ISTITUTO NAZIONALE DI ASTROFISICA
OSSERVATORIO ASTRONOMICO D'ABRUZZO

STATEMENT OF WORK

Document Number	E-MAO-000-INA-SOW-008_01
Title	***Statement of Work for the Design and Manufacturing of the Calibration Unit Optomechanical System for the MORFEO Instrument of the ELT***
Contracting Authority	*INAF - Osservatorio Astronomico d'Abruzzo* *Via Mentore Maggini snc, 64100 TERAMO* *www.oa-abruzzo.inaf.it*

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Art. 1 - Definitions and purpose of the document

1.1 Definitions

AD	Applicable Documents
AIT	Assembly, Integration and test
Calibration Unit Optomechanical System	In this document, in the "Disciplinare" and in the Draft Contract the term "Calibration Unit Optomechanical System" means the optomechanical system of the Calibration Unit itself, according to Preliminary Design documentation. The term "Calibration Unit Optomechanical System" includes all the items to be supplied, as shown in Sections 3.2 and 3.3 of **AD1**.
Bidder	Any company or other economic operator that submits an offer for the present Call.
BoM	Bill of Material
CI	Configuration Item
CIDL	Configuration Item Data List
CIL	Configuration Item List
CMX	Compliance Matrix
Company or Contractor	The company or other economic operator that signs with INAF the contract for this project.
Contracting Authority	INAF - Osservatorio Astronomico d'Abruzzo (INAF-OAAb) is the contracting authority for this project
COTS	Commercial Off-The-Shelf
CRE	Change Request
CSR	Change Status Report
CU	Calibration Unit
DDP	Delivered Duty Paid
ELT-MORFEO	*Extremely Large Telescope - Multiconjugate Adaptive Optics Relay For ELT Observations*

ESO	European Southern Observatory (ESO). It is the commissioning party of MORFEO. ESO is entitled to participate, as a reviewer, to the Final Design Review.
Factory	Throughout this document, "Factory" refers to the contractor premises, where the first acceptance test is carried out.
FAT	Factory Acceptance Test
FDR	Final Design Review
FMEA	Failure Mode and Effect Analysis
Functional requirements	Requirements that indicate the purpose and function of the supply.
HAZMAT	Hazardous Materials
ICD	Interface Control Document
INAF-OAAb	Istituto Nazionale di Astrofisica - Osservatorio Astronomico d'Abruzzo
LLIs	Long Lead Items
KOM	Kick-Off Meeting
MAIT	Manufacture, Assembly, Integration and test
MTBF	Mean Time Before/Between Failure(s)
MTTR	Mean Time To Repair
NC	Non-Compliance
NHA	Next Higher Assembly
NLA	Next Lower Assemblies
NPRD	Non-electronic Parts Reliability Data
OAT	On-site Acceptance Test
OEM	Original Equipment Manufacturer
On-site	Throughout this document, "On-site" refers to the INAF-OAAb site.
Optional Requirements	Requirements that are not mandatory for the acceptance of the proposal but can give additional points in the evaluation of the offer
PA	Product Assurance

PAE	Preliminary Acceptance in Europe
PAC	Provisional Acceptance Chile
PEC	Posta Elettronica Certificata (Certified electronic e-mail)
PDR	Preliminary Design Review
Quality and Performance requirements	Requirements that define what performance and level of service the supply must have
RAMS	Reliability, Availability, Maintenance and Safety
RD	Reference Documents
RFW	Request For Waiver
RFD	Request For Deviation
RIXs	Review Item Comments / Questions / Discrepancies
SLA	Service Level Agreement
SoW	Statement of Work
Supply	All the items to be provided by the Contractor and included in the offer
TBD	To Be Defined
TBC	To Be Confirmed
Technical requirements	Requirements that define the characteristics and technical specifications of the supply.
TRL	Technological Readiness Level
WP	Work Package

In this document and in all other documents of the Call the following convention applies:

- **Shall** indicates a mandatory requirement
- **Should** indicates an optional, desired requirement
- **Will** indicates a circumstance expected to happen.

1.2 Purpose of the document

This document describes and specifies the subject of the contract and the relative milestones and deliverables. The technical requirements for the Calibration Unit Optomechanical System are described in **AD1**, **AD2**, **AD3**, **AD4, AD5** and are integral part of this Statement of Work, while the contractual and financial aspects are described in the document "Disciplinare di Gara" (*Tender Instructions*) and drafted in "Schema di Contratto" (*Draft Contract*).

Art. 2 - Background, context and vision

MORFEO (formerly known as MAORY) is a post-focal adaptive optics module that forms part of the first light instrument suite for ELT, the ESO Extremely Large Telescope (39m diameter) currently under construction. The main function of MORFEO is to relay the light beam from the ELT focal plane to the client instruments while compensating the effects of the atmospheric turbulence and other disturbances affecting the wavefront from the scientific sources of interest. MORFEO enables high angular resolution observations in the near infrared over a large field of view (~1 arcmin^2) by real time compensation of the wavefront distortions due to atmospheric turbulence. Wavefront sensing is performed by both laser and natural guide stars while the wavefront compensation is performed by adaptive deformable mirrors in MORFEO, which work together with the telescope's adaptive and tip tilt mirrors M4 and M5 respectively.

MORFEO is being designed and built by a Consortium of partners in Italy, France and Ireland, together with ESO. INAF, as the leading institute, is responsible for all the major procurements and for the integration of the whole instrument that will take place at the Bologna Integration Hall located beside INAF OAS Institute in Bologna, Via Gobetti 93/3, Italy.

2.1 Definitions Timeline of MORFEO project (Phases and Reviews)

Preliminary Design Phase

During this phase the conceptual design of MORFEO, originally produced during the Phase A Study, is developed into a preliminary design for the fulfilment of the requirements defined in the MORFEO Technical Specification.

Preliminary Design Review (PDR)

The purpose of this review is to scrutinise the compatibility of the preliminary design with the Technical Specification and its applicable documents. During the PDR the overall instrument, the cost, schedule and risks associated with the development of MORFEO as well as the status of the interface design documents shall be reviewed. The PDR shall take place when the hardware development specifications and the software top level design documents and their corresponding verification/test plans are available. The MORFEO PDR took place in two distinct phases: April 2021 and July 2021. The formal conclusion of the PDR occurred in February 2023.

Final Design Phase

In this phase MORFEO is designed down to the level of components. The major manufacturing drawings must be available at the end of this phase.

Final Design Review (FDR)

The purpose of this review is to ensure that the detailed hardware and software design solutions as reflected in the submitted drawing set, the interface design documents and other relevant documents satisfy the requirements established by all technical specifications. The review shall also demonstrate that the instrument and its subsystems can be successfully integrated into the observatory. There is the possibility of having earlier FDR for critical or Long Lead Items (LLIs) components.

The Calibration Unit Optomechanical System is a critical subsystem of MORFEO since its design and implementation could require significant time and effort and can influence the overall schedule.

Manufacture, Assembly, Integration and Test (MAIT) Phase

The MORFEO MAIT phase comprises two main sub-phases:

1. The subsystem MAIT, including the construction/procurement of the pieces composing the subsystem, the assembly and integration of such pieces and the test of the integrated subsystem as a stand-alone unit at the factory.
2. The system AIT, that involves the assembly and integration of the various subsystems in order to compose the full system and the test of the integrated MORFEO system at the INAF Integration Site.

Preliminary Acceptance in Europe (PAE)

Once MORFEO has been assembled, aligned and all sub-system tests performed in the Consortium's Integration Facility, the system acceptance tests foreseen in the PAE test Plan shall be performed. During the PAE the Consortium shall demonstrate to ESO the conformity of the instrument performance with the technical specifications and its applicable documents.

After the successful completion, ESO will grant Preliminary Acceptance (Europe) and authorise the shipment of MORFEO to the final observatory location. The PAE meeting shall be held at the Consortium's Integration Facility.

The PAE is planned for 2030.

Transport and Incoming Inspection Phase

After passing the PAE, the Consortium has to pack MORFEO in a manner suitable for road and air or sea transport. The transport will be organised by the Consortium.

Once arrived at the Chile location the material is inspected to verify that it hasn't received any damage during the transport.

Installation and Commissioning Phase

The MORFEO system will be assembled, integrated and tested in the Integration and Assembly Area at the telescope and then moved to the Nasmyth platform and commissioned.

Provisional Acceptance (Chile) (PAC)

The PAC has the objective to demonstrate that the instrument meets the requirements of the Technical Specifications and its applicable documents, and that all tasks described in this SoW have been satisfactorily fulfilled.

The PAC is planned for 2032 and is followed by a 2-year guarantee period.

Art. 3 - Subject of the contract

This SoW applies to the delivery of the ***Calibration Unit Optomechanical System*** (which includes optics, mountings, adjustments, mechanical supporting structures, tools and everything needed with them, as indicated in **Section 4.4**). It will cover:

- the Final Design phase;
- the Manufacturing phase, which includes the Assembly, Integration and Test (MAIT) at the company premises;
- the delivery and commissioning at the INAF-OAAb integration hall (Teramo, Italy);
- training (as described in Table 6).

Assuming as T0 the date of the Contract Signature with the selected contractor, the project shall follow the timeline indicated in **Section 4.3**.

The Kick Off Meeting shall mark the official start of project activities. The Kick Off Meeting shall take place within 30 days from contract signature.

The Applicable and Reference Documents for this supply are listed in the following sections.

3.1 Applicable Documents and Files

The following applicable documents (AD) and files, of the exact version shown, form a part of this document to the extent described herein. In the event of conflict between the documents referenced herein and the contents of this document, the contents of this document are the superseding requirement.

AD1 E-MAO-PU0-INA-SPE-004_01 MORFEO Calibration Unit Optomechanical System – Technical specifications

AD2 E-MAO-PUA-INA-MOD-001_02 MORFEO Calibration Unit Optomechanical System – Optical Model (direct) (ZAR file)

AD3 E-MAO-SF0-INA-SPE-004_01 MORFEO Optics Common Requirements

AD4 SAF-GEN-MAN-3444 ESO Safety Conformity Assessment Procedure, Version 5

AD5 E-MAO-PU0-INA-ICD-002_01 MORFEO Calibration Unit Optomechanical System – Optical Interfaces

3.2 Reference Documents

Reference documents (RD) are cited, but do not constitute requirements for the supply. They may be MORFEO Consortium internal and external documents, and other resources considered to be useful as background information for the Contractor (to help in the full understanding of the requirements and technical specification, and to be used as a starting point for the final design).

RD1 E-MAO-PUA-INA-DER-002_01 MORFEO Calibration Unit Optomechanical System – OFDR Design and Analysis Report

RD2 E-MAO-PUA-INA-TN0-002_01 MORFEO Calibration Unit Optomechanical System – Preliminary Optical Prescriptions

RD3 E-MAO-PUA-INA-MOD-002_01 MORFEO Calibration Unit Optomechanical System – Preliminary Mechanical Model (STEP file)

3.3 Definition of Project Items

The subject of the contract concerns the optical and mechanical components of the Calibration Unit of MORFEO and all the related documentation.

The Contractor shall procure and deliver the items specified in **Section 4.4** of this document and in Section 3.3 of **AD1**, according to the Optical Model in **AD2** and the Optical Interfaces in **AD5**, considering as a starting point the Design and Analysis Report in **RD1**, and as further references the Optical Prescriptions in **RD2** and the (3D) Preliminary Mechanical Model in **RD3**.

Art. 4 - Contractual Phases, acceptance procedure, deliverables, timeline and milestones

4.1 Contractual Phases

The project shall include the following phases:

a) Phase 1 - Final Design and Optional Early Procurement of LLIs (firm phase)

Subphase 1.1 - Final Design:

- Design and performance analysis of the Calibration Unit Optomechanical System
- Design of testing setup and other deliverables (tools)
- Delivery of the expected documentation (full list and timeline specified in **Sections 4.4** and **4.5**).
- Final Design Review

Subphase 1.2 - Optional Early Procurements of LLIs:

- Procurement of optical elements necessary for the construction of the Calibration Unit Optomechanical System and which require long production times (list to be proposed by the Contractor and to be approved by INAF at contract signature).
- Delivery of the expected documentation (full list and timeline specified in **Sections 4.4** and **4.5**).

b) Phase 2 - Procurement, Manufacturing, Assembly, Integration and Test (conditional phase)

Subphase 2.1 - Procurement, Manufacturing and Assembly:

- Procurement and/or manufacturing of the elements needed to build the Calibration Unit Optomechanical System and their Assembly;
- Delivery of the expected documentation (full list and timeline specified in **Sections 4.4** and **4.5**).

Subphase 2.2 - Integration and Test:

- Integration and Factory Acceptance Test;
- Delivery to INAF-OAAb and On-site Acceptance Test.
- Delivery of the expected documentation (full list and timeline specified in **Sections 4.4** and **4.5**).

- Training: Calibration Unit Optomechanical System alignment, operation and maintenance procedures, use of the delivered tools and equipment, packing/unpacking of the supplied items.

The full description of the expected timeline and milestones is reported in **Section 4.3**.

Only optical elements can be proposed for the Early Procurement. It is expected that the elements necessary for the construction of the optics and which require long production times (Long-Lead Items), are the optics blanks. Additional prototyping and/or bread-boarding can be proposed by the Contractor.

The transition between Phase 1 and the (conditional and not guaranteed) Phase 2 will be subjected to internal (INAF review) and external (ESO review) conditions.

INAF will accept the Final Design of the Calibration Unit Optomechanical System upon review and implementation of the joint recommendations from the MORFEO Consortium and ESO.

4.2 Acceptance procedure

The acceptance procedures shall be as follows:

Phase 1

INAF will approve the Final Design by evaluating the corresponding documents (full list and timeline specified in **Sections 4.4** and **4.5**), and will declare it successfully closed after the successful implementation of all the relevant actions coming from the FDR.

INAF will accept the (optional) Early Procurements by evaluating the procurement documentation and verifying that the purchased elements are available and in working conditions.

Phase 2

For Phase 2 there shall be a readiness review and two separate acceptance procedures, that shall be carried out after the delivery of the expected documentation (full list and timeline specified in **Sections 4.4** and **4.5**). These three milestones are the following:

Integration Readiness Review: It ensures that the activities to be carried out in the Integration phase are clearly identified, sorted out and scheduled, have assigned resources, and the responsible persons and the success criteria for all activities are clear.

Factory Acceptance: Acceptance procedures for the physical equipment (Calibration Unit Optomechanical System) will be carried out through structured test sessions at company premises. The procedures shall start with the verification that all the expected items (listed in Sections 3.2 and 3.3 of **AD1**) are present and in working conditions. These test sessions will verify that the Calibration Unit Optomechanical System fulfils all the technical specifications.

On-site Acceptance: (also referred to as "commissioning") comprises the execution of test and verification procedures (at the presence of the Contractor personnel). The Contractor is responsible for the correction of any non-compliances until the Calibration Unit Optomechanical System fulfils all the technical requirements.

This acceptance phase ends under the condition that all the waivers for the Calibration Unit Optomechanical System are closed and all agreed changes are implemented.

4.3 Timeline and Milestones

In the following the high-level project schedule is reported, under the form of Gantt chart and under tabular form.

The date of the Kick Off Meeting of Phase 1 shall be decided at the time of the contract signature (T0) and must in any case take place within 30 days from the date of the contract signature.

The start of Phase 2 (T1) will happen when all Action Items arising from the Calibration Unit Optomechanical System FDR are closed, and in any case only after formal approval to proceed from INAF-OAAb.

In the following schedule (Figure 1 and Table 1) we have assumed, as a tentative reference, T1=T0+15. However, T1 could be different from that assumption, but in any case, not greater than T0+20, as specified in Section 3.4 of the document "Disciplinare di Gara".

All the dates of milestones are to be considered tentative and shall be confirmed at project start, except for the following (see also Section 18.3 of the document "Disciplinare di Gara - Tender Instructions"):

- Delivery of Final Design documentation (T0+10)
- Duration of Phase 2 (T1+24)

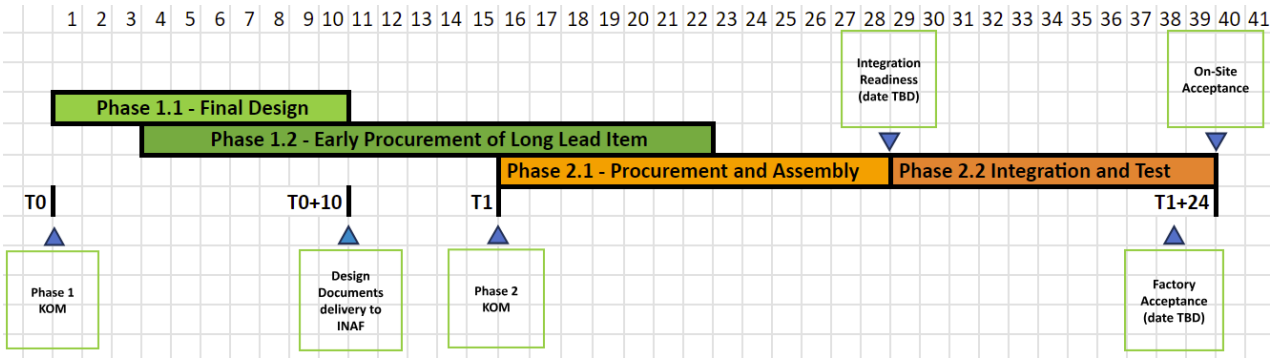

Figure 1. Project schedule of the Calibration Unit Optomechanical System in graphical form (Units are in Months).

Calibration Unit Optomechanical System **Phase 1 - Final Design and Optional Early Procurements (T0: start of activities)**			
Activity/Milestone	**Start**	**Stop**	**Description**
Subphase 1.1 - Final Design			
Contract Signature	T0		Contract signature. Kick-Off Meeting to be arranged within 30 days from contract signature.

Kick Off Meeting (KOM)	T0+1		The main objectives of the KOM are to confirm mutual understanding of the scope of the work specified herein, including its applicable specifications. The documents supporting the KOM shall be submitted to INAF-OAAb one week before the KOM, for review.
Interfaces finalisation	T0	T0+2	The objective of this activity is to ensure that all the interfaces are defined. This is a common (INAF-OAAb and Contractor) activity for the definition of interfaces with MORFEO and other Calibration Unit components provided by INAF-OAAb.
Design & Analyses	T0	T0+10	The objective of this activity is to carry out the final design and analysis of the Calibration Unit Optomechanical System, in order to be ready to start Phase 2. If identified, Long-Lead item design shall be submitted earlier in time to undergo a review by INAF-OAAb (see Subphase 1.2 schedule)
Delivery of Final Design documentation	T0+10		All the documentation of Final Design is delivered to INAF-OAAb.
Final Design Review (FDR)	T0+10	T0+K	The purpose of this review is to ensure that the detailed design solutions as reflected in the submitted drawing set, the interface design documents and other relevant documents satisfy the requirements established by the Technical Specifications and other applicable documents (**AD1**, **AD2**, **AD3**, **AD4, AD5**). The FDR is considered successfully closed after the successful implementation of all the relevant actions triggered by the review. The positive conclusion of the FDR is the condition for the start of Phase 2. (The value of 'K' is TBD, though is expected to be between 15 and 20 at most)
Activity/Milestone	**Start**	**Stop**	**Description**
Subphase 1.2 - Optional Early Procurement			
Long-Lead Items Final Design Review (LLIs FDR)	T0+2.5	T0+3	This milestone has the objective of reviewing the documentation and design of Long-Lead Items (if needed), to assess their maturity and to formally authorise the start of such early procurements.

Early procurement of LLIs (if needed)	T0+3	T0+R	The objective of this activity is to procure all the elements that require a long time to be built and that could impact the overall schedule if their construction is not started in Phase 1. (The value of 'R' shall be proposed by the bidder)
Long-Lead Items Acceptance	T0+R	T0+R+ 0.5	Verification that the purchased elements are available and in working conditions in the factory.

Table 1. Project schedule of the Calibration Unit Optomechanical System for Phase 1 in tabular form (Shifts are in Months) and separated for the two SubPhases (Final Design and Optional Early Procurement, respectively).

The reviews reported in Table 1 are detailed in the following:

- **FDR – Final Design Review**

  In this review the final design of the Calibration Unit Optomechanical System is verified. Phase 2 cannot start until the FDR has been successfully accepted.
  ESO can participate in this review as a reviewer and as joint approving authority.

- **LLIs FDR - Long-Lead Items Final Design Review**

  In this review the design of Long-Lead Items, the subsystem budget that drives this design and the overall subsystem design are verified in order to assess the maturity of the project and the start of their procurement.

Calibration Unit Optomechanical System Phase 2 - Procurement, Manufacturing, Assembly, Integration and Test (T1: start of activities)			
Activity/Milestone	**Start**	**Stop**	**Description**
Subphase 2.1 - Procurement, Manufacturing and Assembly			
Kick Off Meeting for Phase 2 (KOM2)	T1		The objective of this Meeting is to verify the presence of all conditions to start Phase 2. The procurement of all non-LLI elements can start after this meeting.
Procurement of other (non LLI) items	T1	T1+N	This activity has the objective to procure all the remaining elements (non-LLI) according to the Parts List/Bill of Materials provided with the Final Design. (The value of 'N' shall be proposed by the bidder)

Delivery of the Calibration Unit Optomechanical System Dummy	T1+6		This milestone marks the delivery to INAF of the Calibration Unit Optomechanical System Dummy, as specified in Sections 3.3 and 4.4 of **AD1**.
Subphase 2.2 - Integration and test			
Integration Readiness Review (IRR)	T1+Q-0.5	T1+Q	The purpose of this activity is to verify that the elements of the integration phase (items, plans, tools, procedures and resources) are clearly identified. The positive conclusion of the review is the condition for the start of the integration. (The value of 'Q' shall be proposed by the bidder)
Integration	T1+Q	T1+M	The objective of this activity is to integrate, align and test the CU Optomechanical System at the Contractor's premises and to prepare it for the Factory Acceptance. Interfaces and integration tests of the CU subsystems provided by INAF-OAAb (see Section 3.2 of **AD1**) shall be done during this period. During this phase training to INAF personnel shall be provided. (The value of 'M' shall be proposed by the bidder)
Factory Acceptance Readiness Review (FARR)	T1+M-0.5	T1+M	At this milestone, the CU Optomechanical System, fully integrated, shall be ready for the execution of Factory Acceptance Test. (The value of 'M' shall be proposed by the bidder)
Factory Acceptance Test (FAT)	T1+M	T1+F	This activity has the objective to verify that the CU Optomechanical System is performing according to its specifications and that all the requirements are fulfilled, at Contractor's premises. (The value of 'F' shall be proposed by the bidder)

Factory Acceptance	T1+F		This milestone marks the positive acceptance of the CU Optomechanical System at the Contractor's premises and the consequent authorisation to ship it to the INAF-OAAb facility for the final MORFEO-CU Integration. A Test and Inspection report is signed by both INAF and Contractor. All the training activities (mounting, integration, alignment, cleaning, stripping, …) have to be completed by this milestone.
On-Site Acceptance Readiness Review (OARR)	T1+22.5		After the transport of the CU Optomechanical System to INAF-OAAb facility and after its integration, the CU Optomechanical System is ready for the execution of the Acceptance Test.
On-Site Acceptance Test (OAT)	T1+23	T1+2	During this activity, INAF-OAAb reserves the possibility to carry out selected tests on the CU Optomechanical System to verify the fulfilment of all the requirements and specifications, at INAF-OAAb premises.
On-Site Acceptance (End of Phase 2)	T1+24		This milestone marks the positive conclusion of the Test and commissioning at INAF-OAAb premises and the consequent final acceptance by INAF-OAAb. A Test and Inspection report is signed by both INAF and the Contractor.

Table 2. Project schedule of the Calibration Unit Optomechanical System in Phase 2 in tabular form (Shifts are in Months).

The reviews reported in Table 2 are detailed in the following:

- **IRR - Integration Readiness Review**

The Integration Readiness Review takes place before starting the integration of the Calibration Unit Optomechanical System. It includes the verification that all the activities to be carried out in the Integration Phase are clearly identified, prioritised and scheduled. The responsibility for each of the activities must be also clearly identified.

- **FARR - Factory Acceptance Readiness Review**

The Factory Acceptance Readiness Review takes place before starting the tests at the Contractor's premises, with the Calibration Unit Optomechanical System fully integrated and all the required information is gathered in the documentation. FARR assess test objectives, scope, methods and

procedures, and safety. FARR is also intended to determine if any changes are required in planning, resources, training, equipment, or timing to successfully proceed with the test.

- **OARR - On-site Acceptance Readiness Review**

The On-site Acceptance Readiness Review takes place before starting the tests at the INAF-OAAb premises. OARR assess test objectives, scope, methods and procedures, and safety. It also includes inspection and unboxing of the supply. OARR is also intended to determine if any changes are required in planning, resources, training, equipment, or timing to successfully proceed with the test.
During the execution of the OARR the presence of Contractor personnel is required.

The test sessions reported in Table 2 are detailed in the following:

- **FAT - Factory Acceptance Test**

The Factory Acceptance Test is the process of provisional acceptance that assesses the proper functioning of the system(s) at the Contractor's premises. All interfaces, maintenance, packing and unpacking procedures are also verified.
Test procedures, methods and timeline of the FAT of the Calibration Unit Optomechanical System shall have been defined in detail in the relevant MAIT Plan by the Contractor. The MAIT Plan shall ensure the proper implementation of all requirements contained in the Compliance Matrix.
Once the FAT is successfully passed, the Calibration Unit Optomechanical System can be transported to the INAF-OAAb integration site.
During the FAT all technical and interface requirements, foreseen to be verified by test and described in the MAIT plan, shall be verified. The results of such tests shall be documented in the test reports.
The tests executed at the Contractor's premises shall reproduce to the maximum possible extent the real operational conditions.
When needed, simulators and mock-up devices shall be used to mimic interfaces and operational conditions.
A Test and inspection report (FAT version) shall be issued at the end of the test session, signed by the appointed INAF-OAAb responsible and counter-signed by a Contractor's representative.

- **OAT - On-site Acceptance Test**

In this test session, executed at INAF-OAAb premises under the responsibility of INAF, a subset of technical requirements and interface requirements is tested.
Test procedures, modes and timeline of the OAT shall be agreed and defined in detail in the relevant Calibration Unit Optomechanical System MAIT Plan.
During the execution of the OAT, the presence of Contractor personnel is required. The contracting authority reserves the possibility to carry out further selected tests with its own personnel.
A Test and inspection report (OAT version) shall be issued at the end of the test session, signed by the appointed INAF-OAAb responsible and counter-signed by a Contractor's representative.

4.4 Deliverables

Types:

- D: Document

- M: 2D/3D Model, Drawing
- E: Equipment
- S: Services

Refer to Table 2, Table 7 and Table 8 for milestones and delivery dates.

For the definition of the Calibration Unit Optomechanical System and of the elements composing it, see **AD1** (Sections 3.2 and 3.3), **AD2**, **RD1**, **RD2**.

Note that the code used hereby is intended only to enumerate and identify the deliverable items. The final document numbering shall be agreed with INAF-OAAb at the contract signature.

Calibration Unit Optomechanical System Technical Deliverables (Documents)

Code	Title	Type	Description
PUA-CMX-001	Calibration Unit Optomechanical System Compliance Matrix	D	Compliance Matrix to Requirements. The Compliance Matrix shall, as a minimum: 1. List in a tabular format all the requirements that have been identified in the Call documentation, including the interface requirements. 2. Recapitulate for each requirement the type and method of verification adopted (by Design, Analysis, Inspection or Test). 3. Provide a statement of compliance and the reference to the document where the compliance is demonstrated or shown. In case of non-compliance (or partial compliance) indicate the pending assessment, possible remarks and the link to the related requirements. 4. List any reference to NCs, CREs or RF(W/D)s documents. 5. Reference to the location of the verification description within the document datapack.
PUA-DER-001	Calibration Unit Optomechanical System Design Report	D	Design of the CU Optomechanical System. The Design Report shall contain, as a minimum: a. Assumptions, such as design constraints, environmental conditions other than specified in technical specification, maintenance concept, access concepts. b. Materials used in the design with physical properties as well as chemical behaviour, applicable treatments and their purposes. c. Detailed description of the system design, all

			relevant components subsystems and function with reference to every specified requirement. d. Any part of the design that is not closed and problem areas. e. All the description required to prove the requirement that has to be verified by design according to CMX. f. TRL (according to the appendix of the present document) assessment for critical technologies shall be provided, making sure that FDR TRL 6 is achieved for all items. The design shall cover the optical, mechanical and electrical design. The tools shall be part of the design.
PUA-ANR-001	Calibration Unit Optomechanical System Analysis Report	D	Analysis of the CU Optomechanical System. The Analysis Report, taking into account the actual system design demonstrating that the referred requirement is met, shall contain, as a minimum: a. Requirement analysis b. Functional analysis c. Performance analysis d. Interface analysis in operational conditions e. Reliability analysis f. Earthquake analysis g. Buckling analysis h. Ghost & Stray Light analysis i. Further analyses, as appropriate j. All the analyses required to prove the requirement that has to be verified by analysis according to CMX.
PUA-SPE-001	Calibration Unit Optomechanical System Budget	D	Technical/Error Budget. The Technical/Error Budget shall highlight, at all levels, how a requirement belonging to the Next Higher Assembly (NHA) is broken down into requirements belonging to the Next Lower Assemblies (NLA) which applies to individual elements of the concerned product. The Document shall contain the following set of information, as a minimum: 1. Purpose of the Document; in this section the purpose of the document shall be identified. 2. Scope of the Document; in this section the scope of the document shall be identified.

			3. Applicable Documents; in this section all the documents referred to in the technical budget shall be listed. 4. Definitions & Conventions; in this section all definitions and conventions used in the Document shall be given. 5. General Assumptions; in this section all general assumptions used in elaborating the technical budget shall be given. This includes assumptions on the mode of error combination (linear, quadratic, etc.), assumptions on the load cases (worst case, average case, etc.), approach regarding margins, etc. 6. Operational Conditions; in this section all operational conditions under which the technical budget applies shall be given. This includes the operational mode and the environmental conditions. 7. Contributors/Error Sources; in this section all contributors or error sources included in the technical budget shall be identified, described and discussed. Any special assumption made as well as a justification of the allocated value (results of an analysis, test result, comparison with past experience, etc.) shall be given with proper references to the relevant documentation. 8. Technical Budget; in this section the technical budget shall be presented, for instance in the form of a flow chart or in a tabular format, with clear identification of margins at the relevant level. 9. Conclusion; the conclusion shall summarise the outcome of the technical budget in terms of compliance to the top-level requirements, associated margins, critical component(s) of the technical budget, associated Project risk and specific plan for conforming to the budget allocation and mitigating risks.
PUA-ICD-001	Calibration Unit Optomechanical System Interface Control Document	D	The ICD shall list, for each interface: 1. Interface name and reference number 2. The items to be interfaced 3. The description of the interface 4. The verification status of the interface

			5. Reference to Change Request or Request for Waiver, if applicable 6. Status and comments. For mechanical interfaces, the copies of the drawings of the items to be interfaced shall be attached to the document. The ICD shall be carefully amended with the updated versions of the drawings.
PUA-PLA-004	Calibration Unit Optomechanical System MAIT Plan	D	The document shall describe the Manufacturing, Assembly, Integration and Test Plan, that shall be established for the CU Optomechanical System. The MAIT plan shall give detailed definitions, requirements, conditions and constraints of all manufacturing, assembly, integration, alignment and test activities performed in the factory. Facilities shall be identified and briefly described. Requirements and definitions shall be given for support equipment to cover MAIT phases including handling, transport and storage. The document contains a clear and well detailed verification plan describing the tests to be performed to verify the compliance of the CU Optomechanical System to the specifications.
PUA-DWG-001	Calibration Unit Optomechanical System Manufacturing Drawings	M	The package shall contain: Assembly drawings, parts drawings and manufacturing drawings. 'Drawings' in this context include electronic circuit diagrams. The drawing set shall be delivered according to the product breakdown structure (drawings numeration to be discussed and agreed with INAF-OAAb). The document also includes cables and cooling pipes routing.
PUA-DWG-002	Calibration Unit Optomechanical System As-Built Drawings	M	Drawings after building. The package shall contain the drawings at all levels of the project, in particular of the as-built product. 'Drawings' in this context include electronic circuit diagrams. The drawing set shall be delivered according to the product breakdown structure (drawings numeration to be discussed and agreed with the INAF-OAAb).
PUA-MOD-001	Calibration Unit Optomechanical	M	3D Models and other technical Models. It includes CAD models, FE models, optical models

	System Models		and any other computational and simulation models. The models shall be delivered according to the product breakdown structure. ESO standards shall be used for the modelling, as defined in the following applicable documents of **AD1**: AD1 (ISO 10110), AD2 (ESO-192984), AD3 (ESO-191462).
PUA-LIS-001	Calibration Unit Optomechanical System Parts List / Bill of Materials (BoM)	D	List of parts composing the system. The parts list shall contain as minimum: 1. Title or Identification: Name of the item which is shown in its drawing. 2. Part Number: a. For standard components (fasteners) the dimensions and quality shall be provided according to ISO standards (e.g. ISO 4017-M8x20-8.8). b. For COTS parts the number shall be complete to enable reordering. 3. Quantity: amount of pieces used in the assembly or subassembly. 4. Original Equipment Manufacturer (OEM) Name: Extra information shall be given to enable the customer to contact the OEM. (This does not have to be in the parts list) In case an alternate component (or more than one) that may substitute a baseline component is available, this shall be listed and the same information as for the original component shall be provided. A clear indication of being an alternate component, and for which baseline component, shall also be given. (For instance, if a motor of a certain type and make can be used in lieu of the baseline motor, then the alternate motor shall be listed, too.) The BoM is a multilevel list of all components contained in a Configuration Item (CI). The BoM shall be delivered in a hierarchical multi-level form. Each sub-assembly shall be listed along with the components that make up that subassembly. An individual part may be listed in the BoM multiple times if it is included in more than one sub-assembly.

PUA-PLA-005	Calibration Unit Optomechanical System Development and Verification Plan	D	Development Plan. The Design, Development and Verification Plan shall present the overall instrument design development, validation and verification plan in terms of strategy, organisation and processes. It shall aim to demonstrate how to ensure the compliance of the instrument design and the means to verify it. It shall address the strategy regarding the main technical risks, associated foreseen prototype and testing activities and the achievement of the Technology Readiness Levels defined in Appendix A as required for the different project phases.
PUA-CIDL-001	Calibration Unit Optomechanical System CIDL	D	Configuration Item Data List. The Configuration Item Data List (CIDL) shall present the product configuration for a CI at one moment in time of the Project (typically a project milestone) by means of listing the requirements, design/development, manufacturing and operational documentation relevant for a CI. It shall contain as a minimum: 1. CI identification (part number and serial number, where appropriate) 2. List of the technical specifications 3. List of the ICDs 4. List of the design/analysis reports 5. List of the drawings 6. Bill of Material (BoM) & Parts List 7. List of plans 8. List of procedures 9. List of manuals 10. List of verification documentation 11. A section called Change Status Report (CSR) which identifies the status of approved CREs and RF(W/D)s. All documents shall be recorded in the CIDL as a minimum with their: 1. Document Title 2. Document Number 3. Document Version 4. Document Status (draft, released, etc.) 5. Status Date.
PUA-TRP-001	Report on Calibration	D	Report on integration readiness of the CU

	Unit Optomechanical System Integration Readiness Review		Optomechanical System. The document shall clearly describe the steps executed to assess integration readiness at the factory and the corresponding detailed results. It has the structure of a Test and Inspection Report. This document shall clearly assess the presence of all the elements and all the conditions needed to start the integration.
PUA-TRP-002	Report on Test and Inspection of the Calibration Unit Optomechanical System	D	Report on Test and Inspection. This document shall include at least the following sections: 1. Purpose; in this section the purpose of the Test Report explicitly stating the requirements that have been verified, shall be identified. 2. Scope of the Test Report; in this section the scope of the Test Report shall be identified. 3. Applicable and Reference Documents; in this section all the documents applicable to the Test Report shall be listed along with the documents used as reference. 4. Test Results; in this section the findings of the Test shall be provided. The results shall be processed in such a way that they will be directly comparable with the verification items verified. A comparative table shall summarise the actual versus the nominal ones required. 5. Conclusions; in this section a statement concerning the conformance of the Test results with the specified requirements shall be given. In case of non-compliances, the reference to the related NC requirements shall be provided and the impact on the final performance and recovery actions shall be discussed.
PUA-RRR-001	Calibration Unit Optomechanical System Risk Analysis	D	This document describes the approach to the Risk Management, classification, ranking and mitigation. This document shall include: 1. Introduction 2. Methodology 3. Risk Register. The Risk Register shall be kept updated as new risks emerge, change or are no longer valid.
PUA-LIS-002	Calibration Unit	D	The Spare Part List shall contain all the information

	Optomechanical System Spare Parts List		related to the spare parts necessary to operate and maintain the CU Optomechanical System. The Spare Part List shall include as a minimum: 1. Recommended amount of spare parts taking into account the findings of the RAM Analysis and the information provided in the Maintenance Manual 2. OEM name and contact details (website, etc.) 3. Contractor name and contact details 4. Item name 5. Type designation 6. Dimensions 7. Specification 8. Delivery times 9. Expected lifetime on the shelf 10. Any special storage prescriptions (power up, high altitude influence, etc.) 11. Storage conditions 12. Consumables 13. Fragile and/or critical parts 14. Components or parts with very long delivery time or which are custom-made 15. Off-the-shelf / Custom-made products.
PUA-ANR-002	Calibration Unit Optomechanical System RAMS document	D	This document shall contain: a. RAM Analysis, including as a minimum: 1. Description of the System under examination 2. Assumptions used in the Analysis 3. Methodology used (e.g. Parts Count method as per Military Handbook (MIL-HDBK)-217F) 4. Reliability data sources (e.g. Non-electronic Parts Reliability Data (NPRD)-95) 5. Prediction of Reliability and Availability based on failure rates 6. Optimum preventive replacement time for components in a repairable System 7. Spare parts requirements and production rate, spare parts inventory 8. Mean Time Between Failures (MTBF) computation 9. Down time of the Product and its availability taking into account MTBF, Mean Time To Repair (MTTR), Time for Preventive Maintenance. 10. FMEA

			b. Hazard List and Analysis, which shall identify all hazards arising from the design of the instrument including component failures, critical human errors and hazards resulting from functional relationships between components and equipment belonging to the instrument. c. Hazardous Material List, including as a minimum: 1. Hazardous Materials (HAZMAT) identification 2. HAZMAT categorization 3. HAZMAT data tracking. d. Safety File, collecting all safety relevant documentation applicable to the product.

Table 3. Technical documents of the Calibration Unit Optomechanical System.

Calibration Unit Optomechanical System Technical Deliverables (Hardware)

Code	Title	Type	Description
PUA	Calibration Unit Optomechanical System	E	CU Optomechanical System, as specified in Section 3.3 of **AD1**.
PUD	Calibration Unit Optomechanical System Tools	E	CU Optomechanical System Tools, as specified in Section 3.3 of **AD1**.
PUE	Calibration Unit Optomechanical System Dummy	E	CU Optomechanical System Dummy, as specified in Sections 3.3 and 4.4 of **AD1**.

Table 4. Hardware deliverable items of Calibration Unit Optomechanical System.

Calibration Unit Optomechanical System Management Deliverables (Documents)

Code	Title	Type	Description
PUA-PRR-001	Calibration Unit Optomechanical System Progress	D	Description of project status and activities carried out for the CU Optomechanical System in the reporting period (every 2 months).

	Report		The Progress Report shall summarise on a periodic basis the progress of the Project. The Progress Report shall summarise the results achieved in the period and those planned for the next period at all levels of the Project, showing them against the planned date identified in the Project Schedule and highlighting any deviation. It shall also describe the critical issues detected at any level (i.e. technical, programmatic) of the Project during the reporting period and identify the mitigation actions. The progress report shall be accompanied with the Action Item List and the status of all Action Items which shall also be reviewed at each progress meeting. The Progress Reports shall cover a full calendar month and shall be issued not later than 3 (three) working days after the end of the reporting period. It shall contain, as a minimum: 1. Schedule update 2. Status List of Change Requests (CREs), RF(W/D)s, NCs and Audits, including trends 3. Risk Register update 4. Overview of major events in the forthcoming period (in particular inspections and tests).
PUA-LIS-001	Calibration Unit Optomechanical System Action Item List	D	This document shall list all the actions agreed between the Contractor and INAF. For each Action Item it shall contain as a minimum: 1. The content of the action 2. The originator 3. The actionee 4. The due date and the closure date 5. The reference to the documents containing a verifiable basis for the closure of the action.
PUA-MIN-001	Calibration Unit Optomechanical System Minute of the Meeting	D	Minute of Meeting (MOM), including Action Item List for the CU Optomechanical System (prepared by Contractor's personnel and sent by 2 days after each meeting).
PUA-SCD-001	Calibration Unit Optomechanical System Schedule	D	Project Schedule of the CU Optomechanical System. It includes GANTT Charts (in single A4 sheets) of the project with indication of the critical path.

PUA-PLA-001	Calibration Unit Optomechanical System Project Management Plan	D	Project Management Plan of the CU Optomechanical System. This document shall: 1. Describe the management approach implemented by the Contractor to control the project; 2. Describe the organisational structure of the project; 3. Contain an organisational chart which summarises the organisation and the lines of authority, including all Contractor partners; 4. Describe the responsibility and the authority of each function in the organisational charts: job descriptions for the key functions; 5. Describe the interrelation among the different functions in the organisation; 6. Contain a list of key personnel including job position, relevant qualification, experience and contact information. The Project Management Plan shall also include the Project plan: 1. Master Plan which shall describe the program logic and the main project phases; 2. Procurement and payment schedule; 3. Work Breakdown Structure (WBS); 4. Work Package (WP) descriptions for the WPs in the WBS, containing at least: a. WP number according to the WBS b. Title of the WP c. Input to the WP d. Description of the task(s) to be performed e. Output of the WP f. Staff allocated in Full Time Equivalents g. Responsible WP manager h. Duration of the task i. Milestones j. Start / end dates/events.
PUA-PLA-002	Calibration Unit Optomechanical System Product Assurance Plan	D	System Product Assurance/Quality Assurance Plan of the CU Optomechanical System. The Product Assurance Plan shall describe the Project Product and Quality Assurance organisation, methods, tools and Procedures that the Contractor intends to implement for the work under Contract. The document shall contain the following information, as a minimum:

			1. Purpose: Relation to product development; 2. Quality Assurance Functions: organisation and work tasks; 3. Documentation: Control, changes, deliverable and non-deliverable documents that are subject to configuration control; 4. Policies, Procedures and Practices: listing all requirements, design implementation, test and documentation; 5. Reviews and Audits: Scheduled and non-scheduled; 6. Configuration Management: Means of assuring that adequate procedures and controls are documented and implemented (unless described in a dedicated document); 7. Problem Reporting: Processing, tracking and reporting; 8. Corrective and Preventive Actions: Processing, tracking and reporting; 9. Media Control: Libraries, protection; 10. Testing and Inspection: Environment, traceability, sampling methodology.
PUA-PLA-003	Calibration Unit Optomechanical System Configuration Management Plan	D	CU Optomechanical System Configuration Management Plan. The Configuration Management Plan shall describe the Project configuration Management organisation, methods, tools and Procedures that the Contractor intends to implement for the work under Contract. Alternatively, the Software part may be covered in a separate dedicated document: in this case, a reference shall be provided. The Plan shall define, as a minimum: 1. Configuration Management Responsibilities and Authorities 2. Responsibilities and Authorities 3. Dispositioning authority 4. Configuration Management Process 5. Configuration Management Planning 6. Configuration Identification 7. Change Management 8. Configuration Status Accounting 9. Configuration Audit.

			The Configuration Management Plan shall define: 1. The handling of contractual and technical changes 2. The handling of the interfaces internal to the Project 3. The handling of the interfaces external to the Project. The Configuration Management System to be implemented on the basis of the approved. Configuration Management Plan shall ensure that: 1. The manufacturing documentation is in line with the design documentation 2. The Product is in line with the manufacturing documentation 3. Changes are not implemented without due Analysis and approval 4. Required design, item or component and/or manufacturing changes are properly documented in CREs to be established by the Contractor 5. RF(W/D)s and Nonconformities (NC)s are properly handled.
PUA-MAN-001	Calibration Unit Optomechanical System Operating Manual	D	Manual for operational use of the CU Optomechanical System, including all the operating instructions for the user, such as installation, packing and unpacking.
PUA-MAN-002	Calibration Unit Optomechanical System Maintenance Manual	D	The Maintenance Manual shall contain the detailed maintenance Procedures with related drawings. It shall contain the maintenance requirements and scheduling for all items included in the supply. All the following types of Maintenance shall be considered: 1. Corrective: a. Deferred Maintenance b. Remedial Maintenance c. Shutdown Corrective Maintenance 2. Preventive: a. Routine Maintenance b. Running Maintenance 3. Predictive: a. Condition-based Predictive Maintenance b. Statistical-based Predictive Maintenance The related maintenance actions shall be provided in a tabular format.

			Each intervention shall be described with the following information, as a minimum: 1. Item(s) to be maintained; 2. Number and qualification of maintenance personnel needed; 3. Total time needed to perform the intervention and each phase of the intervention; 4. Supporting tools and equipment (including access); 5. Step by step procedure, including detection, preparation, location and isolation, disassembly (gaining access), repair or removal, reassembly, realignment/readjustment, checkout (verification of fault elimination); 6. Required parts, consumables; 7. Safety measures; 8. Check after action and start up; 9. Fault detection; 10. Fault isolation; 11. Fault elimination; 12. Verification of fault elimination.

Table 5. Management documents of the Calibration Unit Optomechanical System.

Calibration Unit Optomechanical System Technical Services Deliverables

Code	Title	Type	Description
-	Calibration Unit Optomechanical System Training	S	CU Optomechanical System training for all the procedures and activities mentioned in Section 4 of **AD1**.

Table 6. Services deliverable items of the Calibration Unit Optomechanical System.

4.5 Deliverable timeline

The deliverables of the Calibration Unit Optomechanical System are expected to be delivered at each milestone according to Table 7 and Table 8.
(I stands for 'Release Issued', D for 'Draft', U for 'Update')

Code	Title	Phase 1			Phase 2			
		KOM	LLI FDR	FDR	KOM2	IRR	FARR	OARR
Technical Docs								
PUA-CMX-001	Calibration Unit Optomechanical System Compliance Matrix	I	U	U	(U)	U	U	U
PUA-DER-001	Calibration Unit Optomechanical System Design Report		D[1]	I		(U)	(U)	(U)
PUA-ANR-001	Calibration Unit Optomechanical System Analysis Report		D[1]	I		(U)	(U)	(U)
PUA-SPE-001	Calibration Unit Optomechanical System System Budget		I	(U)		(U)	(U)	(U)

[1] The section related to the Early procurement shall be not in draft version. Alternatively, a dedicated Early procurement related Design and analysis docs shall be provided.

Code	Title	Phase 1			Phase 2			
		KOM	LLI FDR	FDR	KOM2	IRR	FARR	OARR
PUA-ICD-001	Calibration Unit Optomechanical System Interface Control Document		I	(U)		(U)	(U)	(U)
PUA-PLA-004	Calibration Unit Optomechanical System MAIT Plan		D[1]	I		U	U	(U)
PUA-DWG-001	Calibration Unit Optomechanical System Manufacturing Drawings		I[2]	I[3]		(U)	(U)	(U)
PUA-DWG-002	Calibration Unit Optomechanical System As Built Drawings					I	U	(U)
PUA-MOD-001	Calibration Unit Optomechanical System Models		I[2]	I[3]		(U)	(U)	(U)
PUA-LIS-001	Calibration Unit Optomechanical System Parts List/Bill of Materials		I	U		U	(U)	(U)

[2] Issued the early procurement relates, drafted the others

[3] All the drawings/models that were drafted for the early procurement

Code	Title	Phase 1			Phase 2			
		KOM	LLI FDR	FDR	KOM2	IRR	FARR	OARR
PUA-PLA-005	Calibration Unit Optomechanical System Development and Verification Plan	I	(U)	U	(U)	(U)		
PUA-CIDL-001	Calibration Unit Optomechanical System CIDL	I	U	U	(U)	(U)	(U)	(U)
PUA-TRP-001	Report on Calibration Unit Optomechanical System Integration Readiness					I		
PUA-TRP-002	Report on Test and Inspection of Calibration Unit Optomechanical System						1[4]	2[5]
PUA-RRR-001	Calibration Unit Optomechanical System Risk Analysis	I	U	U	(U)	U	U	U
PUA-LIS-002	Calibration Unit Optomechanical		I	U		U	(U)	(U)

[4] Issued at the end of FAT by the Contractor

[5] Issued at the end of OAT by INAF

Code	Title	Phase 1			Phase 2			
		KOM	LLI FDR	FDR	KOM2	IRR	FARR	OARR
	System Spare Parts List							
PUA-ANR-002	Calibration Unit Optomechanical System RAMS documents		I	U		U	(U)	(U)
Hardware								
PUA	Calibration Unit Optomechanical System						I	U
PUD	Calibration Unit Optomechanical System Handling Tools						I	U
PUE	Calibration Unit Optomechanical System Dummy					I[6]		

Table 7. Technical Deliverables expected at each milestone for Calibration Unit Optomechanical System.

[6] To be delivered not later than T1+6

Code	Title	Phase 1			Phase 2			
		KOM	LLI FDR	FDR	KOM2	IRR	FARR	OARR
Management Docs								
PUA-PRR-001	Progress Report	At regular interval						
PUA-LIS-003	Action Item List	At regular interval						
PUA-MIN-001	MoM	At each meeting						
PUA-SCD-001	Schedule	I	(U)	U	(U)	U	U	(U)
PUA-PLA-001	Project Management Plan	I	(U)	U	(U)	U	U	(U)
PUA-PLA-002	Product Assurance Plan	I	(U)	U	(U)	U	U	(U)
PUA-PLA-003	Configuration Management Plan	I	(U)	U	(U)	U	U	(U)
PUA-MAN-001	Calibration Unit Optomechanical System Operating Manual			D		I	U	(U)
PUA-MAN-002	Calibration Unit Optomechanical System Maintenance Manual			D		I	U	(U)
Services								

Code	Title	Phase 1			Phase 2			
		KOM	LLI FDR	FDR	KOM2	IRR	FARR	OARR
Training	Calibration Unit Optomechanical System Training						I[7]	

Table 8. Management and Services Deliverables expected at each milestone for the Calibration Unit Optomechanical System.

[7] It is intended that the training is completed by the end of FAT

4.6 Meetings

We describe in the following the location and the objectives of the main project meetings.
ESO is fully entitled to attend any of the meetings described below.

- ***Kick-off meetings***

Location:
The Kick-off meetings (both for Phase 1 and for Phase 2) shall take place at INAF premises (Italy, exact location will be communicated after the Contract signature).

Objectives:
The purpose of the meetings is to verify the presence and adequacy of all the foreseen documentation and to assess the preparedness of the Company to start the activities foreseen in the phase and to review the identified risks.

Process:
The Contractor sends to INAF-OAAb all the requested documentation 2 weeks (10 working days) before the meeting.
During the meeting the documents are commented on and discussed. Actions can be taken in order to correct errors, insert missing information or improve the quality of the documents.
Acceptance criteria for all the deliverables are agreed.

Success criteria:
The meeting is considered successfully completed if:
- all the KOM documentation is delivered on time and has the expected level of completeness and quality;
- the project team is ready and adequate for the work to be started;
- all critical actions taken during the review are successfully closed.

- ***Review meetings***

Location:
Reviews may take place alternatively at the Contractor's premises, at INAF-OAAb premises or by teleconference.

Objectives:
The purpose of Reviews is to formally assess the preparation of the expected deliverable items, at the level of completeness foreseen at that stage of the project. The Reviews are identified as such in Table 1 and Table 2.
Agenda items of Reviews shall include but not necessarily be limited to:
1. Presentation of the deliverables due for that Review and discussion of RIXs
2. Status of pending Action Items

3. Outcome of the Review
4. **Process:**

The Contractor sends to INAF-OAAb all the requested documentation with due advance with respect to the meeting date (in any case not less than 2 weeks / 10 working days).

INAF-OAAb representatives read the documentation and prepare comments and indications under the form of RIXs (Review Item Comments, Questions or Discrepancies). During the meeting the RIXs are discussed and closed, as much as possible. Actions can be taken in order to correct non-compliances, insert missing information or improve the quality of the documents.

Approval conditions:

Reviews are considered successfully completed if:

- all the deliverable items have the expected level of completeness and quality as per criteria defined and agreed at Kick Off;
- all critical actions taken during the review are successfully closed.

The Contractor's personnel shall attend, if invited, MORFEO reviews with ESO, at ESO premises or at INAF premises. The costs of these missions shall be in charge of the Contractor for up to 4 travels (2 days for 2 persons).

ESO is allowed to send representatives to attend any project milestone meeting.

The Factory Acceptance Test shall take place at the Contractor's premises.

The On-Site Acceptance Test shall take place at the INAF-OAAb premises.

- ***Progress Meetings***

Location:

Progress meetings may take place alternatively at the Contractor's premises, at INAF premises or by teleconference.

Objectives:

The purpose of these meetings is to assess the preparation of the expected deliverable items, as defined in Table 3, Table 4, Table 5 and Table 6, i.e. the deliverables foreseen for the next Review (Table 7 and Table 8) at the level of completeness foreseen at that stage of the project.
Progress Meetings are normally held every month. More frequent Progress Meetings can be requested by INAF-OAAb.
Agenda items shall include but not necessarily be limited to:

1. Status of the Action Items List;
2. Progress over the reporting period;
3. Activities for the next period;

4. Changes to status of compliance, configuration changes (if any);
5. Updated schedule.

Process:
The Contractor sends to INAF-OAAb all the requested documentation as defined Table 3, Table 4, Table 5 and Table 6 with reasonable advance with respect to the meeting date (in any case not less than 2 weeks / 10 working days).

Approval conditions:
Progress Meetings are informative meetings and no specific approval conditions are foreseen.

Additional meetings may be requested either by INAF-OAAb or the Contractor. With due notice to the Contractor, INAF-OAAb reserves the right to invite Third Parties to meetings to facilitate information exchange. Third Parties can include, for example, INAF personnel not directly involved in the project, members of the MORFEO Consortium, external experts in technical or management/administrative matters.

For each meeting the requester shall propose an agenda in electronic form and shall compile and distribute any presentation given at the meeting.

INAF-OAAb may request, at least 15 days in advance, access to the integration laboratories and support to make extra measurements directly on the components of the supply. The Contractor shall answer to this request by an acceptance of the proposed date or by an alternative proposition of date(s) within 10 days from the initial proposed date.

Access to laboratories may be requested at any time during Phase 2, whenever deemed necessary by INAF. The best time slot shall be agreed within a reasonable amount of time.

Art. 5 - Supporting Tasks

5.1 Project Management

The Contractor shall implement a centralised Project Management System and shall nominate a Project Manager.

The Contractor's Project Management Office shall coordinate and control the project resources, all technical and commercial activities, and manage all activities required to successfully complete the Contract.

The Contractor's Project Manager shall be the principal point of contact and have full authority to deal with all matters related to the Contract, including but not limited to technical matters.

The Contractor shall implement a product-oriented Work Breakdown Structure starting from the activities described in this document. The Work Packages shall be clearly identified, with appointed WP Managers, WP inputs / outputs, milestones and timelines.

The Contractor shall implement a Master Plan based on the Work Breakdown Structure. The Master Plan shall be updated or reconfirmed with each Progress Report.

In addition to the Master Plan the Contractor shall establish a detailed planning, including detailed networks, dependencies, bar charts, milestones, resource allocation, etc.

The detailed schedule shall integrate the activities of all subcontractors involved in the project (if any).

Progress reports shall provide a brief account of the progress of the work done by the Contractor, encompassing all aspects within the reporting period.

Progress Reports shall be communicated to the INAF-OAAb point of contact in electronic format (e.g. as PEC/e-Mail attachment). Progress Reports shall include the draft agenda of the next progress meeting.

The Contractor's Project Management System (procedures, personnel, documents and tools) shall be described in the Project Management Plan (see description of deliverable items).

Management deviations, impacting project scope/quality, time or cost, shall be reported to INAF-OAAb, as change request or request for waiver for approval. Once approved by INAF-OAAb and by the Contractor, the change shall be formalised in a contract amendment. If the change comprises schedule shift or other variations that would imply penalties, such penalties can be waived by mutual agreement in the updated contract.

Technical deviations that do not have impacts on scope/quality, time or cost, may be proposed by both parties and discussed in the first available Progress Meeting (or in a dedicated Meeting in case of urgency). Once agreed by INAF-OAAb and by the Contractor, these deviations shall become part of the technical baseline and shall be reported in detail in the project documentation.

5.2 Configuration Management

To make sure proper Configuration Management is implemented, the Contractor shall have in place a sound and effective Configuration Management System.

Any element to be developed in the project shall comply with the configuration control requirements and principles stated in the following:

- 'Item' is any physical or non-physical component of inventory, single pieces, assemblies, software code or similar that are part of the product.

- Every configured product item shall have a unique identifier that shall be used to manage (document, retrieve, identify) and to reference the configuration item.
- As a minimum, all configuration items delivered by the Contractor or referenced by a document delivered by the Contractor shall be the subject of the Configuration Management System.
- The Contractor shall provide information (e.g., as part of the Configuration Management Plan), on how the item numbering system works.
- The Contractor shall provide evidence that their numbering system is capable of providing unique numbers across all their contracts for the foreseeable future.
- The item number shall only contain the following characters: modern alphabet, ciphers, space, underscore, hyphen-minus and dot.
- Configuration items with the same identifier shall be interchangeable. I.e. if the specification, or criteria, for Form, Fit and Function of a particular item are met, then the item may generally be considered interchangeable with other items with the same requirements. If not, it needs a new dedicated identifier.
- Items shall be identified and where possible marked by the items unique reference and serial number to provide traceability and configuration control.
- The Configuration Item List (CIL) shall contain all product elements that will be under configuration control. This list is applicable for both hardware and software elements.
- For each configuration item, the Contractor shall provide a Configuration Item Data List (CIDL) containing all documents relevant to such configured item. As such, the CIDL shall list all applicable requirements and specification documents, drawings, analyses, models, test reports, bill of materials, lists, etc. The CIDL shall be updated and delivered with each progress report. The 'as-built' version of the CIDL shall be delivered at delivery of the product/item.

The Contractor's Configuration Management System applied in the execution of the specific Contract shall fulfil, as a minimum all requirements, principles and applicable documents contained in this SOW.

The Configuration Management Plan shall be produced by the Contractor and shall define the Configuration Management procedures and the Configuration Management System that is used in the execution of this contract.

The Configuration Management Plan may use company-wide or standard documents but shall detail how such procedures will be used in the execution of the specific Contract.

5.3 Product Assurance

The general approach concerning the fulfilment of all specified PA requirements (including quality assurance, RAMS, Configuration Management, and Software Product Assurance) shall be described in the Product Assurance Plan. The detailed tasks to be performed during the individual project phases shall be included as all other project activities in the project planning.

If the Contractor is not ISO 9001 certified, under request of the MORFEO PA manager it shall provide evidence that the production and service provision proceed under controlled conditions, thus assuring that manufacturing and procurement processes are under adequate control and monitoring.

In addition to the specified safety requirements foreseen by ISO 9001 and where not explicitly stated otherwise, the Contractor shall comply with all relevant National safety laws and legislation applicable to the design, development, manufacturing, installation and operation of the contracted item.

Art. 6 - Commercial guarantee and technical assistance

A standard warranty of 2 years after the final acceptance at INAF-OAAb premises ("On-Site Acceptance") of the Calibration Unit Optomechanical System shall be provided by the Contractor.

The extension of the warranty beyond the 2 years can be proposed in the offer by the Contractor and will give additional points in the proposal evaluation.

The baseline for the warranty shall be the change/repair of the defective piece.

The Contractor responsibilities shall cover all costs related to shipment and repair of the defective piece, and to travel of personnel in case of change/repair on site. This applies to any location in Europe.

INAF-OAAb will be responsible for dismounting and remounting the Calibration Unit assembly (as a whole) from the MORFEO instrument.

When a defect is reported, INAF-OAAb will give formal notice of the issue to the Contractor specifying if a change/repair is needed on site.

The Contractor is released from its financial obligations only when an improper use of the product is proven. In such cases, the Contractor shall anyway provide technical support upon specific separate agreement with INAF-OAAb.

It shall be possible to supply or re-manufacture a deliverable item or some of its components for a duration of 15 years.

- **After-sales technical assistance to be provided:**

1) *Times for replacement of defective products / spare parts.* The defective component must be replaced within 60 calendar days from its reception at the Contractor site or from the defect notification in case of on-site replacement.
2) *Mode that will be used to notify the malfunction.* The contracting authority will communicate the malfunction to the Contractor using an agreed e-mail address.
3) *Charges for replacement of spare / malfunctioning parts.* During the warranty period, the replacement of any non-functioning product shall be borne by the Contractor, including the collection of the defective part and the delivery of the replacement part. The replacement operation shall be conducted by Contractor's personnel or, if agreed upon with INAF-OAAb, by the contracting authority remotely assisted by the Contractor.

Art. 7 - Delivery

- **Transport insurance policy**

  Insurance on transport is mandatory and shall be paid by the Contractor.

- **Packing and Transport method**

  Care and responsibility of the Contractor shall be to choose high quality external materials, rigid and in good conditions. The boxes must be new and must not have been used beforehand. The size of the boxes shall be based on the final size of the products, avoiding semi-empty packages. The packing must guarantee the maximum safety of the goods by the transport company. Care shall be taken of the internal packaging, which provides protection for the goods during transport and during delivery. The internal packaging must be able to protect the product from shocks and vibrations. All possible openings shall be sealed, using high quality resistive products. The Contractor shall insert on the outer edges of the box plastic or cardboard protectors that distribute the pressure evenly and avoid damage to the outer casing.

  Transport shall be carried out with means (trucks, trains, ships, air freight) that guarantee the absorption of vibrations and bumps, in order not to cause damages to the transported goods. Transport means shall also ensure that the products are kept within the acceptable range of temperature and humidity. Transport means (and their drivers) must be certified for the transport of fragile goods.

  For details on packing and transport requirements, refer to Section 4.3 and 6 of **AD1** and to Sections 3.1 and 3.8 of **AD3**.

- **Responsibilities and support**

  Delivery at INAF-OAAb premises shall be under the responsibility of the Contractor, who shall give at least two weeks' advance notice of the Estimated Time of Arrival of the concerned item.

  Logistic support shall be provided by INAF-OAAb according to plans and requirements set in the Design and in the AIT Phases, and documents as specified in Table 3.

  Where INAF-OAAb manpower is required to support delivery tasks, the Contractor shall provide all necessary manuals and instructions for such manpower to safely perform its tasks according to requirements.

- **Location and delivery times**

  The Calibration Unit Optomechanical System must be delivered to the following locations:

  - *Teramo Integration Hall*
    INAF – Osservatorio Astronomico d'Abruzzo
    Via Mentore Maggini snc, 64100 Teramo (TE) - ITALY;
  - Alternative delivery locations must be agreed in advance, tentatively at the beginning of Phase 2.

  Detailed information for the delivery will be provided at the time of the shipping.

- **Shipping methods**

  In accordance with the terms **INCOTERMS DDP** - *Delivered Duty Paid*. In the DDP mode the Contractor covers all costs and risks of the shipment and of import/export.

- **Method of unloading goods**

  The unloading will take place on the ground floor, under the responsibility of the courier appointed by the Contractor. The coordination for the organization and preparation of the unloading will be managed by INAF-OAAb. The Contractor's personnel shall oversee the unloading and carry out the inspections to verify that no damage occurred during transportation and/or during the unloading (data logger, shock indicators, etc.).

Art. 8 - General Conditions

8.1 Quality System

The Contractor shall implement a quality system based on the ISO 9001 standard.

The certification of the Contractor with ISO 9001 standard is considered a plus.

Alternatively, the Contractor should be able to demonstrate the existence and the use of an equivalent internal quality system.

More specifically, the Contractor shall demonstrate the existence and use processes ensuring the final quality of the product by means of:

- Contractual management and validation
- Documentary management
- Manufacturing management
- Personnel Safety
- Production controls and calibration of the associated measuring tools.

8.2 Audits

INAF-OAAb is authorised to perform audits at the Contractor premises during all the duration of the contract in order to validate and evaluate the Contractor quality system, as well as the progress of the contract execution.

INAF-OAAb will inform the Contractor of its intention to perform an audit for a given date at least 15 days in advance. The Contractor shall answer to this request by an acceptance of the proposed date or by an alternative proposition of date(s) within 10 days from the initial proposed date.

8.3 Personnel Safety

The Contractor shall respect all applicable laws and regulations relative to personnel safety and working conditions. The Contractor is fully liable for the safety of its personnel.

The Contractor shall formally notify to INAF-OAAb before implementation any use of known or potential harmful material (including, but not limited to, radioactive, bio-hazardous, chemically dangerous materials) during the manufacturing process or included in the delivered product. In that case, an official acceptance from INAF-OAAb of this (these) material(s) is mandatory prior to its implementation.

The Contractor shall formally notify to INAF-OAAb of all potential risk or danger linked with the use or the handling of its products. In that case, safety measures shall be transmitted to INAF-OAAb and accepted before any delivery.

8.4 Traceability

The Contractor shall ensure the traceability and the recording of the product's main components, materials or sub-contracted operations. The rules and conventions for the tracing components and elements of the system will be detailed in the relevant documentation produced by the Contractor (Parts List / Bill of Materials and CIDL).

The list of these items shall be agreed with INAF-OAAb before manufacturing. For each delivered product and for each of the identified item, the following information shall be available:

- Item manufacturer or sub-contractor
- Identification number
- Batch or serial number
- Manufacturing or service date

8.5 Documentation

All deliverable documents produced during the project shall be written in English language and shall be transmitted under electronic format.

Applicable associated file formats are:

- Word, Excel and PDF under ISO A4 size, for textual documents;
- PDF, DXF, Inventor IDW under ISO A0 to A4 size, for drawings;
- Zemax ZAR, for optical design files;
- STEP, Inventor IAM and IPT, for 3D models.

Other formats must be agreed between the Contractor and INAF-OAAb.

Templates for Change Request, Request for Waiver and Non Conformance Report will be provided by INAF-OAAb and will be applicable.

All internal or deliverable documentation related to the present Statement of Work associated Contract shall be archived and recoverable during the duration of 15 years after the end of the manufacturing phase.

The Contractor is responsible for verifying all documentation made available by INAF-OAAb for the Contract execution, including the present Statement of Work and its applicable documents. The Contractor shall give notice to INAF-OAAb of any errors, discrepancy or missing information in this documentation. The Contractor shall not modify documents made available by INAF-OAAb. In case of errors, discrepancy or missing information, the correct information will be provided by INAF-OAAb.

8.6 Confidentiality

Both parties undertake to ensure confidentiality of information communicated by the terms of the present Contract and not to publish it, divulge it to third parties (apart from ESO), use it for any other purpose than those stated in the present Contract. Both parties agree to do so for the entire duration of the Contract and for a period of 5 years following expiry or termination of the Contract. Confidential information must be sent only by registered letter with recorded delivery or by equivalent digital means (e.g. PEC).

Art. 9 - Modification Management

9.1 Change Request

During its execution, the Contractor and INAF-OAAb can propose modifications to the Contract.

Such proposals shall be addressed to the other party by means of a formal change request. This change request shall include detailed motivation and explanation of the proposed change. It will identify clearly all the documents and products impacted by the change. When issued by the Contractor, it shall also include all potential impacts positive or negative in terms of quality, performance, schedule and cost. When issued by INAF-OAAb, this information will be given by the Contractor in reply to the change request.

Each Change Request shall be identified by a unique identifier, which shall be used in all subsequent correspondence.

Provided the input is complete, the receiving party shall respond (change approved or rejected) to any such Change Request within 4 weeks of its receipt, or, in the case of complex changes, inform the other party on the expected completion date within 2 weeks of its receipt. If the input is not complete, the receiving part shall ask for the missing information within 2 weeks.

If the change of scope is significant, an amendment of contract conditions may be agreed.

INAF-OAAb will provide a template for Change Request at the Kick Off Meeting.

9.2 Request for Waiver

A request for waiver is an official request from the Contractor to INAF-OAAb to release or use a non-compliant product. A request for waiver is limited to specific individual products or limited in time before repair. If this limitation does not apply, a change request shall be issued.

A request for waiver shall include detailed motivation and explanation of the waiver requested. It will identify clearly all the products impacted and if relevant the foreseen date of repair. It shall also include all potential

impacts positive or negative in terms of quality, performance, schedule and cost. INAF-OAAb will pronounce the acceptance decision of the request within 4 weeks after reception of the completed request. If the change of scope is significant, an amendment of contract conditions may be agreed.

INAF-OAAb will provide a template for Request for Waiver at the Kick Off Meeting.

9.3 Non-Conformances

In case where a non-conformance or discrepancy of any kind is detected during the project execution, the Contractor shall give notice to INAF-OAAb by means of a Non-Conformance Report within 1 week after detection. These Reports can refer to any technical, manufacturing, schedule and quality aspect, particularly in cases where a detected non-conformance may lead to a late delivery of products.

9.4 Contract Amendment

In case of a contract amendment consecutive to a change or a waiver, the financial conditions revision will be based on the cost breakdown given at the contract signature.

Art. 10 - Obligations of the Contractor

- **Appointment and duties of the Contract Manager**

  The Contractor shall indicate its own Contract Manager with whom the Contracting Authority will be able to interact, for contractual matters, until the issue of the certificate of conformity (test certificate) of the supply.

- **Appointment and duties of the Project Manager of the supply**

  The Contractor shall indicate its own Project Manager of the supply that will ensure the effective and timely completion of the Contract. The Contractor's Project Manager, supported by other internal personnel, as needed, shall coordinate and control the project resources and manage all activities required to successfully complete the Contract. The project manager shall implement a more detailed, product-oriented, Work Breakdown Structure based on the Work Breakdown Structure described in this document. Work Packages shall be clearly identified, with appointed

Work Package Managers, Work Package input / output, milestones and timelines.

- **Appointment and duties of the Technical Manager of the supply**

  The Contractor shall indicate its own Technical Manager of the supply with which the contracting authority will be able to interact for technical matters, until the issuing of the certificate of conformity of the supply. The figures of Contract Manager, Project Manager and Technical Manager of the supply may coincide.

Appendix A. Technological Readiness Level definition (TRL)

TRL	Technology Readiness	Description
1	Basic principles observed and reported	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Example might include paper studies of a technology's basic properties.
2	Technology concept and/or application formulated	Invention begins. Once basic principles are observed, practical applications can be invented. The application is speculative and there is no proof or detailed analysis to support the assumption. Examples are still limited to paper studies.
3	Analytical and experimental critical function and/or characteristic proof of concept	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4	Component and/or breadboard validation in laboratory environment	Basic technological components are integrated to establish that the pieces will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of 'ad hoc' hardware in a laboratory.
5	Component and/or breadboard validation in relevant environment	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so that the technology can be tested in a simulated environment. Examples include 'high fidelity' laboratory integration of components.
6	System/subsystem model or prototype demonstration in a relevant environment	Representative model or prototype system, which is well beyond the breadboard tested for TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. An example is the testing of a prototype in a high fidelity laboratory environment or in simulated operational environment.
7	System prototype demonstration in an operational environment	Prototype near or at planned operational system. Represents a major step up from TRL 6, requiring the demonstration of an actual system prototype in an operational environment. Examples include testing the prototype in an observatory environment.
8	Actual system completed and qualified through test and demonstration	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system to determine if it meets design specifications.
9	Actual system proven through successful mission operations	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. In almost all cases, this is the end of the last "bug fixing" aspects of true system development. Examples include using the system under operational mission conditions.