REQUEST FOR PROPOSALS (RFP) – CONTRACT ND1013C

FOR

GEMINI NORTH ADAPTIVE OPTICS (GNAO)

"LASER LAUNCH TELESCOPES (LLTs)"

STATEMENT OF WORK

V 4.0

APRIL 3, 2020

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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
1.0	3/17/20	Approved for release	E. Marin
2.0	3/25/20	Updated section 3.2.4 to add “The Contractor shall execute the final OAT by end of December 31 2022.”	E. Marin
3.0	4/1/20	Changed made to reflect submitted questions. Sections 3.2.4 and 3.2.5 updated to clarify the order of activities, and clarify that the mention of "final acceptance test" is the "factory acceptance test".	E. Marin
4.0	4/3/20	Updated section 3.1 to change the requirement to a single Project Management Plan and provide a sample template.	E. Marin

1 Introduction

The Gemini Observatory seeks to procure five (5) Laser Launch Telescopes (LLTs) that will serve its current and future needs. In this context LLTs refers to a work package and not only the final optical element that launches the laser beam to sky. This Statement of Work (SOW) identifies the content, general approach, deliverable items, and overall work required of a Contractor to provide:

1. Five physical LLTs;
2. Necessary Documentation;
3. Necessary Support equipment;

The SOW defines the programmatic and technical background of the project including necessary tasks, reports, review meetings and deliverables.

The LLT Specification Document (GNAO-LLT-RFP-002) defines the technical specifications.

The Contract documents defines the contractual requirements.

1.1 Program Background

The GNAO project is one of three projects in the GEMMA (Gemini in the Era of Multi-Messenger Astronomy) program funded by the National Science Foundation through a Cooperative Support Agreement with the Association of Universities for Research in Astronomy.

The GNAO facility consists of 4 major products: the Laser Guide Star Facility (LGSF), the Adaptive Optics Bench (AOB), the GNAO System Controller (SyCo) and the Real Time Controller (RTC) System. All efforts associated with this SOW are under the auspices of the Gemini GNAO Project Technical Representative (GPTR).

The Product, as defined in the SOW, delivers five Laser Launch Telescopes necessary for the GNAO Laser Guide Star Facility.

1.2 Technical Background

The GNAO system 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 GNAO system will produce near diffraction-limited image quality for near-infrared observations. The GNAO system will deliver stable image quality across a 2’ (arc-minute) 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 asterism constellation for low order tip/tilt and a 5-LGS asterism for high order correction. The LGSF integrates closely with the other GNAO systems and the telescope to generate the 5-LGS asterism necessary for AO corrections.

In addition to the MCAO system currently under development for GNAO, the LGSF will also support a wide field Ground Layer Adaptive Optics (GLAO) system that will use at least 4-LGSs and correct over a 10’ (arc-minute) diameter field. The GLAO system will deliver 2x the ensquared energy to all instruments providing the equivalent of “super-seeing” even in poor conditions.

In order to support both the MCAO and the GLAO LGS asterisms, the GNAO project requires 5 LLTs.

2 Scope

The Scope includes necessary design interactions with the Gemini GPTR and Gemini Contractors, development of plans, and documentation to finalize and optimize interfaces between GNAO subsystems and other elements of the telescope system.

The Scope products include all necessary hardware, hardware controllers, electronics, sensors, and documentation required to operate the LLTs to contract specifications.

The Contractor shall provide all material and labor, either directly or through appropriate subcontractors, including but not limited to engineering, design, implementation, verification, validation, packaging, shipping, on site installation, and on site acceptance testing necessary to provide the operational LLTs product.

The LLTs product shall conform to the LLTs Specification document (GNAO-LLT-RFP-002) and its associated compliance documents.

The Scope excludes provision of control software and user interfaces.

The SOW defines reports, reviews, and final deliverables.

2.1 Interfaces

The Contractor shall provide all the components necessary to interface the LLTs product to the GNAO LGSF, as defined in the associated Interface Control Documents (ICDs). Since the GNAO LGSF is still under development, many of the related ICDs have not yet been completely defined. These ICDs will be developed in collaboration with the Contractor during the design phase of the LLTs.

Although interfaces will be developed in collaboration between the LLTs Contractor and Gemini GNAO project, the Contractor shall have control over all internal interfaces of the LLTs. The Gemini GPTR shall have control over all external interfaces between the LLTs and other systems. Both the Contractor and the Gemini GPTR shall analyze all external interfaces.

2.2 GNAO LGSF LLTs

The Contractor shall provide LLTs as specified in (GNAO-LLT-RFP-002).

The LLTs shall provide two main functions:

1. Receive a linear polarized beam and project an enlarged circularly polarized beam of a 589 nm input laser on to the mesospheric sodium layer;
2. Provide for steering of the beam over a patrol field large enough for both the MCAO and GLAO asterisms

2.3 Multiple units

The Contractor shall provide five (5) interchangeable units that meet the specifications and tolerances as defined in (GNAO-LLT-RFP-002).

2.4 Optics, Mechanical Hardware, Electrical Hardware, Software and Controls

The Contractor shall provide the LLTs fully assembled with all optical and mechanical hardware, electronics, and cabling from their fixed locations to their terminations.

2.5 Maintenance and Testing Equipment

The Contractor shall develop and provide all the equipment required to integrate, test, maintain and operate the LLTs. This includes written manuals for operation and maintenance, spare parts list, consumables, and tests of all the components. The Contractor shall provide all plans, specifications and procedures required to fabricate, assemble, integrate and test the LLTs.

2.6 Factory Testing

The Contractor shall perform component, subsystem, and system testing at their facility to verify the LLTs perform and operate in accordance with design specifications to reduce project risk, minimize on site integration schedule, and support manufacture, integration, and overall system testing for operational optimization and on site acceptance.

The Contractor shall furnish all equipment, hardware and utilities necessary to operate the LLTs during factory testing, excluding the GNAO Project supplied LGSF System Controller.

2.7 Packaging, Shipping, and Storage

The Contractor shall provide appropriate packaging materials and devices required for safe transport of each product and shall provide shipping from the manufacturer’s facility

to the telescope base facility in Hilo, Hawaii. Packaging and shipping materials must be suitable for reuse in transport from the telescope base facility in Hilo, Hawaii to the telescope facility on the summit of Maunakea. All packaging and shipping material shall be adequate for long term outdoor storage. Preferably each unit shall have its own shipping and storage container.

2.8 On site Integration and Acceptance Testing

The Contractor shall supply supervision, labor, specialized equipment, operators, and procedural support for on site lab integration of the LLTs at the telescope base facility in Hilo, Hawaii.

The Contractor shall perform on site acceptance testing of all LLTs at the appropriate times to confirm performance and to facilitate final delivery.

The contractor shall provide remote support at the time of the final installation of the GNAO LGSF LLTs at the telescope site at Maunakea, Hawaii.

2.9 Documentation

The Contractor shall supply the GPTR with all drawings, models, specifications, material certification, literature and manuals, as well as complete as-built design specifications and drawings of the product, in an approved common electronic format (such as AutoCAD file format and pdf). The GPTR shall add all documents to its electronic archive (document control system). Contractor shall provide all documents written in English.

3 Contractor Work

The Contractor shall perform the following tasks and work phases under the scope of this effort:

1. Management and Project Plan
2. Initial Engineering Review Phase
3. Preliminary Design Phase
4. Critical Design Phase
5. GNAO LGSF LLTs Integration, Implementation, Verification, and Validation Phase
6. GNAO LGSF LLTs Delivery, Integration, and Acceptance Phase

The Contractor shall perform specific work tasks defined in SOW Section 3.2 and provide schedules as defined in SOW Section 3.1.

3.1 Contract Management and Project Management Plan

The Contractor shall provide a Management Plan (PMP) at the time of proposal. A sample PMP is available for free download at the following location:

https://www.projectmanagementdocs.com/template/project-planning/project-management-plan/#axzz6IZYyFDv6.

This template above is simply an example, and the Contractor is not required to use this template, nor required to complete every section included in the template. The required information that Contractors must include is listed below.

The PMP shall include at a minimum a:

1. Team Structure Description
2. Work Breakdown Structure (WBS) recommended to level 4
3. Product Breakdown Structure (PBS)
4. Work Schedule and Milestones
5. Cost Management Plan (labor and materials)
6. Quality Assurance Plan
7. Systems Engineering Management Plan
8. Build Plan
9. Factory Integration and Test Plans and Procedures
10. On site Acceptance Test Procedures
11. Payment Schedule
12. Final Delivery Date

The Team Structure Description shall identify and describe the technical and management team as well as key individuals, their responsibilities, and lines of reporting, as well as identify a single technical and contractual point of contact within the Contractor organization. Status, reviews, meetings, and daily technical issues will be coordinated with the Contractor technical point of contact.

The Work Schedule and Payment Milestones shall incorporate clear transition points from design and specification tasks to build and custom purchases.

The PMP shall identify target dates for Specific Design Review meetings defined in SOW Section 4.8 .

The Contractor shall include a Quality Assurance Plan which details quality processes and procedures to be used in the Contractor's facility during the execution of this work.

The Contractor shall include a Systems Engineering Management Plan that details the systems engineering processes and procedures Contractor shall follow during the execution of the work.

The Contractor Management and PMP shall be subject to negotiation and final approval by AURA and the Gemini GPTR.

3.1.1 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 GPTR and the Contractor.

SOW Section 8 Contractual Notes defines the formal contract change request process.

Contractor and Gemini shall address items and issues not affecting performance, schedule, or cost on a case by case basis.

3.1.2 Non-Conformance and Remediation

During the course of the project, the Contractor shall immediately report any non-conformance project work to the Gemini GPTR.

The Gemini GPTR shall review and approve requested remediation effort as described in SOW Section 8 Contractual Notes.

3.1.3 Request for Deviation/Waiver

During the course of the project effort the Contractor may submit a Request for Deviation prior to the manufacture of an item seeking a planned variance from specified requirements. The Contractor may submit a Request for Waiver 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 deviation or waiver shall be allowed until the GPTR reviews and approves in writing the request. The formal contract change request process is detailed in SOW Section 8 Contractual Notes.

3.1.4 Task Completion and Payment Application

The Contractor PMP shall identify and define deliverable documentation necessary to define task completion, in particular those deliverables linked to payment milestones.

The Contractor shall submit milestone payment invoices upon successful completion of milestone events.

The Contractor may complete Milestone events in advance of the date appearing in the milestone schedule.

SOW Section 8 Contractual Notes defines the payment application process.

3.1.5 Facility Access

The Contractor shall provide GPTR and authorized members access to the Contractor facility(s) to observe project work during normal hours of operation.

GPTR shall identify and request authorization for project members.

While on site, the Contractor shall provide the Gemini GNAO individuals with phone and internet capabilities adequate to support technical interactions and access to observe testing as required.

While on site, GPTR and authorized members shall follow and comply with the Contractor safety rules and policies.

3.2 Project Phase Work

3.2.1 Initial Engineering Review Phase

This section of the SOW describes the Work conducted by the Contractor during the Initial Engineering Review Phase of the project.

The Contractor shall perform a detailed analysis of the requirements summarized in the LLTs Specifications Document (GNAO-LLT-RFP-002).

The Contractor shall prepare a compliance matrix which addresses all requirements specified for which the Contractor can completely meet and those clearly identified as requirements for which the Contractor is unable to meet.

The Contractor shall also present any lower level internal requirements in a compliance matrix. The compliance matrix shall define how each requirement in the specification will be verified (i.e. analysis, test, inspection, demonstration).

During the Kick-off Meeting, defined in SOW Section 4.8.1, Contractor shall review their compliance matrix to address all LLTs requirements, identifying any stressing or critical risk requirements and present a risk register to include mitigation strategy and schedule.

3.2.1.1 Initial Engineering Review Phase Deliverables

Initial Engineering Review Phase Deliverables shall include but not be limited to:

1. Initial Requirements Compliance Matrix w/ Verification Plan
2. Initial Risk Register
3. Post Kick-off Meeting Report

3.2.2 Preliminary Design Phase

This section of the SoW describes the Work conducted by the Contractor during the Preliminary Design Phase of the project.

The Contractor shall develop a Preliminary Design for the LLTs. Also included shall be detailed analysis and/or modeling necessary to verify the LLTs performance. All integration and test plans shall be developed to the preliminary stage.

Early in the Preliminary Design stage the Contractor and the GPTR shall define and agree on the interface protocol between the LLTs and the LGSF System Controller to be developed by the GNAO project. This is to allow the LGSF System Controller to progress in parallel with the LLTs work.

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 should be done during this phase to confirm that the chosen solution is fit for purpose.

The Preliminary Design Phase shall culminate in a Preliminary Design Review at the Contractor's facility, as defined in SOW Section 4.8.2. The meeting shall focus on the design as developed, critical risk areas, and those requiring decisions by the GPTR and the Contractor to enable continued design work.

If Contractor proposes a mature design during the Initial Engineering Review Phase of the project that clearly meets Gemini requirements as defined in the LLTs Specifications Document (GNAO-LLT-RFP-002), Contractor may request in writing an exemption to proceed directly to the Critical Design Phase. The GPTR shall review the request and have the authority to approve or deny the exemption request.

3.2.2.1 Preliminary Design Phase Deliverables

Preliminary Design Phase Deliverables shall include but not be limited to:

1. Preliminary LLT design
2. Preliminary analysis & modeling to verify LLT performance
3. Necessary prototyping demonstrating LLT or subsystem performance
4. Preliminary external interfaces
5. Preliminary integration and test plan
6. Compliance matrix with verification plan
7. Risk Register

3.2.3 Critical Design Phase

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

Upon successful completion and approval of the Preliminary Design Phase, the Contractor shall proceed with the Critical Design Phase of the product and implementations.

During the Critical Design Phase, the Contractor shall not deviate from the Preliminary Design without written permission from the GPTR.

The Critical Design effort entails completion of all design work necessary for the fabrication of the LLTs.

Work performed by the Contractor in this phase shall include all required analysis and modeling to ensure viability of the design as developed.

The Contractor early in the design phase shall completely resolve any sub-system testing needed to support analysis and modelling.

The Contractor early in the design phase shall completely resolve any and all mechanical, electrical, utility, and software interfaces.

The Contractor in the design phase shall finalize all external LLT ICDs and finalize all internal ICDs for each interface between all external hardware and software components.

Contractor in the design phase shall provide the GPTR with all ICD documents for final review and approval.

The Critical Design Phase shall culminate in a Critical Design Review (CDR) as defined in SOW Section 4.8.3.

3.2.3.1 Critical Design Phase Deliverables

Critical Design Phase Deliverables shall include but not be limited to:

1. Final LLT design
2. Final analysis & modeling to verify LLT performance
3. Final external interfaces and ICDs
4. Near Final Factory Acceptance Test Plan
5. Compliance matrix with verification plan
6. Risk Register

3.2.4 Implementation, Integration, Verification and Validation Phase

This section of the SOW describes the Work conducted by the Contractor during the Implementation, Integration, Verification and Validation Phase for the project.

Upon successful completion and approval of the Critical Design Phase, the Contractor shall proceed with Implementation, Integration, Verification and Validation Phase.

Upon successful completion and approval of the Critical Design Phase, the Contractor may procure necessary project equipment, materials, and components.

The Contractor shall implement and test the specified interfaces, and integrate these components into project deliverables.

During this phase the GPTR shall provide to the Contractor an LGSF System Controller adequate to support the beam pointing system integration and testing. This Gemini deliverable does not preclude the Contractor from developing an internal test controller and user interface to exercise the hardware, provided that the final operation of the LLT is in no way dependent on the Contractor’s test controller or interfaces.

The Contractor shall commence system verification once the first LLT product is fully assembled and characterized.

The Contractor shall complete the Factory Acceptance Test (FAT) plan, as defined in SOW Section 4.8.4,

The contractor shall execute the FAT plan and prove, to the greatest extent possible, that the LLT meets all requirements detailed in the LLTs Specifications Document (GNAO-LLT-RFP-002). As well as all internal contractor defined requirements.

The Contractor shall complete the On site Assembly and Integration (OAI) plan.

The Contractor shall provide a plan and be available remotely for the final LLT integration on Maunakea, Hawaii and provide a plan for any On Sky Acceptance Tests (SAT).

The Contractor shall create a Pre-Delivery Acceptance Test Report documenting the results of all tests described in the Factory Acceptance Test plan.

The Contractor shall complete the compliance matrix, and document any revisions or changes to the FAT plan made during integration and testing.

The Implementation, Integration, Verification, and Validation Phase shall culminate in a Factory Acceptance Test at the Contractor's facility, as defined in SOW Section 4.8.4. The FAT shall focus on LLT performance verification through the execution of selected FAT tests.

The Contractor and GPTR shall agree in advance of the FAT which FAT test GPTR shall observe during the FAT.

3.2.5 Delivery, Integration, and Acceptance Phase

This section of the SOW describes the Work conducted by the Contractor during the Delivery, Integration, and Acceptance Phase of the project.

With GPTR written approval, Contractor shall proceed to package the LLTs in a manner that shall protect them from harm during transit in accordance with the specifications contained in the LLT Specifications Document (GNAO-LLT-RFP-002).

Contractor shall deliver all LLT products to the Gemini Telescope base facility located in Hilo, Hawaii.

The Contractor shall perform in Hilo Hawaii on site assembly and installation of the product as defined in the On site Assembly and Installation (OAI) plan.

The Contractor shall execute the On site Acceptance Test (OAT) plan.

The Contractor shall execute the OAT at the telescope base facility in Hilo, Hawaii.

The Contractor shall execute the final OAT by end of December 31 2022.

Contractor shall present the OAI plan at the Factory Acceptance Test Review defined in SOW Section 4.8.4.

The Contractor OAI plan shall specify all necessary procedures, identify all necessary tooling, utilities and handling equipment, and provide a detailed schedule of planned tasks.

The Contractor shall provide all necessary supervision, labor, equipment, operators, and procedural support to perform the OAI.

The Contractor shall perform on site acceptance testing as defined in the On site Acceptance Test (OAT) plan. The Contractor shall present the OAT at the Factory Acceptance Test Review defined in SOW Section 4.8.4.

The Contractor shall conduct and complete the OAT plan to confirm all LLTs perform to specifications and requirements. The OAT plan shall address and verify all items in the compliance matrix.

The Contractor shall demonstrate all maintenance procedures during the on site acceptance tests.

The Contractor shall provide Gemini personnel with necessary training for safe operation and periodic maintenance.

The Contractor shall present the results of the OAT Phase at the OAT Final Review defined in SOW Section 4.8.5.

3.3 On Site Acceptance Test Plan

The Contractor shall prepare an On Site Acceptance Test Plan (OTP).

The OTP shall describe verification work necessary to demonstrate LLT performance and specifications satisfy contract obligations.

The OTP shall describe in sufficient detail procedures and methods necessary for the Contractor to execute the OTP during On Site Acceptance Testing (OAT) and for GPTR to perform the verification, and to repeat the verification at a later date by qualified, trained observatory staff.

The OTP shall clearly state the success criteria for each test, as well as any test prerequisites.

The OTP shall clearly list and describe required test items including specialty tools, equipment, handling fixtures, software and hardware needed, for each tested requirement.

The OTP shall itemize and describe any utilities, services or hardware the Contractor requests Gemini to provide for the OAT. Gemini in good faith shall attempt to provide the items when and where possible.

The OTP shall include sufficient detail for GPTR to both evaluate the appropriateness of each test (with respect to the requirement and success criteria) and to repeat the test independent of the Contractor at a later date.

The OTP plan shall include an agreed subset of FAT test performed by the Contractor post-delivery to demonstrate all LLTs meet Specifications post shipment.

The OTP shall include any on-sky tests Gemini shall perform at the SAT.

4 Communication, Reports and Reviews

4.1 Communications

Neither the Contractor nor GPTR shall modify any contractual or technical aspect of the Work by verbal or informal email communications.

AURA contract officer (AURA) in consultation with the GPTR and the Contractor shall execute in writing all necessary and agreed contract modifications in accordance with the terms of the Contract.

When the Contractor requires technical information from AURA, the GPTR shall provide the information using an agreed Technical Directive form.

The GPTR shall number Technical Directives in sequential order, sign and date the form and release the Technical Directive to Contractor in PDF file format via email.

AURA and the Contractor may informally communicate in order to explore issues and ideas related to the Work; however, the GPTR must be copied on all substantive email communications between AURA and the Contractor and be provided with summaries of all meetings and discussion.

Once informal communications have converged on a solution to an issue, the GPTR 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 in accordance with the terms of the Contract.

4.2 Progress Reports

The Contractor shall prepare and submit the below reports and reviews throughout the duration of the Work.

Contractor shall deliver all written reports and presentations in English.

All written reports shall include a title, date, author, and version number.

Where designs or other information are proprietary AURA, Gemini and Contractor participants shall execute non-disclosure agreements with the Contractor as required to support information transfer.

4.3 Informal Weekly Progress Reports

The Contractor shall participate in informal progress update discussions at a minimum weekly via telephone or email. Formal presentations of overall program status are not required, but the Contractor shall be prepared to discuss schedule status, technical issues, critical risks, risk mitigation strategies, scheduling and staffing. The objective of these updates is to keep the GPTR informed of progress and problems and to collaborate on resolution of issues.

4.4 Monthly Progress Reports

The Contractor shall provide written monthly progress reports in MS Word, PowerPoint, or PDF file format.

Contractor shall deliver the monthly progress reports via email by the 20th of each month.

Progress monthly reports shall highlight progress and activities performed the previous month. Monthly progress reports shall include but not be limited to:

1. Report on status of action items.
2. Percentage of completion of scheduled tasks and indicate schedule variances.
3. Cost and Schedule performance indicators.
4. A review of issues hindering project completion with discussion on proposed mitigation strategies.
5. Identify closed issues and resolution.
6. A review of project tasks planned for the upcoming month with discussion on completion strategies and strategies for successful completion.
7. A table summarizing risks and associated mitigation strategies
8. An updated schedule to consist of the current approved project plan to completion compared to the approved baseline plan schedule, percent complete and with margin for completion date uncertainty

Contractor and GPTR shall discuss and agree to a specific report format during the Kick-Off meeting defined in SOW Section 4.8.1.

Contractor shall record and maintain a monthly progress report action list for the duration of the project.

4.5 Non-Conformance Reporting

The Contractor shall report any project non-conformance to the GPTR for review and possible remediation. The report shall summarize non-conformance items and propose a corrective action plan for GPTR review and approval. SOW Section 8 Contractual Notes defines the formal contract change request process.

4.6 Access to Work and Information

The Contractor shall grant AURA personnel and representatives access during normal working hours to places where the Contractor performs project Work including access to locations where the Contractor's subcontractors are performing project Work.

Upon a written request by GPTR, the Contractor shall allow the GPTR to view and copy requested design documentation, reports, or data and hardware produced under this Contract. The Contractor shall satisfy the request within (3) working days of the request.

4.7 Delays

If events occur that may cause an impact to the schedule, 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 GPTR of any intention or plan to change contractors and or utilize additional contractors and or their facilities.

The Contractor shall promptly notify the GPTR in writing of any event that may negatively impact performance, schedule or completion of the Work and shall promptly revise the Project Plan accordingly for GPTR review and approval.

4.8 Specific Meetings and Reviews

The Contractor shall host specific meetings and reviews throughout the duration of the Work as described below and identified by the Contractor in their Program Plan described in SOW Section 3.1. These meetings shall provide the GPTR with the ability to monitor and review Contractor plans and results to ensure work compliance and approve Milestone payments. Where necessary, the GPTR will provide written approval of the completion of activities for payment. Specific requirements for Milestone completion, payment application, and purchaser review are provided in the contract document.

The Contractor is encouraged to integrate multiple topics (where plausible) to minimize project meetings.

The Contractor shall submit agendas and provide all supporting presentation and reference materials at least two weeks prior to the meeting.

4.8.1 Kick-Off Meeting

The Contractor shall hold a contract Kick-Off Meeting at their facility unless agreed otherwise in writing by the Contractor and the GPTR.

At the Kick-Off Meeting, the Contractor shall present the Project Management Plan clearly identifying personnel, approach to work, schedule, and major milestones as described in SOW Section 3.1. The meeting will also serve to converge on expectations for meeting content, review responses, report content and format.

At the Kick-Off Meeting the Contractor shall present and discuss their proposed technical solution, their Compliance Matrix, their Risk Register, their detailed project schedule and any other technical or contract items requiring clarification.

The Compliance Matrix shall not be construed as giving the Contractor permission to deviate from the Specifications. All Specifications are mandatory. The Compliance Matrix only provides an efficient means of disclosing challenges Contractor encounters in meeting Specifications or other contractual obligations. The Compliance Matrix shall include a report detailing any and all noncompliance and proposed compliance solutions. The Contractor shall update and revise the Compliance Matrix thru the duration of the Work.

At the Kick-Off Meeting the Contractor and the GPTR shall agree upon a process for resolving action items and plan for future meetings and reviews.

At a minimum, the Contractor project manager and technical leads shall participate in the Kick-Off Meeting, other participants may participate via video-conference.

At a minimum of two weeks prior to the Kick-Off Meeting the Contractor shall provide an itemized list of questions and issues needing discussion and resolution.

Within 10 business days post Kick Off Meeting, GPTR shall present Contactor with a list of comments requiring a response from the Contractor.

Within 10 business days of receiving the GPTR comments the Contractor shall provide the GPTR with a summary of the Kick-Off meeting discussions, an itemized list of items agreed and resolved and a list of follow-up action items. The Contractor shall include their responses to items raised by GPTR in this summary.

4.8.2 Preliminary Design Review

The Contractor shall host and conduct a Preliminary Design Review held at their facility unless otherwise agreed to by the Contractor and the Gemini GPTR, following completion of work identified in SOW Section 3.2.2. The goal of the meeting is to demonstrate a product design and the outline 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. All design trade options shall be resolved.
2. All major design risks shall be eliminated or reduced to an acceptable level.
3. Technical Performance Metrics (TPM) shall be identified and tracked.
4. An outline of the Factory Acceptance Test (FAT) plan, On site Assembly and Installation (OAI) plan, and On site Acceptance Test (OAT) plan for each LLTs product implementation.
5. The interfaces shall be defined in the Interface Definition Document (IDD) for Optical, Mechanical, Electrical, and Control interfaces.
6. A complete stage plan for the Critical Design Stage.

The Preliminary Design shall be considered complete when the Contractor completes all tasks listed above and are reviewed and approved by GPTR.

4.8.3 Critical Design Review

The Contractor shall conduct a Critical Design Review held by video conferencing (or at their facility as decided by Gemini) following completion of work identified in SOW Section 3.2.3. The meeting shall present a detailed product design to be engineered and tested which meets requirements.

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

1. A final dictionary of command and status items.
2. A build set of Internal System Interface Documents. All interfaces between internal and external hardware or software subsystems shall be finalized and documented.
3. A final design of the optical, mechanical, electrical, and control subsystems and components of the LLTs.
4. A final report on Technical Performance Metrics.
5. A draft Factory Acceptance Test (FAT) plan, On site Assembly and Installation (OAI) plan, and On site Acceptance Test (OAT) plan for each LLTs product implementation.
6. ICDs of interfaces defined in Preliminary Design Phase as established in the Interface Definition Document (IDD) for Optical, Mechanical, Electrical, and Control interfaces.
7. A draft phase plan for the GNAO Implementation, Integration, Verification, and Validation phase

The Critical Design shall be considered complete when the Contractor completes all tasks listed above and are reviewed and approved by the GPTR.

4.8.4 FAT Review

The Contractor shall host and conduct a FAT Review following completion of work identified in SOW Section 3.2.4. for the first LLT unit. The subsequent LLTs units also require the contractor to host at least one Gemini representatives at their respective FAT. These meetings 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 the GPTR.

A Factory Acceptance Test Review shall be considered complete when all of the tests defined in the Factory Acceptance Test Plan, including those repeated at the FAT Review, have been successfully passed, documented, reviewed and approved by the GPTR.

4.8.5 OAT Final Review

After successful completion of the Delivery, Integration, and Acceptance Phase defined in Section 3.2.5 of this SOW, the Contractor shall present a review of the on site acceptance testing results. Technical notes, calculations, measurements, etc., supporting the testing shall be presented and made available to the GPTR. Measurements shall be performed, recorded, presented, and provided. The Contractor shall archive and make available to the GPTR 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 with traceability to requirements.

4.8.6 General Status Review Meetings

During the course of this effort, an informal general status meeting shall be held at a minimum of every three months (Quarterly Project Reviews) if no specific meetings or reviews described in SOW Section 4.8. are scheduled. The proposed date and the agenda of these general status meetings will be cooperatively developed. The intent is to communicate Contractor progress on the effort and to address any potential issues regularly and proactively. The QPRs may be either remote or on-site meetings.

5 Deliverables Summary

The Contractor shall provide contract deliverables described below in accordance with the project schedule. Where designs or other information are proprietary, AURA will execute non-disclosure agreements with the Contractor to support information transfer.

5.1 Hardware Equipment

The Contractor shall supply and deliver all physical and intellectual products including optical, mechanical, electrical, electronics, cables, support equipment, handling equipment and packaging to the Gemini telescope base facility in Hilo, Hawaii.

Contractor shall register all commercial licenses to AURA.

The Contractor shall provide and deliver all manuals and documentation necessary to support the operation and periodic maintenance of five functional LLTs.

5.2 Preliminary and Critical Design Documentation

The Contractor shall provide design documents sufficient to allow functional reviews at the Preliminary and Critical Design Reviews including but not limited to engineering models, drawings, calculations, analysis and discussions.

Contractor shall make all documentation available in native file format for future AURA Gemini use such as Word, Excel, and PowerPoint.

Contractor shall deliver all CAD files and or models in their native file format, STEP file format and PDF.

Contractor shall deliver all documents written in English with a title, author, date and version number.

5.3 Written Reports

The Contractor shall provide all written reports as specified in SOW Section 4.

Each review meeting requires a written report and may also require an actual presentation.

The Contractor shall provide all documents with a title, author, date and version number.

Contractor shall write all documents and make all presentations in English.

5.4 Reviews and Meeting Documents

The Contractor shall provide all materials presented during the specific meetings and reviews described in SOW Section 4.8.

5.5 Results of Analysis and Modeling

The Contractor shall provide results from all design calculations, analysis, and modeling conducted by the Contractor 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 if possible to enable additional analysis by AURA Gemini.

5.6 Interface Control Documentation

The Contractor shall provide as interface control documents as needed to define and to describe the interfaces between the product and other GNAO subsystems. Specifically, the Contractor shall provide interfaces described in the document (GNAO-LLT-RFP-002).

5.7 Drawings, and Specifications

The Contractor shall provide electronic versions of all drawings and specifications in support of their Work. The drawings shall have a drawing ID number, title, author, date, and version number. Contractor shall revise drawings as necessary through the duration of the Work 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 and the GPTR shall agree to a drawing numbering scheme at time of Kick-Off Meeting and follow that scheme through the duration of the Work.

The Contractor shall deliver all drawings including assembly, subassembly, part and detail fabrication drawings in their native file formation, in STEP file format and PDF.

5.8 Documentation and Models

Contractor shall provide documentation as specified in this SOW. The Contractor shall provide all engineering models and computer media copies of designs, drawings, models, etc. All documentation shall be available in native format (3D models, drawings) for future AURA Gemini use. All documents shall be written in English and have a title, author, date, version number.

5.9 Monthly Progress Reports

The Contractor shall provide progress updates via email each month as defined in SOW Section 4.4. These reports are intended to aid the GPTR in maintaining visibility into Contractor status and provide inputs for AURA Gemini's monthly status report to partners and funding agencies.

6 Customer Furnished Equipment

The GPTR shall provide an LGSF System Controller and user interface package adequate for the testing, verification, and validation of the LLT performance and specifications. The LGSF System Controller shall conform to control interfaces developed during the design phase.

7 Schedules

7.1 Work Schedule

The Contractor shall provide a detailed work schedule for all major activities and indicate the relevant work milestones per their Project Management Plan defined in SOW Section 3.1. The work schedule shall identify proposed dates for review meetings and indicate timelines for all tasks with a maximum resolution of 2 weeks in duration.

7.2 Payment Schedule

The Contractor shall provide a Milestone Payment Schedule as described in Contractor Project Management Plan defined in SOW Section 3.1.

The GPTR shall review and approve all milestone payments.

AURA shall make milestone payments in accordance with Contract documents.

8 Contractual Notes

8.1 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 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.

8.2 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.

8.3 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 GPTR of an intention or plan to change contractors and or utilize additional contractors and or their facilities.

The Contractor shall promptly notify the GPTR 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 GPTR via email for approval.

8.4 Non-Conformance and Remediation

During the course of this effort, the Contractor shall immediately report any non-conformance to the GPTR. 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 GPTR. The formal contract change request process is detailed in the contract document.

8.5 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 GPTR. The formal contract request for change process is detailed in the contract document.

8.6 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.

8.7 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.

9 Acronym Table

AOB	Adaptive Optics Bench
ATP	Acceptance Test Plan
AURA	Association of Universities for Research in Astronomy
CAD	Computer Aided Design
CDR	Critical Design Review
GEMMA	Gemini in the Era of Multi Messenger Astronomy
GLAO	Ground Layer Adaptive Optics
GNAO	Gemini North Adaptive Optics system
GPTR	GNAO Project Technical Representative
FAT	Factory Acceptance Test
ICD	Interface Control Document
IDD	Interface Definition Document
LGS	Laser Guide Star
LGSF	Laser Guide Star Facility
LLTs	Laser Launch Telescope
MCAO	Multi-Conjugate Adaptive Optics
NGS	Natural Guide Star
OAI	On Site Assembly and Integration
OAT	On Site Acceptance Test
PBS	Product Breakdown Structure
PDR	Preliminary Design review
QPR	Quarterly Progress Report
RFP	Request for Proposal
RTC	Real Time Controller
SAT	On Sky Acceptance Test
SOW	Statement of Work
SyCo	System Controller
TBA	To Be Assigned
TBC	To Be Confirmed
TBD	To Be Determined
TCS	Telescope Control System
TPM	Technical Performance Metrics
TT	Tip-tilt
WBS	Work Breakdown Structure
WFS	Wavefront Sensor