives shall be numbered in sequential order.

Staff from the GNAO Project Office and the Contractor may informally communicate in order to explore issues and ideas related to the Work. The GNAO Project Technical Representative and the Contracts Officer must be copied on all substantive email communications between AURA and Contractor personnel and be provided with summaries of all meetings and discussions where they were not present.

Once informal communications have converged on a solution to an issue, the GNAO Project Technical Representative will either document the agreed solution using a Technical Directive or shall ask the AURA Contracts Officer to prepare a Contract Amendment or Change Order, depending on the nature of the resolution of the issue.

The GNAO AOB Tech representative will be the single point of contact with the other GNAO Technical Representatives and Work Package Managers (RTC, Laser and SyCo) and will provide the coordination and the necessary transfer of information between the AOB Contractor and the other GNAO Products.

6.2 Progress Reports

The Contractor shall perform the following reporting and reviews throughout the duration of this effort. Where designs or other information are proprietary, AURA and Gemini and the Contractor participants will execute non-disclosure agreements with the Contractor as required to support information transfer. Each review requires the delivery of both a written report and a presentation (in English). All written reports shall include a title, date, author, and version number.



6.2.1 Informal Weekly Progress Reports

The Contractor shall provide informal progress updates at least weekly via telephone or video conferencing and will be attended by the GNAO Project Technical Representative, PM, PI, and SE Lead. Formal presentations of overall project status are not required, but the Contractor shall be prepared to discuss schedule status, technical issues, critical risks and resolutions, and staffing. The objective of these updates is to keep the GNAO Project Technical Representative informed of progress and problems and to enable interactive efforts toward reaching effective engineering designs and issue resolutions.

6.2.2 Monthly Progress Reports

The Contractor shall provide written monthly progress reports (preferred format: MS Word; acceptable format: pdf). Monthly reports shall be delivered via email by the 10th of each month and shall highlight progress and activities performed the previous month, including:

1. Report on the status of action items
2. Percentage of completion of scheduled tasks and indicate schedule variances
3. Cost and Schedule performance indicators
4. Identify new problems or issues for tracking and resolution
5. Identify closed issues and resolution
6. Major activities and tasks planned for the upcoming month
7. A table summarizing risks and associated mitigation strategies
8. An updated schedule to consist of the currently approved project plan to completion compared to the approved baseline plan schedule, percent completed and margin for completion date uncertainty.
9. Large procurements

Specific report format details shall be discussed and negotiated during the Kick-Off meeting. The action list shall be maintained and updated by the Contractor.

6.3 Meetings and Reviews

The Contractor shall organize, hold, conduct and budget in specific meetings and reviews throughout the duration of this effort as described below and identified by the Contractor in their Project Management Plan. The meetings shall provide the GNAO Project Technical Representative the ability to (i) review and agree on Contractor plans, (ii) ensure work compliance and (iii) enable payments. Where necessary, the GNAO Project Technical Representative will provide written approval of the completion of activities for payment. Specific requirements for milestone completion, payment application, and Gemini/customer review are provided in the contract document.



The Contractor is encouraged to integrate multiple topics (where plausible) in order to minimize the number of in-person meetings. The Contractor shall submit agendas and provide all supporting presentation materials at least two weeks in advance of meeting dates for the GNAO Project review. The Contractor Project Management Plan scheduled dates shall be updated and adjusted as required during the duration of this effort.

6.3.1 Main Project Stage Reviews

With the exception of the IPER that shall be held remotely by videoconferencing, the Contractor shall organize, hold, conduct, and budget in, the main stages and phases reviews in person, at their site. The full Contractor team shall attend. The GNAO PM, PI, SE Lead and the AOB Technical Representative shall attend the meeting in person, as well as any GNAO team member deemed critical for a given review (estimated on a case-by-case basis, likely up to 5 people attending the various reviews in person). A review panel (maximum of 5 people) shall be designated by the GNAO team to evaluate the work performed and presented at the reviews. The review panel shall attend, if possible, the reviews in person. Ten business days prior to the review date, the Contractor shall submit to the GNAO Project Technical Representative all the documentation (see Appendix 10.2) related to the incoming review. A summary of the meeting discussions and a list of action items shall also be provided to the GNAO Project Technical Representative, 5 business days after the meeting date.

6.3.1.1 Kick-Off Meeting

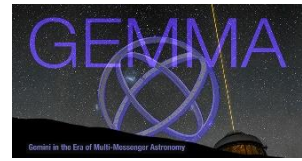
Within two weeks of the contract start, the Contractor and GNAO Team (the AOB Technical Representative, the PM, the PI, and the SE Lead) shall meet in person at the Contractor location for the Kick-Off meeting of the AOB work.

6.3.1.2 Initial Planning and Evaluation Review

Within 2 months of the contract start, the Contractor shall hold a IPER (at the end of the Initial Planning and Evaluation Stage). The meeting shall be held by video conferencing unless otherwise agreed to by the Contractor and the GNAO Project Technical Representative, and shall include the full Contractor team and the full AOB team. The Contractor shall present the Project Management Plan and the System Engineering Management Plan, clearly identifying personnel, approach to work, schedule, and major milestones. The meeting shall also serve to converge on expectations for following meetings content, reviews responses, reports content and format.

The Contractor shall also present the results of the review for:

- The AOB requirements, as defined in the accompanying Specifications document [AD-01].
- The conceptual design developed by the GNAO Team during the project Conceptual Design Stage.



The Contractor shall review their compliance matrix to address all AOB requirements, identifying any critical risk requirements and present a risk register to include mitigation strategies and schedule. The Compliance Matrix shall not be construed as giving the Contractor permission to deviate from the Specifications; i.e., all Specifications are mandatory and the Compliance Matrix only provides for an efficient means of disclosure of failures to meet the Specifications. The Compliance Matrix shall be accompanied by a report detailing any noncompliance noted, and any other technical or interface issues that will need to be resolved during the Critical Design effort and describing the proposed methods of resolving these issues.

The Contractor and the GNAO Project Technical Representative shall agree upon a process for resolution of action items and close-out/planning of meetings and reviews to support the engineering design cycle.

The Contractor shall document their presentation along with unresolved questions and issues. This documentation shall be submitted to the GNAO Project Technical Representative 10 business days in advance of the IPER.

The Contractor shall submit to GNAO Project Technical Representative a summary of the IPER discussions and a list of action items within 5 business days after the meeting. The Contractor shall include their responses to items raised by the GNAO Project Technical Representative and the GNAO team in this summary. AURA will provide the Contractor with a list of comments for response within 10 business days after the IPER.

6.3.1.3 Preliminary Design Review

The Contractor shall host and conduct a Preliminary Design Review following completion of the work identified in Section 5.2.1.2. The goal of the meeting is to describe and demonstrate a product design and the definition of associated interfaces and subsystems in the product.

The Contractor shall complete the following tasks for the design to be considered ready for a preliminary design review:

1. A preliminary optomechanical design shall be presented, based on an optical modeling software (such as Zemax) and matching CAD, which fulfill the requirement and performance described in the AOB Specification document [AD-01].
2. AO dimensioning shall be finalized and major optical and hardware components shall be identified.
3. All design trade options shall be resolved.
4. All major design risks shall be eliminated or reduced to an acceptable level.
5. Technical Performance Metrics (TPM) shall be identified and tracked.
6. All system budgets and tolerances shall be established and documented.



7. A list of all devices to be controlled and the method by which they will be controlled, via the defined interfaces, shall be established.
8. A preliminary set of internal system interface documents shall be written. All interfaces between internal hardware or software subsystems shall be defined and documented, including any software systems from third-party vendors.
9. A description of the computing hardware, networking, and any extra hardware needed to interface the computing system to external hardware shall be established. The information shall be final, or near-final, at this stage.
10. An outline of the Factory Acceptance Test (FAT) plan, On-site Assembly and Installation (OAI) plan, and On-site Acceptance Test (OAT) plan shall be defined.
11. A complete stage plan for the Critical Design Stage shall be defined.

The Contractor shall provide the documents listed in the documentation deliverable table provided in Appendix 10.2. The Preliminary Design shall be considered complete when all of the tasks listed above are complete for the AOB.

6.3.1.4 Critical Design Review

The Contractor shall conduct a Critical Design Review following completion of the work identified in Section 5.2.1.3. The meeting shall present a detailed product design to be engineered and tested which meets stated requirements.

In preparing for the critical design the Contractor shall prepare, at a minimum:

1. A set of documentation that completely describes and explains the design of the AOB, demonstrates the AO performance attained and demonstrates the proper execution of the required functions.

The documentation shall be at a stage such that any senior engineer can understand how the AOB is designed and how the system and sub-components can be Integrated and tested to demonstrate that the system is meeting requirements and performance as presented in the AOB Specification document [AD-01]. The information shall include:

- An overview of the final optomechanical design.
- List of the final selection for the optical and hardware components.
- Description of all major optical and hardware components and their specifications.
- Description of the alignment procedure
- Description of the calibration procedure for the optical and hardware elements concerned.
- Final Factory Acceptance Test (FAT) plan.



- A description of how devices will be controlled via the defined software interfaces
 - Internal interface definition
2. All interfaces between internal and external hardware or software subsystems shall be finalized and documented in ICD format, indicating how the interfaces are designed for their integration.
 3. A test plan for the AOB/RTC integration and test.
 4. A final design of the computing hardware, networking, and any extra hardware needed to interface the computing system to external hardware.
 5. A final report on Technical Performance Metrics.
 6. A draft Factory Acceptance Test (FAT) plan, Onsite Assembly and Installation (OAI) plan, and On-site Acceptance Test (OAT) plan for each RTC System implementation.
 7. A complete stage plan for the AOB Implementation, Integration, Verification, and Validation stage

The Contractor shall provide the documents listed in the documentation deliverable table provided in Appendix 10.2. The Critical Design shall be considered complete when (i) all of the tasks listed above are complete for the AOB product, and (ii) the design is complete and demonstrated to meet all the stated requirements.

6.3.1.5 IIV&V Acceptance Review

The Contractor shall host, at their site, and conduct a FAT Review (or IIV&V Review) following completion of the work identified in Section 5.2.2. This meeting shall review the documented results of the Contractor's factory acceptance tests and repeat a subset of the tests carried out by the Contractor in executing the Factory Test Plan.

The suite of tests required to be passed for acceptance at the FAT Review shall be agreed two months in advance between the Contractor and GNAO Project Technical Representative.

The Contractor shall provide the documents listed in the documentation deliverable table provided in Appendix 10.2. The FAT Review shall be considered complete when all of the tests defined in the FAT Plan, including those repeated at the FAT Review, have been successfully passed, documented, and reviewed by the GNAO Project Technical Representative.

6.3.1.6 Final On-site Acceptance Review

After successful completion of the Transition to Observation (TTO) Stage work (presented in Section 5.2.3), the Contractor shall host and conduct a Final Acceptance Review of the onsite acceptance testing results (OAT). Technical notes, calculations, measurements, etc., supporting the testing shall be presented and made available to the GNAO Project Technical Representative.



Measurements shall be performed, recorded, presented, and provided. The Contractor shall archive and make available to the GNAO Project Technical Representative all test results.

At the conclusion of this review, the Contractor shall deliver a written On-site Acceptance Test Report within three weeks, summarizing all data, measurements (including uncertainties), inspection reports, calculations, etc. conducted during the integration and testing and traceability to requirements. The Contractor shall also provide user manuals and other documentation deliverable for the TTO as presented in Appendix 10.2.

6.3.2 Product Integration Readiness and Quarterly Review Meetings

Quarterly Progress Review (QPR) meetings shall be held at a frequency of every three months, if no other specific meetings or reviews are scheduled. The intent of the QPRs is to proactively communicate Contractor progress and potential issues to the GNAO Project Technical Representative on a regular basis.

After the CDR, the first upcoming QPRs shall be used for the Product Integration Readiness Review (PIRR). The PIRR is dedicated to review and verify that all the design documents, including ICDs, drawings, and schematics will allow the Contractor to start the integration and testing of the AOB. A deliverable of this review is the FAT, according to the schedule presented in the project plan.

The GNAO PM, PI, and the AOB Technical Representative shall attend these reviews. During the Design Phase and the Build Phase, every other review shall be held in person at the Contractor site (otherwise, the meeting shall be held by videoconferencing). During the TTO Phase, the review will be held in person at the Gemini North site in Hilo, Hawai'i.

The proposed date and the agenda of these general status meetings will be cooperatively developed and shall focus on:

- The progress of the planned Work
- Deviations from WBS activities, schedule, cost, reason of deviation, and resolution strategy
- Planned progress for the next quarter

QPRs dates shall be defined by the Contractor during the project planning phase. The length of the meeting will be evaluated on a case-to-case basis, depending on the progress and/or issues to be presented, and the review may span a few hours to multiple days. To estimate the time needed for the QPR, the Contractor shall provide a meeting agenda and updated scope/cost/schedule estimates to the GNAO Project Technical Representative two weeks prior to the scheduled review date.



7 Quality Assurance

The Contractor shall prepare a Quality Assurance plan explaining how the products of the contracted work (to design, build and deliver the AOB to Gemini) will meet quality standards allowing the GNAO system to operate at Gemini Observatory without losing functionality or performance during the intended operational life cycle of 20 years.

8 Customer Furnished Equipment

The GNAO Project shall provide the Contractor with any hardware, software, and user interfaces required to support the integration and testing of controllable devices in the AOB, using the interfaces defined in the AOB Specification document [AD-01].

9 Contractual notes

9.1 Contract Changes

Any changes or non-conformance in the contracted effort that affect technical requirements, schedule, or cost shall only be authorized through written notification from the AURA Contracts Officer. AURA may at any time, by a written order, make changes within the general scope of the Contract for compliance by the Contractor, in any one or more of the following: (i) drawings, designs, or specifications, where the supplies or services to be furnished are to be specifically manufactured or produced for AURA in accordance therewith; (ii) method of shipment or packing; (iii) place of delivery; and (iv) delivery schedule and period of performance of work. If any such change causes an increase or decrease in the cost of or the time required for performance of any part of the work under this Contract or (whether or not changed by such written order), an equitable adjustment shall be made in the order price or delivery schedule and period of performance or both, and the Contract shall be modified in writing accordingly. Any claim by Contractor shall be asserted within 20 days from the date of receipt by Contractor of the notification of change.

Express terms, conditions, price, and extension of time for completion of the Work, or an increase or decrease in consideration to either AURA or the Contractor, may not be modified except by means of a written Amendment signed by the AURA Contacts Officer and accepted by the Contractor. Oral agreements to modify or add work are unenforceable.

A Change Order means any a written proposal prepared and signed by the contractor and shall contain: a description of any changes in the work requested by AURA and impact to the scope of work; any schedule adjustment, the price or consideration, if any, associated with modification; and an itemization of labor hours (by worker category, if applicable) and purchased goods/services.



Once the Change Order modifications and consideration, if any, have been agreed upon by the parties, an amendment, describing the Change Order modification and the agreed consideration adjustment, shall be signed by both the AURA Contracts Officer and the Contractor. The amendment and the terms contained therein shall be incorporated into this Contract. Issues not affecting performance, schedule, or cost will be addressed individually.

Delays

The Contractor shall notify AURA immediately, in writing, of any delay in the performance of specified services. The notice shall include, at a minimum, the nature or cause of the delay, the anticipated length of the delay, the impact to the delivery schedule and Contractor's plan to mitigate the impact to the delivery schedule, if any. AURA, at its sole discretion, shall determine if the cause of the delay is reasonable and what, if any, relief shall be granted. Contractor's notification shall not be construed as repudiation by Contractor of his obligations under this Contract.

The Contracts Officer may order the Contractor to suspend, delay, or interrupt all or any part of the Work for such period of time as she may determine to be appropriate for the convenience of AURA. Any such order shall be made in writing. Upon receipt of such writing, the Contractor shall immediately suspend all work per the terms of the notice. AURA may subsequently issue a Restart notice to inform the Contractor to resume the Work. In the case of a suspension, the Contractor shall be entitled to consideration for services rendered up to the time of receipt of the writing.

In no event shall Contractor be responsible for delays that are due to events outside of the Contractor's control as defined by the contract, Article 21, Force Majeure.

9.2 Deviation

If events occur that may cause an impact to the schedule and cost, the Contractor shall evaluate every possible method to avoid a negative outcome (e.g., a schedule slip or a delay of achieving critical milestones). These methods may include utilization of additional Contractor staffing and facilities and/or changing Contractors. The Contractor shall immediately notify the GNAO Project Technical Representative of an intention or plan to change contractors and or utilize additional contractors and or their facilities.

The Contractor shall promptly notify the GNAO Project Technical Representative via email of any event that may result in a delay in performance or completion of the Work. The Contractor shall revise the Project Plan accordingly to any subsequent delay and submit the revised plan to GNAO Project Technical Representative via email for approval.



9.3 Non-Conformance and Remediation

During the course of this effort, the Contractor shall immediately report any non-conformance to the GNAO Project Technical Representative. The report shall summarize the non-conformance and propose a corrective action plan for review. No remedy shall be allowed until approval is granted from the GNAO Project Technical Representative. The formal contract change request process is detailed in the contract document.

9.4 Request for Change

During the course of this effort, the Contractor may submit a Request for Change prior to the manufacture of an item seeking a planned variance from specified requirements. The Contractor may submit a Request for Change to accept an item which, during manufacture or after inspection, was found to depart from specified requirements, but is considered suitable for use as is or after rework by an approved method. Neither waiver shall be allowed until reviewed and granted from the GNAO Project Technical Representative. The formal contract request for change process is detailed in the contract document.

9.5 Task Completion and Payment Application

The Contractor Project Management Plan shall identify and define deliverable documentation necessary to define task completion, specifically those linked to payment milestones. Generally, the Contractor shall submit invoices for milestone payments upon successful completion of milestone events. Milestone events may be successfully completed in advance of the date appearing in the milestone schedule. The contract documents will define the payment application process.

9.6 Access to Work, Facility and Information

The Contractor shall grant Gemini GNAO individuals, identified and pre-authorized by both parties, general site access, during working hours, to all places where the Work is being performed or AOB activity is specifically occurring, including access to locations where the Contractor's subcontractors are performing any part of the Work.

Gemini GNAO individuals will comply with all Contractor safety rules and facility policies. The Contractor shall provide the Gemini GNAO individuals with facility phone and internet capabilities adequate to support technical interactions. The Contractor shall provide Gemini GNAO individuals access to observe testing as required.

Upon request, the Contractor shall allow AURA personnel to view and copy any design documentation, reports, or data produced under this Contract. AURA will make the request for the information not less than 3 working days in advance of the desired time of receipt.



10 Appendix

10.1 Acronym Table

Acronym	Definition
ADC	Atmospheric Dispersion Corrector
AOB	Adaptive Optics Bench
ATP	Acceptance Test Plan
AURA	Association of Universities for Research in Astronomy
CDD	Critical Design Document
CDR	Critical Design Review
CDS	Critical Design Stage
CoDD	Conceptual Design Document
CoDS	Conceptual Design Stage
COTS	Commercial Off-The-Self
CSA	Cooperative Support Agreement
CVP	Commissioning (deploy) and Validation Plan
DM	Deformable Mirror
FAT	Factory Acceptance Test
GEMMA	Gemini in the Era of Multi-Messenger Astronomy
GNAO	Gemini North Adaptive Optics
ICD	Interface Control Document
IDD	Interface Definition Document
IIV&V	Implementation, Integration, Verification and Validation
IPER	Initial Planning and Evaluation Review
IPES	Initial Planning and Evaluation Stage
ISS	Instrument Support Structure



LGS	Laser Guide Star
LGSF	Laser Guide Star Facility
MCAO	Multi Conjugate Adaptive Optics
NGS	Natural Guide Star
NSF	National Science Foundation
OAI	Onsite Assembly and Installation
OAP	Off-Axis Parabola
OAT	Onsite Acceptance Test
PBS	Product Breakdown Structure
PDD	Preliminary Design Document
PDR	Preliminary Design Review
PDS	Preliminary Design Stage
PMP	Project Management Plan
PIRR	Product Integration Readiness Review
QA	Quality Analysis
RD	Requirement Document
RfP	Request for Proposal
RTC	Real-Time Controller
SEMP	System Engineering Management Plan
S&MM	Service and Maintenance Manual
SMM	Software Maintenance Manual
SMP	Safety Management Plan
SOW	Statement of Work
SyCo	System Controller
TM	Technical Manual
TTM	Tip-Tilt Mirror



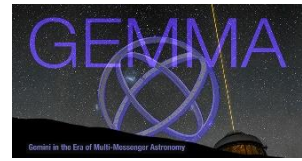
TTO	Transition to Operation
UM	User Manual
WBS	Work Breakdown Structure
WFE	Wavefront Error
WFS	Wavefront Sensor
WPM	Work Package Manager

10.2 Documentation table

AOB Deliverable Documentation Set							
Phase	Document ID	Document Filename	Stage				
			CoD	PD	CD	IIV&V	TTO
DESIGN Phase	GNAO-AOB-CoD-01	Project Management Plan (PMP)	√ CC	√	√	√	√
	GNAO-AOB-CoD-02	System Engineering Management Plan (SEMP)	√ CC	√	√	√	√
	GNAO-AOB-CoD-03	Safety Management Plan (SMP)	√ CC	√	√	√	√
	GNAO-AOB-CoD-04	Requirements Document (RD)	√	√	√ CC	√	√
	GNAO-AOB-CoD-05	Conceptual Design Document (CoDD)	√				
	GNAO-AOB-CoD-06	CoDS End Stage Report	√				
	GNAO-AOB-PD-10	Preliminary Design Document (PDD)		√ CC	√	√	√
	GNAO-AOB-PD-11	Interface Definition Document (IDD)		√ D	√ CC	√	√
	GNAO-AOB-PD-12	Acceptance Test Plan (ATP)		√ D	√ CC		√
	GNAO-AOB-PD-13	PDS End Stage Report		√			
	GNAO-AOB-CD-14	Critical Design Document (CDD)			√ CC		
	GNAO-AOB-CD-15	Interface Control Document (ICD)			√ CC		
	GNAO-AOB-CD-16	Implementation, Integration and Verification Plan			√		
	GNAO-AOB-CD-17	CDS End Stage Report			√		
BUILD Phase	GNAO-AOB-IIV&V-20	As-built records				√ CC	√
	GNAO-AOB-IIV&V-21	Recommended Spares List				√ CC	√
	GNAO-AOB-IIV&V-22	IIV&V Acceptance Test Report				√ CC	√
	GNAO-AOB-IIV&V-23	Service and Maintenance Manual (S&MM)				√ CC	√
	GNAO-AOB-IIV&V-24	User Manual (UM)				√ CC	√
	GNAO-AOB-IIV&V-25	Technical Manual (TM)				√ CC	√
	GNAO-AOB-IIV&V-26	Software Maintenance Manual (SMM)				√ CC	√
	GNAO-AOB-IIV&V-27	Commissioning (deploy) & Validation Plan (CVP)				√ D	√ CC
	GNAO-AOB-IIV&V-28	IIV&V End Stage Report				√	
TRANSITION Phase	GNAO-AOB-TTO-31	Final Acceptance Test Report					√
	GNAO-AOB-TTO-32	TTO End Stage Report					√

AOB= RTC or AOS, √ = Required, D = Draft, CC = Change Control

Fig 2: Documentation deliverable table.



10.3 Documents description

- **Project Management Plan [PMP]:** Describes the project (internal or contracted) management approach, methodology, practices, processes, and tools that apply to the lifetime of the project. The PMP describes the specifics related to the creation, monitoring, and control of management elements including budget, cost, schedule, risk, work elements, resources, and communication.
- **System Engineering Management Plan [SEMP]:** Describes the system engineering approach, methodology, practices, processes and tools that apply to the internal or external project during its duration.
- **Safety Management Plan [SMP]:** Describes the approach to keeping personnel and the instrument safe during the project.
- **Requirements Document [RD]:** Describes the entire System Requirements Specifications associated with the deliverable products of the project and contracted products, to the level the GNAO facility will be designed and verified for the final transition to Operations. By requirements specifications means a set of requirements decomposed and flowed down from science requirements to the lowest layer of the product design.
- **Design Document (Conceptual, Preliminary, Critical):** Describes the current end-of-stage/phase design of the Project, WPs and Contracts, the Associated Hardware, and the Associated Software at the end of each design stage/phase.
- **End-Stage Reports:** Describes the progress of the Project/WPs/Contracts to date, including how the stage performed against the original plan baseline. The report recounts the major successes and challenges of the stage, suggest future actions based on lessons learned, and include requests related to deviations associated with the next stage.
- **Interface Definition Document (IDD):** Describes the definition of the existing interfaces at all the layers of the products and sub-products of GNAO Facility and the interfaces to the Observatory. An IDD is also required for contracted products.
- **Acceptance Test Plan [ATP]:** Describes the test plan for the GNAO WPs and Contracted products of the project both pre and post transitions to the next layer in the GNAO project.
- **Interface Control Documentation (ICD):** Describes the implementation of all the internal and external interfaces of GNAO Products that integrate the Facility as described in the IDD. ICDs may contain drawings and schematics to describe the implementation of mechanical, electrical, optical, etc.



- **Integration, and Verification Plan:** Provides a description of the technical processes and procedures to integrate, verify, to validate the GNAO Products developed in-house and contracted.
- **As-built Records:** Provides the project with all the specifications, 3D models, 2D manufacturing drawings, wiring diagrams, and software code to successfully refabricate and acquire the in-house and contracted products of the GNAO facility such that they could be duplicated.
- **Recommended Spares List:** Provides the project with a list of GNAO hardware components the project believes are important for Gemini to obtain. It includes a list of GNAO products Associated Hardware spares that shall be purchased by the project.
- **IIV&V Acceptance Test Report:** Documents the results of the product's verification to meet requirements performed before they have been fully transitioned to the next layer or to the observatory for final acceptance. The test may include those at the subsystem (sub-product) level.
- **Service and Maintenance Manual [S&MM]:** Provides maintenance staff with the product information necessary to service and maintain the GNAO products and the integrated MCAO facility.
- **User Manual [UM]:** Provides GNAO products users and Gemini Instrument Scientist with an understanding of the products and facility, respectively and they operation, providing information on the configuration, modes of operation, user calibration procedures, and performance characteristics.
- **Technical Manual [TM]:** Provides staff the necessary technical information to assemble, align, calibrate, cabling, to place the GNAO products and integrated facility into an operational state and also provide a technical understanding of the design and structure of the products that integrate the GNAO facility.
- **Software Maintenance Manual [SMM]:** Provides Gemini staff with a description of the GNAO products and facility software at a level of detail a programmer familiar with the Gemini software environment, but not initially familiar with the facility software, can maintain it properly.
- **Commissioning (deploy) & Validation Plan:** Describes the plan and procedures needed to systematically characterize the performance of the GNAO Facility in all of its modes and verifying and validating any remaining concept of operations and science requirements. The plan for first light commissioning will be a subset of this document.
- **Final Acceptance Test Report:** Document the results of the final product validation to meet stakeholders' expectations as defined in the science drivers, the contracts and/or the WPs once transitioned to the top product layer or transitioned to the



observatory for either first light, commissioning and science verification. The Final Acceptance Test Report provides the outcomes of the Commissioning and Validation Plan.