

**Landsat Data Continuity Mission (LDCM)  
Implementation Phase**

**Statement of Work (SOW)**

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**SECTION J OF RFP5-12345-JLB  
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## **INTRODUCTION**

This Statement of Work (SOW) defines the Contractor's efforts required to implement the Landsat Data Continuity Mission (LDCM). LDCM is a data specification-based procurement for seasonal, global, highly calibrated, multi-spectral imaging of the Earth's land surface, continuation of the Government's Landsat data archives beyond Landsat 7, and continuation of multi-decadal land-use/land-cover change measurements. The LDCM will meet both National Aeronautics and Space Administration (NASA) research needs and United States Geological Survey (USGS) research and operational requirements for a minimum of five years beginning with its Initial Operational Capability (IOC). The customer for the LDCM is the United States Government with NASA acting as the contracting organization. The term "Government" is used throughout as the customer/receiving organization. The LDCM Project Office is the organization representing NASA for this contract.

## **I. SCOPE**

The LDCM Contractor shall provide all of the necessary resources to deliver the LDCM data to the USGS/Earth Resources Observation Systems (EROS) Data Center (EDC) (USGS/EDC) Active Archive, and to the National Satellite Land Remote Sensing Data Archive (NSLRSDA) located at the USGS/ EDC. The Contractor shall have end-to-end responsibility for the successful delivery of specification-compliant data that can produce specification-compliant Data Products. The Contractor shall perform the following:

1. Develop and operate a system that acquires and delivers LDCM Data and Validation Data Products (VDPs).
2. Provide management and systems engineering functions in support of the LDCM, including conducting reviews, meetings, compliance testing and special studies.
3. Define, develop, and maintain interfaces for all Contractor systems that interface with Government systems.
4. Provide systems in support of, and perform, data scheduling, collection, processing, and delivery.
5. Perform all data calibration and validation functions, both pre- and post-launch, to ensure delivery of LDCM Data Specification compliant data.
6. Define, develop, maintain, and deliver LDCM data processing algorithms and coefficients.

## II. WORK TO BE PERFORMED

### *1.0 Program Management*

The Contractor shall perform all direct management functions, including but not limited to: resource management, scheduling, subcontract management, configuration management, quality assurance, business management, and risk management. The Contractor shall provide a management structure responsible for overall project control to ensure that the requirements of this SOW and contract are successfully accomplished. The Contractor's management approach shall be documented in the Program Execution Plan in accordance with the CDRL. The prime Contractor shall ensure that it and all major subcontractors perform these same program management functions as detailed below, as applicable to their specific responsibilities. The Contractor shall deliver a Monthly Schedule Report in accordance with the Contract Schedule.

#### 1.1 Reviews/Meetings

The status of the technical effort, program schedule, financial condition and business development activities shall be communicated to the LDCM Project on a regularly scheduled basis. The Contractor shall conduct Management Program Status Reviews (MPSR), including presentation package, in accordance with the CDRL. At least once a quarter, the MPSR shall be conducted face-to-face. After Initial Operational Capability (IOC), the Contractor shall only conduct MPSRs quarterly. The program financial, technical, business and operational status and related activities shall be documented in the Monthly Operations/Anomaly Report in accordance with the CDRL.

The Contractor shall conduct informal Technical Interchange Meetings (TIMs) with the Government on technical issues concerning the program. Either the Contractor or the Government may request a TIM. The Contractor shall track action items arising from TIMs, for resolution/response and report status at the MPSRs.

In addition to MPSRs and TIMs, the Contractor shall conduct the following major progress reviews and provide review packages in accordance with the CDRL:

- ❑ Delta Preliminary Design Review ( $\Delta$ PDR)
- ❑ Critical Design Review (CDR)
- ❑ Instrument Pre-Ship Review (IPSR)
- ❑ Pre-Environmental Review (PER)
- ❑ System Pre-Ship Review (SPSR)
- ❑ Initial Operational Capability Review (IOCR)

These reviews should not be considered a comprehensive set of reviews for the Contractor's program. Additional reviews that the Contractor deems necessary to

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successfully execute the program should be conducted at the Contractor's discretion. In general, the Contractor shall notify the Government at least 10 working days in advance of lower level Contractor subsystem reviews to allow the Government time to attend the review as part of its insight activities.

The Contractor shall develop and apply a process for capturing and responding to review action items identified by the Government. Major progress reviews, as defined above, are not complete until actions are dispositioned, subject to the approval of the Contracting Officer.

### 1.2 Risk Management and Mitigation

The Contractor shall perform and maintain a comprehensive risk management and mitigation program. Risks and mitigation analyses shall include risks to the Contractor's business, system performance, LDCM requirements, interfaces with any Government systems, and other risks that may impact the Government's ability to receive LDCM Data Packages and VDPs. The risk management plan shall be documented as part of the Program Execution Plan in accordance with the CDRL. The Contractor's risk list shall be presented and reviewed at all MPSRs.

### 1.3 Assurance of Data Product Quality

The Contractor shall assure the quality of the LDCM Data and VDPs by employing activities, defined by the Contractor, to manage processes and procedures during development, test and operations. The Contractor shall deliver a Data Quality Assurance Plan in accordance with the Contract Schedule.

### 1.4 Special Studies, Analyses, and Tasks

The Contractor shall perform analyses, studies, or other task orders (including, but not limited to, the generation, characterization, and delivery of customized VDPs) relating to topics that may affect the acquisition, generation, characterization, quality, and/or delivery of LDCM Sensor Data, Data Packages, or VDPs, as authorized by the Government and in accordance with contract clause C.2. Customized VDPs may include non-standard imagery, imagery that uses manipulated calibration coefficients, or products from new or altered data processing algorithms.

## *2.0 Systems Engineering*

The Contractor shall perform all systems engineering activities needed to ensure that the LDCM Data Packages, and VDPs meet or exceed all requirements and specifications. The systems engineering effort shall encompass all phases of the LDCM program. The

prime Contractor shall perform, and ensure all its major subcontractors perform, systems engineering functions to execute the following tasks, as applicable to their specific responsibilities.

## 2.1 Concept of Operations

The Contractor shall provide a concept of operations for the system that produces LDCM Data Packages and VDPs. The Concept of Operations shall be developed and delivered in accordance with the Contract Schedule.

## 2.2 Compliance Testing

The Contractor shall conduct a comprehensive test program, for all system phases, that assures that the LDCM Data Packages and VDPs will reliably comply with all LDCM specifications. The Contractor shall develop and deliver a Data Specification Compliance Plan and a Data Specification Compliance Report in accordance with the Contract Schedule.

### 2.2.1 Data Flow Testing

The Contractor shall develop and implement a test of the flow of data from Contractor-provided systems into Government systems. The Contractor shall also test the interface of Government inputs into its system, including but not limited to seasonality file updates, high priority requests, and requests for VDPs. The Contractor shall verify the accuracy and completeness of any databases, look-up tables and algorithms as part of these tests. The Contractor shall provide Data Flow Test Plan/Procedures and a Data Flow Test Report for all pre- and post-launch tests in accordance with the CDRL.

Prior to the System Pre-Ship Review, the Contractor shall conduct one or more successful tests which exercise the entire data flow chain from receipt of sensor data at the focal plane of the instrument used to acquire LDCM data to delivery of Active Archive Data Packages, NSLRSDA Data Packages, and Validation Data Products to the USGS/EDC Active Archive, to NSLRSDA, and to the Government Calibration/Validation System, respectively. Success shall be measured against the test goals defined in the Contractor's Data Flow Test Plan. The Contractor shall conduct pre-test reviews of the procedures, scripts, test support, and coordination for each test. The Contractor shall conduct TIMs to disclose the results of the test(s).

After launch, and no later than 15 days after instrument first light, the Contractor shall perform a preliminary data flow test between the observatory and all Government interfaces.

As a condition of and prior to IOC, the Contractor shall successfully conduct a test that demonstrates delivery of specification-compliant Active Archive Data Packages and NSLRSDA Data Packages to the USGS/EDC Active Archive and NSLRSDA, respectively, as well as delivery of Government-requested specification-compliant Validation Data Products. At a minimum the test shall include planning, data collection, and delivery of Active Archive and NSLRSDA Data Packages containing an average of 250 WRS-2 scenes per day throughout one uninterrupted 16-day WRS-2 cycle. During this test, the contractor shall demonstrate receipt and implementation of a seasonality file, receipt and fulfillment of Special Requests, collection of calibration data from all on-board calibration sources, and a spacecraft propulsive maneuver. The contractor shall define this test in the Data Flow Test Plan/Procedures and provide results in a Data Flow Test Report in accordance with the CDRL.

### 2.3 Interface Control

The Contractor shall develop and maintain interfaces, interface controls, and Interface Control Documents for any Contractor developed and operated systems that must operate with, provide data to, or receive data from, any Government systems. The Contractor shall provide a detailed set of Data Operations Procedures for all data package/product delivery interfaces between the LDCM Contractor and Government systems in accordance with the CDRL. The Contractor shall develop and deliver Interface Control Documents (ICDs) to Government Systems and Data Operations Procedures in accordance with the Contract Schedule.

### 2.4 Sustaining Engineering

The Contractor shall provide for all personnel, services and equipment required for system maintenance and sustaining engineering in support of all LDCM data deliveries together with a documentation process for addressing changes, upgrades, and anomalies, including reporting, tracking, and anomaly resolution, to ensure that all Contractor delivered LDCM Data Packages and VDPs meet all LDCM specifications throughout the contract period of performance.

### *3.0 Data Package Collection and Delivery*

The Contractor shall acquire LDCM Data Packages from a Contractor developed, owned and operated system and deliver Active Archive Data Packages to the USGS/EDC Active Archive and NSLRSDA Data Packages to NSLRSDA in accordance with the LDCM Data Specification.

### 3.1 Scheduling and Tasking

The Contractor shall develop a scheduling and tasking system that ensures the global and spatial coverage required in the LDCM Data Specification. Interfaces to the Government for seasonality files and high priority target coverage shall be developed, implemented and operated.

#### 3.1.1 Seasonality File Updates

The Contractor shall accept Government-furnished seasonality files/updates from NASA/Goddard Space Flight Center as inputs into its scheduling and tasking system.

#### 3.1.2 Special Acquisitions

The Contractor shall accept LDCM requests for special acquisitions from NASA/Goddard Space Flight Center and acquire them in accordance with the LDCM Data Specification.

### 3.2 Contractor Data Storage

The Contractor shall store all LDCM Sensor Data and Ancillary Data until delivery of the associated LDCM Data Packages to the USGS/EDC Active Archive and NSLRSDA is verified and accepted in accordance with the applicable ICD.

### 3.3 Data Delivery

The Contractor shall deliver LDCM NSLRSDA Data Packages to NSLRSDA and LDCM Active Archive Data Packages to the USGS/EDC Active Archive in accordance with the LDCM Data Specification and the applicable ICD. The Contractor shall prepare and deliver a Daily Data Delivery Report in accordance with the Contract Schedule.

The Contractor shall develop and deliver a LDCM Data Collection and Processing System Document and Data Format Control Documents in accordance with the Contract Schedule.

### 3.4 Data Anomaly Resolution

The Contractor shall investigate and resolve any Contractor system anomalies, impacting or potentially impacting, LDCM Data Specification compliance during the contract performance period. In parallel, the Government will investigate applicable Government processes for anomalies. If the cause is not identified in these separate investigations, the



Contractor shall support a joint Contractor/Government investigation. The progress, plans and resolution of anomaly investigations shall be documented in the Monthly Operations/Anomaly Report in accordance with the CDRL.

#### *4. Calibration/Validation*

The Contractor shall establish a calibration and data validation program that characterizes system performance, meets the Calibration/Validation (Cal/Val) requirements in Contract Attachment I, and maintains a well-characterized, highly calibrated system throughout the contract performance period. The Contractor shall be responsible for pre- and post-IOC measurements and tests to ensure that the LDCM Data Packages and VDPs meet or exceed LDCM Data Specification requirements.

##### 4.1 Validation Data Products

The Contractor shall provide LDCM VDPs from the Contractor developed, owned, and operated data processing system and deliver these products to the Government. The Contractor shall produce and deliver VDPs in accordance with the LDCM Data Specification.

###### 4.1.1 Validation Data Product Ordering Mechanisms

The Contractor shall provide the capability to receive orders for LDCM Validation Data Products via an authorized electronic request from the Government Calibration/Validation Team.

###### 4.1.2 Validation Data Product Distribution

The Contractor shall provide the capability to deliver LDCM Validation Data Products to the Government Calibration/Validation System at NASA/Goddard Space Flight Center via electronic means.

##### 4.2 Pre-Launch Calibration/Validation

###### 4.2.1 Calibration/Validation Plan

The Contractor shall develop and deliver a Calibration/Validation Plan in accordance with the Contract Schedule that describes the approach for testing and characterizing the qualities of the LDCM Data. This plan shall include Pre-Launch, Commissioning, and Post-IOC calibration activities.

#### 4.2.2 Calibration/Validation Procedures

The Contractor shall develop procedures by which all calibration/validation testing will be performed. These procedures shall include Pre-Launch, Commissioning, and Post-IOC activities. The Calibration/Validation Procedures shall be delivered to the Government in accordance with the Contract Schedule.

#### 4.2.3 Calibration/Validation Data/Reports

The Contractor shall deliver to the Government all Calibration/Validation Test Reports and the summary Calibration/Validation Report in accordance with the Contract Schedule. Pre- and post-launch sensor test and calibration data shall be made electronically available to the Government. Data from Cal/Val test equipment (e.g., integrating spheres) shall also be made electronically available to the Government.

#### 4.2.4 Independent Testing

To maintain continuity of the Landsat data archives and calibration to the National Institute of Standards and Technology (NIST), the Contractor shall provide access to the Contractor's radiometric calibration sources sufficient for the Government and/or its subcontractors to conduct source characterization at the Contractor's facility. The Contractor shall also provide coordination and support sufficient for the Government and/or its subcontractors to conduct independent pre-launch measurements of the Contractor's radiometric calibration sources at the Contractor's facility.

For LDCM Transfer Radiometer testing, the Contractor shall provide access sufficient for the Government and/or its subcontractors to conduct source characterization in the Contractor's laboratory environment for a total of five 2-day periods; three 2-day periods prior to LDCM instrument calibration; and two 2-day periods after instrument calibration. In addition, the Contractor shall provide access sufficient for the Government and/or its subcontractors to conduct source monitoring during LDCM instrument calibration activities.

For NIST/Earth Observing System (EOS) radiometric scale realization activities, two 4-day periods, one prior to LDCM instrument calibration with the calibration source and one after, shall be accommodated.

The Contractor shall account for these periods of access in the contract and program schedule. The advance notice for arranging such access shall be agreed to by the parties.

#### 4.2.5 Cross-Calibration Plan

The Contractor shall provide a detailed plan, including estimated schedule, for a joint contractor-Government effort to cross-calibrate the LDCM sensor(s) with the Landsat 7 Enhanced Thematic Mapper Plus (ETM+). The Contractor shall deliver this plan at the CDR. The Contractor shall include this plan with the final Calibration/Validation Plan.

#### 4.3 Commissioning Phase Calibration/Validation

The Contractor shall implement the commissioning phase Cal/Val activities detailed in the Calibration/Validation Plan leading to LDCM Data Packages and VDPs that meet the LDCM Data Specification. The Contractor shall provide results in a Calibration/Validation Report in accordance with the CDRL.

Beginning at first light and ending at IOC, the Contractor shall accept up to 10 scene acquisition requests per day from the Government and acquire the requested scenes.

During Commissioning, the Contractor shall provide Government access to all sensor calibration data.

Between first light and IOC the Contractor shall generate and deliver up to 10 VDPs per day, at the request of the Government, derived from any acquired LDCM Sensor Data. VDPs derived from LDCM Sensor Data acquired prior to the 16-day pre-IOC test (see paragraph 2.2.1) need not meet the LDCM Data Specification.

#### 4.4 Post-IOC Calibration/Validation

The Contractor shall systematically and regularly calibrate the operational system and characterize the data for the duration of the contract. The Contractor shall provide periodic reports of Cal/Val activities and tests in the Monthly Operations/Anomaly Report in accordance with the CDRL.

The Contractor shall provide to the Government Cal/Val data and scenes used for Cal/Val. The Contractor shall report results in Calibration/Validation Test Reports in accordance with the CDRL.

The Contractor shall operate and maintain, for the duration of the contract, the system that generates VDPs. The Contractor shall accept orders for, and produce, up to 10 VDPs per day from this system.

If the LDCM Data Packages required to generate the VDPs are available at the Contractor storage facility, then the Contractor shall deliver the requested VDPs within 2 business days after receiving a Government request.

If the LDCM Data Packages required to generate the VDPs are not available to the Contractor, then the Government will provide a copy of the required LDCM Data Packages. The Contractor shall deliver the requested VDPs within 2 business days of receipt of the data packages.

### *5.0 Algorithms*

The Contractor shall develop and document all algorithms used to create and process LDCM Sensor Data and Ancillary Data and produce the LDCM Data Packages and VDPs. The Contractor shall deliver to the Government all algorithms used to create and process LDCM Sensor Data and to produce the LDCM Data Packages and VDPs. The delivered algorithms are for public release to the extent allowable by U.S. export laws and regulations. These algorithms shall include but are not limited to:

- Aggregation
- Data compression and decompression
- Radiometric correction and calibration
- Radiometric artifact correction
- Geolocation
- Geometric correction
- Sampling and resampling for cartographic registration

Algorithms delivered to the Government shall be the identical algorithms used in the production of LDCM Sensor Data, LDCM Data Packages, and VDPs. Changes to these algorithms shall be delivered to the Government at least five business days before they are used to generate LDCM Sensor Data, LDCM Data Packages and VDPs, along with sufficient documentation that describes the changes and why they were required.

The Contractor shall provide detailed documentation in the Flight and Ground Systems Data Processing Algorithms Description in accordance with the CDRL.

### *6.0 Additional Data Collection Observatories*

For any observatories in addition to or augmenting the initial observatory providing LDCM data, the Contractor shall perform all work required by this SOW for their development, test and employment in providing LDCM Data and Validation Data Products under this contract, except for CDRLs as defined below.

The Contractor shall develop and deliver the following CDRL items, defined as Pre-IOC deliverables, for additional data collection observatories:

- Calibration/Validation Test Reports
- Data Specification Compliance Report

- Data Flow Test Report

Notwithstanding the deliverables above, the Contractor shall provide updates to any applicable Pre-IOC CDRL items if there are observatory or ground system architecture changes that may impact the acquisition, processing, or delivery of LDCM Data Packages and Validation Data Products.

For the following Post-IOC deliverables, the Contractor shall include information on any and all observatories used in the collection of LDCM data:

- Management Program Status Review
- Monthly Operations/Anomaly Report
- Calibration/Validation Report
- Daily Data Delivery Report

For any observatories in addition to or augmenting the initial observatory providing LDCM data, the Contractor shall conduct, and provide deliverables for, only the Pre-Environmental Review and Initial Operational Capability Review in accordance with the respective Data Item Descriptions.

For any observatories in addition to or augmenting the initial observatory providing LDCM data, the Contractor shall, at a minimum, conduct one end-to-end data flow test prior to shipment of the observatory to the launch site. The Contractor shall demonstrate the ability of any new observatory to provide specification compliant LDCM data, and the continued functionality of interfaces, before the Government will consider accepting data from any additional observatory.