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SECTION J OF RFP5-12345-JLB
ATTACHMENT I

Landsat Data Continuity Mission (LDCM) Implementation Phase

Calibration/Validation Requirements

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Goddard Space Flight Center
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DOCUMENT REVISION HISTORY

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CONTRACT CHANGE HISTORY

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1.0 Introduction

The LDCM is the next in a series of missions designed to provide a continuous long-term land surface data set. The LDCM contractor has the responsibility for providing a well calibrated and well characterized data set from its sensor, to ensure this data continuity. The Government has the responsibility for independently assuring that the contractor's data are of equal quality and are specification compliant. The following calibration validation requirements are an essential component of that assurance program. The results of the tests shall be reported as part of the program's set of Contract Data Requirements Lists (CDRLs).

2.0 Calibration Validation Requirements

2.1 During the pre launch phase the contractor shall, at a minimum:

a) Characterize the relative spectral radiance response for each band of the instrument and the variation of this response within the band.

i. The in-band (between 1% response points) relative spectral radiance response shall be measured at the integrated instrument level under simulated on-orbit operating conditions (vacuum and focal plane temperatures) for a representative sample of the detectors in all bands. This sample shall include at least 5% of the detectors in each band uniformly distributed across the focal plane, i.e., samples from each sensor chip assembly. Bandwidths, band centers, edge slopes and spectral flatness shall be determined from the relative spectral response.

ii. The full relative spectral radiance response of the instrument shall be determined down to 1 x 10^-5 across the wavelength range of the sensitivity of the detectors used in the particular band. This determination shall be based on measurements of the mirrors as well as measurements made after detectors are mated to filters or at higher levels of assembly. The detector/filter measurements shall be made under operational temperature and angular conditions with adjacent bands illuminated. The integrated out of band response shall be determined using the solar exoatmospheric curve in section 6.2.3 of the data specification as a weighting function.

b) Characterize the stability of the spectral transmission of the spectral band bandpass filters between ambient and vacuum conditions at their expected operating temperature. Witness filters shall be measured in ambient and daily over at least 7 days of continuous vacuum exposure.

c) Characterize the spatial edge response based on measurements at the integrated instrument level under simulated on-orbit operating conditions (vacuum and temperatures) for a representative sample, i.e., 9 field angles (Scale Factors of Field of View (FOV): -1, -.89, -.77, -.63, -.44, 0, .44, .77, .89, 1.0) across the entire FOV in all bands. Determine the spatial edge response slope, overshoot and uniformity. Characterize the Ground Sample Distance and determine the aliasing metric. Examine edge spread response data for possible crosstalk between spectral bands on the same focal plane.

d) Characterize the stray light rejection and internal light scattering of the instrument based on measurements at the component level or above and analysis. Include a stray light analysis of any solar diffuser panel in the deployed position. This analysis shall include glints and shadowing on the diffuser by the observatory as well as the instrument itself. Collect data at the integrated instrument level sufficient to look for instrument stray light effects not predicted by the model. Characterize any observed effects to allow for possible improvements to the instrument stray light model.

e) Radiometrically calibrate all detectors at the integrated instrument level in absolute units with NIST traceability under simulated on-orbit operating conditions (vacuum and focal plane temperature). Characterize the calibration across the expected instrument operating temperature range. Collect sufficient calibration data sets and characterization data at the integrated instrument level to project that the calibrated data will meet the absolute radiometric accuracy, radiometric signal to noise, and radiometric stability requirements on orbit.

f) Determine the mathematical equation(s) to convert the instrument output in DN to input radiance in W/m^2-sr-um. Demonstrate the validity of the equation(s) with integrated instrument level measurements for a sampling of detectors.

g) Characterize the on-board calibration devices for on-orbit use. This shall include characterization of the bidirectional reflectance of any on-board solar diffuser calibration panel across the range of incidence and view angles to be used on orbit. Provide an integrated instrument level observation of at least one device that is expected to be radiometrically stable through launch. This observation shall be repeatable on orbit to assess the transfer of the pre-launch radiometric calibration to on-orbit calibration.

h) Characterize the Signal to Noise Ratio (SNR) of all detectors by integrated instrument level measurements under simulated on-orbit operating conditions (across the on-orbit sensor temperature range and in vacuum) and across the dynamic range of the sensor.

i) Characterize the coherent noise of the LDCM instrument with observatory level measurements under simulated on-orbit operating conditions including contributions from the spacecraft (across temperature range and in vacuum).

j) Characterize the linear polarization sensitivity of the LDCM instrument by component level measurements and analysis. Measure the linear polarization sensitivity of a sampling of detectors (center and edges of field of view) at the integrated instrument level.

k) Characterize the bright target recovery and pixel-to-pixel electrical crosstalk of the LDCM instrument by focal plane level or above level measurements.

l) Collect data at the integrated instrument level sufficient to look for image artifacts such as pattern noise, striping, etc. Characterize any observed image artifacts to allow for possible improvements to the imagery.

m) Determine all detector lines-of-sight relative to the instrument coordinate system.

n) Measure the alignment of the instrument to the spacecraft to relate detector lines-of-sight in instrument coordinates to the spacecraft attitude control system reference

o) Measure the timing of the detector-sampling pattern including any detector-specific electronic delays, sample phasing (e.g., even/odd detector timing offsets), and frame rate (i.e., time between samples) for each detector.

p) Demonstrate the stability of band-to-band internal geometry over the expected range of operating temperatures to validate the error budgets and models underlying the sensor design.

q) Demonstrate the ability to accurately reconstruct and register images in bands 1-5, from data collected under conditions that simulate the on-orbit target motion. Simulation may be performed in segments over the full FOV of the instrument. This demonstration shall also include, but not be limited to, post-environmental observatory-level ambient testing, using an external target, to validate performance prior to shipment.

2.2 During the post launch phase the contractor shall, at a minimum:

a) Periodically characterize the spatial edge response in all bands, excluding the cirrus band (Band 9). Determine the spatial band edge response slope, and overshoot. Characterize the ground sample distance and aliasing (twice during Commissioning and 1/quarter thereafter).

b) Periodically characterize the stray light performance, bright target recovery and crosstalk of the LDCM instrument (once during Commissioning and 1/year thereafter).

c) Periodically characterize the relative detector response for detectors within a band (once during Commissioning and 1/quarter thereafter) and update the calibration parameters to correct pixel-to-pixel non-uniformity as necessary.

d) Periodically characterize the stability and absolute radiometric calibration of the spectral bands (once during Commissioning and 1/quarter thereafter [or more frequently depending on stability of instrument]) and update the absolute calibration coefficients and uncertainties as required to meet performance specifications.

e) Periodically characterize the noise of the LDCM instrument at dark (both coherent and total noise) and at multiple illuminated levels between dark and L(high) (twice during commissioning and 1/quarter thereafter).

f) Measure the registration accuracy of the spectral bands after processing to Level 1Gs (twice during Commissioning and 1/quarter thereafter)

g) Measure the registration accuracy of the spectral bands after processing to Level 1Gt (twice during Commissioning and 1/quarter thereafter)

h) Measure the registration accuracy for multi-temporal images of the same WRS scene (twice during Commissioning and 1/quarter thereafter)

i) Measure the in-flight absolute and relative geodetic accuracy performance of the Level 1Gs data products (twice during Commissioning and 1/quarter thereafter)

j) Measure the in-flight absolute geodetic accuracy performance of the Level 1Gt validation data products (twice during Commissioning and 1/quarter thereafter)

k) Characterize Instrument to Spacecraft Alignment (twice during Commissioning and as required to maintain absolute and relative geodetic accuracy performance thereafter)

l) Characterize the band locations on the focal plane(s) (twice during Commissioning and as required to maintain band registration accuracy performance thereafter)

2.3 All radiance calibration sources and transfer radiometers used by the contractor prior to launch shall be calibrated to National Institute of Standards and Technology (NIST) standards for radiometric calibrations.