# REQUEST FOR QUOTATION

SOLICITATION NUMBER: RFQ AG-8447-S-15-0004

DIGITAL AERIAL IMAGERY
Ashley National Forest, Utah & Wyoming

Solicitation Issue Date: May 20, 2015
Quotation Due Date: June 19, 2015

U.S. DEPARTMENT OF AGRICULTURE
FARM SERVICE AGENCY
AERIAL PHOTOGRAPHY FIELD OFFICE

NOTICE TO SUPPLIER

Any quotation submitted for this RFQ must be identified with the following information labeled on the outside of the mailing package:

**SOL.NO: AG-8447-S-14-0004**
**DUE DATE: June 19, 2015, 3:00 PM**
**RECEIVING OFFICE: CONTRACTING**

Mail To: AERIAL PHOTOGRAPHY FIELD OFFICE
CONTRACTING OFFICER
2222 WEST 2300 SOUTH
SALT LAKE CITY UTAH 84119

## NOTICE TO PROSPECTIVE SUPPLIERS:

SUPPLIERS ARE CAUTIONED TO NOTE THE FOLLOWING SPECIAL REQUIREMENTS:

Section A contains instructions for submission of quotations. Responses should be limited to 30 8-1/2”x11” single-sided pages (equivalent double-sided is acceptable). Letters of commitment, camera calibration reports, and documentation to support camera approval may be provided in an attachment without page restriction.

Items include 4-band, 8-bits per band color corrected stereo imagery, Digital Orthorectified Quarter-Quarter Quadrangle tiles (DOQQQ) , and Compressed Project Mosaic (CPM). Options for uncorrected stereo imagery and increased quantities are included (Section B-5).

**NOTE: This project contains requirements that vary from similar past projects:**

- A-4 Samples are required for non-frame based sensors or proposed deviation from image resolution
- A-5: Past performance references are required without recent APFO digital contracts
- B-2: 60-day delivery for stereo; 90-day delivery for ortho imagery
- C-5.1: Photographic Conditions
- C-5.3: Minimum sun angle to reduce shadow; overlap for stereo coverage & minimal tree lean
- C-6.1 & 6.3: Pre-production sample requirements
- Exhibit 4 and 8: Changes in progress report and flight line/exposure numbering requirements

This solicitation is a Total Small Business Set-Aside (FAR 52.219-6) and is subject to the Availability of Funds Clause (FAR 52.232-18).

The complete text of any or all clauses referenced herein may be obtained by submitting a request, identifying this solicitation number, to the Contracting Officer, USDA, FSA, Aerial Photography Field Office, 2222 West 2300 South, Salt Lake City, Utah 84119. Complete copies of the FAR in loose-leaf or CFR form may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington D.C. 20402.

# REQUEST FOR QUOTATION
(THIS IS NOT AN ORDER)

THIS RFQ [x] IS [ ] IS NOT A SMALL BUSINESS SET-ASIDE



| 1. REQUEST NO. | 2. DATE ISSUED | 3. REQUISITION/PURCHASE REQUEST NO. | 4. CERT. FOR NAT. DEF. UNDER BDSA REG. 2 AND/OR DMS REG. 1 | RATING |
|---|---|---|---|---|
| AG-8447-S-15-0004 | 5/20/2015 | | | |

5a. ISSUED BY
USDA-FSA-APFO, 2222 W. 2300 S., Salt Lake City,UT 84119

6. DELIVER BY (Date)
12/29/2015

5b. FOR INFORMATION CALL (NO COLLECT CALLS)

| NAME | TELEPHONE NUMBER | |
|---|---|---|
| | AREA CODE | NUMBER |
| Michelle Clifford | 801 | 844-2909 |

7. DELIVERY
[x] FOB DESTINATION [ ] OTHER (See Schedule)

9. DESTINATION
a. NAME OF CONSIGNEE
USDA-FSA-APFO
b. STREET ADDRESS
2222 West 2300 South
c. CITY
Salt Lake City
d. STATE
UT
e. ZIP CODE
84119

8. TO:
a. NAME
b. COMPANY
c. STREET ADDRESS
d. CITY
e. STATE
f. ZIP CODE

10. PLEASE FURNISH QUOTATIONS TO THE ISSUING OFICE IN BLOCK 5a ON OR BEFORE CLOSE OF BUSINESS (Date)
6/19/2015

IMPORTANT: This is a request for information and quotations furnished are not offers. If you are unable to quote, please so indicate on this form and return it to the address in Block 5a. This request does not commit the Government to pay any costs incurred in the preparation of the submission of this quotation or to contract for supplies or service. Supplies are of domestic origin unless otherwise indicated by quoter. Any representations and/or certifications attached to this Request for Quotation must be completed by the quoter.

## 11. SCHEDULE (Include applicable Federal, State and local taxes)

| ITEM NO. (a) | SUPPLIES/ SERVICES (b) | QUANTITY (c) | UNIT (d) | UNIT PRICE (e) | AMOUNT (f) |
|---|---|---|---|---|---|
| 1 | Ashley National Forest, UT & WY<br>4-band, 30cm resolution aerial imagery<br>Stereo Imagery, 8-bit color corrected,<br>Materials listed in Section B-3.1<br>price per square mile | 2,189 | SM | | |
| 2 | DOQQQ Orthorectified Imagery<br>Materials listed in Section B-3.2<br>average price per DOQQQ | 780 | EA | | |
| 3 | Option for uncorrected stereo imagery<br>materials listed in Section B-3.3<br><br>Submit signed quotations on or before<br>3:00pm MDT June 19, 2015 to address<br>in 5a, Attn: Contracting Officer<br>Quotations must include this form,<br>Sections A-1 - A-5, Certification<br>pg.4-7, other information necessary | 2,189 | SM | | |

| 12. DISCOUNT FOR PROMPT PAYMENT | a. 10 CALENDAR DAYS (%) | b. 20 CALENDAR DAYS (%) | c. 30 CALENDAR DAYS (%) | d. CALENDAR DAYS NUMBER | PERCENTAGE |
|---|---|---|---|---|---|
| | | | | | |

NOTE: Additional provisions and representations [x] are [ ] are not attached.

| 13. NAME AND ADDRESS OF QUOTER | 14. SIGNATURE OF PERSON AUTHORIZED TO SIGN QUOTATION | 15. DATE OF QUOTATION |
|---|---|---|
| a. NAME OF QUOTER | | |
| b. STREET ADDRESS | 16. SIGNER | |
| | a. NAME (Type or print) | b. TELEPHONE AREA CODE |
| c. COUNTY | | |
| d. CITY / e. STATE / f. ZIP CODE | c. TITLE (Type or print) | NUMBER |

NOTE: THIS SECTION MUST ACCOMPANY ANY QUOTATION SUBMITTED.

SECTION A

REQUIRED STATEMENTS OF SUPPLIERS

| **A-1 AIRCRAFT TO BE USED IN COMPLETION OF ITEM(S) IN THIS CONTRACT** | | | |
|---|---|---|---|
| Make/Model | Registration Number | Operating Ceiling | Supplier Owned (check appropriate block) |
| | | | [ ] Yes [ ] No* |
| | | | [ ] Yes [ ] No* |
| *If the aircraft is/are not supplier owned, a written statement of availability from the owner of the aircraft must be enclosed. (See Section C-3) | | | |

| **A-2 CAMERA(S) TO BE USED IN COMPLETION OF ITEM(S) IN THIS CONTRACT** | | | | |
|---|---|---|---|---|
| Serial Number | Camera Make/Model | Check if on file | Report Date | Supplier Owned |
| | | [ ] | | Yes [ ]<br>No* [ ] |
| | | [ ] | | Yes [ ]<br>No* [ ] |
| Current calibration report(s) must be enclosed or on file at the Aerial Photography Field Office. *If the camera(s) is/are not supplier owned, a written statement of availability from the owner(s) of the camera(s) must be enclosed. (See Section C-3) | | | | |

| **A-3 INCOMPLETE CONTRACTS AS OF DATE OF QUOTATION** | | |
|---|---|---|
| *Indicate Square Miles* | Remaining Work During Acquisition Period | Remaining Work During Processing Period |
| U.S. Government Contracts: | | |
| All Other Contracts: | | |
| Total: | | |
| Include contracts that would utilize the resources listed in A-1 and A-2. | | |

A-4 TECHNICAL CAPABILITY STATEMENT

A brief statement regarding the supplier's technical capability and plan to successfully perform this contract must be submitted with the quotation: 1) the planned technical approach to imagery acquisition, including project scheduling and site basing of aircraft to ensure completion within the period stated in Section B-2, address of local conditions and restrictions, flight plan and exposure count, subcontract management for imagery acquisition (if applicable); 2) Resources available for the project (aircraft, camera and crew) and potential impact of concurrent workload; 3) Imagery processing, including methods and software for production of deliverables in Section B-3, including stereo block files, AT/ortho processes, and subcontract management for processing (if applicable); 4) Quality control methodology and processes to ensure products delivered meet requirements; 5) Key personnel qualifications. Please limit the response to 30 8-1/2"x11" single-sided (or double-sided equivalent) pages, excluding letters of commitment, camera calibration reports, and documentation to support camera approval.

If a non-frame based digital sensor system is being proposed, the statement must include: 1) a detailed description of the process used in creating files in a tile format similar to that which is produced by a frame based sensor, and 2), two overlapping sample images from the particular sensor proposed over terrain similar to project area. Any proposal to achieve the required spatial resolution (GSD) from imagery acquired outside the original image resolution tolerances in Attachment B, paragraph 3.3, must include samples as described in item 2) above.

A-5 PAST PERFORMANCE REFERENCES

If no previous digital imagery acquisition contracts have been held with the USDA Aerial Photography Field Office in the past three years, list at least two (2) references, with which the supplier has held similar contracts. If possible, one reference should be within the Federal government. Include a brief description of the work, company or agency name, address, name of person to contact, telephone number, and email address.

A-6 EVALUATION OF QUOTATIONS

6.1 Quotations shall be evaluated according to the following criteria, including all supporting information furnished by the supplier with their quotation.

(a) Price: Completed SF-18 including price per unit and total amount for each item listed. In the event of a mathematical error, the unit price takes precedence over the extended price.

(b) Technical Capability: Completed Section A and brief statements describing 1) the planned technical approach to imagery acquisition, including project scheduling and site basing of aircraft to ensure completion within the period stated in Section B-2, address of local conditions and restrictions, flight plan and exposure count, subcontract management for imagery acquisition (if applicable); 2) Resources available for the project (aircraft, camera and crew) and potential impact of concurrent workload; 3) Imagery processing, including methods and software for production of deliverables in Section B-3, including stereo block files, AT/ortho processes, and subcontract management for processing (if applicable); 4) Quality control methodology and processes to ensure products delivered meet requirements; 5) Key personnel qualifications. Statements will be evaluated and rated by each member of an evaluation team for technical capability, as well as understanding of the work required, potential risks involved, and mitigation of those risks.

(c) Past Performance: Past performance record of similar projects or references. If there is no USDA record of past performance, nor a reasonable way to obtain a past performance reference from the information provided, the lack of past performance information will have no effect on the evaluation.

Please note: Technical capability and past performance, when combined, are more important when compared to price.

6.2 The Government reserves the right to make an award to other than to the lowest priced quotation, or highest technically rated quotation, when the perceived benefits and tradeoffs provide the Government the best value. The Government will place an order with the responsible source whose quotation represents the greatest value and is determined to be in the best interest of and the most advantageous to the Government, price and other factors considered.

## A-8 REPRESENTATIONS AND CERTIFICATIONS

### 8.1 ANNUAL REPRESENTATION AND CERTIFICATIONS (DEC 2014) (FAR 52.204-8)

(a)

(1) The North American Industry classification System (NAICS) code for this acquisition is **_541922**.

(2) The small business size standard is **_$7.5 Million**.

(3) The small business size standard for a concern which submits an offer in its own name, other than on a construction or service contract, but which proposes to furnish a product which it did not itself manufacture, is 500 employees.

(b)

(1) If the provision at 52.204-7, System for Award Management, is included in this solicitation, paragraph (d) of this provision applies.

(2) If the provision at 52.204-7 is not included in this solicitation, and the offeror is currently registered in the System for Award Management (SAM), and has completed the Representations and Certifications section of SAM electronically, the offeror may choose to use paragraph (d) of this provision instead of completing the corresponding individual representations and certification in the solicitation. The offeror shall indicate which option applies by checking one of the following boxes:

[_] (i) Paragraph (d) applies.

[_] (ii) Paragraph (d) does not apply and the offeror has completed the individual representations and certifications in the solicitation.

(c)

(1) The following representations or certifications in SAM are applicable to this solicitation as indicated:

(i) 52.203-2, Certificate of Independent Price Determination. This provision applies to solicitations when a firm-fixed-price contract or fixed-price contract with economic price adjustment is contemplated, unless—

(A) The acquisition is to be made under the simplified acquisition procedures in Part 13;

(B) The solicitation is a request for technical proposals under two-step sealed bidding procedures; or

(C) The solicitation is for utility services for which rates are set by law or regulation.

(ii) 52.203-11, Certification and Disclosure Regarding Payments to Influence Certain Federal Transactions. This provision applies to solicitations expected to exceed $150,000.

(iii) 52.204-3, Taxpayer Identification. This provision applies to solicitations that do not include the provision at 52.204-7, System for Award Management.

(iv) 52.204-5, Women-Owned Business (Other Than Small Business). This provision applies to solicitations that—

(A) Are not set aside for small business concerns;

(B) Exceed the simplified acquisition threshold; and

(C) Are for contracts that will be performed in the United States or its outlying areas.

(v) 52.209-2, Prohibition on Contracting with Inverted Domestic Corporations—Representation.

(vi) 52.209-5; Certification Regarding Responsibility Matters. This provision applies to solicitations where the contract value is expected to exceed the simplified acquisition threshold.

(vii) 52.214-14, Place of Performance--Sealed Bidding. This provision applies to invitations for bids except those in which the place of performance is specified by the Government.

(viii) 52.215-6, Place of Performance. This provision applies to solicitations unless the place of performance is specified by the Government.

(ix) 52.219-1, Small Business Program Representations (Basic & Alternate I). This provision applies to solicitations when the contract will be performed in the United States or its outlying areas.

(A) The basic provision applies when the solicitations are issued by other than DoD, NASA, and the Coast Guard.

(B) The provision with its Alternate I applies to solicitations issued by DoD, NASA, or the Coast Guard.

(x) 52.219-2, Equal Low Bids. This provision applies to solicitations when contracting by sealed bidding and the contract will be performed in the United States or its outlying areas.

(xi) 52.222-22, Previous Contracts and Compliance Reports. This provision applies to solicitations that include the clause at 52.222-26, Equal Opportunity.

(xii) 52.222-25, Affirmative Action Compliance. This provision applies to solicitations, other than those for construction, when the solicitation includes the clause at 52.222-26, Equal Opportunity.

(xiii) 52.222-38, Compliance with Veterans' Employment Reporting Requirements. This provision applies to solicitations when it is anticipated the contract award will exceed the simplified acquisition threshold and the contract is not for acquisition of commercial items.

(xiv) 52.223-1, Biobased Product Certification. This provision applies to solicitations that require the delivery or specify the use of USDA-designated items; or include the clause at 52.223-2, Affirmative Procurement of Biobased Products Under Service and Construction Contracts.

(xv) 52.223-4, Recovered Material Certification. This provision applies to solicitations that are for, or specify the use of, EPA- designated items.

(xvi) 52.225-2, Buy American Certificate. This provision applies to solicitations containing the clause at 52.225-1.

(xvii) 52.225-4, Buy American--Free Trade Agreements--Israeli Trade Act Certificate. (Basic, Alternates I, II, and III.) This provision applies to solicitations containing the clause at 52.225- 3.

(A) If the acquisition value is less than $25,000, the basic provision applies.

(B) If the acquisition value is $25,000 or more but is less than $50,000, the provision with its Alternate I applies.

(C) If the acquisition value is $50,000 or more but is less than $79,507, the provision with its Alternate II applies.

(D) If the acquisition value is $79,507 or more but is less than $100,000, the provision with its Alternate III applies.

(xviii) 52.225-6, Trade Agreements Certificate. This provision applies to solicitations containing the clause at 52.225-5.

(xix) 52.225-20, Prohibition on Conducting Restricted Business Operations in Sudan--Certification. This provision applies to all solicitations.

(xx) 52.225-25, Prohibition on Contracting with Entities Engaging in Certain Activities or Transactions Relating to Iran—Representation and Certification. This provision applies to all solicitations.

(xxi) 52.226-2, Historically Black College or University and Minority Institution Representation. This provision applies to solicitations for research, studies, supplies, or services of the type normally acquired from higher educational institutions.

(2) The following certifications are applicable as indicated by the Contracting Officer:

[Contracting Officer check as appropriate.]

___ (i) 52.204-17, Ownership or Control of Offeror.

___ (ii) 52.222-18, Certification Regarding Knowledge of Child Labor for Listed End Products.

___ (iii) 52.222-48, Exemption from Application of the Service Contract Labor Standards to Contracts for Maintenance, Calibration, or Repair of Certain Equipment--Certification.

___ (iv) 52.222-52 Exemption from Application of the Service Contract Labor Standards to Contracts for Certain Services--Certification.

___ (v) 52.223-9, with its Alternate I, Estimate of Percentage of Recovered Material Content for EPA-Designated Products (Alternate I only).

___ (vi) 52.227-6, Royalty Information.

___ (A) Basic.

___ (B) Alternate I.

___ (vii) 52.227-15, Representation of Limited Rights Data and Restricted Computer Software.

(d) The offeror has completed the annual representations and certifications electronically via the SAM Web site accessed through https://www.acquisition.gov . After reviewing the SAM database information, the offeror verifies by submission of the offer that the representations and certifications currently posted electronically that apply to this solicitation as indicated in paragraph (c) of this provision have been entered or updated within the last 12 months, are current, accurate, complete, and applicable to this solicitation (including the business size standard applicable to the NAICS code referenced for this solicitation), as of the date of this offer and are incorporated in this offer by reference (see FAR 4.1201); except for the changes identified below *[offeror to insert changes, identifying change by clause number, title, date]*. These amended representation(s) and/or certification(s) are also incorporated in this offer and are current, accurate, and complete as of the date of this offer.

| FAR Clause | Title | Date | Change |
|---|---|---|---|
| | | | |
| | | | |

Any changes provided by the offeror are applicable to this solicitation only, and do not result in an update to the representations and certifications posted on SAM.

A-9 SOLICITATION PROVISIONS INCORPORATED BY REFERENCE (FEB 1998) (FAR 52.252-1)

This solicitation incorporates one or more solicitation provisions by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. The offeror is cautioned that the listed provisions may include blocks that must be completed by the offeror and submitted with its quotation or offer. In lieu of submitting the full text of those provisions, the offeror may identify the provision by paragraph identifier and provide the appropriate information with its quotation or offer. Also, the full text of a solicitation provision may be accessed electronically at this/these address(es):

http://farsite.hill.af.mil/
https://acquisition.gov/
www.arnet.gov

52.204-7 System for Award Management (Jul 2013)

52.225-25 Prohibition on Contracting with Entities Engaging in Certain Activities or Transactions Relating to Iran—Representation and Certification (Dec 2012)

# SECTION B

## PROJECT SERVICES, SUPPLIES AND REQUIREMENTS

### B-1 DIGITAL AERIAL PHOTOGRAPHY SERVICES AND SUPPLIES

1.1 Furnish direct digital aerial imagery and all related services and supplies in accordance with the requirements, specifications, terms, conditions, clauses, and provisions specified herein. For purposes of this combined service/supply contract, the services portion is considered the management, execution, and related services associated with the acquisition of the imagery. The supply portion is considered all material, processing, and activities required to manufacture the end products derived from the raw imagery acquired during the services portion of the contract.

1.2 Intended Use of Imagery

The imagery shall be used by the United States Forest Service for forest, range, and park resource management, monitoring and inventory. Imagery is used to support the management of land, minerals, vegetation, wildlife habitat, recreation and travel. Additional supported activities include watershed health assessments, riparian monitoring, forest health evaluations, and preliminary engineering conceptual designs. Aerial imagery depicting the current vegetation condition is needed to establish structural class, canopy closure, and plant association for use in determining vegetation departure from the historic range of variability and in establishing baseline monitoring data. Natural resource and other data will be collected and evaluated by means of photo interpretation (visual display and stereo viewing), image processing and geographic information systems (GIS) technologies.

### B-2 PROJECT AREA

Provide aerial imagery services and related materials for the acquisition and production of leaf-on, 30cm resolution, 4-band, direct digital stereo imagery for the following project area:

| **Project Item 1: Ashley National Forest, Utah and Wyoming** | | | | | |
|---|---|---|---|---|---|
| **Approximate Acquisition Period** | **Square Miles** | **DOQQQ** | **UTM Zone** | **Project Code** | **Project Identifier** |
| July 1 through September 30, 2015 | 2,189 | 780 | 12 | 614010 | FS-6-15-1 |

## B-3 MATERIALS TO BE DELIVERED

All stereo imagery deliverables shall be shipped no later than sixty (60) days from the end of the acquisition period or any season extension; all orthorectified imagery deliverables no later than one hundred ninety (90) days. Early delivery is encouraged to facilitate timely inspection and avoid delays due to peak seasonal inspection workload. Corrected materials shall be shipped as soon as possible after correction is made, but no later than 30 days after receipt of the materials or data required for corrections. Corrected or resubmitted materials must be delivered on media separate from original materials being submitted and include a separate packing slip. The Contractor shall maintain a copy of the digital data until the Government formally accepts the deliverables.

### 3.1 LINE ITEM 1: STEREO IMAGERY DELIVERABLES

| Stereo Imagery Deliverables | Format | Metadata Required | Media | Sample Naming (See Exhibit 2) | Gov't Approval Required | Quantity & Frequency |
|---|---|---|---|---|---|---|
| Project Flight Plan<br>Section C-5.2 | Esri® Compatible Shapefile | None | Email or DVD | None | Review Only | Prior to Notice to Proceed |
| Pre-production Image Samples<br>Section C-6.1 | GeoTIFF | Yes | DVD or FTP site | 614010_0027_0001_20150827_8b.tif | Yes | One image for each landscape defined in Section C-6.1 |
| 4-Band, 8-bit per band, Color Corrected, Georeferenced, Uncompressed Digital Image Files<br>Section C-6.1 | GeoTIFF<br>(see Table 2.1(a) below) | Yes, one per image file | Internal Hard Drive | 614010_0027_0001_20150827_8b.tif | Yes | Entire project item, unless interim partial delivery approved |
| Pre-production samples for Stereo Block File<br>Section C-6.5 | .blk or .prj | Yes | DVD or FTP site | 614010_8b_01.blk | Yes | One block file with 4 overlapping images |
| Stereo Block Files for each Area<br>Section C-6.5 | Either .blk or .prj | Yes, one per block file | Internal Hard Drive | 614010_8b_01.blk thru<br>614010_8b_04.blk | Yes | Include with stereo imagery delivery; updated with reflights |
| Project Geodatabase<br>Project Acquisition Feature Dataset<br>Image Footprint Feature Class<br>Flight Line Feature Class<br>Photo Center Feature Class | Esri® File Geodatabase | Yes, one file per geodatabase | Internal Hard Drive | Project_Geodatabase_614010_6dash15.gdb<br>prescott_614010_6dash15_1<br><br>georeferenced_614010_30_4_8_6dash15_1<br>flight_line_614010_6dash15_1<br>photo_center_614010_6dash15_1 | Yes | Include with stereo imagery; update with additional feature classes or reflights |

| | | | | | | |
|---|---|---|---|---|---|---|
| Progress Reports | Content of email or attached text file See Exhibit 4 | No | Email | N/A | No | One per day per project area for each day imagery is acquired |

(a) Stereo Imagery Support Files

| **Stereo Imagery Deliverables - Support Files Included with Image Files** | | | |
|---|---|---|---|
| **Frame-Based Sensor** | | **Scanning (Pushbroom) Sensor Files for Each Flight Line** | |
| .tif | uncompressed, georeferenced image | .ads | header with pointers to .tif segments |
| .aux | auxiliary statistic/projection file | .hist | xml file containing histogram |
| .rrd | reduced resolution dataset pyramid file | .min | minification header |
| .txt & xml | Metadata in both .txt and .xml format | .odf | orientation data file |
| | | .odf.adj | adjusted orientation after AT |
| | | .sup | support/orientation file |
| | | .tif | image segment |
| | | .txt & .xml | Metadata and other text files |
| Image naming convention with above extensions, ie: 614010_0027_0001_20140827_8b.rrd | | | |

## 3.2 LINE ITEM 2: DOQQQ ORTHORECTIFIED IMAGERY DELIVERABLES

| **Line Item 2: DOQQQ Orthorectified Imagery Deliverables** | **Format** | **Metadata Required** | **Media** | **Sample Naming (See Exhibit 2)** | **Gov't Approval Required** | **Quantity & Frequency** |
|---|---|---|---|---|---|---|
| Pre-production Samples<br>Section C-6.3 | GeoTIFF | Yes | DVD or FTP site | m_3311162_ne_2_13_30_2015721.tif | Yes | One DOQQQ for each landscape defined in Section C-6.1 |
| 4-band 8-bit Digital Orthorectified Quarter Quadrangles (DOQQQ)<br>Auxiliary File<br>Pyramid File<br>Metadata File<br>Section C-6.3 | GeoTIFF<br><br>AUX<br>RRD<br>TXT & XML | Yes, separate file for each DOQQQ | Internal Hard Drive | m_3311162_ne_2_13_30_20150721.tif<br><br>m_3311162_ne_2_13_30_20150721.aux<br>m_3311162_ne_2_13_30_20150721.rrd<br>m_3311162_ne_2_13_30_20150721.xml | Yes | Entire project, unless interim partial delivery approved |
| RMSE Accuracy and Quality Control Reports | ASCII | None | Internal Hard Drive | Contractor determined | No | Include with ortho delivery |
| Seamline Feature Class and Orthorectified Image Index Feature Class included in Project Geodatabase<br>Section C-7.2 | Esri® file Geodatabase | Yes, one for geodatabase | Internal Hard Drive or DVD | seamlines_614010_6dash15_1<br>ortho_index_614010_30_4_6dash15_1 | Yes | Include with ortho delivery; updated with corrections or reflights |
| Compressed Project Mosaic (CPM)<br>Auxiliary File<br>Metadata File<br>Section C-6.4 | ECW<br><br>AUX<br>TXT & XML | Yes, separate file for each CPM | Internal Hard Drive | 614010_6-15-1_m.ecw<br><br>614010_6-15-1_m.aux<br>614010_6-15-1_m.xml | Yes | One file |

## 3.3 OPTION LINE ITEM 3: UNCORRECTED STEREO IMAGERY DELIVERABLES

The Government will consider pricing for the optional award line item indicated below. The Contracting Officer may exercise this option upon contract award or by notice to the Contractor within 60 days after the end of the approximate acquisition period stated in B-2. This optional line item will be awarded only with the corresponding base item.

| **Option Line Item 3: Uncorrected Stereo Imagery Deliverables** | **Format** | **Metadata Required** | **Media** | **Sample Naming (See Exhibit 2)** | **Gov't Approval Required** | **Quantity & Frequency** |
|---|---|---|---|---|---|---|
| Pre-production sample<br>Section C-6.2 | GeoTIFF | Yes | DVD or FTP site | 612140_0027_0001_20150827_16b.tif | Yes | One sample image |
| 4-Band, 16-bit per band, Uncorrected, Georeferenced, Uncompressed Digital Image Files<br>Section C-6.2<br>(see Table 3.1(a) for stereo imagery support file requirements) | GeoTIFF | Yes, separate file for each image file | Internal Hard Drive | 614010_0027_0001_20150827_16b.tif | Yes | Entire project, unless ranger district or other area approved |
| Stereo Block Files for each Area<br>Section C-6.5 | Either .blk or .prj | Yes, one per block file | Internal Hard Drive | 614010_16b_01.blk thru 614010_16b_04.blk | Yes | Include with stereo imagery delivery; updated with reflights |

## B-4 OPTION FOR INCREASED QUANTITY (FAR 52.217-6) (Mar 1989)

The Government may increase the quantity of supplies called for in the Schedule at the unit price specified. The Contracting Officer may exercise the option upon mutual agreement with the Contractor prior to the end of the approximate acquisition period stated in Section B-2, or extension thereof. Delivery of the added items shall continue at the same rate as the like items called for under the contract, unless the parties otherwise agree. The quantity may be increased by up to 30% of the original quantities stated in B-5.1 and B-5.2 of this section.

## B-6 GOVERNMENT-PROVIDED INFORMATION

The Government shall provide the information listed below. Shapefiles provided may be in projections that differ from the projection requirements of the final product. The contractor is responsible for notifying the Contracting Officer of any discrepancies or problems encountered in using this information within two business days

### 6.1 Project Boundary Shapefile

The Contractor will be furnished upon award one (1) Esri® compatible shapefile containing the project boundary for each Project Item awarded. Due to the unique footprint of digital sensors the Contractor is responsible for the complete stereo coverage acquisition of the shapefile area, including the boundaries.

### 6.2 Metadata Templates

The Contractor will be furnished upon award data text files (.txt), as applicable, containing Federal Geographic Data Committee (FGDC) compliant metadata templates with Remote Sensing Extensions where applicable to be used for: (1) the georeferenced uncompressed digital image files in Sections C-6.1 and C-6.2 (if awarded) ; (2) the DOQQQ files required in Section C-6.3; (3) the CPM files required in Section C-6.4; (4) the Stereo Block Files in Section C-6.5; (5) the Project Geodatabase in Section C-7.2. Government provided templates will not be provided for other required metadata.

### 6.3 Stereo Block Area Boundary Files

The contractor will be furnished upon award an Esri® compatible shapefile containing the area boundaries for creation of stereo block files in Section C-6.5.

### 6.4 DOQQQ Shapefile

The Contractor will be furnished upon award Esri® compatible shapefile(s) containing the required DOQQQ for each project item awarded. The shapefile does not include the buffer area required in Section C-6.3. The contractor must add the required buffer to the shapefile provided.

### 6.5 Project Geodatabase Template

The Contractor will be furnished upon award one (1) Esri® compatible file geodatabase template for use in producing the Project Geodatabase in Section C-7.2.

## B-7 ADMINISTRATIVE REQUIREMENTS

### 7.1 Notice to Proceed

The Notice to Proceed will be given by telephone or email, and confirmed by signed correspondence. Failure of the Contractor to proceed with flights on a project item within ten (10) calendar days after a "Notice to Proceed" is given, without documentation of weather or ground preventing imagery collection, may be considered as evidence of failure to perform the

work so as to ensure its timely completion. As evidence of performance, Progress Reports shall be submitted.

7.2 Notice to the Government of Delay

The Contractor shall immediately, upon becoming aware of any difficulties in meeting performance requirements during the photographic season or when difficulties are encountered which may delay deliveries under the contract, notify the Contracting Officer in writing thereof. Such notification shall identify difficulties, the reasons therefore, and the estimated period of anticipated delay. Refer to Section B-8, FAR 52.213-4(e) for excusable delays.

FAILURE OF THE CONTRACTOR TO GIVE SUCH NOTICE MAY PRECLUDE LATER CONSIDERATION OF ANY CLAIM FOR NON-PERFORMANCE DUE TO WEATHER CONDITIONS OR ANY REQUEST FOR AN EXTENSION OF CONTRACT TIME.

7.3 Contract Extensions

IT IS THE EXPRESSED INTENT OF THE GOVERNMENT TO HAVE ALL IMAGERY REQUIRED UNDER THIS CONTRACT COMPLETED WITHIN THE APPROXIMATE ACQUISITION PERIOD SPECIFIED IN SECTION B-2.

(a) Acquisition Period Extension: The Government reserves the right to extend the approximate acquisition period of this contract beyond that stated in Section B-2 by written notice to the contractor at any time prior to the end of the period, at no increase in price. (FAR 52.217-08, Option to Extend Services)

(b) Extension of the Term of the Contract: The Government may extend the term of this contract, at no increase in price, by written notice to the Contractor within six (6) months after the acquisition period has ended. The Contracting Officer may extend this option twice. (FAR 52.217-09, Option to Extend the Term of the Contract)

7.4 Subcontract Management

If the Contractor uses subcontractors in the performance of the contract, a plan and procedure will be established to manage its subcontractors. Before entering into a subcontract that was not included in the quotation, the Contractor shall inform the Contracting Officer and submit information required by the Contracting Officer to determine acceptability and approval of the anticipated subcontractor and imagery acquisition equipment to be used. Information required may include a subcontract management plan, references, key personnel, processing software/methods, etc. The Contractor is solely responsible for the performance and cost control of its partnerships and subcontractors.

7.5 Ownership of Materials

The Government shall receive copyright and ownership to all data delivered under this contract, including but not limited to photographic materials, imagery, databases, and paper products, upon formal acceptance. The Contractor agrees to transfer copyright to the Government upon acceptance. The Contractor may maintain copyright and ownership of all original or derived works which are not required submittals under this contract. The Contractor is encouraged to

create, market, and sell derived works not related to or in direct competition with the data delivered under this contract. For example, if this contract requires that 30cm georeferenced, uncorrected imagery be delivered to the Government, the Contractor may create 50cm imagery from the original product, prior to its submittal to the Government, and resell it to other Government agencies or the general public. However, the Government also maintains the rights to derive additional products from the data delivered under this contract. No public distribution of the original or derived works shall be made prior to acceptance by the Government unless specified in the contract or authorized by the Contracting Officer.

7.6 Partial Coverage

If the Contractor obtains only partial coverage for any project item during the season, all partial imagery and contract deliverables shall be processed and delivered according to the requirements specified for completed imagery. Interim products may be required to satisfy partial delivery. The requirement for processing partial coverage may be waived only by the Contracting Officer.

7.7 Inspection and Acceptance Procedures

Refer to Section B-8, FAR 52.213-4(d) and (h). All materials specified in Section B-3 will be inspected to determine conformance to all contract requirements and specifications. Inspection of the image files will be performed utilizing a comprehensive method of quality assurance inspection procedures including a random sampling technique to test for compliance to the horizontal accuracy requirement in the imagery delivered. The Government will make every effort to inspect all material specified within 60 calendar days after they are received at the point designated and notify the contractor if unable to meet this schedule. The Government will notify the contractor of acceptance following inspection of all materials submitted, including those resubmitted for correction. A partial acceptance may be made for partially completed project areas following inspection of all materials submitted for imagery acquired during the acquisition period. The Government intends to exercise its post-acceptance rights within one year of the final acceptance date.

7.8 Payments

(a) Electronic Invoicing and Payment Requirements: Payment requests must be submitted electronically through the U.S. Department of the Treasury's Invoice Processing Platform System (IPP). "Payment request" means any request for contract financing payment or invoice payment by the Contractor. To constitute a proper invoice, the payment request must comply with the requirements identified in the applicable Prompt Payment clause included in the contract. The IPP website address is: https:/www.ipp.gov

(b) Partial Payments: For a partially completed project item or a partially completed area within a project item, acceptance and payment will be made on a unit price basis at the rate of ninety percent (90%) of the amount due. Any payment thus made is partial payment of the contract. Upon completion and acceptance of the complete project item or area within the project item, the remaining payment will be made, total the full payment due for the project item or line item. Partial Payments must be approved by the Contracting Officer under the conditions stated in FAR 52.232-1, Payments.

7.9 Permits and Responsibilities

The Contractor shall, without additional expense to the Government, be responsible for obtaining any necessary licenses and permits, and for complying with any Federal, State, and municipal laws, codes, and regulations applicable to the performance of the work. The Contractor shall also be responsible for all damages to persons or property that occurs as a result of the Contractor's fault or negligence. The Contractor shall also be responsible for all materials delivered and work performed until completion and acceptance of the entire work, except for any completed unit of work which may have been accepted under the contract.

7.10 Aircraft Regulations and Certifications

All aircraft used in the performance of the work under this contract shall be maintained and operated in accordance with all regulations required by the U.S. Department of Transportation, Federal Aviation Administration (FAA). Aircraft operated in the acquisition of aerial photography under this contract shall be FAA certified to the highest flying altitude specified in the solicitation.

7.11 Statement of Equivalent Rates for Federal Hires (FAR 52.222-42) (May 2014)

In compliance with the Service Contract Act of 1965, as amended, and the regulations of the Secretary of Labor (29 CFR Part 4), this clause identifies the classes of service employees expected to be employed under the contract and states the wages and fringe benefits payable to each if they were employed by the contracting agency subject to the provisions of 5 U.S.C. 5341 or 5332.

*This Statement is for Information Only:It is not a Wage Determination*

| **Employee Class** | **Monetary Wage -- Fringe Benefits** |
|---|---|
| Aircraft Pilot | $28.36 |
| First Officer | $25.82 |
| Aerial Photographer | $14.17 |

7.12 Wage Determination

The Wage Determination applicable to any contract resulting from this solicitation is determined by the location of the Contractor's establishment. Wage Determination number 1995-0222, Revision 38, dated January 14, 2015, will be applicable for Contractors located nationwide. See Exhibit 6, Wage Determination.

7.13 Non-Discrimination Statement

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its program and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information,

political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of Discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW., Washington, DC 20250-9410, or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

B-8 FAR 52.213-4 – TERMS AND CONDITIONS – SIMPLIFIED ACQUISITIONS (OTHER THAN COMMERCIAL ITEMS) (MAY 2015)

(a) The Contractor shall comply with the following Federal Acquisition Regulation (FAR) clauses that are incorporated by reference:

(1) The clauses listed below implement provisions of law or Executive order:

(i) 52.222-3, Convict Labor (June 2003) (E.O. 11755).

(ii) 52.222-21, Prohibition of Segregated Facilities (Apr 2015).

(iii) 52.222-26, Equal Opportunity (Apr 2015) (E.O. 11246).

(iv) 52.225-13, Restrictions on Certain Foreign Purchases (Jun 2008) (E.O.s, proclamations, and statutes administered by the Office of Foreign Assets Control of the Department of the Treasury).

(v) 52.233-3, Protest After Award (Aug 1996) (31 U.S.C. 3553).

(vi) 52.233-4, Applicable Law for Breach of Contract Claim (Oct 2004) (Pub. L. 108-77, 108-78 (19 U.S.C. 3805 note)).

(2) Listed below are additional clauses that apply:

(i) 52.232-1, Payments (Apr 1984).

(ii) 52.232-8, Discounts for Prompt Payment (Feb 2002).

(iii) 52.232-11, Extras (Apr 1984).

(iv) 52.232-25, Prompt Payment (Jul 2013).

(v) 52.232-39, Unenforceability of Unauthorized Obligations (Jun 2013).

(vi) 52.232-40, Providing Accelerated Payments to Small Business Subcontractors (Dec 2013)

(vii) 52.233-1, Disputes (May 2014).

(viii) 52.244-6, Subcontracts for Commercial Items (Apr 2015).

(ix) 52.253-1, Computer Generated Forms (Jan 1991).

(b) The Contractor shall comply with the following FAR clauses, incorporated by reference, unless the circumstances do not apply:

(1) The clauses listed below implement provisions of law or Executive order:

(i) 52.204-10, Reporting Executive Compensation and First-Tier Subcontract Awards (Jul 2013) (Pub. L. 109-282) (31 U.S.C. 6101 note) (Applies to contracts valued at $25,000 or more).

(ii) 52.222-19, Child Labor—Cooperation with Authorities and Remedies (Jan 2014) (E.O. 13126). (Applies to contracts for supplies exceeding the micro-purchase threshold).

(iii) 52.222-20, Contracts for Materials, Supplies, Articles, and Equipment Exceeding $15,000 (May 2014) (41 U.S.C. chapter 65) (Applies to supply contracts over $15,000 in the United States, Puerto Rico, or the U.S. Virgin Islands).

(iv) 52.222-35, Equal Opportunity for Veterans (Jul 2014) (38 U.S.C. 4212) (Applies to contracts of $100,000 or more).

(v) 52.222-36, Equal Employment for Workers with Disabilities (Jul 2014) (29 U.S.C. 793) (Applies to contracts over $15,000, unless the work is to be performed outside the United States by employees recruited outside the United States.) (For purposes of this clause, “United States” includes the 50 States, the District of Columbia, Puerto Rico, the Northern Mariana Islands, American Samoa, Guam, the U.S. Virgin Islands, and Wake Island.)

(vi) 52.222-37, Employment Reports on Veterans (Jul 2014) (38 U.S.C. 4212) (Applies to contracts of $100,000 or more).

(vii) 52.222-41, Service Contract Labor Standards (May 2014) (41 U.S.C. chapter 67) (Applies to service contracts over $2,500 that are subject to the Service Contract Labor Standards statute and will be performed in the United States, District of Columbia, Puerto Rico, the Northern Mariana Islands, American Samoa, Guam, the U.S. Virgin Islands, Johnston Island, Wake Island, or the outer Continental Shelf.)

(viii)(A) 52.222-50, Combating Trafficking in Persons (Mar 2015) (22 U.S.C. chapter 78 and E.O. 13627) (Applies to all solicitations and contracts).

(B) Alternate I (Mar 2015) (Applies if the Contracting Officer has filled in the following information with regard to applicable directives or notices: Document title(s), source for obtaining document(s), and contract

performance location outside the United States to which the document applies).

(ix) 52.222-55, Minimum Wages Under Executive Order 13658 (Dec 2014) (Executive Order 13658) (Applies when 52.222-6 or 52.222-41 are in the contract and performance in whole or in part is in the United States the 50 States and the District of Columbia).

(x) 52.223-5, Pollution Prevention and Right-to-Know Information (May 2011) (E.O. 13423) (Applies to services performed on Federal facilities).

(xi) 52.223-15, Energy Efficiency in Energy-Consuming Products (Dec 2007) (42 U.S.C. 8259b) (Unless exempt pursuant to 23.204, applies to contracts when energy-consuming products listed in the ENERGY STAR® Program or Federal Energy Management Program (FEMP) will be—

(A) Delivered;

(B) Acquired by the Contractor for use in performing services at a Federally-controlled facility;

(C) Furnished by the Contractor for use by the Government; or

(D) Specified in the design of a building or work, or incorporated during its construction, renovation, or maintenance).

(xii) 52.225-1, Buy American —Supplies (May 2014) (41 U.S.C. chapter 83) (Applies to contracts for supplies, and to contracts for services involving the furnishing of supplies, for use in the United States or its outlying areas, if the value of the supply contract or supply portion of a service contract exceeds the micro-purchase threshold and the acquisition--

(A) Is set aside for small business concerns; or

(B) Cannot be set aside for small business concerns (see 19.502-2), and does not exceed $25,000).

(xiii) 52.226-6, Promoting Excess Food Donation to Nonprofit Organizations (May 2014) (42 U.S.C. 1792) (Applies to contracts greater than $25,000 that provide for the provision, the service, or the sale of food in the United States).

(xiv) 52.232-33, Payment by Electronic Funds Transfer— System for Award Management (Jul 2013) (Applies when the payment will be made by electronic funds transfer (EFT) and the payment office uses the System for Award Management (SAM) database as its source of EFT information.)

(xv) 52.232-34, Payment by Electronic Funds Transfer—Other than System for Award Management (Jul 2013) (Applies when the payment will be made by EFT

and the payment office does not use the SAM database as its source of EFT information.)

(xvi) 52.247-64, Preference for Privately Owned U.S.-Flag Commercial Vessels (Feb 2006) (46 U.S.C. App.1241) (Applies to supplies transported by ocean vessels (except for the types of subcontracts listed at 47.504(d).)

(2) Listed below are additional clauses that may apply:

(i) 52.209-6, Protecting the Government's Interest When Subcontracting with Contractors Debarred, Suspended, or Proposed for Debarment (Aug 2013) (Applies to contracts over $30,000).

(ii) 52.211-17, Delivery of Excess Quantities (Sep 1989) (Applies to fixed-price supplies).

(iii) 52.247-29, F.o.b. Origin (Feb 2006) (Applies to supplies if delivery is f.o.b. origin).

(iv) 52.247-34, F.o.b. Destination (Nov 1991) (Applies to supplies if delivery is f.o.b. destination).

(c) *FAR 52.252-2, Clauses Incorporated by Reference (Feb 1998).* This contract incorporates one or more clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. Also, the full text of a clause may be accessed electronically at this/these address(es):

http://farsite.hill.af.mil/

https://acquisition.gov/

www.arnet.gov

(d) *Inspection/Acceptance.* The Contractor shall tender for acceptance only those items that conform to the requirements of this contract. The Government reserves the right to inspect or test any supplies or services that have been tendered for acceptance. The Government may require repair or replacement of nonconforming supplies or reperformance of nonconforming services at no increase in contract price. The Government must exercise its postacceptance rights --

(1) Within a reasonable period of time after the defect was discovered or should have been discovered; and

(2) Before any substantial change occurs in the condition of the item, unless the change is due to the defect in the item.

(e) *Excusable delays.* The Contractor shall be liable for default unless nonperformance is caused by an occurrence beyond the reasonable control of the Contractor and without its fault or negligence, such as acts of God or the public enemy, acts of the Government in either its

sovereign or contractual capacity, fires, floods, epidemics, quarantine restrictions, strikes, unusually severe weather, and delays of common carriers. The Contractor shall notify the Contracting Officer in writing as soon as it is reasonably possible after the commencement of any excusable delay, setting forth the full particulars in connection therewith, shall remedy such occurrence with all reasonable dispatch, and shall promptly give written notice to the Contracting Officer of the cessation of such occurrence.

(f) *Termination for the Government's convenience.* The Government reserves the right to terminate this contract, or any part hereof, for its sole convenience. In the event of such termination, the Contractor shall immediately stop all work hereunder and shall immediately cause any and all of its suppliers and subcontractors to cease work. Subject to the terms of this contract, the Contractor shall be paid a percentage of the contract price reflecting the percentage of the work performed prior to the notice of termination, plus reasonable charges that the Contractor can demonstrate to the satisfaction of the Government, using its standard record keeping system, have resulted from the termination. The Contractor shall not be required to comply with the cost accounting standards or contract cost principles for this purpose. This paragraph does not give the Government any right to audit the Contractor's records. The Contractor shall not be paid for any work performed or costs incurred that reasonably could have been avoided.

(g) *Termination for cause.* The Government may terminate this contract, or any part hereof, for cause in the event of any default by the Contractor, or if the Contractor fails to comply with any contract terms and conditions, or fails to provide the Government, upon request, with adequate assurances of future performance. In the event of termination for cause, the Government shall not be liable to the Contractor for any amount for supplies or services not accepted, and the Contractor shall be liable to the Government for any and all rights and remedies provided by law. If it is determined that the Government improperly terminated this contract for default, such termination shall be deemed a termination for convenience.

(h) *Warranty.* The Contractor warrants and implies that the items delivered hereunder are merchantable and fit for use for the particular purpose described in this contract.

52.204-10 Reporting Executive Compensation and First-Tier Subcontract Awards (Jul 2013)

52.204-13 System for Award Management Maintenance (Jul 2013)

52.219-06 Notice of Total Small Business Set-Aside (Nov 2011)

52.219-28 Post-Award Small Business Program Representation (Jul 2013)

52.227-1 Authorization and Consent (Dec 2007)

52.227-14 Rights in Data -- General (May 2014)

52.243-1 Changes -- Fixed Price (Aug 1987)

# SECTION C

## DESCRIPTION/SPECIFICATIONS/WORK STATEMENT

### C-1 SCOPE OF CONTRACT

The general scope of the contract is to procure precise vertical aerial imagery for natural resource inventory and analysis and stereo model review. The Contractor is responsible for furnishing direct digital imagery and related services and supplies in accordance with requirements, specifications, terms and conditions specified herein.

#### 1.1 Technical Requirements and Specifications

The technical requirements and specifications of this contract are described in this section and Attachments A, B, and C which define the essential elements in securing high quality digital imagery. Any deviation from the specifications stated herein may cause increased time and effort in using the imagery as intended.

#### 1.2 Delivery and Performance

All contract materials shall be shipped within the time limits and to the place of delivery specified herein. Performance of the contract shall be authorized and monitored by the Contracting Officer.

#### 1.5 Labor and Materials

The Contractor shall furnish all materials, equipment, transportation, superintendence, and labor as required herein. The Contractor shall execute and finish the imagery acquisition, imagery production and related services for the project specified and shall deliver to the USDA all materials called for in Sections B-3 and B-4 (if awarded).

### C-2 APPLICABLE DOCUMENTS

#### 2.1 Attachments

The following documents attached to this solicitation document are considered requirements and specifications under the resulting contract(s), as applicable to the Contractor's technical proposal:

(a) Aerial Photography Field Office (APFO) USDA Specification for Digital Camera Based Acquisition, Modified for USFS Resource Imagery March 26, 2012 (Attachment A)
(b) Aerial Photography Field Office (APFO) USDA Digital Imagery Quality Specification, Modified for USFS Resource Imagery March 26, 2012 (Attachment B)
(c) USDA Digital File Format Specification, Version 1.0, January 24, 2013

## 2.2 References

The following documents referenced in this solicitation document are considered requirements and specifications under the resulting contract(s), as applicable to the Contractor's technical proposal:

(a) Federal Geographic Data Committee (FGDC) Specification, FGDC-STD-001-1998 ("Content Standard for Digital Geospatial Metadata")
(b) Federal Geographic Data Committee (FGDC) Specifications, FGDC-STD-007.3-1998 ("Geospatial Positioning Accuracy Standards, Part 3: National Standard for Spatial Data Accuracy")
(c) Code of Federal Regulation (CFR) Title 14 ("Federal Aviation Regulations")
(d) GeoTIFF Revision 1.0 Specification, dated December 28, 2000 (Version 1.8.2)
(e) TIFF Specification Revision 6 dated June 3, 1992 (Adobe Systems Inc.)

# C-3 GENERAL REQUIREMENTS

The Contractor shall furnish all materials, equipment, transportation, superintendence, and labor required to plan, acquire, manage, and process digital imagery for the project item specified in Section B.

# C-4 EQUIPMENT REQUIREMENTS

## 4.1 Platform/Camera Requirements

(a) The direct digital imagery acquisition requirements will be for the collection of visible (Red, Green, Blue) and color near infrared (IR) imagery captured simultaneously. The digital sensor system shall be a tested, stable, geometrically calibrated system with appropriate documentation and comply with the technical requirements and specifications of this contract, and Attachment A: USDA Digital Camera Specification.

(b) Platform/Camera Approval: Any equipment (platform and cameras) proposed to be used by the Contractor must be approved for use by the Contracting Officer (see Attachment A, paragraph 4.0, Digital Camera Approval Requirements, for instructions and process for platform/camera approval). If the platform and camera proposed for use are not owned by the Contractor, a written statement of availability from the owner of the equipment shall be provided to the Contracting Officer.

(b) System Malfunction: The Contracting Officer shall have the right to require the removal of a camera from use when deficiencies in imagery attributable to the camera are found to exist (see Attachment A, paragraph 3.7, System Malfunctions). Any platform/camera removed from use by the Contracting Officer shall not be returned to use on any APFO contract until the cause of the malfunction is corrected to the satisfaction of the Contracting Officer. That determination will be based on acceptable samples, field reports, manufacturer reports, and/or calibration reports.

4.2 Aircraft Requirements

(a) FAA Certification. All aircraft used in the performance of this contract shall be maintained and operated in accordance with all regulations required by the U.S. Department of Transportation, Federal Aviation Administration (FAA). Aircraft operated in the acquisition of aerial imagery under this contract shall be FAA certified to a service ceiling with operating load (crew, sensor system, oxygen, and other required equipment) of not less than the highest altitude required.

(b) Positive Control Airspace. The project item areas may contain areas of controlled or restricted airspace. It is the responsibility of the Contractor to obtain all approvals necessary to assure that required clearances are achieved. When the flight plan and location of any project area coverage fall within positive-control airspace, the aircraft must contain the appropriate equipment to operate in such positive-control areas within the purview of the Federal Aviation Regulations. In addition, 18 USC Section 795 requires permission of the commanding officer to photograph or map some military and naval installations. If any delay to the acquisition or production schedule is caused due to 18 USC Section 795 or similar statutes, the Contractor is required to notify the Contracting Officer in writing within 72 hours and shall include detail information regarding the issue, point of contact at the installation, and estimated delay. (See Section B-7.12, Permits and Responsibilities.)

(c) Aircraft Configuration. The design of the aircraft shall be such that when the sensor system is mounted with all its parts within the outer structure, an unobstructed field of view is obtained. The field of view shall be shielded from the exhaust gases, oil, effluence, and air turbulence. The sensor system port glass shall be free of scratches and of such quality that it will not degrade the resolution or the accuracy of the sensor system.

(d) Airborne Global Positioning System. The aircraft shall have an Airborne Global Positioning System (ABGPS), Inertial Measurement Unit (IMU) system capable of generating accurate control points used in the creation of the photo-center data file (see Section C-7.2, Project Geodatabase).

C-5 IMAGERY ACQUISITION REQUIREMENTS

5.1 Photographic Conditions

Imagery shall be acquired leaf-on when skies are clear, free from smoke, clouds, cloud shadows, excessive haze, and well-defined images can be resolved. The ground shall be free from snow below timberline, standing water (other than natural or man-made ponds and lakes), flood waters from streams which have overflowed their banks, and wet ground which obscures vegetation or other features. If any conditions besides clouds and cloud shadows noted above are present at time of acquisition, the Contracting Officer should be contacted to determine whether conditions would be acceptable for acquisition due to potential mission time constraints.

## 5.2 Flight Planning

The Contractor is responsible for flight planning the project area to ensure acquisition of precision, high quality stereo and orthorectified imagery meeting the requirements of this section. The Contractor shall submit a flight plan for review prior to receiving the Notice to Proceed to commence acquisition of the project area. The flight plan shall consist of shapefiles compatible with Esri® ArcGIS 10.1 and newer version software, including: a DEM-applied coverage polygon shapefile, a flight line shapefile, and an exposure station point shapefile. Table attributes should include pre-determined flying altitudes (above sea level) and exposure station locations. Exposure station location shall include at a minimum flight line and exposure number in consecutive order.

## 5.3 Flight Requirements

The Contractor shall obtain precise vertical digital imagery in accordance with the following technical requirements:

(a) Spatial Resolution: All imagery shall be acquired at 30 cm ground sample distance (GSD) or higher resolution.

(b) Radiometric Resolution: All imagery shall be collected at a minimum of 12-bits per band.

(c) Minimum Sun Angle: All imagery shall be collected during the portion of the day when the minimum sun angle exceeds 45 degrees. Where practical, a higher sun angle should be utilized over steep canyon areas to minimize shadow and enable viewing of ground features.

(d) Overlaps: Endlap: Optimum 62%; Minimum 57%; Recommended Maximum 67%
Sidelap: Optimum 30%; Minimum 20%; Recommended Maximum 45%

The minimum overlaps above may not be adequate for stereo viewing in areas of high relief. The contractor is responsible for determining overlaps necessary to ensure stereo viewing and/or ortho mosaic compilation with minimal tree lean. The recommended maximum may be exceeded in order to provide this coverage.

(e) Coverage: Imagery shall be collected to provide complete stereo coverage of the project area and boundaries in the government-provided shapefile defined in Section B-6.1, Project Boundary Shapefile.

(f) Tilt. It is desired that exposures be made when the optical axis of the digital sensor is in a vertical position. The Contractor shall not acquire imagery when the tilt (departure from the vertical) of any exposure exceeding four degrees (4º) or relative tilt between any two successive exposures exceeding six degrees (6º). Tilt shall not average more than 2 degrees (2º) in any 16 km (10 mile) section of a flight line and shall not average more than 1 degree (1º) for the entire project.

(g) Crab. Any series of two or more images shall not be crabbed in excess of five degrees (5º) as measured between images in a line and between adjoining lines.

## C-6 DIGITAL IMAGERY PROCESSING

Digital images shall be processed to meet the requirements of this section, Attachment B, USDA Digital Imagery Quality Specifications, and Attachment C, USDA Digital File Format Specifications. GeoTIFF files must be processed to meet requirements of Adobe TIFF and GeoTIFF Specifications. All image files and supporting files shall use the naming convention specified in Exhibit 2, File Naming Convention and shall be stored on a hard drive (See Section C-9) according to the Hard Drive Directory Structure Template, Exhibit 10.

(a) Image Description TIFF Tag: The ImageDescription Tag shall contain the following project item name: "USDA-FSA-APFO-U.S. Forest Service Resource Program."

(b) Metadata: The Contractor shall create a metadata file for each digital image and stereo block file described in this section. Metadata files shall be created in accordance with the template provided by the Government (see Section B-6.2) and Federal Geographic Data Committee (FGDC), FGDC-STD-001-1998 specification. Metadata files shall be compatible with ArcGIS 10.1 and must parse cleanly through the USGS metadata parser "mp" version 2.9.23 with Remote Sensing Extensions without any errors.

### 6.1 Color Corrected Stereo Image Files

The Contractor shall produce 4-band, 8-bit per band, color corrected, georeferenced, uncompressed, digital image files at the resolution stated in Section C-5.3 to provide stereo coverage of the project area and boundaries defined in the Project Boundary Shapefile, (see Section B-6.1). The image shall be submitted in the native camera footprint. Non-frame based sensors shall submit imagery in a tile format comparable to frame-based sensors. The file shall be projected in the 1983 North American Datum (NAD83), using the native Universal Transverse Mercator (UTM) zone specified in Section B-2 in meters. If any digital image files are rejected by the contractor's quality control process and/or reflights are acquired, only one acceptable image file shall be submitted.

(a) Image Quality: The Contractor shall make necessary radiometric adjustments, including stretching, dodging, color correction, etc., to the acquired imagery in order to match ground conditions at the time of exposure and to ensure the best possible color balance for both natural color and color infrared. Images shall ***not*** contain 0 cell values.

(b) Pre-Production Sample: Prior to production, the Contractor shall submit a radiometrically corrected GeoTIFF image for evaluation of contrast and color balance for each of the varying landscapes, including:

1. Coordinate 591200 4506500 – alpine, coniferous forest, meadow, riparian
2. Coordinate 536000 4422700 – coniferous & deciduous forest, woodland, shrubland

One sample image of each landscape described above meeting all requirements of this section and C-6 must be submitted as a GeoTIFF for evaluation of naming convention, tags, metadata, etc. The Government will evaluate and provide a selection with comments no later than five (5) business days from receipt. Additional samples may be submitted for review if approved by the Contracting Officer.

(c) File Format. The georeferenced tagged image file (GeoTIFF) shall have the following band order: Red, Green, Blue, and Infrared. GeoTIFF files shall be properly georeferenced so that the image is oriented north up when viewed in GIS software including Esri® ArcMap and ERDAS Imagine.

(d) Raster Support Files. The Contractor shall provide an AUX (Esri® and ERDAS compatible Auxilary statistic/projection file) and a RRD (Esri® and ERDAS compatible Reduced Resolution Dataset pyramid file) for each image file. Each AUX file shall have statistics calculated with the Skip Factor in the X and Y as 1, and Bin Type as Direct. In addition, the AUX file shall contain the proper projection information for the tile and shall match the information in the GeoTIFF header. Each RRD file shall be created using a 3X3 kernel, Binomial Interpolation.

(e) Georeferenced Accuracy. The principal point shall have an accuracy not exceeding a 6 meter offset from true ground.

6.2 Uncorrected Stereo Image Files *(If Option Line Item 3 is awarded)*

The Contractor shall produce 4-band, 16-bit per band, radiometrically uncorrected, georeferenced, uncompressed digital image files at the resolution stated in Section C-5.3, to provide stereo coverage of the project area and boundaries defined in the Project Boundary Shapefile, (see Section B-6.1). Non-frame based sensors shall submit imagery in a tile format comparable to frame-based sensors. The file shall be projected in the 1983 North American Datum (NAD83), using the native Universal Transverse Mercator (UTM) zone specified in Section B-2 in meters. If any digital image files are rejected by the contractor's quality control process and/or reflights are acquired, only one acceptable image file shall be submitted.

(a) Image Quality. The Contractor shall ***not*** make any radiometric enhancements, such as stretching, dodging, or other Look Up Table (LUT) adjustments, to the acquired imagery. The imagery shall not contain any borders, artifacts, or other non-image items.

(b) File Format. The imagery shall be in accordance with the Adobe TIFF and GeoTIFF Specifications and shall have the following band order: Red, Green, Blue, and Infrared. GeoTIFF files shall be properly georeferenced so that the image is oriented north up when viewed in GIS software including ESRI ArcMap and ERDAS Imagine).

(c) Raster Support Files. The Contractor shall provide an AUX (ESRI and ERDAS compatible Auxilary statistic/projection file) and a RRD (ESRI and ERDAS compatible Reduced Resolution Dataset pyramid file) for each image file. Each AUX file shall have statistics calculated with the Skip Factor in the X and Y as 1, and Bin Type as Direct. In addition, the AUX file shall contain the proper projection information for the tile and shall match the information in the GeoTIFF header. Each RRD file shall be created using a 3X3 kernel, Binomial Interpolation.

(d) Pre-production Sample. The Contractor shall submit a single 4-band, 16-bit per band image prior to production for Government review. The sample shall be a TIFF meeting the

requirements of the contract, including TIFF and GeoTIFF tags as specified in Attachment C, and submitted on a standard CD or DVD. The Government will evaluate and provide an approval or disapproval letter with comments no later than five (5) business days, with a goal of three (3) business days. Additional project item area samples may be submitted for review if approved by the Contracting Officer.

(e) Georeferenced Accuracy. The principal point shall have an accuracy not exceeding a 6 meter offset from true ground.

6.3 Digital Orthorectified Quarter-Quarter Quadrangle (DOQQQ) Tiles

The Contractor shall provide ortho-rectification services to produce 4-band, 8-bits per band, mosaicked digital orthorectified quarter-quarter quadrangles (DOQQQs) for the project area defined in the Project Boundary Shapefile referenced in Section B-6.1, plus a 100 meter buffer beyond the boundary. The DOQQQ shall cover the entire image area of one quarter of a quarter of a USGS standard quadrant, plus a 100 meter buffer on all four sides. The 100 meter buffer is not included in the DOQQQ shapefile provided. The DOQQQs shall be projected in NAD83 UTM Zone specified in Section B-2 in meters.

(a) Image Quality: The Contractor shall radiometrically balance the images used to create the DOQQQs to eliminate any checkerboard pattern appearance across the project, or for as large of a block practical. Exceptions to this requirement may be made in cases where block or project-wide radiometric balancing would cause significant discoloration across the project, such as reflights. Significant radiometric differences among image frames inhibits interpretation of ground features. The DOQQQs shall not contain any borders, artifacts, or other non-image items. The image portion of the DOQQQ file shall ***not*** contain 0 cell values. The non-image or no-data portion of the DOQQQ file shall be set to 0,0,0,0.

(b) Image Source: The Contractor may use imagery from multiple exposures, i.e., using the "sweet spot" from a preceding or succeeding image, when creating the tile images. Using "chips" (imagery pieces from other frames) to correct defects is also permitted. All exposures shall be from the same type of sensor and must be from the same acquisition season. When multiple exposures are used in creating a tile, the acquisition date with the largest area shall be used when reporting dates in a single date field, such as metadata or attribute data. An average or mean date shall not be used.

(c) Seamlines: Image seams should be blended to a smooth seam. Visible seamlines within or between tiles which exhibit a noticeable edge or displacement effect are not acceptable. Sharp contrast should not be visible at seams, as it affects image interpretation. Seamlines should be centered on linear features such as roads, rivers, streams, and trails when available. When linear features are not available, seamlines shall be placed at landcover type transition areas such as between a meadow and forested area or based on terrain breaks derived from topographic data such as ridgelines and valley bottoms. Placement of seamlines in tree and shrub vegetation should be minimized.

(d) Partial DOQQQ: When a DOQQQ partially covers the boundary, the Contractor may elect to submit a partial DOQQQ so that it completely covers the boundary, plus a 100 meter buffer on the outside of the boundary.

(e) Pre-Production Sample: Prior to production of the DOQQQs', the Contractor shall submit for Government review a sample DOQQQ for each diversified project landscape (see Section 6-1(b)). The samples shall be a GeoTIFF and meet all image requirements in this section, including tags specified in Attachment C, submitted on a standard DVD. The Government will evaluate and provide an approval or disapproval with comments no later than five (5) business days, with a goal of three (3) business days. Additional project item area samples may be submitted for review if approved by the Contracting Officer..

(f) Spatial Resolution: Specified in Section C-5.3(a).

(g) Horizontal Accuracy: All well-defined points tested on orthorectified tiles shall fall within 6.0 meters of true ground at a 95% confidence level (see FGDC-STD-007.3-1998, page 3-10).

(h) Digital Elevation Model (DEM). The Contractor may use any digital elevation model for terrain-correcting the imagery required to meet horizontal accuracy specifications in paragraph (g) and quality requirements of this section and Attachment B. The Contractor shall document the elevation dataset used during the orthoimagery production process including, but not limited to corrections made to an existing dataset, in the process description metadata field.

(i) File Format. The DOQQQ tiles shall be a georeferenced tagged image file following the naming convention in Exhibit 2 and Exhibit 5, Quarter-Quarter Quad Numbering Logic.

(j) Raster Support File: The Contractor shall provide an AUX (Esri® and ERDAS compatible Auxilary statistic/projection file) and a RRD (Esri® and ERDAS compatible Reduced Resolution Dataset pyramid file) for each image file. Each AUX file shall have statistics calculated with the Skip Factor in the X and Y as 1, and Bin Type as Direct. In addition, the AUX file shall contain the proper projection information for the tile and shall match the information in the GeoTIFF header. Each RRD shall be created using a 2X2 kernel, Binomial Interpolation. The files shall use the same naming convention as the image tiles but with an ".rrd" and ".aux" extension respectively.

(k) Metadata. Metadata shall include a separate lineage section for each georeferenced, uncompressed digital image file used in the creation of the DOQQQ. The lineage title will contain the actual file name of the image tile used.

## 6.4 Compressed Project Mosaic (CPM)

The Contractor shall produce a 4-band, 8-bit per band, compressed project mosaic (CPM) file for each contiguous area defined in Section B-6.1, Project Boundary Shapefiles. The CPM shall be projected in the UTM Zone specified in Section B-2, NAD83 in meters. Requirements for this product shall be the same as those listed in Section C-6.3, Digital Orthorectified Quarter-Quarter Quadrangle Tiles (DOQQQ), with the exception of the following elements:

(a) Image Quality. The Contractor shall balance the DOQQQs to eliminate any checkerboard pattern appearance across the project, or for as large of a block practical.

(b) Horizontal Accuracy. The accuracy requirements from Section C-6.2(g), Horizontal Accuracy Requirements, shall be preserved when creating the CPM using the imagery associated with the quarter-quarter quadrangle tiles.

(c) Compression Ratio. 20:1

(d) File Format. The CPM tiles shall be a 4-band, 8-bit per band Enhanced Compression Wavelet (ECW) format created in accordance with Attachment C.

6.5 Stereo Block Files

The Contractor shall provide stereo block files so that digital image files created in Section C-6.1, Color Corrected Stereo Images and C-6.2, Uncorrected Stereo Images *(if awarded)*, can be brought in and viewed in stereo-pairs with very minimal adjustment to the x or y parallax. Data fields in the stereo block file shall be populated with sensor specific data. Each block file should include the average flying height for the area covered by that block file, rather than for the entire project area. The file shall be projected in the 1983 North American Datum (NAD83), 1988 North American Vertical Datum (NAVD) GEOID12A (or most recent), using the native Universal Transverse Mercator (UTM) zone specified in Section B-2 in meters. In the case of reflights or the completion flight line(s) during an additional acquisition season, the stereo block file must be updated to include new and/or reflown imagery for the affected flight lines.

(a) Image Reference Structure: One stereo block file shall be produced for each area contained in the Stereo Block Area Boundary Shapefile provided under B-6.3 and each bit depth of stereo imagery provided.

(a) Pre-Production Sample: The Contractor shall provide a sample stereo block file pointing to and containing four (4) stereo images. The block file shall point to only the images provided with the sample.

(b) File Format. The stereo block files shall be Leica Photogrammetry Suite (LPS) compatible and shall be readable in Stereo Analyst extensions for ERDAS IMAGINE 2011 and Esri® ArcGIS 10.1 and newer. The Government prefers the use of .blk files. See Exhibit 2 for naming convention. The files shall be stored on a hard drive (See Section C-9) according to the Hard Drive Directory Structure Template, Exhibit 10.

6.7 Regional Settings

All digital files, including imagery and metadata, shall be created using standard ANSI English-US setting. For example, periods (ACII 46) shall be used to separate the whole number from the fractional portion when recording decimal numbers and data representing a long date shall be recorded as “Thursday, August 18, 2013 5:09:38 PM.”

## C-7 PROJECT MANAGEMENT

The Contractor shall establish and maintain a project management system with a designated project manager for this effort. Project management consists of those activities required to plan, manage, administer, and control efforts to accomplish the objective of the contract. The project manager identified in the proposal will serve as the primary point of contact for the Contractor's activity with the Government. Any change in project manager during performance of this contract must be approved by the Contracting Officer based on a written request including a summary of the candidate's experience.

### 7.1 Progress Reports

A Progress Report is required for each day progress is made in acquiring project imagery. Each progress report shall be sent by email transmission not later than the day following performance and only for days when performance was accomplished. In the event that day is a holiday or non-business day, the report shall be sent on the next business day. Separate reports are required from each photographic crew assigned to a project item. Such "next day" reporting shall start when the Contractor receives the Notice to Proceed, and continue until the area is completed or the photographic season and any extensions end. If reflights are determined necessary or ordered by the Contracting Officer, progress reports covering such performance are required.

An e-mail address will be provided at contract award. See Exhibit 4, Progress Report, for syntax and example.

### 7.2 Project Geodatabase

The Contractor shall produce a file Geodatabase, compatible with Esri® ® ArcGIS 10.1 and newer versions, according to the template provided by the Government (see Section B-6.5), projected in the same coordinate system as specified in Section B-2. The geodatabase shall contain a feature data set that contains a polygon feature class for each georeferenced exposure footprint, a line feature class for each flight line, and a point feature class for each photo center location delivered under this contract. The project geodatabase shall also contain a polygon feature class for an orthorectified image index and a line feature class for the seamlines. The photo-center location, UTM coordinates, shall be corrected to reflect the physical ground location and shall be accurate within 6 meters (19.7 feet) of true ground. The coordinates shall be expressed in meters and formatted to the same datum and projection required for the GeoTIFF image files. The project geodatabase shall be resubmitted with corrections reflecting any image corrections, reflights, or completion of additional flights after original submission. The filename for the Geodatabase and all feature data sets shall use the naming convention specified in Exhibit 2, File Naming Convention. The files shall be stored on a hard drive (See Section C-9) according to the Hard Drive Directory Structure Template, Exhibit 10.

(a) Photo Center Point Feature Class. The project acquisition feature dataset shall include the following attributes for the photo center point feature class:

| ATTRIBUTE DESCRIPTION | COLUMN NAME | DATA TYPE | EXAMPLE |
|---|---|---|---|
| Project Identification Code | PROJID | Char(6) | 614010 |
| Flight Line number | FLTLN | Char(4)± | 0027 |
| Exposure number | EXPNUM | Char(4)± | 0001 |
| Date of exposure (YYYY-MM-DD) | IDATE | Char(10) | 2015-08-27 |
| Image file name | NAME | Char(50) | 614010_0027_ 0001_20150827.tif |
| Point Acquisition date/time* | DATE | Char(16) | 08/27/2015 13:52 |
| Color Type** | BCON | Char(3) | M4B |
| Camera type*** | CAM_TYPE | Char(20) | Digital |
| Camera manufacturer | CAM_MAN | Char(50) | Zeiss |
| Camera model | CAM_MOD | Char(25) | DMC |
| Sensor serial number | SENSNUM | Char(100) | 30029 |
| UTM zone | UTM | Char(3) | 12 |
| Corrected center point northing | NORTH | Double(19)‡ | 4342654.243 |
| Corrected center point easting | EAST | Double(19)‡ | 448901.634 |
| Flight altitude in meters at camera (MMMMM.MM; MSL) | FLTALT | Double(19)‡ | 7048.63 |
| Number of GPS satellites acquired | GPSNUM | Short Integer | 5 |
| Position Dilution of Precision (PDOP) | PDOP | Double(19)‡ | 1.5 |
| IMU omega value (UTM) (Radians) | OMEGA | Double(19)‡ | .0001358 |
| IMU phi value (UTM) (Radians) | PHI | Double(19)‡ | .01073000 |
| IMU kappa value (UTM) (Radians) | KAPPA | Double(19)‡ | -.873265 |

± Padded with leading zeros
‡ Double data type shall be length of 19 (18 precision, 11 scale)
* Local 24-hour clock. The start/end time will be for the collection of the individual polygon (will be the same for frame-based systems)
** Possible values are: NC (natural color), CIR (color infrared), and M4B (4-band)
*** Possible values are: Digital or Film

(b) Flight Line Feature Class. The project acquisition feature dataset shall include the following attributes for the flight line feature class:

| ATTRIBUTE DESCRIPTION | COLUMN NAME | DATA TYPE | EXAMPLE |
|---|---|---|---|
| Project Identification Code | PROJID | Char(6) | 614010 |
| Flight Line number | FLTLN | Char(4)[±] | 0027 |
| Date of exposure (YYYY-MM-DD) | IDATE | Char(10) | 2015-08-27 |
| Flight Line start date/time[*] | SDATE | Char(16) | 08/27/2015 13:52 |
| Flight Line end date/time[*] | EDATE | Char(16) | 08/27/2015 13:53 |
| Color Type[**] | BCON | Char(3) | M4B |
| Camera type[***] | CAM_TYPE | Char(20) | Digital |
| Camera manufacturer | CAM_MAN | Char(50) | Intergraph |
| Camera model | CAM_MOD | Char(25) | DMC |
| Sensor serial number | SENSNUM | Char(100) | 30029 |
| Flight Line Direction | DIR | Char(20) | North |
| Flight altitude in meters at camera (MMMMM.MM; MSL) | FLTALT | Double(19)[‡] | 7048.63 |

[±] Padded with leading zeros
[‡] Double data type shall be length of 19 (18 precision, 11 scale)
* Local 24-hour clock. The start/end time will be for the collection of the individual polygon (will be the same for frame-based systems)
** Possible values are: NC (natural color), CIR (color infrared), and M4B (4-band)
*** Possible values are: Digital or Film

(c) Image Footprint Polygon Feature Class. The project acquisition feature dataset shall include the following attributes for the image footprint polygon feature class. The image footprint polygon shall represent the actual ground displacement of the image acquired:

| ATTRIBUTE DESCRIPTION | COLUMN NAME | DATA TYPE | EXAMPLE |
|---|---|---|---|
| Project Identification Code | PROJID | Char(6) | 614010 |
| Flight Line number | FLTLN | Char(4)[±] | 0027 |
| Exposure number | EXPNUM | Char(4)[±] | 0001 |
| Date of exposure (YYYY-MM-DD) | IDATE | Char(10) | 2015-08-27 |
| Image file name | NAME | Char(50) | 614010_0027_0001_20150827.tif |
| Polygon start date/time[*] | SDATE | Char(16) | 08/27/2015 13:52 |
| Polygon end date/time[*] | EDATE | Char(16) | 08/27/2015 13:53 |
| Color Type[**] | BCON | Char(3) | M4B |
| Camera type[***] | CAM_TYPE | Char(20) | Digital |

| | | | |
|---|---|---|---|
| Camera manufacturer | CAM_MAN | Char(50) | Intergraph |
| Camera model | CAM_MOD | Char(25) | DMC |
| Sensor serial number | SENSNUM | Char(100) | 30029 |
| Corrected center point latitude (DD.DDDDDD)**** | LAT | Double(19)‡ | 57.71936 |
| Corrected center point longitude (-DDD.DDDDDD)**** | LON | Double(19)‡ | -135.41498 |

± Padded with leading zeros
‡ Double data type shall be length of 19 (18 precision, 11 scale)
* Local 24-hour clock. The start/end time will be for the collection of the individual polygon (will be the same for frame-based systems)
** Possible values are: NC (natural color), CIR (color infrared), and M4B (4-band)
*** Possible values are: Digital or Film
****Decimal degrees

(d) Seamline Feature Class. The feature class for orthorectified tiles in Paragraph 6.2 (if awarded) shall include the following attributes:

| ATTRIBUTE DESCRIPTION | COLUMN NAME | DATA TYPE | EXAMPLE |
|---|---|---|---|
| Project Identification Code | PROJID | Char(6) | 614010 |
| Area Name | AREA_NM | Char(100) | Ashley National Forest |
| Method of Creation*** | METHD | Char(10) | Manual |
| Software Used to Generate Seamlines | SOFT | Char(50) | Socet_Set |

*** Possible values are: Manual or Automatic

(e) Orthorectified Image Index Feature Class. A single feature class for all orthorectified tiles in Paragraph 6.2 (if awarded) shall include the following attributes.

| ATTRIBUTE DESCRIPTION | COLUMN NAME | DATA TYPE | EXAMPLE |
|---|---|---|---|
| Project Identification Code | PROJID | Char(6) | 614010 |
| Area Name | AREA_NM | Char(100) | Ashley National Forest |
| Majority Date of Imagery (YYYY-MM-DD) | IDATE | Char(10) | 2015-08-27 |
| Image File Name | NAME | Char(50) | m_3311162_ne_2_13_30_20150721.tif |
| Pixel Resolution in centimeters | RES | Double(5) | 30 |
| Color Type** | BCON | Char(3) | M4B |
| Image Type*** | IMG_TYPE | Char(20) | DOQQQ |

** Possible values are: NC (natural color), CIR (color infrared), and M4B (4-band)
*** Possible values are: DOQ, DOQQ, DOQQQ

(f) Metadata. The Contractor shall create metadata files in accordance with the template provided by the Government (see Section B-6.2) and Federal Geographic Data Committee

(FGDC), FGDC-STD-001-1998 specification. Metadata files shall be compatible with ArcGIS 10.1 and must parse cleanly through the USGS metadata parser "mp" version 2.9.23 with Remote Sensing Extensions without any errors.

## C-8 QUALITY CONTROL

Quality control shall be exercised by the Contractor continuously throughout the performance of the contract. Procedures shall be established to assure that all contract materials are delivered in accordance with the delivery schedule and at the required level of accuracy and quality. The Contractor shall inspect and constantly monitor the image quality and coverage, and shall undertake immediate reflights of any imagery where the quality fails to meet minimum requirements of the contract specifications. USDA inspection and acceptance procedures are described in Section B-7.14, Inspection and Acceptance and Section B-8, FAR 52.213-4(d).

### 8.1 RMSE Accuracy and Quality Control Report

The Contractor shall provide RMSE accuracy reports and quality control reports generated during the AT and/or orthorectification processes for all image files. The reports shall be delivered in a non-proprietary format mutually agreeable to the Government and Contractor. The Contractor may use any consistent and logical naming convention.

## C-9 MEDIA REQUIREMENTS

Original submission of materials should be delivered on separate media from any remakes, and include a separate packing slip.

Internal SATA Hard Drives: All hard disk drives (HDDs) used to deliver imagery shall be internal Serial Advanced Technology Attachment (SATA) II & III, 3½ inch, 6.0 Gbit/s transfer-rate hard drives, with a minimum rotation speed of 7,200 rpm, not more than 2 Terabyte capacity. **Maximum disk space that can be used cannot exceed ninety percent (90%) of the individual hard drive capacity.** The SATA drives shall be formatted using Microsoft's NTFS file system. Each drive will be enclosed in a static bag and shall have one label attached directly to the outer surface of the static bag and one placed directly on the internal hard drive identifying the project contained on the drive in accordance with Exhibit 5, Figure 2, Hard Drive Labeling Requirements. The drives shall become property of the Government and will not be returned to the Contractor.

LIST OF DOCUMENTS, EXHIBITS, AND OTHER ATTACHMENTS


| Exhibit | Description | Page |
|---|---|---|
| Exhibit 1 | Project Map (1 page)<br>Figure 1, Project Boundaries and DOQQQ | 38 |
| Exhibit 2 | File Naming Convention (3 pages) | 39-41 |
| Exhibit 3 | Quarter-Quarter Quad Numbering Logic (1 page) | 42 |
| Exhibit 4 | Progress Report (1 page) | 43 |
| Exhibit 5 | Labeling Requirements (2 pages) | 44-45 |
| Exhibit 6 | Wage Determination (4 Pages) | 46-49 |
| Exhibit 7 | Glossary and Definitions (2 pages) | 50-51 |
| Exhibit 8 | Flight Line Naming (2 pages) | 52-53 |
| Exhibit 9 | ListGeo Samples (3 pages) | 54-56 |
| Exhibit 10 | Hard Drive Directory Structure Template (1 page) | 57 |

Attachment A: Aerial Photography Field Office (APFO) Specification for Digital Camera Based Acquisition (4 pages)

Attachment B: Aerial Photography Field Office (APFO) USDA Digital Imagery Quality Specification (4 pages)

Attachment C: USDA Digital File Format Specification, Version 1.0, dated January 24, 2013, (39 pages)

EXHIBIT 1

**Figure 1(a)**

PROJECT MAP

U.S. DEPARTMENT OF AGRICULTURE
AERIAL IMAGERY
SOLICITATION NO: AG-8447-S-15-0004 (USDA-FS-6-15)
ITEM 1: Ashley National Forest,
UTAH & WYOMING
GROUND SAMPLE DIST: 30 cm (11.8 inches)
IMAGERY: 4 Band Direct Digital
PROJECT IDENTIFICATION CODE: 614010

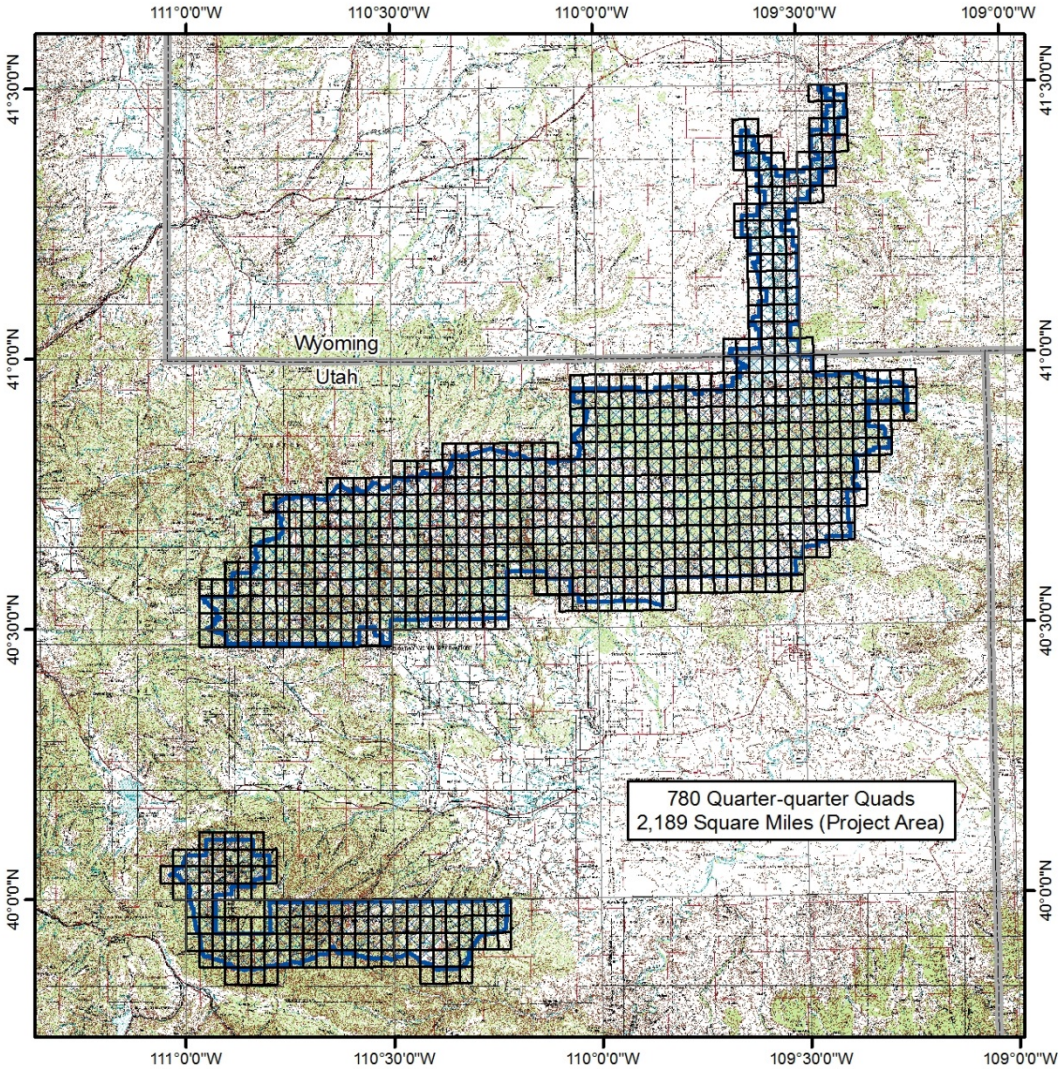


EXHIBIT 2
FILE NAMING CONVENTION

**Georeferenced, Digital Image Files:**

File Name: <project code>_<flight line >_<exposure>_<yyyymmdd>_<bitspectral>.tif

<project code> - project code for each project item specified in Section B
<flight line> - flight line number (4 characters padded with leading zeros)
<exposure> - consecutively numbered value (4 characters padded with leading zeros)
<yyyymmdd> - image exposure date
<bitspectral> - image bit depth (16b, 8b, 16bp for panchromatic band)

Example: 614010_0027_0001_20150821_8b.tif
614010_0027_0001_20150821_16b.tif

**Quadrangle, Quarter Quadrangle and Quarter-Quarter Quadrangle Image Tiles:**

QQQ File Name: m_<lat><lon><quad>_<loc>_<n>_<xx>_<r>_<yyyymmdd>.tif

QQ File Name: m_<lat><lon><quad>_<loc>_<xx>_<r>_<yyyymmdd>.tif

Q File Name: m_<lat><lon><quad>_<xx>_<r>_<yyyymmdd>

m = multispectral
<lat> - latitude, identified by 2 digit numerical value of a 1º block
<lon> - longitude, identified by 3 digit numerical value of a 1º block (including the leading "0" if needed)
<quad> - quadrangle number, identified by grid number
<loc> - quadrangle location, identified by grid letters (nw, ne, sw, se)
<n> - quarter quadrangle location, identified by number (1, 2, 3, 4)
<xx> – two digit UTM zone
<r> - resolution in centimeters
<yyyymmdd> - date of acquisition (majority date)

QQQ Example: m_3311162_ne_1_12_30_20150721.tif
QQ Example: m_3311162_ne_12_30_20150721.tif
Q Example: m_3311162_12_30_20150721.ecw

**Compressed Project Mosaic File:**

File Name: <project code>_<projid>-<item>_<m>.ecw

<project code> - project code
<projid> - project identifier
<item> - item number
<m> - band designator ("m" = multi spectral, "n" = natural color, "c" = infrared)

Example: 614010_6-15-1_m.ecw

EXHIBIT 2 (Cont'd)

**Project Geodatahase:**

File Name: Project_Geodatabase_<project code>_<projid>.gdb

<project code> - project code for each project item specified in Section B
<projid> - project identifier (from B-2); replace "-" with "dash"

Example: Project_Geodatabase_614010_ 6dash15.gdb

**Project Acquisition Feature Dataset:**

File Name: <area name>_<project code>_<projid>_<item>

<area name> - name of forest or grassland
<project code> - project code for each project item specified in Section B
<projid> - project identifier (from B-2); replace "-" with "dash"
<item> - project item number

Example: ashley_614010_6dash15_1

**Image Footprint Feature Class:**

File Name: <footprint type>_<project code>_<spatial resolution>_<spectral resolution>_<radiometric resolution>_<projid>_<item>

<footprint type> - sensor footprint based upon level of processing. Must be uncorrected, georeferenced, or ortho
<project code> - project code for each project item specified in Section B
<spatial resolution> - ground sample distance in units as dictated by the contract
<spectral resolution> - number of bands
<radiometric resolution> - bit depth (either 8 or 16)
<projid> - project identifier (from B-2); replace "-" with "dash"
<item> - project item number

Example: georeferenced_614010_30_4_8_6dash15_1

**Flight Line Feature Class:**

File Name: flight_line_<project code>_<projid>_<item>

<project code> - project code for each project item specified in Section B
<projid> - project identifier (from B-2); replace "-" with "dash"
<item> - project item number

Example: flight_line_614010_6dash15_1

EXHIBIT 2 (Cont'd)

**Photo Center Feature Class:**

File Name: photo_center_<project code>_<projid>_<item>

<project code> - project code for each project item specified in Section B
<projid> - project identifier (from B-2); replace "-" with "dash"
<item> - project item number

Example: photo_center_614010 _6dash15_1

**Orthorectified Image Index Feature Class:**

File Name: ortho_index_<project code>_<spatial resolution>_<spectral resolution>_<projid>_<item>

<project code> - project code for each project item specified in Section B
<spatial resolution> - ground sample distance in units as dictated by the contract
<spectral resolution> - number of bands
<projid> - project identifier (from B-2); replace "-" with "dash"
<item> - project item number

Example: ortho_index_614010 _30_4_6dash15_1

**Seamline Feature Class:**

File Name: seamlines_<project code>_<projid>_<item>

<project code> - project code for each project item specified in Section B
<projid> - project identifier (from B-2); replace "-" with "dash"
<item> - project item number

Example: seamlines_614010_6dash15_1

**Stereo Block File:**

File Name: <project code>_<bit>_<spectral>_<block no>.blk

<project code> - project code for each project item specified in Section B
<bit> - image bit depth (16b or 8b)
<spectral> - spectral resolution; m = multispectral; p = panchromatic
<block no> - consecutively numbered value for each image bit depth
(2 characters padded with leading zero)

Example: 614010_16b_01.blk through 614010_16b_04.blk
614010_8b_01.blk through 614010_8b_04.blk

EXHIBIT 3

QUARTER-QUARTER QUAD NUMBERING LOGIC

112° 00' 00"
34° 00' 00" •

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 |
| 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 |
| 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 |
| 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 |

• 33° 00' 00"
111° 00' 00"

| | |
|---|---|
| NW | NE |
| SW | SE |

| | |
|---|---|
| 1 | 2 |
| 4 | 3 |

The ID for this QQQ would be:
3311162_ne_2

Each Block (ie: A3) is a full Quad within the 1 degree grid; it is further subdivided into 4 quarter-quads, i.e. 3311162_ne

Then the quarter quad is further subdivided into quarter-quarter quads:

Sample: 3311162_ne_2 Where:

Latitude: Identified by 2 digit numerical value of a 1 degree block.
Longitude: Identified by 3 digit numerical value of a 1 degree block, including a leading “0" as needed.
Quadrangle Number: Identified by grid number (01, 02, 03, ... 63, 64).
Quarter Quadrangle Location: Identified by grid letters (nw, ne, sw, se)
Quarter-Quarter Quadrangle Location: Identified by grid numbers (1, 2, 3, 4)

EXHIBIT 4
EXHIBIT 4 (CON'T)

PROGRESS REPORT CONVENTION

Text File Naming Convention:

PROJECT IDENTIFIER (N-YY-ITEM)_DATE FLOWN (YYYYMMDD)_STATUS

i.e: 6-15-1_20150731_A

Field Headers:
Text is case sensitive and must occur in the order below on a separate line from the body items.

Body Items:
All data elements are required for each line of data submitted. Data elements are to be separated by 5 ASCII decimal 32 (white space). Acquisition and rejected exposure should be submitted as separate reports.

| DESCRIPTION | FIELD HEADER | KEYWORD | FORMAT |
|---|---|---|---|
| Latitude | LAT | N/A | DD.DDDDD |
| Longitude | LON | N/A | -DDD.DDDDD |
| Status* | STATUS | N/A | Char(1)* |

* Status Field:
A - Indicates the Exposure Station has been collected
R – Indicates the contractor has rejected a previously acquired Exposure Station

**Sample Acquired Imagery Report**
File name: 6-15-1_20150731_A

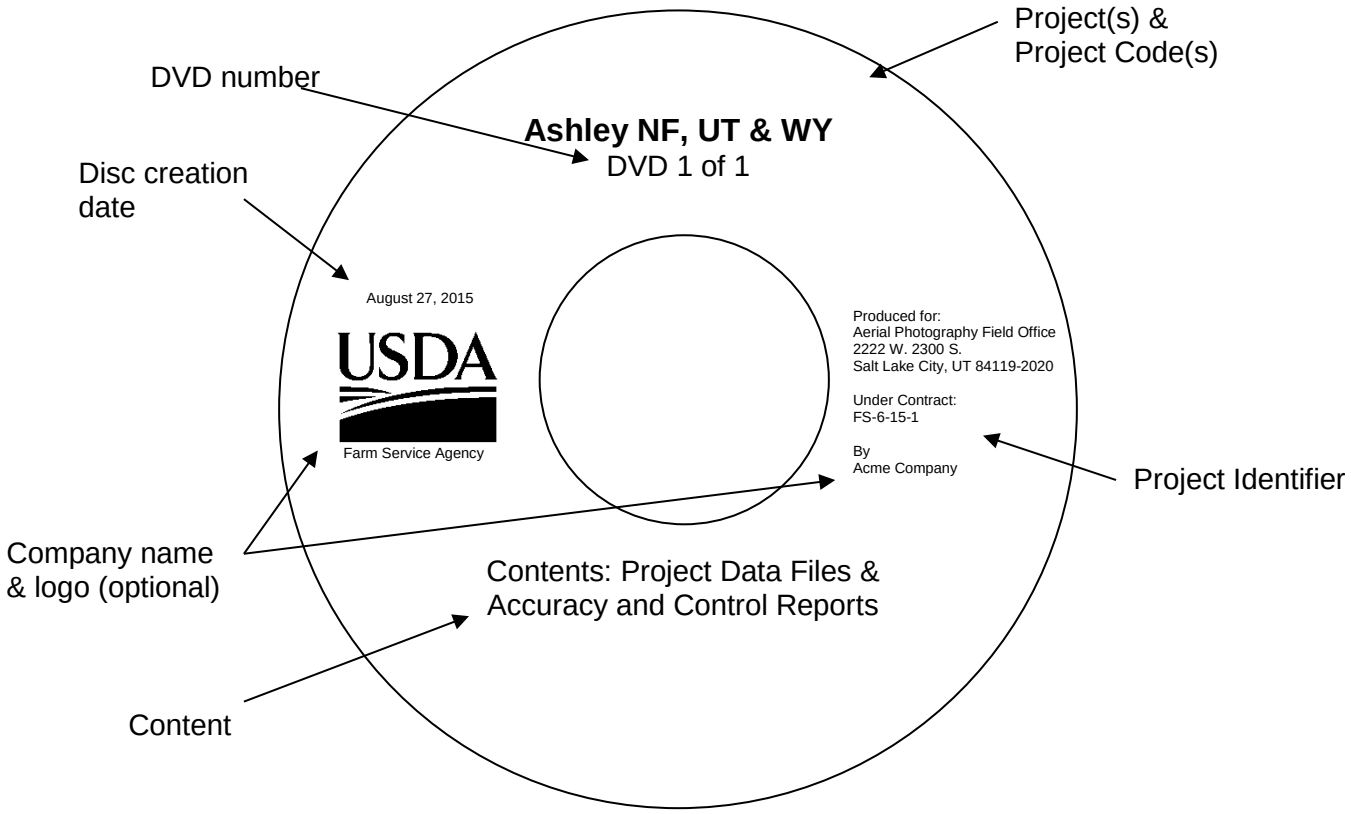
```
LAT,LON,STATUS
64.00002,-144.18751,A
64.04166,-144.18750,A
64.08332,-144.18752,A
64.12501,-144.18751,A
```

**Sample Rejected Imagery Report**
File name: 6-15-1_20150801_R

```
LAT,LON,STATUS
64.00002,-144.18751,R
64.04166,-144.18750,R
64.08332,-144.18752,R
64.12501,-144.18751,R
```

EXHIBIT 5
**Figure 1**

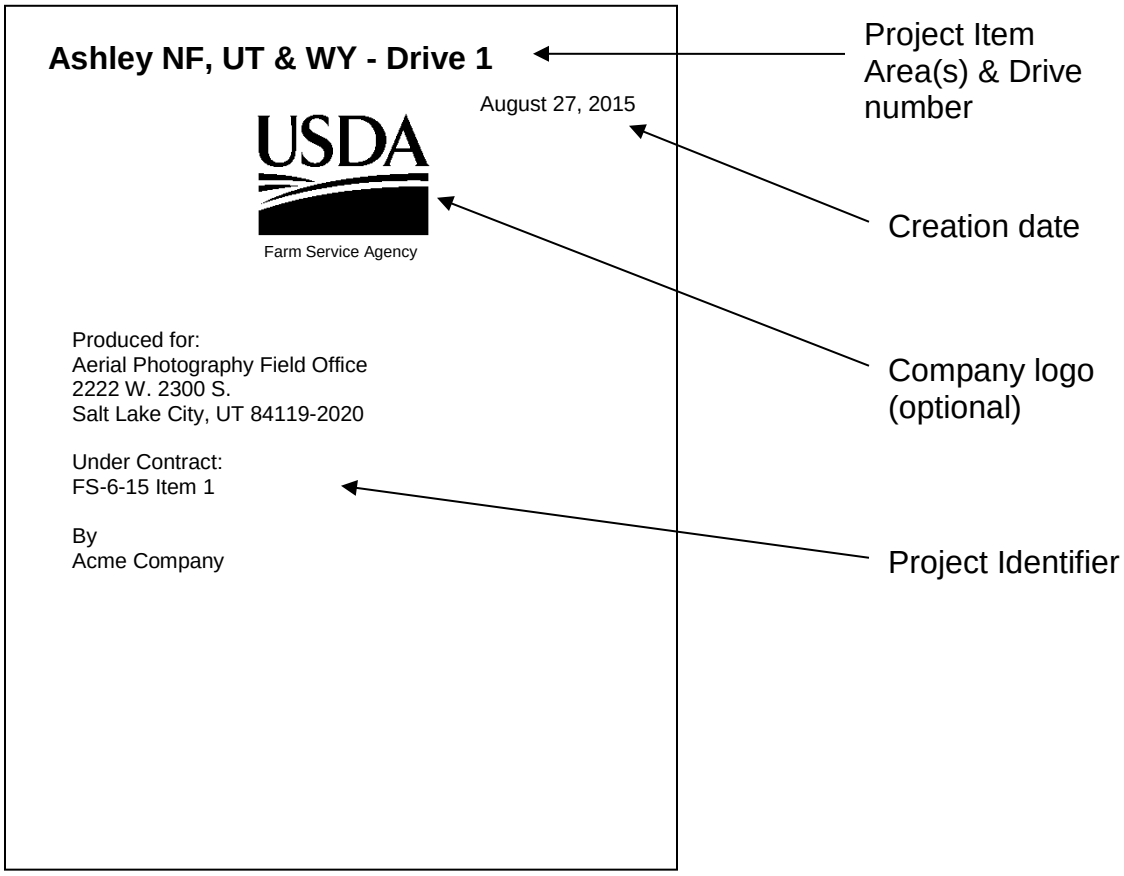
DVD Labeling Requirements




| ELEMENT | EXAMPLE |
|---|---|
| DVD Number | DVD 1 of 1 |
| Company name & logo | Acme Company |
| Content | Project Data Files & Accuracy and Control Reports |
| Project Identifier | FS-6-15-1 |
| Creation date | August 27, 2015 |
| Project | Ashley NF, UT & WY |
| Project Code | 614010 |

EXHIBIT 5
**Figure 2**

Hard Drive Labeling Requirements




| ELEMENT | EXAMPLE |
|---|---|
| Company name & logo | Acme Company |
| Project Identifier | FS-6-15-1 |
| Creation date | August 27, 2015 |
| Project item area & drive number | Ashley NF, UT & WY – Hard Drive 1 |

Approximate label dimensions: 3-1/2” (width) x 4-1/2” (height)

EXHIBIT 6

| | |
|---|---|
| REGISTER OF WAGE DETERMINATIONS UNDER THE SERVICE CONTRACT ACT<br>By direction of the Secretary of Labor | U.S. DEPARTMENT OF LABOR<br>EMPLOYMENT STANDARDS ADMINISTRATION<br>WAGE AND HOUR DIVISION<br>WASHINGTON, D.C. 20210 |
| Diane C. Koplewski, Director<br>Division of Wage Determinations | Wage Determination No: 1995-0222<br>Revision No: 38<br>Date of Revision: 01/14/2015 |

---

Note: Executive Order (EO) 13658 establishes an hourly minimum wage of $10.10 for 2015 that applies to all contracts subject to the Service Contract Act for which the solicitation is issued on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least $10.10 (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract. The EO minimum wage rate will be adjusted annually.

Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.
Nationwide: Applicable in the continental U.S. Alaska, Puerto Rico, Hawaii and Virgin Islands.

---

**Fringe Benefits Required Follow the Occupational Listing**

Employed on U.S. Government contracts for aerial photographer, aerial seeding, aerial spraying, transportation of personnel and cargo, fire reconnaissance, administrative flying, fire detection, air taxi mail service, and other flying services.

| OCCUPATION CODE - TITLE | FOOTNOTE | RATE |
|---|---|---|
| 31010 - Airplane Pilot | | 28.36 |
| (not set) - First Officer (Co-Pilot) | | 25.82 |
| (not set) - Aerial Photographer | | 14.17 |

EXCEPT SCHEDULED AIRLINE TRANSPORTATION AND LARGE MULTI-ENGINE AIRCRAFT SUCH AS THE B-727, DC-8, AND THE DC-9.

---

ALL OCCUPATIONS LISTED ABOVE RECEIVE THE FOLLOWING BENEFITS:

HEALTH & WELFARE: $4.02 per hour or $160.80 per week or $696.79 per month

VACATION: 2 weeks paid vacation after 1 year of service with a contractor or successor, 3 weeks after 5 years, and 4 weeks after 15 years. Length of includes the whole span of continuous service with the present contractor or successor, wherever employed, and with the predecessor contractors in the performance of similar work at the same Federal facility. (Reg. 29 CFR 4.173)

HOLIDAYS: A minimum of ten paid holidays per year: New Year's Day, Martin Luther King Jr.'s Birthday, Washington's Birthday, Memorial Day, Independence

Day, Labor Day, Columbus Day, Veterans' Day, Thanksgiving Day, and Christmas Day. (A contractor may substitute for any of the named holidays another day off with pay in accordance with a plan communicated to the employees involved.) (See 29 CFR 4.174)

VACATION (Hawaii): 2 weeks paid vacation after 1 year of service with a contractor or successor; 3 weeks after 10 years, and 4 weeks after 15 years. Length of service includes the whole span of continuous service with the present contractor or successor, wherever employed, and with the predecessor contractors in the performance of similar work at the same Federal facility. (Reg. 29 CFR 4.173)

HEALTH & WELFARE (Hawaii): $1.66 per hour, or $66.40 per week, or $297.73 per month hour for all employees on whose behalf the contractor provides health care benefits pursuant to the Hawaii prepaid Health Care Act. For those employees who are not receiving health care benefits mandated by the Hawaii prepaid Health Care Act, the new health and welfare benefit rate will be $4.02 per hour.

HAZARDOUS PAY DIFFERENTIAL: An 8 percent differential is applicable to employees employed in a position that represents a high degree of hazard when working with or in close proximity to ordnance, explosives, and incendiary materials. This includes work such as screening, blending, dying, mixing, and pressing of sensitive ordnance, explosives, and pyrotechnic compositions such as lead azide, black powder and photoflash powder. All dry-house activities involving propellants or explosives. Demilitarization, modification, renovation, demolition, and maintenance operations on sensitive ordnance, explosives and incendiary materials. All operations involving re-grading and cleaning of artillery ranges.

A 4 percent differential is applicable to employees employed in a position that represents a low degree of hazard when working with, or in close proximity to ordnance, (or employees possibly adjacent to) explosives and incendiary materials which involves potential injury such as laceration of hands, face, or arms of the employee engaged in the operation, irritation of the skin, minor burns and the like; minimal damage to immediate or adjacent work area or equipment being used. All operations involving, unloading, storage, and hauling of ordnance, explosive, and incendiary ordnance material other than small arms ammunition. These differentials are only applicable to work that has been specifically designated by the agency for ordnance, explosives, and incendiary material differential pay.

** UNIFORM ALLOWANCE **

If employees are required to wear uniforms in the performance of this contract (either by the terms of the Government contract, by the employer, by the state or local law, etc.), the cost of furnishing such uniforms and maintaining (by laundering or dry cleaning) such uniforms is an expense that may not be borne by an employee where such cost reduces the hourly rate below that required by the wage determination. The Department of Labor will accept payment in accordance with the following standards as compliance:

The contractor or subcontractor is required to furnish all employees with an adequate number of uniforms without cost or to reimburse employees for the actual cost of the uniforms. In addition, where uniform cleaning and maintenance is made the responsibility of the employee, all contractors and subcontractors subject to this wage determination shall (in the absence of a

bona fide collective bargaining agreement providing for a different amount, or the furnishing of contrary affirmative proof as to the actual cost), reimburse all employees for such cleaning and maintenance at a rate of $3.35 per week (or $.67 cents per day). However, in those instances where the uniforms furnished are made of "wash and wear" materials, may be routinely washed and dried with other personal garments, and do not require any special treatment such as dry cleaning, daily washing, or commercial laundering in order to meet the cleanliness or appearance standards set by the terms of the Government contract, by the contractor, by law, or by the nature of the work, there is no requirement that employees be reimbursed for uniform maintenance costs.

The duties of employees under job titles listed are those described in the "Service Contract Act Directory of Occupations", Fifth Edition (Revision 1), dated September 2014, unless otherwise indicated.

REQUEST FOR AUTHORIZATION OF ADDITIONAL CLASSIFICATION AND WAGE RATE
Standard Form 1444 (SF-1444)

Conformance Process:

The contracting officer shall require that any class of service employee which is not listed herein and which is to be employed under the contract (i.e., the work to be performed is not performed by any classification listed in the wage determination), be classified by the contractor so as to provide a reasonable relationship (i.e., appropriate level of skill comparison) between such unlisted classifications and the classifications listed in the wage determination. Such conformed classes of employees shall be paid the monetary wages and furnished the fringe benefits as are determined (See 29 CFR 4.6(b)(2)(i)). Such conforming procedure shall be initiated by the contractor prior to the performance of contract work by such unlisted class(es) of employees (See 29 CFR 4.6(b)(2)(ii)). The Wage and Hour Division shall make a final determination of conformed classification, wage rate, and/or fringe benefits which shall be retroactive to the commencement date of the contract (See 29 CFR 4.6(b)(2)(iv)(C)(vi)). When multiple wage determinations are included in a contract, a separate SF-1444 should be prepared for each wage determination to which a class(es) is to be conformed.

The process for preparing a conformance request is as follows:

1) When preparing the bid, the contractor identifies the need for a conformed occupation(s) and computes a proposed rate(s).

2) After contract award, the contractor prepares a written report listing in order the proposed classification title(s), a Federal grade equivalency (FGE) for each proposed classification(s), job description(s), and rationale for proposed wage rate(s), including information regarding the agreement or disagreement of the authorized representative of the employees involved, or where there is no authorized representative, the employees themselves. This report should be submitted to the contracting officer no later than 30 days after such unlisted class(es) of employees performs any contract work.

3) The contracting officer reviews the proposed action and promptly submits a report of the action, together with the agency's recommendations and pertinent information including the position of the contractor and the employees, to the Wage and Hour Division, U.S. Department of Labor, for review (See 29 CFR 4.6(b)(2)(ii)).

4) Within 30 days of receipt, the Wage and Hour Division approves, modifies, or disapproves the action via transmittal to the agency contracting officer, or notifies the contracting officer that additional time will be required to process the request.

5) The contracting officer transmits the Wage and Hour decision to the contractor.

6) The contractor informs the affected employees.

Information required by the Regulations must be submitted on SF-1444 or bond paper.

When preparing a conformance request, the "Service Contract Act Directory of Occupations" (the Directory) should be used to compare job definitions to ensure that duties requested are not performed by a classification already listed in the wage determination. Remember, it is not the job title, but the required tasks that determine whether a class is included in an established wage determination. Conformances may not be used to artificially split, combine, or subdivide classifications listed in the wage determination.

** OCCUPATIONS NOT INCLUDED IN THE SCA DIRECTORY OF OCCUPATIONS **
Aerial Photographer
The aerial photographer must be skilled in reading flight maps, capable of assisting the pilot to adhere to flight lines, be able to level and operate a cartographic camera and its auxiliary equipment mounted in the aircraft so that the photographs that are taken will have the required forward lap and side lap for use in photogrammetric mapping equipment, and possess a working knowledge of aerial films and camera filters to insure proper exposure of the films.

First Officer (Co-Pilot)
Is second in command of commercial airplane and its crew while transporting passengers, mail, or other cargo on scheduled or nonscheduled flights. Assists or relieves an airline captain in operating the controls of an airplane; monitoring flight and engine instruments; and maintaining air-to-ground communications.

# EXHIBIT 7

## GLOSSARY, DEFINITIONS AND FILE EXTENSIONS

Acquisition Period: The calendar period in which the project item area imagery is required to be acquired.

Camera System: The combination of lens, cone, magazine(s), and camera filter(s) which have been calibrated as an integral unit.

Contracting Officer's Representative (COR): A person who is responsible for specific technical and administrative duties related to a contract.

Direct Digital Imagery: Vertical, high resolution imagery directly captured using a digital sensor. Either airborne or space-borne systems.

Exposure Stations: Pre-determined locations where photo centers of individual frames are to be exposed.

Georeferenced: Registering data with correct real world coordinates. Defining location using map coordinates and assignment of a known reference system, which allows data to be viewed, queried, and analyzed with other geographic data.

Ground Sample Distance: The ground sample distance is the distance on the ground represented by each pixel in the x and y components.

Original Imagery/Photography: All aerial imagery/photography, as secured by the Contractor, prior to its inspection by the USDA, including any reflights made at the discretion of the Contractor.

Project Item Area: An area or areas described in the Schedule for which an award shall be made to one offeror.

Reflight Photography: Photography reflown to replace original imagery/photography rejected by USDA.

Remake Materials: Any contract materials ordered remade by USDA.

Stereomodel: The area covered by the conjugate images of three successive overlapping exposures.

Uncorrected: No radiometric corrections or enhancements.

FILE EXTENSIONS (Refer to Attachment C for additional file extensions)

.ads: ADS header (text) file, with pointers to .tif segments (for scanning sensors).

.aux: Stands for “auxiliary file.” A file that accompanies the raster in the same location and stores any auxiliary information that cannot be stored in the raster file itself, including statistical information for the raster data set. It can also store the color map, histogram or table, coordinate system, transformation, and projection information.

EXHIBIT 7 (Cont'd)

.blk: Stands for "block file." A term used to describe and characterize all of the information associated with a photogrammetric mapping project, such as projection, spheroid, and datum; imagery; camera or sensor model information; GCPs; and geometric relationship between imagery and the ground. A block file is a binary file.

.gdb: Stands for "geodatabase." A geodatabase is a collection of geographic datasets of various types used in ArcGIS and managed in either a file folder or a relational database.

.hist: Stands for "histogram." XML file containing histogram of imagery.

.odf: File that contains absolute orientation data for every image.

.odf.adj: File that contains adjusted (more accurate) absolute orientation data than what is contained in the .odf data.

.prj: Stands for "project file." A SOCET SET file containing the information required to restore the current state of a work. All necessary files, settings, and preferences are stored in the project file.

EXHIBIT 8

FLIGHT LINE AND EXPOSURE NUMBERING

Flight line numbers and exposure numbers within a flight line shall not be duplicated within a project item.

**Flight Line:** Flight lines shall be numbered consecutively beginning with flight number 0001 for the project item:

North-South oriented flights: Begin with the most westerly flight line, and continue numbering each flight line consecutively moving eastward through the project.

East-West oriented flights: Begin with the most northerly flight line and continue numbering each flight line consecutively moving southward through the project.

Flight line numbers: shall start at 0001 and remain sequential across the project, regardless of the order flown.

Pre-Submission Reflights: If reflights are necessary prior to submission of the imagery, the flight line number shall remain the same as the original.

Post-Inspection Reflights: If reflights are necessary due to the Government's rejection of images submitted, the last two digits shall remain the same as the original flights. The first digit shall begin with a 1 for the first reflight required, a 2 for the second, etc. For example:

If flight line 0015 requires a reflight, the first reflight would be numbered 1015. If a second reflight were required after resubmission and inspection of the first, it would be numbered 2015.

**Exposure Number:** Exposures shall be numbered consecutively starting at 0001 at the northern end of each North-South flight line (at the western end for East-West flights) and continue in sequence through the last exposure, regardless of the order flown. The exposure number shall restart at 0001 for each flight line.

Reflights: Exposure numbers shall remain the same as the original flight. A reflight shall contain a minimum of two exposures to ensure consistent stereo coverage.

**North-South Flight Line and Exposure Numbering Example**

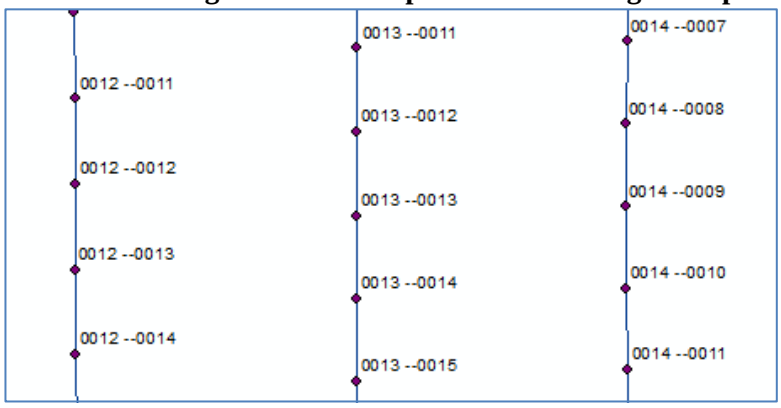
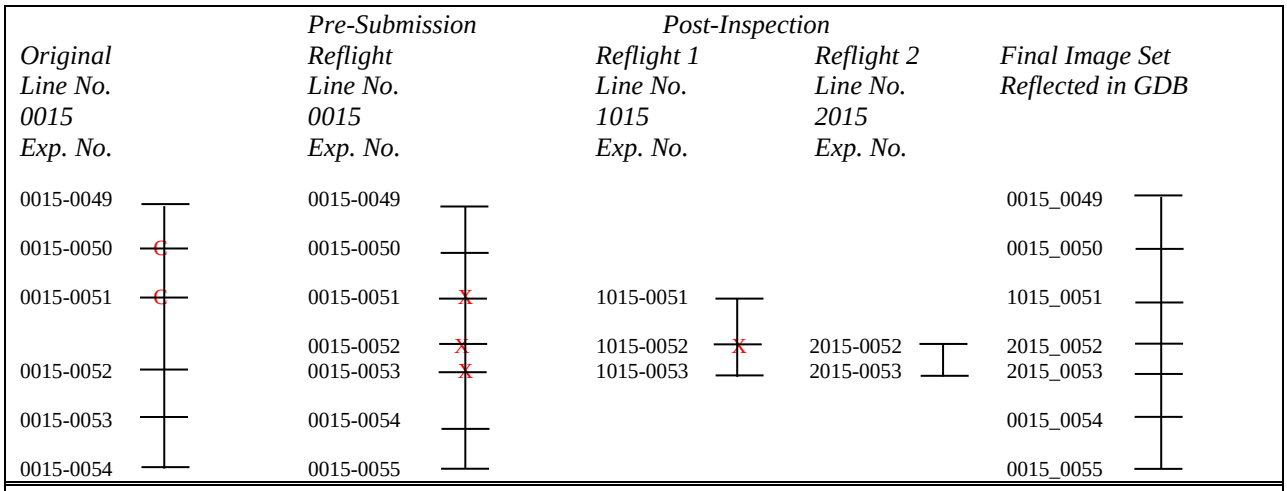


EXHIBIT 8 (Continued)

FLIGHT LINE AND EXPOSURE NUMBERING

## Reflight Numbering Examples




| Original Exposures | Exposures 0050 & 0051 Reflown Pre-Submission Submitted as follows: | Exposures 0051, 0052 & 0053 Rejected from Inspection (1st Reflight) | Resubmitted Exposure 0052 Rejected from Inspection (2nd Reflight) | Final Imagery Set |
|---|---|---|---|---|
| 0015_0049 | 0015_0049 | | | 0015_0049 |
| 0015_0050 | 0015_0050 | | | 0015_0050 |
| 0015_0051 | 0015_0051 | 1015_0051 | | 1015_0051 |
| | 0015_0052 | 1015_0052 | 2015_0052 | 2015_0052 |
| 0015_0052 | 0015_0053 | 1015_0053 | 2015_0053 | 2015_0053 |
| 0015_0053 | 0015_0054 | | | 0015_0054 |
| 0015_0054 | 0015_0055 | | | 0015_0055 |

Exposures may need to be renumbered within a flight line if reflights occur before the imagery is submitted to the Government.

EXHIBIT 9

EXAMPLE LISTGEO OUTPUT

The following are example ListGeo Output files only. Refer to Attachment C, USDA Digital File Format Specification for geoTIFF tag specifications.

**ListGeo Output – Non-Orthorectified, Georeferenced, GeoTIFF**

The following is an example of a GeoTIFF tag and GeoKey listing from a non-orthorectified, georeferenced GeoTIFF image. This listing is the output of the libgeotiff utility program "listgeo". The projection information below the line "End_Of_Geotiff" is implied by the standard projection and is not stored explicitly in the data file. The descriptions are retrieved from libgeotiff lookup tables in the listgeo application.

```
Geotiff_Information:
   Version: 1
   Key_Revision: 1.0
   Tagged_Information:
      ModelTransformationTag (4,4):
         -0.00290358977   0.260146801      0              521253.412
         0.260078624      0.00303118896    0              4921452.99
         0                0                1              0
         0                0                0              1
      End_Of_Tags.
   Keyed_Information:
      GTModelTypeGeoKey (Short,1): ModelTypeProjected
      GTRasterTypeGeoKey (Short,1): RasterPixelIsArea
      GeogGeodeticDatumGeoKey (Short,1): Datum_North_American_Datum_1983
      GeogEllipsoidGeoKey (Short,1): Ellipse_GRS_1980
      ProjectedCSTypeGeoKey (Short,1): PCS_NAD83_UTM_zone_13N
      PCSCitationGeoKey (Ascii,58): "Universal Transverse Mercator; North American 1983;
GRS80"
      ProjLinearUnitsGeoKey (Short,1): Linear_Meter
      ProjNatOriginLongGeoKey (Double,1): -105
      ProjNatOriginLatGeoKey (Double,1): 0
      ProjFalseEastingGeoKey (Double,1): 500000
      ProjFalseNorthingGeoKey (Double,1): 0
      ProjScaleAtNatOriginGeoKey (Double,1): 0.9996
      End_Of_Keys.
   End_Of_Geotiff.
```

PCS = 26913 (NAD83 / UTM zone 13N)
Projection = 16013 (UTM zone 13N)
Projection Method: CT_TransverseMercator

EXHIBIT 9 (Continued)

EXAMPLE LISTGEO OUTPUT

```
 ProjNatOriginLatGeoKey: 0.000000 (  0d 0' 0.00"N)
   ProjNatOriginLongGeoKey: -105.000000 (105d 0' 0.00"W)
   ProjScaleAtNatOriginGeoKey: 0.999600
   ProjFalseEastingGeoKey: 500000.000000 m
   ProjFalseNorthingGeoKey: 0.000000 m
GCS: 4269/NAD83
Datum: 6269/North American Datum 1983
Ellipsoid: 7019/GRS 1980 (6378137.00,6356752.31)
Prime Meridian: 8901/Greenwich (0.000000/  0d 0' 0.00"E)
Projection Linear Units: 9001/metre (1.000000m)

Corner Coordinates:
Upper Left    (  521253.412, 4921452.989)  (104d43'58.44"W, 44d26'45.84"N)
Lower Left    (  524849.681, 4921494.892)  (104d41'15.73"W, 44d26'46.78"N)
Upper Right   (  521231.112, 4923450.393)  (104d43'59.15"W, 44d27'50.57"N)
Lower Right   (  524827.382, 4923492.296)  (104d41'16.39"W, 44d27'51.52"N)
Center        (  523040.397, 4922472.643)  (104d42'37.43"W, 44d27'18.69"N)
```

**ListGeo Output – Orthorectified GeoTIFF**

The following is an example of a GeoTIFF tag and GeoKey listing from an orthorectified GeoTIFF image. This listing is the output of the libgeotiff utility program “listgeo”. The projection information below the line “End_Of_Geotiff” is implied by the standard projection and is not stored explicitly in the data file. The descriptions are retrieved from libgeotiff lookup tables in the listgeo application.

```
Geotiff_Information:
   Version: 1
   Key_Revision: 1.0
   Tagged_Information:
      ModelTiepointTag (2,3):
         0            0            0
         337962       3763838      0
      ModelPixelScaleTag (1,3):
         2            2            1
      End_Of_Tags.
   Keyed_Information:
      GTModelTypeGeoKey (Short,1): ModelTypeProjected
      GTRasterTypeGeoKey (Short,1): RasterPixelIsArea
      GTCitationGeoKey (Ascii,45): "6131202012m_3311162_nw_12_2_20120714"
      ProjectedCSTypeGeoKey (Short,1): PCS_NAD83_UTM_zone_12N
```

EXHIBIT 9 (Continued)

EXAMPLE LISTGEO OUTPUT

```
    PCSCitationGeoKey (Ascii,21): "NAD83 / UTM zone 12N"
    ProjLinearUnitsGeoKey (Short,1): Linear_Meter
    End_Of_Keys.
  End_Of_Geotiff.


PCS = 26915 (name unknown)
Projection = 16015 ()
Projection Method: CT_TransverseMercator
  ProjNatOriginLatGeoKey: 0.000000 (  0d 0' 0.00"N)
  ProjNatOriginLongGeoKey: -93.000000 ( 93d 0' 0.00"W)
  ProjScaleAtNatOriginGeoKey: 0.999600
  ProjFalseEastingGeoKey: 500000.000000
  ProjFalseNorthingGeoKey: 0.000000
GCS: 4269/NAD83
Datum: 6269/North American Datum 1983
Ellipsoid: 7019/GRS 1980 (6378137.00,6356752.31)
Prime Meridian: 8901/Greenwich (0.000000/  0d 0' 0.00"E)
Projection Linear Units: 9001/metre (1.000000m)

Corner Coordinates:
Upper Left    ( 337962.000,3763838.000)  ( 94d45'16.56"W, 34d 0' 9.55"N)
Lower Left    ( 337962.000,3756208.000)  ( 94d45'11.47"W, 33d56' 1.94"N)
Upper Right   ( 344456.000,3763838.000)  ( 94d41' 3.51"W, 34d 0'13.09"N)
Lower Right   ( 344456.000,3756208.000)  ( 94d40'58.63"W, 33d56' 5.47"N)
Center        ( 341209.000,3760023.000)  ( 94d43' 7.54"W, 33d58' 7.53"N)
```

EXHIBIT 10

# Hard Drive Directory Structure Template

The following table shows the correct data directory structure for hard drives. All directories shall be created at the root directory unless indicated otherwise.

| DIRECTORY NAME | DESCRIPTION OF CONTENTS |
|---|---|
| \georeferenced | Uncorrected or color corrected georeferenced imagery. All stereo block files and associated support files. If a Leica ADS sensor is used, the following files as well: .ads, .hist, .odf, .odf.adj |
| \gps | *No data is to be stored here* |
| \gps_base | Any GPS ground data used to supplement the ABGPS positional data adjustments such as base stations or CORS |
| \index | Project file geodatabase |
| \minification | All scanning sensor minification files (.min). *Note: This directory shall only include data if a scanning sensor is used* |
| \ortho | *No data is to be stored here* |
| \ortho\doqqq | All orthorectified doqqq imagery. All associated .rrd, .aux, and .met files. Includes world files and .ige files |
| \ortho\doqq | All orthorectified doqq imagery. All associated .rrd, .aux, and .met files. Includes world files and .ige files |
| \ortho\doq | All orthorectified doq imagery. All associated .rrd, .aux, and .met files. Includes world files and .ige files |
| \ortho\cpm | All orthorectified, compressed project mosaic imagery. All associated .rrd, .aux, and .met files. May include world files. |
| \rmse | Root mean square error accuracy and quality control reports |

# AERIAL PHOTOGRAPHY FIELD OFFICE (APFO) SPECIFICATION FOR DIGITAL CAMERA BASED ACQUISITION

(Dated February 1, 2012 – Modified for USFS Resource Imagery March 26, 2012)

## 1.0 INTRODUCTION AND BACKGROUND

The U.S. Federal Government has not established an independent government evaluation and calibration policy for digital cameras since sensor technology is still rather new. Until a policy is developed and implemented, the U.S. Department of Agriculture (USDA), Farm Service Agency (FSA) has proceeded to validate the quality and capabilities of current digital cameras by obtaining relevant information from camera manufacturers, data providers, and other government agencies and organizations. The following specifications and requirements have been developed to ensure that any digital camera proposed for use on USDA contracts meets minimum requirements to provide the highest quality digital imagery products.

## 2.0 DIGITAL CAMERA SPECIFICATIONS AND REQUIREMENTS

This document covers camera specifications and requirements for any direct-digital imagery acquisition under contract to APFO. Cameras for acquiring precise vertical digital imagery are required to be tested and calibrated. Cameras proposed for use must be of comparable, or better, precision and quality as traditional film-based stereoscopic mapping cameras. Imagery captured with digital cameras must also be compatible with analytical mensuration procedures used in photogrammetric surveys and in preparing accurate orthophotography. Documentation and sample imagery will be reviewed and verified by the Government before approval is granted. Only approved digital cameras shall be used on contracts administered by APFO.

## 3.0 GENERAL REQUIREMENTS

Digital cameras must be tested and calibrated with manufacturer certification documentation. The camera must be geometrically stable and suitable for use in precise, high-accuracy photogrammetric orthoimagery applications. All delivered imagery shall be acquired and processed in such a way as to eliminate or minimize pixel or band offset or misalignment between bands. The camera shall provide the following:

### 3.1 Spatial Resolution

The camera shall provide the spatial resolution and field of view necessary to meet the ground sample distance (GSD) requirement as specified in the contract.

### 3.2 Image Fusion

Pan sharpening will be permitted to achieve the necessary spatial resolution requirements. The multi-spectral bands may be used at a ratio no greater than 1:5 (multi-spectral to panchromatic) to achieve the required spatial resolution.

3.3 Radiometric Resolution and Accuracy

The camera's sensor shall capture and record a minimum of 12-bits of image information per color channel. If more than one lens and more than one shutter are used in the camera, the difference in radiometric values between two panchromatic or two multi-spectral sensors shall be less than ±5%. For example, a 12-bit image shall not have more than ±205 difference in gray values.

3.4 Spectral Resolution

The camera shall capture, as a minimum, natural color (approximately 440 – 850 nm) and near infrared color (approximately 780 – 850 nm) channel data simultaneously or near simultaneously using a single camera (near simultaneously is defined as less than 500 milliseconds). Additional multi-spectral bands may be collected with a secondary or auxiliary camera and/or system.

3.5 Camera Operation

The digital camera and its mount shall be checked for proper installation prior to each mission. An automatic exposure control device is permitted, but a manual override capability is required for some types of terrain to achieve proper coverage and exposure. The camera mount shall be regularly serviced and maintained and shall be insulated against aircraft vibration.

3.6 Camera Maintenance

The contractor shall perform all maintenance in accordance with the manufacturers recommended and established procedures. The contractor shall maintain a complete history of all maintenance done to the camera system and have it available for Government inspection. The contractor shall provide certification that the system has been maintained, preventive maintenance and calibration performed, to the manufacturers requirements.

3.7 System Malfunctions

The contracting officer shall be notified of all camera malfunctions within 72 hours with a written report of the malfunction. A malfunction is defined as a failure in any element or process of the camera that causes an interruption of the normal operations of the camera system (camera system is defined as the camera and any key components, such as camera mount, airborne global positioning system, and on-board data storage). All malfunctions or failures of global positioning systems or inertial measurement unit systems shall also be reported directly to the contracting officer.

## 4.0 DIGITAL CAMERA APPROVAL REQUIREMENTS

All digital cameras must be approved by the Contracting Officer before acquiring imagery under any APFO contract. When requesting approval, the Contractor shall submit, or have on file with APFO, a report of calibration (see Paragraph 4.1), sample digital imagery (see Paragraph 4.2), and camera documentation (see Paragraph 4.3).

### 4.1 Calibration Reports

Calibration reports for each digital camera proposed for use shall be submitted to the contracting officer with the contractor's proposal and prior to project imagery acquisition if the digital camera is removed and remounted. The contractor shall follow manufacturer's specifications for appropriate calibration and recalibration. The calibration reports shall address the geometric performance of the camera, and at a minimum, include:

(a) Date of report
(b) The name of the person or company performing the calibration
(c) The methodology and procedures used for calibration
(d) Final calibration parameters, such as calibrated focal length, lens distortion values, radiometric calibration parameters, and principal point location.

NOTE: The government recognizes that individual calibration reports, procedures, and parameters may be unique to a certain manufacturer since equipment and systems vary from manufacturer to manufacturer.

### 4.2 Sample Imagery Requirements

The Contractor shall acquire and submit with their proposal, sample images from the digital camera proposed for use. The sample imagery shall provide the following minimum characteristics:

(a) Display the same GSD resolution required in the solicitation.
(b) Represent the type of terrain (agriculture, cropland, forest, etc.) that is similar to the proposed project area.
(c) Re-sampled and submitted as an 8-bits per band image (unless the solicitation requires only 16-bit per band image delivery, in which case the sample imagery shall be submitted as a 16-bits per band image).
(c) If ortho-rectification is required under the proposed solicitation, the sample image shall be ortho-rectified with the projection specified in the solicitation (for example, North American Datum 1983 (NAD83) and UTM Zone 12).
(d) Sample shall be produced and submitted in the footprint and file format specified in the solicitation (for example, DOQQ formatted, GeoTIFF image).
(e) The sample imagery shall fit on one standard CD or DVD. Delivered media will become part of the official Government contract file and will not be returned.

## 4.3 Camera Documentation Requirements

The Contractor shall provide with their proposal detailed documentation of the digital camera proposed for use. Documentation may include brochures, technical specifications, marketing material, manufacturer's user manuals, or other descriptive literature. The documentation shall contain at a minimum the following information:

(a) General overview information
(b) Product configuration description
(c) Camera component description
(d) Technical specifications
(e) Computer management and storage systems
(f) Image acquisition and processing workflow

.

# AERIAL PHOTOGRAPHY FIELD OFFICE (APFO)
# USDA DIGITAL IMAGERY QUALITY SPECIFICATION

(Dated February 1, 2012 – Modified for USFS Resource Imagery March 26, 2012)

## 1.0 SCOPE

This document establishes the image quality criteria to be used in the production of digital imagery products for all contracts issued by the United States Department of Agriculture's (USDA) Aerial Photography Field Office.

## 2.0 APPLICABLE DOCUMENTS

In the event of conflict between the contents of this specification and the documents referenced herein, the contents of this specification shall take precedence.

2.1 National Agriculture Imagery Program (NAIP) Suggested Best Practices – Final Report, dated Feb 1, 2007 (ITT Space Systems Division)

## 3.0 GENERAL REQUIREMENTS

USDA uses imagery for various programs including, but not limited to forest management, agriculture land use analysis, natural resource inventory, and extraction of data by means of photogrammetric interpretation. The complex nature and need for consistent imagery requires adherence to exact format and content of this specification.

3.1 Image blemishes, scratches and artifacts. Imagery shall be free of blemishes, scratches, and artifacts that obscure ground feature detail. The following table defines the maximum acceptable limits for blemishes, scratches, and artifacts. Clusters of blemishes, scratches, and artifacts that do not individually meet these criteria may be considered unacceptable.

| ACCEPTABLE, IMAGE BLEMISHES, SCRATCHED, AND ARTIFACTS | |
|---|---|
| 1 pixel wide | 100 pixels in length |
| 2 pixels wide | 60 pixels in length |
| 3 pixels wide | 20 pixels in length |
| 4 – 12 pixels wide | 12 pixels in length |

3.2 Band-to-Band Registration Accuracy. Misregistration between any color bands shall not exceed 1 pixel.

3.3 Original Image Resolution. The original image, original scan, or original capture used to create the imagery shall not be resampled from the original image resolution greater or less than the following numbers in order to meet the Ground Sample Distance (GSD) specified in the contract:

| GROUND SAMPLE DISTANCE (GSD) | ORIGINAL IMAGE RESOLUTION | |
|---|---|---|
| | MAXIUMUM (meters) | MINIMUM (meters) |
| 0.3-meter | 0.15 | 0.32 |
| 0.5-meter | 0.25 | 0.53 |
| 1-meter | 0.50 | 1.05 |

## 4.0 UNCORRECTED IMAGERY

Uncorrected imagery is defined as imagery that has been minimally processed before exporting to a non-camera specific file format, such as a TIFF. Uncorrected imagery is the closest "match" to a traditional film negative that the direct-digital camera can provide without having the end-user employ special and/or non-standard software.

4.1 Non-image data. Imagery shall only use a pixel digital number (DN) of zero (0) for non-data values.

4.2 Image Quality. The Contractor shall not make any radiometric enhancements, such as gamma correction, histogram stretching, dodging, or other Look Up Table (LUT) adjustments, to the acquired imagery. The imagery shall not contain any borders, artifacts, or other non-image items.

## 5.0 COLOR CORRECTED IMAGERY

Imagery required to be color-corrected shall be adjusted so that the image matches the ground at the time of exposure. Adjustments shall include, but not limited to, any dodging, gamma correction, histogram stretching, brightness adjustments, and/or color balancing. The files shall not contain any borders, artifacts, or other non-image items.

5.1 Non-image data. Imagery shall only use a pixel digital number (DN) of zero (0) for non-data values.

5.2 Natural Color Image Quality.

(a) Clipping. Imagery shall have a tonal range that prevents the clipping of highlight or shadow detail from the image. When calculated against the luminosity histogram, the cumulative pixel count between the first and last five histogram bin

values (5 and 250 respectively for 8-bit depth) shall not be less than 98.0%, with a preferred value greater than 99%.

(b) Contrast. When calculated against the luminosity histogram, the difference between the histogram digital number (DN) value that contains 99.0% of the cumulative pixel count and the DN value that contains 1.0% shall be greater than ±59% of the bit depth, ±4% (aim point of 150, ±10 for 8-bit depth). If the cumulative pixel count percentage falls between two histogram bin values, the closest value shall be used. For example, if an 8-bit image has a luminosity DN value 222 contains 99% of the cumulative pixel count and DN value 44 contains 1% count, therefore the difference is 178.

| BIT DEPTH | DN DIFFERENCE | | |
|---|---|---|---|
| | TARGET | MINIMUM | MAXIUMUM |
| 8-bit | 150 | 140 | 160 |
| 16-bit | 38,550 | 35,930 | 41,170 |

(c) Brightness. Imagery shall have a mean pixel count within ±7.5% of the middle DN value allowed for the bit depth. For example, an 8-bit depth image must have the histogram mean value between 108 and 147.

| BIT DEPTH | MEAN DN | |
|---|---|---|
| | MINIMUM | MAXIUMUM |
| 8-bit | 108 | 147 |
| 16-bit | 27,853 | 37,683 |

(d) Color Balance. Imagery should have a neutral tonal range without the dominance of any individual color. The difference between the minimum and maximum DN value in a RBG triplet of any nearly neutral objects within the image shall be less than 5.

5.2 Color infrared Imagery. All color infrared imagery shall have proper contrast to allow highlight and shadow detail.

5.3 Multispectral Imagery. Multispectral Imagery shall be radiometrically processed such than the natural color bands (RGB) meet the quality requirements in paragraph 5.1.

## 6.0 ORTHORECTIFIED IMAGERY

All orthorectified imagery shall be color-corrected in accordance with paragraph 5.0.

6.1 Geographic Extent. Imagery shall cover the entire image area, including the required minimum buffer on all four sides. Extents shall be computed by projecting the geographic corners and side midpoints to the appropriate projection, then adding the buffer on each side of the resulting minimum bounding rectangle.

6.2 Specular reflections. Specular reflections in the imagery should be minimized, especially in agriculture areas, by patching the area using "chips" from different imagery but shall be from the same type of camera and must be from the same acquisition season. Any chips used in the imagery shall not have more than ±3 pixels offset or the specified horizontal accuracy, whichever is the lesser distance, -between the chip and principal image. Any chips used shall be radiometrically balanced in accordance with paragraph 6.3(a).

6.3 Image Mosaicking. Imagery may be created using multiple image segments from the same acquisition collection to produce the final product.

(a) Radiometric Balance. When a mosaic is made from two or more image segments, the brightness and color values between the image segments will be adjusted to match that of neighboring image segments. The join lines between the overlapping image segments will be chosen to minimize tonal variations. Localized adjustment of the brightness and color values will be done to reduce radiometric differences between join areas.

6.4 Spatial. All orthoimagery shall meet the horizontal accuracy requirement of the specified project.

## 7.0 DEFINITIONS

Chip – Each separate piece of a mosaicked image that contributes to the final image.

Clipping – The presence of pixels exhibiting the minimum or maximum digital number in an image's dynamic range.

Digital Number – The value (0-255 for an 8-bit image) that depicts the pixel radiance for that color band.

Dodging – Manipulating the intensity of part of a photograph by selectively shading or masking.

Resample – Interpolation of pixel values based upon neighboring pixel values.

Uncorrected Imagery – Imagery that has been minimally processed, including no radiometric enhancements, such as stretching, dodging, or other Look Up Table (LUT) adjustments, to the acquired imagery.

# USDA Digital File Format Specification

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## 1.0 PREFACE

For many years the Aerial Photography Field Office (APFO) has used the "USDA Digital Orthoimagery Quarter Quadrangle (DOQQ) Description and Specification" when contracting for Farm Service Agency's (FSA) National Agriculture Imagery Program (NAIP) imagery. However, APFO is the lead procurement office for all United States Department of Agriculture's (USDA) imagery projects greater than 100 square miles. These programs require a variety of delivery and file formats to meet the needs and diversity of various USDA's users. The previous specification was written specifically for one program, and thus was too rigid to be easily implemented for other acquisitions, resulting in continuous modifications to the specification and inefficiencies in implementation, interoperability, and data exchange. Thus, this specification has been updated to alleviate these issues. The intent is to apply this specification, as written and without modification, to all imagery contracts.

An important area of consideration for the use of imagery (raster) data is the encoding format. Various department agencies that use the APFO for procurement of imagery have valid requirements to make selected imagery data holdings available in Geographic Tagged Image File Format (GeoTIFF) in addition to other formats, including but not limited to JPEG 2000, LizardTech MrSID, and ERDAS Imagine files.

While GeoTIFF (and other formats) are widely used, they have many format options which often result in non-interoperability among disparately developed implementations. This USDA Digital File Format Specification was developed to help meet objectives for deployment of capabilities with automation and interoperability in mind. The primary rationale is to enable more timely support for delivering imagery in a format suitable for direct ingest by Geographic Information System (GIS) and/or Remote Sensing (RS) application software tools readily available to those working to support department activities.

This document specifies the requirements that shall be used for the exchange of georeferenced or ortho rectified imagery when opting to use the varied formats identified in the Appendices. The aim of this specification is to enable the interchange of rectified constraints within the design objectives of promoting interoperability for the exchange of raster information.

## 2.0 INTRODUCTION

This specification outlines the requirements and encoding rules that shall be used for the exchange of imagery data when opting to use the formats outlined herein. It constitutes a description of the bounds and constraints for the use of each file format within the design objectives of promoting interoperability and data exchange. It conforms with all normative documents identified in Section 5.0.

While GeoTIFF is not the only format detailed in this specification, it is a core format for encoding spatial raster data, and thus is a core component of this specification. GeoTIFF is a public domain specification which allows georeferencing information to be embedded within a TIFF file. Potential embedded information includes projections, coordinate systems, datums, and other information needed to

establish the spatial reference for the imagery or gridded data contained in the file. The GeoTIFF format augments the TIFF format, so TIFF-enabled software incapable of reading and interpreting the specialized georeferencing metadata should still be able to open a GeoTIFF file sufficiently to at least view the image data.

The main body of this specification addresses the scope of this work, conformance with other recognized industry specifications and national specifications, terms and definitions, an acronym and file extension reference, and the applicability and use of this document. The document then addresses various file format requirements and references the Appendices for the file format specifications.

## 3.0 SCOPE

This document establishes the file format criteria to be used in the production of digital imagery for all contracts issued by APFO. It may also be applied to all internal production activities at APFO that result in products that require archiving and public distribution.

## 4.0 CONFORMANCE

Any GeoTIFF data claiming conformance with this specification is claiming conformance with applicable normative documents in Section 5, and shall pass conformance requirements testing as part of the quality assurance process upon delivery of data to the USDA.

Other file formats detailed in this specification may or may not conform with normative documentation and reference information in Section 5. These file formats shall still pass testing as part of the quality assurance process upon delivery of data to USDA, to ensure requirements of this specification are met.

## 5.0 NORMATIVE DOCUMENTS

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies.

### 5.1 Industry Specifications

- The Tagged Image File Format (TIFF) – Tagged Image File Format, Revision 6.0, Adobe Systems Inc., June 1992. TIFF is a copyrighted standard of Adobe Systems, Inc. (http://partners.adobe.com/public/developer/en/tiff/TIFF6.pdf)

- GeoTIFF Format Specification, Revision 1.0, 10 November 1995; version 1.8.2 The GeoTIFF Format Specification is a public domain extension of TIFF that provides a robust and flexible method of storing georeferencing information is a TIFF file. (http://www.remotesensing.org/GeoTIFF/spec/GeoTIFFhome.html )

Supporting documents describing the scope of this document and call out requirements, and recommendations.

### 5.2 National Specifications

*TBD*

### 5.3 Informative References

*NGA Standardization Document - Implementation Profile for Tagged Image File Format (TIFF) and Geographic Tagged Image File Format (GeoTIFF) - NGA.IP.0001_1.0, 2008-11-18*

## 6.0 GLOSSARY

### 6.1 Terms and Definitions

Affine Transformation – A geometric transformation that scales, rotates, skews, and/or translates images or coordinates between any two Euclidean spaces. It is commonly used in GIS to transform maps between coordinate systems. In an affine transformation, parallel lines remain parallel, the midpoint of a line segment remains a midpoint, and all points on a straight line remain on a straight line. Source: Esri Online Dictionary

Band – A range of wavelengths of electromagnetic radiation. Also, image data gathered at this wavelength range.

Field – Refers only to the entire field, including the value, of the geokey (as defined in the TIFF Specification).

Georeference – Aligning geographic data to a known coordinate system so it can be viewed, queried, and analyzed with other geographic data. (Source: Esri® Online Dictionary)

GeoTIFF – Public domain metadata standard which allows georeferencing information to be embedded within a .TIFF file.

Image File Directory – Contains information about the image. There must be at least 1 IFD in a TIFF file and each IFD must have at least one entry.

Metadata – Description of the content, quality, condition, and other characteristics of the data.

Orthorectification - A process of removing sources of distortion from an image and correcting aerial photography to the point where measurements of a feature on the photograph approximate ground measurements of the same feature. (Source: Satellite Imaging Corporation)

Private tags – TIFF tags numbered 32,768 or higher. Private tags are not defined in the TIFF Specification.

Public tags – TIFF tags that are defined by the TIFF Specification.

Rectified Grid – A grid that has an affine transformation between the grid coordinates and the coordinates of an external coordinate reference system.

Tag – Refers only to the identifying number portion of the geokey (as defined in the TIFF Specification).

## 6.2 Acronyms and Abbreviations

GeoPDF – A .pdf file created by TerraGo Technologies that contains geospatial information such as layers and object data.

ERDAS – Earth Resources Data Analysis System

JPEG and JPEG 2000 – Joint Photographic Experts Group. A commonly used method of compression for digital imagery. JPEG 2000 is an updated wavelet compression of JPEG with more flexibility in the codestream.

MrSID – Multi-resolution seamless image database. Proprietary format developed by LizardTech for encoding raster graphics.

TIFF – Tagged Image File Format.

## 6.3 File Extensions

.ecw – Stands for enhanced compression wavelet. An ERDAS ER Mapper compressed file format specifically designed for geospatial imagery.

.ige – Stands for large raster spill file. One of two ERDAS IMAGINE files created when an image requiring more than 4GB of disk space is created. It contains the actual image data in a separate non-HFA file format (normally with the extension .ige).

.img – Stands for “image file.” An ERDAS IMAGINE file used to store raster data, including file information, ground control points, sensor information, layer information, attribute data, statistics,

map information, projection information, pyramid layers, data file values, compression, and block size. This file uses Hierarchal File Format (HFA).

.jp2 – Stands for jpeg 2000. Compressed image created using JPEG 2000 Core Coding; incorporates a wavelet compression algorithm instead of Digital Cosine Transform (DCT) compression used by standard JPEG images; can be stored using lossy and lossless compression.

.pdf – Stands for portable document format. For the purpose of this document, .pdf refers to a geopdf.

.ovr – Stands for overlay file. Similar to the .rrd file, .ovr is a file format for storing pyramid layers for a raster dataset.

.rrd – Stands for "reduced resolution dataset." A file containing pyramids created for a raster dataset.

.sid – Stands for seamless image database. A lossless compressed image file developed by LizardTech

.tif – Stands for "tagged image file." High-quality graphics format often used for storing images with many colors, such as digital photos; short for "TIFF;" includes support for layers and multiple pages. For the purpose of this document, .tif refers to a GeoTIFF.

## 7.0 APPLICABILITY AND USE OF THIS DOCUMENT

The primary purpose of this document is to establish guidelines and specifications for imagery developed by or for APFO. The intent is to allow for great flexibility of data structure, spatial density, quality, and format, while supporting sharing and reuse of the data.

## 8.0 TIFF AND GEOTIFF REQUIREMENTS

This section of this File Format Specification defines the minimum set of format options, features, and data elements necessary to promote interoperability for the exchange of Tagged Image File Format (TIFF) and GeoTIFF-formatted files. This section establishes a common frame of reference to address adequate georeferencing parameters and data value attribution needed by geospatial applications to utilize GeoTIFF-formatted images. Only uncompressed TIFF or GeoTIFF imagery that has been georeferenced or orthorectified is addressed by this section of this specification. Requirements for compression (see Sub-Section 8.2.10) and georeferenceable imagery (see Sub-Section 8.2.2) are not supported in this specification.

TIFF is an image file format used for storing and interchanging raster images. TIFF is a portable format, not specific to or favoring any particular operating systems, file systems, compilers, or processors. It is also extensible and designed to evolve as new needs arise.

GeoTIFF is a set of TIFF tags (extensions to the Baseline TIFF Format) that describe spatial information associated with TIFF imagery that originate from any digital sensor, scanned aerial photography, scanned maps, or as a result of geographic analysis or similar processes. GeoTIFF uses a small set of reserved TIFF tags to store a broad range of geo-referencing information.

This specification addresses the following fundamental topics for application and use of TIFF and GeoTIFF files:

- Required TIFF and GeoTIFF tags for standardized use of TIFF and GeoTIFF-formatted files.
- Image data or pixel structures relating to: strips, tiling, compression, precision, number of bands, etc.
- Preferred coordinate reference systems, datums.

This specifications main characteristic allows:

- All types of imagery conformant to TIFF Baseline: bi-level, grayscale, palette color image, 3-bands RGB (full color), and multi-spectral.
- Optional TIFF tiling (TIFF extension specified in section 15 of the TIFF standard) for high volume data. This option cannot be used in conjunction with TIFF striping. The use of this option may cause some interoperability problems, and must be identified as such at a different conformance level.

## 8.1 Data Capture

TIFF provides 2 tags for specifying the scanner or instrument manufacturer and model: Make and Model. These fields may be populated according to product specification requirements.

However the production process is usually far more complex than the simple acquisition of an image by a scanner or a camera, and the full process needs to be documented by additional metadata (i.e. process description).

Use of Make and Model tags is consequently optional: in case they are populated, the information should be consistent with additional metadata (i.e. process description).

## 8.2 TIFF and GeoTIFF Requirements

In general, imagery data delivered in TIFF or GeoTIFF format will conform to (not deviate from) the TIFF and GeoTIFF formats as defined in the referenced TIFF and GeoTIFF specifications. The following clauses constrain the implementation of TIFF and GeoTIFF for the purposes of this specification.

### 8.2.1 General File Structure and Data Value Types

The TIFF structure includes an 8-byte image file header that points to the first Image File Directory (IFD). This specification calls for a single IFD in each TIFF file and this IFD must have at least one entry. The IFD contains information about the image, as well as pointers to the actual data. All used fields are listed, and information that does not fit in the IFD is listed in other parts of the file. The IFD begins with a 2-byte count of the number of directory entries (i.e., the number of fields), followed by a sequence of 12-byte field entries, followed by a 4-byte offset of the next IFD (or 0 in the case there is no other IFD). This 4-byte (32 bit) structure of the offset allows TIFF and GeoTIFF file sizes up to 4GB (2**32 bytes). This specification only supports file sizes up to 2GB.

A GeoTIFF file is a TIFF 6.0 file, and inherits the file structure as described in the corresponding portion of the TIFF Specification. All of the GeoTIFF information is encoded in six TIFF tags, which are designed to store a broad range of georeferencing information, catering to geographic as well as projected coordinate system needs. These GeoTIFF keys will contain no private Image File Directories (IFD's), binary structures, or other private information invisible to baseline TIFF 6.0 readers.

The GeoTIFF 1.0 standard uses a MetaTag (GeoKey) approach to encode dozens of data elements into just six TIFF 6.0 tags. GeoKeys are structurally similar to TIFF 6.0 tags, but at one lower level of abstraction. GeoKeys are used within the tags to store the projection parameters and coordinate system information. All keys are referenced from one tag, the GeoKeyDirectoryTag. See Table 2.1, Appendix A for details. Not all the keys will be used when formatting GeoTIFF in conformance with this specification. This specification requires that only certain essential GeoTIFF keys be populated. Other keys may require default values.

The GeoTIFF specification requires interpret (reader) implementations to support all documented TIFF 6.0 tag data-types, and in particular requires the Institute of Electrical & Electronic Engineers (IEEE) double-precision floating point 'DOUBLE' type tag. The documented data types for use with TIFF tags are:

- BYTE = 8-bit unsigned integer
- ASCII = 8-bit byte that contains a 7-bit American Standard Code for Information Interchange (ASCII) code. The last byte of an ASCII sequence (string) must be null (binary zero)
- SHORT = 16-bit (2-byte) unsigned integer
- LONG = 32-bit (4-byte) unsigned integer
- FLOAT = Single precision (4-byte) IEEE format
- DOUBLE = Double precision (8-byte) IEEE format
- RATIONAL = Two LONGs: the first represents the numerator of a fraction; the second, the denominator
- SBYTE = 8-bit signed (twos complement) integer
- UNDEFINED = 8-bit byte containing anything, depending on the definition of the field.

- SSHORT = 16-bit (2-byte) signed (twos complement) integer
- SLONG = 32-bit (4-byte) signed (twos complement) integer
- SRATIONAL = Two SLONGs: the first represents the numerator of a fraction; the second, the denominator.

Note: Appendix A identifies which data type applies to each tag selected for use by this specification.

TIFF implicitly types all range values (data sample values) as unsigned integer values. The representation of imagery, however, requires the ability to store the range (data) values in additional representations such as signed integer and floating point. Section 19 of the TIFF standard presents a scheme for describing a variety of data sample formats. The BitsPerSample field in the TIFF Image File Directory defines the number of bits per component.

### 8.2.2 Rectification and Ortho-rectification

A rectified grid has an affine transformation between the grid coordinates and the coordinates of an external coordinate reference system. A rectified grid is defined by an origin in an external coordinate reference system and a set of offset vectors that specify the direction and distance between grid lines within that external coordinate reference system. If the coordinate reference system is related to the earth by a datum, the grid is a georeferenced grid. An orthorectified grid is a georeferenced grid that uses elevation data and where constant scale is maintained throughout the grid.

A referenceable grid is one that can be referenced by some other specified coordinate transform (for example, by a physical sensor geometry model or by a functional fit model of rational polynomials).

This section of this specification is concerned only with georeferenced grids and orthorectified grids. It does not address referenceable grids; for example, those associated with oblique imagery or rubber sheeting.

The GeoTIFF Format Specification describes 5 coordinate transformations 'cases' that the format is able to address:

Case 1: The model-location of a raster point (x,y) is known, but not the scale or orientations.

Case 2: The location of three non-collinear raster points are known exactly, but the linearity of the transformation is not known, and the scale is not to be defined.

Case 3: the position and scale of the data is known exactly, and no rotation or sheering of the image is needed to fit into the model space.

Case 4: (intended for equidistant- sampled data) The raster data requires rotation and/or lateral sheering to fit into the defined model space. To accomplish this, additional information is needed in the form of a transformation matrix. The ModelTransformationTag exists for the purpose of allowing this information to be provided.

Case 5: The raster data cannot fit into the model space with a simple affine transformation. Multiple tie points can be stored in GeoTIFF to allow rubber sheeting of the image in this case.

This specification requires that the scale be identified in the GeoTIFF tags (see Table 2.1 Appendix A), and therefore cases 1 and 2 are not supported. This specification requires only georectified grids and orthorectified grids, therefore case 5 is not supported.

Only cases 3 and 4 are supported by this section of this specification.

### 8.2.3 Coordinate Reference Systems and Datums

The GeoTIFF Configuration GeoKeys establish the general configuration of the file's coordinate system. Each of these GeoKeys is listed below with their general description followed by limitations and constraints established by this specification:

- GTModelTypeGeoKey – Tag 1024. The GTModelTypeGeoKey defines the general type of model coordinate system used – geographic or projected.
- GTRasterTypeGeoKey– Tag 1025. The GTRasterTypeGeoKey establishes if the raster pixel value (imagery or gridded data range value) is located at a point value or if the value fills the square grid cell.
- GTCitationGeoKey – Tag 1026. The GTCitationGeoKey is used to give an ASCII reference to published documentation on the overall configuration of the GeoTIFF file. This key generally shows the projection name or geographic coordinate system name and the units.

Horizontal datum – GeoTIFF has many datums to choose from in the Geodetic Datum numerical codes. This specification recommends the use of North American Datum (NAD83) as the horizontal datum, but allows for World Geodetic System 1984 (WGS84).

Coordinate systems – GeoTIFF allows many geographic latitude-longitude systems and many projected coordinate systems. There are also tags for parameters of coordinate systems or projections not available in the codes. This section of this specification limits expression of coordinate references to NAD83 latitude and longitude (decimal degrees), NAD83 UTM Grid System Northing and Easting (meters), and geographic or projected WGS84 systems.

### 8.2.4 Units of Measure

This section of this specification allows only the implied 'angular degree' unit for the geographic coordinate system, and the default 'meters' unit for the UTM projected coordinate system. User-defined geographic or projected coordinate systems are not allowed by this specification. In order to prevent the use of other horizontal units of measure, the use of the GeoKeys related to horizontal units of measure are prohibited (see Tables 2.x in Appendix A).

Default units are:

- Decimal degrees for longitude and latitude (geographic coordinate system)
- Meters for UTM Grid System Easting and Northing (projected / cartographic coordinate system)

### 8.2.5 Date and Time

There is a TIFF field called DateTime for storing the date and time of file creation. The format for the field in ASCII type is "YYYY:MM:DD HH:MM:SS" with 24 hour time used for the hours and one space character between the date and time, and one terminating NUL character. The length of the string, including the terminating NUL, is 20 bytes. All dates and times shall be expressed in Coordinated Universal Time (UTC).

Use of this tag is recommended in order to support discovery of the data, wherever possible. This information should then be consistent with additional metadata (i.e. required process description). Absence of this tag indicates this information was not available. The Date/Time stamp that will be represented in the TIFF DateTime field shall be the date/time when the image file was created.

### 8.2.6 Collection and Maintenance Constraints

There are several TIFF tags that can carry and address a variety of collection information. These tags should not be populated for the purpose of this section of this specification. The associated additional metadata (i.e. process description) can optionally be used to carry this type of information when needed.

### 8.2.7 Tiling

For low-resolution to medium-resolution images, the standard TIFF method of breaking the image into strips is adequate. However high-resolution images (grids greater than 8192 x 8192) can be accessed more efficiently if the image is broken into roughly square tiles instead of horizontally-wide but vertically-narrow strips.

TIFF extensions offer an internal TIFF tiling mechanism which should be used on large grids / images, based on the most common tiling scheme which is a rectangular grid, by specifying

additional fields for rectangular tiles (for example width and length of a tile). Tile dimensions must be a multiple of 16 (TIFF specifies TileWidth and TileLength be a multiple of 16 for performance in some graphics environments and compression schemes such as JPEG). This internal TIFF tiling extension may not always be supported by commercial or public domain software, especially older TIFF readers.

TIFF internal tiling must NOT be used in conjunction with stripping. When using internal tiles, the grid data may need to be padded to tile boundaries when the grid size is not an integer multiple of the selected tile size.

Generally, for small grids, the data should be organized as a single TIFF file with no tiling, in order to maximize interoperability.

For large grids (greater than 8192 x 8192), TIFF tiling becomes a helpful option, the recommended tile size is 1024 x 1024. Another option is external tiling, when each tile is typically stored within separate files; this option is outside the scope of this section of this specification and is therefore not supported.

### 8.2.8 Number of Bands

The number of bands within a GeoTIFF grid is constrained to be 1-band, 3-bands, and 4 or more bands (multi-spectral). For the case of 3 or more bands, the band interleave shall be the TIFF 'chunky' format, band interleaved by pixel (BIP). In Chunky format the component values for each pixel are stored contiguously. For example, for RGB data, the data is stored as RGBRGBRGB. The BIP data organization can handle any number of bands, and thus accommodates black and white, grayscale, true color, and multi-spectral image data.

Additional information is needed to interpret the image data, such as SamplesPerPixel, BitsPerSample, PhotometricInterpretation, and ExtraSamples:

For 1-band 8-bit Pan Sharpened imagery, the following TIFF fields are documented as follows: SamplesPerPixel = 1, BitsPerSample = 8, PhotometricInterpretation = 1 (BlackIsZero), Do not use ExtraSamples.

For 3-band 8-bit RGB imagery, the following TIFF fields are documented as follows: SamplesPerPixel = 3, BitsPerSample = 8, PhotometricInterpretation = 2 (RGB), Do not use ExtraSamples.

For 4-band 8-bit RGB imagery, the following TIFF fields are documented as follows: SamplesPerPixel = 4, BitsPerSample = 8, PhotometricInterpretation = 2 (RGB), ExtraSamples = 0 (Unspecified data).

For 8-band 16-bit multi-spectral imagery, the following TIFF fields are documented as follows: SamplesPerPixel = 8, BitsPerSample = 16, PhotometricInterpretation = 2 (RGB), ExtraSamples = 0 (Unspecified data).

#### 8.2.9 Range Value Data Types and Precision

For imagery, the range (data) values are constrained to be unsigned integer data, 8 or 16-bits-per-band.

#### 8.2.10 Compression

No TIFF (internal) compression shall be used.

#### 8.2.11 Image File Implementation

This specification addresses the following cases (except explicit contrary notice): base (single) image (one single IFD). The IFD always addresses the image data.

#### 8.2.12 Security Classification

There are no dedicated fields for storing security classification information in TIFF files. Additional metadata should be used to associate security markers and dissemination controls for content of GeoTIFF files. However, inclusion of security constraint information in the ImageDescription tag is an option proposed by this section of this specification in order to support security marking of the data. This provides a consistent place for security metadata within the TIFF structure.

It is recommended to include security constraint information in the ImageDescription field, in addition to the information provided in the additional metadata (i.e. process description) so that this information is displayed even if this metadata is ignored by an application or become separated. This security constraint information should then be consistent with dedicated additional metadata (i.e. process description).

#### 8.2.13 Data Quality

There are neither fields nor any mechanism for storing data quality information (positional accuracy, currency, quality information etc.) in the GeoTIFF format and in this specification. This information needs to be documented by additional metadata (i.e. process description).

## 9.0 LIZARDTECH'S MRSID REQUIREMENTS

MrSID imagery shall be compressed and saved in Generation Three (MG3) format. When encoding the image, the following settings shall be applied:

- compression block size of 64
- both the transparency and background values set to an RGB value of 0,0,0 (black)
- use the “maximum zoom level” applicable to the input image, for example: -checking the “Use Maximum Zoom Levels for Image” button in the encoding options menu.

Compression Ratio. Compression ratio shall be determined by the project or contract specifications. All compression shall be at the same ratio and settings ("region of interest" compressed at a different ratio will not be accepted).

Header Information. The image header shall contain correct Esri® compatible projection information for the mosaic.

Required Files. All standard MrSID® MG3 files generated by the LizardTech software (i.e., .sid, .sdw, and .txt) shall be included.

Configuration File. Provide the text file created when generating the image.

Auxiliary File. Provide an “.aux” file containing Esri® projection information for each image. The auxiliary file shall contain the proper projection information for the image and shall match the information in the image header.

## 10.0 JPEG 2000 REQUIREMENTS

JPEG 2000 imagery shall be compressed and saved in the JPEG 2000 format with an unsigned, 8-bit depth. Compression ratio shall be determined by the project or contract specifications. When encoding the image, the following settings shall be applied:

- Tiling: None
- Code blocks: 64
- Precincts: 256 x 256
- Strip height: 12
- Progression order: rpcl
- Quality layers: 8
- Packet length markers: Yes
- Filter: 9-7
- Tile length markers: No
- Transparency: Yes
- Background: Transparent, Black, White (stated in order of preference)

All compression shall be at the same ratio and settings ("region of interest" compressed at a different ratio will not be accepted).

## 11.0 ERDAS IMG® REQUIREMENTS

IMG imagery shall use the standard outputs as defined in the hierarchical file structure (HFA). The .img file shall be in a tiled format with a block size of 64x64 pixels. The following statistics shall be calculated:

- Minimum and maximum data file values
- Mean of the data file values
- Median of the data file values
- Mode of the data file values
- Standard deviation of the data file values

If the file has been georeferenced, the following map information shall be stored in the raster layer:

- Upper left x, y coordinates
- Pixel size
- Map unit used for measurement (e.g., meters, inches, feet)

An .ige file shall be created for images larger than 4GB. The .ige file shall be in a non-HFA format containing only the actual image data.

## 12.0 ERDAS ER MAPPER ECW® REQUIREMENTS

When creating ECW files, the following input settings shall be used:

- Output file type is .ecw
- Compression type is set to correct spectral resolution (color RGB, grayscale, multiband)
- Generate NULL opacity mask channel is checked
- Compression ratio shall be determined by the project or contract specifications.
- Output resolution is set by the compressor

ERDAS ER Mapper® **must** be used when compressing imagery to the .ecw format. This ensures that all image keys and tags are correctly populated in the output image header.

APPENDIX A

**TIFF/GeoTIFF Image Format Constraints**

## TIFF Format

The file structure for the Image File Header and Image File Directory can be found in the TIFF product specification in Part 1, Section 2: TIFF Structure. There are four Baseline TIFF image types; Bilevel Images, Grayscale Images, Palette-color Images, and RGB Full Color Images. Each type has specific field requirements which can be found in Sections 3 through 6 of the TIFF document. For the purpose of representing imagery, the grayscale and full-color image baselines are appropriate. The use of any private tags, other than those included in this appendix is prohibited for use.

TIFF Specification Document: Revision 6.0 dated June 3, 1992

Table 1.1 describes the "Baseline Fields" defined in Section 8 of the TIFF specification.
Table 1.2 describes the "CCITT Bilevel Encodings" defined in Section 11 of the TIFF specification.
Table 1.3 describes the "Document Storage and Retrieval" defined in Section 12 of the TIFF specification.
Table 1.4 describes the "Differencing Predictor" defined in Section 14 of the TIFF specification.
Table 1.5 describes the "Tiled Images" defined in Section 15 of the TIFF specification.
Table 1.6 describes the "CYMK Images" defined in Section 16 of the TIFF specification.
Table 1.7 describes the "HalftoneHints" defined in Section 17 of the TIFF specification.
Table 1.8 describes the "Associated Alpha Handling" defined in Section 12 of the TIFF specification.
Table 1.9 describes the "Data Sample Format" defined in Section 19 of the TIFF specification.
Table 1.10 describes the "RGB Image Colorimetry" defined in Section 20 of the TIFF specification.
Table 1.11 describes the "YCbCr Images" defined in Section 21 of the TIFF specification.
Table 1.12 describes the "JPEG Compression" defined in Section 22 of the TIFF specification.

<u>Legend for TIFF table</u>:

- Columns Field, Description, Tag, and Type refer to corresponding specification items of tag according to TIFF specifications.
- ROCN column specifies presence of the item:
    - R: required
    - O: optional
    - C: conditional (Condition must be specified)
    - N: Do not use
- Restricted field values: indicates (when applicable) required values for TIFF tag.

## Table 1.1: TIFF 6.0 Baseline Tags

| **TIFF 6.0<br>Section 8** | **Baseline Field Reference Guide** | | | | |
|---|---|---|---|---|---|
| **Field** | **Description** | **Tag** | **Type** | **ROCN** | **Restricted Field Values** |
| Artist | Person who created the image. | 315 | ASCII | R | Populate with the name of the organization who created the file. |
| BitsPerSample | Number of bits per component. | 258 | SHORT | R | Set to the number of bits used to represent each range (sample) value. |
| CellLength | The length of the dithering or halftoning matrix used to create a dithered or halftoned bilevel file. | 265 | SHORT | N | Do not use this key. |
| CellWidth | The width of the dithering or halftoning matrix used to create a dithered or halftoned bilevel file. | 264 | SHORT | N | Do not use this key. |
| ColorMap | Defines an RGB color map for palette color images. | 320 | SHORT | C | Use only with palette color images. |
| Compression | Compression scheme used on the image data.<br>Uncompressed<br>CCITT 1D<br>CCITT Group 3<br>CCITT Group 4<br>LZW<br>JPEG<br>Packbits (32773) | 259 | SHORT | R | Set to 1 (No Compression) |
| Copyright | Copyright notice.<br><br>When access or usage restrictions (or both ) exist for the dataset, populate with the applicable copyright notice of the person or organization that claims the copyright to the image. The complete copyright statement shall be listed in this field including any dates and statements of claims. If no usage restrictions exist, it shall be so stated in this field. | 33432 | ASCII | C | Populate only when any restrictions have been cited by the requestor. |

| | | | | | |
|---|---|---|---|---|---|
| DateTime | Date and time of image creation.<br>The date and time that most closely reflects the currency of the data range values. | 306 | ASCII | R | File creation date |
| ExtraSamples | Description of extra components.<br>Populate with a value of 0 only if SamplesPerPixel is greater that 3 (4-band images). | 338 | BYTE | C | Populate with a value of 0 only if SamplesPerPixel is greater than 3 (multi-spectral images). |
| FillOrder | The logical order of bits within a byte. | 266 | SHORT | O | Desired value is 1 |
| FreeByteCounts | For each string of contiguous unused bytes in a TIFF file, the number of bytes in the string. | 289 | LONG | N | Do not use this key. |
| FreeOffsets | For each string of contiguous unused bytes in a TIFF file, the byte offset of the string. | 288 | LONG | N | Do not use this key. |
| GrayResponseCurve | For grayscale data, the optical density of each possible pixel value. | 291 | SHORT | N | Do not use this key. |
| GrayResponseUnit | The precision of the information contained in the GrayResponseCurve. | 290 | SHORT | N | Do not use this key. |
| HostComputer | The computer and/or operating system in use at the time of image creation. | 316 | ASCII | O | Optional, but not desired |
| ImageDescription | A string that describes the subject of the image. | 270 | ASCII | R | Populate with a description that identifies the acquisition Program name. |
| ImageHeight | The number of rows of pixels in the image. | 257 | SHORT or LONG | R | The number of rows of range values. |
| ImageWidth | The number of columns in the image, i.e., the number of pixels per row. | 256 | SHORT or LONG | R | The number of columns of range values. |
| Make | The scanner manufacturer. The manufacturer of the equipment used to generate the image. | 271 | ASCII | R | The manufacturer of the instrument used to obtain the range values. |
| MaxSampleValue | The maximum component value used. | 281 | SHORT | N | Do not use this key. |
| MinSampleValue | The minimum component value used. | 280 | SHORT | N | Do not use this key. |

| | | | | | |
|---|---|---|---|---|---|
| Model | The scanner model name or number. | 272 | ASCII | R | The model name or number of the instrument used to obtain the range values. |
| NewSubFileType | A general indication of the kind of data contained in this subfile. | 254 | LONG | N | Do not use this tag. |
| Orientation | The orientation of the image with respect to the rows and columns. Set this value to the default value of 1. Orientation of the grid indices to the external coordinate reference system is defined by the GeoTIFF tags. | 274 | SHORT | O | Default is 1 |
| PhotometricInterpretation | The color space of the image.<br><br>Note: A value for the 4-band case is not defined in the TIFF specification. In the 4-band case, use a value of 2 and populate the ExtraSamples tag with a value of 0. | 262 | SHORT | R | Allowed values are:<br>0 - WhiteIsZero<br>1 - BlackIsZero<br>2 - RGB<br>3 – Palette Color<br>4 - Transparency Mask |
| PlanarConfiguration | How the components of each pixel are stored. When more than one band is described by the range values, include this tag and set the value to 1. (chunky format). | 284 | SHORT | C | Default value is 1. Use this tag when more than one band is described by the range values and the component values are stored contiguously (ie chunky format)<br>(Not to be used if Tiling has been used) |
| ResolutionUnit | The unit of measurement for XResolution and YResolution. | 296 | SHORT | R | Default value is 2 (inches). |
| RowsPerStrip | The number of rows per strip<br><br>**No to be used if Tiling has been used.** | 278 | SHORT or LONG | C | The TIFF specification recommends selecting the value for RowsPerStrip such that each strip is about 8k bytes; it makes buffering simpler for readers. |

| | | | | | |
|---|---|---|---|---|---|
| SamplesPerPixel | The number of components per pixel. | 277 | SHORT | R | Allowed values are:<br>1 - (monochrome or transparency mask)<br>3 - (RGB)<br>4 - (4-band data). |
| Software | Name and version number of the software package(s) used to create the image.<br>Populate with description of the software package(s) used to process/create the range values from the raw instrument data or other source of imagery and gridded data. | 305 | ASCII | N | Do not use this tag. |
| StripByteCounts | For each strip, the number of bytes in the strip after compression.<br>**No to be used if Tiling has been used.** | 279 | LONG or SHORT | C | Populate per TIFF specification when opting to use strips.<br>(Not to be used if Tiling has been used) |
| StripOffsets | For each strip, the byte offset of that strip<br><br>**Not to be used if Tiling has been used.** | 273 | SHORT or LONG | C | Populate per TIFF specification when opting to use strips.<br>(Not to be used if Tiling has been used) |
| SubFileType | A general indication of the kind of data contained in this subfile.<br>This field is useful when there are multiple subfiles in a single TIFF file. | 255 | SHORT | N | Do not use this key. |
| Thresholding | For black and white TIFF files that represent shades of gray, the technique used to convert from gray to black and white pixels. | 263 | SHORT | O | Desired value is 1. |
| XResolution | The number of pixels per ResolutionUnit in the ImageWidth direction. | 282 | RATIONAL | R | Populate with intended display resolution. |
| YResolution | The number of pixels per ResolutionUnit in the ImageLength direction. | 283 | RATIONAL | R | Populate with intended display resolution. |

## Table 1.2: CCITT Bilevel Encodings

| **TIFF 6.0<br>Section 11** | **CCITT Bilevel Encodings** | | | | |
|---|---|---|---|---|---|
| **Field** | **Description** | **Tag** | **Type** | **ROCN** | **Restricted Field Values** |
| Compression | Compression scheme used on the image data.<br>Uncompressed<br>CCITT 1D<br>CCITT Group 3<br>CCITT Group 4<br>LZW<br>JPEG<br>Packbits (32773) | 259 | SHORT | R | Set to 1 (No Compression) |
| T4Options[2] | Options for Group 3 Fax compression | 292 | LONG | N | Do not use this key. |
| T6Options[3] | Options for Group 4 Fax compression | 293 | LONG | N | Do not use this key. |

## Table 1.3: Document Storage and Retrieval

| **TIFF 6.0<br>Section 12** | **Document Storage and Retrieval** | | | | |
|---|---|---|---|---|---|
| **Field** | **Description** | **Tag** | **Type** | **ROCN** | **Restricted Field Values** |
| DocumentName | The name of the document from which this image was scanned. | 269 | ASCII | N | Do not use this key. |
| PageName | The name of the page from which this image was scanned. | 285 | ASCII | N | Do not use this key. |
| PageNumber | The page number of the page from which this image was scanned. | 297 | SHORT | N | Do not use this key. |
| XPosition | X position of the image. | 286 | RATIONAL | N | Do not use this key. |
| YPosition | Y position of the image. | 287 | RATIONAL | N | Do not use this key. |

## Table 1.4: Differencing Predictor

| **TIFF 6.0 Section 14** | **Differencing Predictor** | | | | |
|---|---|---|---|---|---|
| **Field** | **Description** | **Tag** | **Type** | **ROCN** | **Restricted Field Values** |
| Predictor | A predictor is a mathematical operator that is applied to the image data before an encoding scheme is applied. | 317 | SHORT | N | Do not use this key. |

## Table 1.5: Tiled Images

| **TIFF 6.0 Section 15** | **Tiled Images** | | | | |
|---|---|---|---|---|---|
| **Field** | **Description** | **Tag** | **Type** | **ROCN** | **Restricted Field Values** |
| TileWidth | The tile width in pixels. This is the number of columns in each tile. | 322 | SHORT or LONG | C | When tiled is allowed: Populate per TIFF specification when opting to use internal tiles. |
| TileLength | The tile length (Height) in pixels. This is the number of rows in each tile. | 323 | SHORT or LONG | C | When tiled is allowed: Populate per TIFF specification when opting to use internal tiles. |
| TileOffsets | For each tile, the byte offset of that tile, as compressed and stored on disk. | 324 | LONG | C | When tiled is allowed: Populate per TIFF specification when opting to use internal tiles. |
| TileByteCounts | For each tile, the number of (compessed) bytes in that tile. | 325 | SHORT or LONG | C | When tiled is allowed: Populate per TIFF specification when opting to use internal tiles. |

## Table 1.6: CYMK Images

| **TIFF 6.0 Section 16** | **CYMK Images** | | | | |
|---|---|---|---|---|---|
| **Field** | **Description** | **Tag** | **Type** | **ROCN** | **Restricted Field Values** |
| InkSet | The set of inks used in a separated (PhotometricInterpretation=5) image. | 332 | SHORT | N | Do not use this key. |
| NumberOfInks | The number of inks. Usually equal to SamplesPerPixel, unless there are extra samples. | 334 | SHORT | N | Do not use this key. |
| InkNames | The name of each ink used in a separated (PhotometricInterpretation=5) image, written as a list of concatenated, NUL-terminated ASCII strings. The number of strings must be equal to NumberOfInks. | 333 | ASCII | N | Do not use this key. |
| DotRange | The component values that correspond to a 0% dot and 100% dot. DotRange[0] corresponds to a 0% dot, and DotRange[1] corresponds to a 100% dot. | 336 | BYTE or SHORT | N | Do not use this key. |
| TargetPrinter | A description of the printing environment for which this separation is intended. | 337 | ASCII | N | Do not use this key. |

## Table 1.7: HalftoneHints

| **TIFF 6.0 Section 17** | **HalftoneHints** | | | | |
|---|---|---|---|---|---|
| **Field** | **Description** | **Tag** | **Type** | **ROCN** | **Restricted Field Values** |
| HalftoneHints | The purpose of the HalftoneHints field is to convey to the halftone function the range of gray levels within a colorimetrically-specified image that should retaintonal detail. | 321 | SHORT | N | Do not use this key. |

## Table 1.8: Associated Alpha Handling

| **TIFF 6.0 Section 18** | **Associated Alpha Handling** | | | | |
|---|---|---|---|---|---|
| **Field** | **Description** | **Tag** | **Type** | **ROCN** | **Restricted Field Values** |
| ExtraSamples | Description of extra components. | 338 | BYTE | C | Populate with a value of 0 only if SamplesPerPixel is greater than 3 (multi-spectral images). |

## Table 1.9: Data Sample Format

| **TIFF 6.0 Section 19** | **Data Sample Format** | | | | |
|---|---|---|---|---|---|
| **Field** | **Description** | **Tag** | **Type** | **ROCN** | **Restricted Field Values** |
| SampleFormat | This field specifies how to interpret each data sample in a pixel.<br>Possible values are:<br>1 – unsigned integer data<br>2 – two's complement signed integer data.<br>3 – IEEE floating point data [IEEE]<br>This field does not specify the size of data samples; the BitsPerSample field does this. | 339 | SHORT | R | Default value is 1.<br><br>Select the value corresponding to the sample format used for representing the range (data) values. |
| SMinSampleValue | The minimum sample value. This tag is used in lieu of MinSampleValue when the sample type is other than integer. The minimum component value used. | 340 | Any | N | Do not use this key. |
| SMaxSampleValue | The maximum sample value. This tag is used in lieu of MaxSampleValue when the sample type is other than integer. The maximum component value used. | 341 | Any | N | Do not use this key. |

## Table 1.10: RGB Image Colorimetry

| **TIFF 6.0 Section 20** | **RGB Image Colorimetry** | | | | |
|---|---|---|---|---|---|
| **Field** | **Description** | **Tag** | **Type** | **ROCN** | **Restricted Field Values** |
| WhitePoint | The chromaticity of the white point of the image. This is the chromaticity when each of the primaries has its ReferenceWhite value. | 318 | RATIONAL | N | Do not use this key. |
| PrimaryChromaticities | The chromaticities of the primaries of the image. This is the chromaticity for each of the primaries when it has its ReferenceWhite value and the other primaries have their ReferenceBlack values. | 319 | RATIONAL | N | Do not use this key. |
| TransferFunction[4] | Describes a transfer function for the image in tabular style. Pixel components can be gamma-compensated, companded, non-uniformly quantized, or coded in some other way. The ransferFunction maps the pixel components from a non-linear BitsPerSample (e.g. 8-bit) form into a 16-bit linear form without a perceptible loss of accuracy. | 301 | SHORT | N | Do not use this key. |
| TransferRange | Expands the range of the TransferFunction. The first value within a pair is associated with TransferBlack and the second is associated with TransferWhite. The ordering of pairs is the same as for pixel components of the PhotometricInterpretation type. | 342 | SHORT | N | Do not use this key. |
| ReferenceBlackWhite | Specifies a pair of headroom and footroom image data values (codes) for each pixel component. The first component code within a pair is associated with ReferenceBlack, and the second is associated with ReferenceWhite. The ordering of pairs is the same as those for pixel components of the PhotometricInterpretation type | 532 | LONG | N | Do not use this key. |

## Table 1.11: YCbCr Images

| **TIFF 6.0<br>Section 21** | **YCbCr Images** | | | | |
|---|---|---|---|---|---|
| **Field** | **Description** | **Tag** | **Type** | **ROCN** | **Restricted Field Values** |
| PhotometricInterpretation | The color space of the image.<br><br>For Specification:<br>Allowed values are:<br>0 - WhiteIsZero<br>1 - BlackIsZero<br>2 - RGB<br>3 – Palette Color<br>4 - Transparency Mask<br>Note: A value for the 4-band case is not defined in the TIFF specification. In the 4-band case, use a value of 2 and populate the ExtraSamples tag with a value of 1. | 262 | SHORT | N | Do not use this key. |
| YCbCrCoefficients | The transformation from RGB to YCbCr image data. | 529 | RATIONAL | N | Do not use this key. |
| YCbCrSubSampling | Specifies the subsampling factors used for the chrominance components of a YCbCr image. | 530 | SHORT | N | Do not use this key. |
| YCbCrPositioning | Specifies the positioning of subsampled chrominance components relative to luminance samples. | 531 | SHORT | N | Do not use this key. |

## Table 1.12: JPEG Compression

| **TIFF 6.0 Section 22** | **JPEG Compression** | | | | |
|---|---|---|---|---|---|
| **Field** | **Description** | **Tag** | **Type** | **ROCN** | **Restricted Field Values** |
| JPEGProc | This Field indicates the JPEG process used to produce the compressed data. | 512 | SHORT | N | Do not use this key. |
| JPEGInterchangeFormat | This Field indicates whether a JPEG interchange format bitstream is present in the TIFF file. | 513 | LONG | N | Do not use this key. |
| JPEGInterchangeFormatLength | This Field indicates the length in bytes of the JPEG interchange format bitstream. | 514 | LONG | N | Do not use this key. |
| JPEGRestartInterval | This Field indicates the length of the restart interval used in the compressed image data. | 515 | SHORT | N | Do not use this key. |
| JPEGLosslessPredictors | This Field points to a list of lossless predictor-selection values, one per component. | 517 | SHORT | N | Do not use this key. |
| JPEGPointTransforms | This Field points to a list of point transform values, one per component. This Field is relevant only for lossless processes. | 518 | SHORT | N | Do not use this key. |
| JPEGQTables | This Field points to a list of offsets to the quantization tables, one per component. | 519 | LONG | N | Do not use this key. |
| JPEGDCTTables | This Field points to a list of offsets to the DC Huffman tables or the lossless Huffman tables, one per component. | 520 | LONG | N | Do not use this key. |
| JPEGACTTables | This Field points to a list of offsets to the Huffman AC tables, one per component. | 521 | LONG | N | Do not use this key. |

## GeoTIFF Format

GeoTIFF data format
All of the GeoTIFF information is encoded in six tags, and numerous keys are available to store projection parameters and coordinate system information. Use of keys and parameters is constrained as indicated . All keys are referenced from one tag, the GeoKeyDirectoryTag. The following information is from the GeoTIFF product specification, Revision 1.0, in Section 1: Baseline GeoTIFF. Specific definitions, formats, and codes can be found in GeoTIFF Format Specification, Revision 1.0. As with baseline TIFF tags, the use of any private GeoTIFF tags, other than those included in this appendix is prohibited.

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Table 2.1 describes the "GeoTIFF Tags" defined in Sections 2.4 – 2.6 of the GeoTIFF Specifications.
Table 2.2 describes the "GeoTIFF Configuration GeoKeys" defined in Sections 2.7 – 2.7.2 of the GeoTIFF Specifications.
Table 2.3 describes the "Geographic CS Parameter Keys" defined in Sections 2.7 – 2.7.2 of the GeoTIFF Specifications.
Table 2.4 describes the "Projected CS Parameter Keys" defined in Sections 2.7 – 2.7.2 of the GeoTIFF Specifications.
Table 2.5 describes the "Vertical CS Parameter Keys" defined in Sections 2.7 – 2.7.2 of the GeoTIFF Specifications.

<u>Legend for GeoTIFF table</u>:

- Columns GeoTIFF tag/key , Description, Tag/Key Id, and Type refer to corresponding specification items of tag according to GeoTIFF specifications.
- ROCN column specifies presence of the item:
    - R: required
    - O: optional
    - C: conditional (Condition must be specified)
    - N: Do not use
- Restricted field values: indicates (when applicable) required values for GeoTIFF geokey.

## Table 2.1: GeoTIFF Tags

| GeoTIFF Tag | Description | Tag | Type | ROCN | Restricted Field Values |
|---|---|---|---|---|---|
| GeoKeyDirectoryTag | Stores GeoKey Directory, which defines and references the "GeoKeys." All Keys in GeoTIFF are referenced from the GeoKeyDirectoryTag All projection and datum information is stored in GeoKeys. See section 2.4 of the GeoTIFF 1.0 Standard. | 34735 | SHORT | R | This tag references all non-ASCII GeoKeys. |
| GeoDoubleParamsTag | Used to store all of the DOUBLE valued GeoKeys, referenced by the GeoKeyDirectoryTag For Profile: | 34736 | DOUBLE | N | Do not use this tag, it is unnecessary because as all Double type GeoKeys are prohibited by this profile. |
| GeoAsciiParamsTag | Used to store all of the ASCII valued GeoKeys, referenced by the GeoKeyDirectoryTag. See section 2.6.1 of the GeoTIFF 1.0 Standard. | 34737 | ASCII | R | This tag is used to store all the ASCII-valued GeoKeys. |
| ModelTiepointTag | Stores raster model tiepoint pairs in the order ModelTiepointTag = (…,I,J,K, X,Y,Z…) where (I,J,K) is the point at location (I,J) in raster space with pixel-value K, and (X,Y,Z) is a vector in model space. The Z value is an offset used in conjuction with the Z pixel scale (tag 33550) to position the data vertically. | 33922 | DOUBLE | R | Populate this tag with the tie point pair that correlates to the grid origin (grid coordinates 0,0) by convention in the upper left corner of the image. For imagery and typical elevation data (no offset), set Z=0 |
| ModelPixelScaleTag | Used to specify the size of raster pixel spacing in the model space units, consists of the following three values ModelPixelScaleTag = (ScaleX, ScaleY, ScaleZ) The X and Y values must be populated and be equal to the ground distance of one pixel. | 33550 | DOUBLE | R | Populate per GeoTIFF specification; For imagery, set Z=0, for elevation data, set Z=1<br>Note: This tag must not be used if the image requires rotation. |
| ModelTransformationTag | Used to specify the transformation matrix between the raster space and the model space, it has the following organization: ModelTransformationTag = (a,b,c,d,e,….,m,n,o,p) | 34264 | DOUBLE | C | Use this tag when the image requires rotation in order to be north-oriented. For further explanation see section 2.6.2 Cookbook for Defining Transformations in the GeoTIFF Format Specification, Rev 1.0, 10 Nov 10, 1995; version 1.8.2 |

**GeoTIFF Configuration GeoKeys**

These keys are to be used to establish the general configuration of a file's coordinate system, including the types of raster coordinate systems, model coordinate systems, and citations if any.

## Table 2.2: GeoTIFF Configuration GeoKeys

| GeoTIFF Key | Description | Key ID | Type | ROCN | Restricted Field Values |
|---|---|---|---|---|---|
| GTModelTypeGeoKey | Defines general type of model coordinate system used, and to which the raster space will be transformed. | 1024 | SHORT | R | The applicable codes are:<br>1 – ModelTypeProjected<br>2 – ModelTypeGeographic |
| GTRasterTypeGeoKey | Establishes the raster space coordinate system – RasterPixelIsPoint, RasterPixelIsArea.<br><br>a. The "PixelIsArea" raster grid space uses coordinates I and J, with (0,0) denoting the upper-left corner of the image, and increasing I to the right, increasing J down. The first pixel-value fills the square grid cell with the bounds top-left = (0,0), bottom-right = (1,1) and so on; by extension this one-by-one grid cell is also referred to as a pixel. An N by M pixel image covers an area with the mathematically defined bounds (0,0),(N,M).<br>b. This raster space designates the upper-left corner of an image. The coordinate pair values for this location shall be “a whole number of pixels.” Each value “must be integer multiple of the resolution” of the image. For a 1-meter resolution image this pair can be odd or even whole numbers, for a 2-meter resolution image this pair needs to even whole numbers.<br>c. The desired result is to have “Exact Pixel Registration,” meaning that pixels from multiple images line up exactly. This should not be | 1025 | 6.3.1.2 codes | R | The applicable codes are:<br>1 – RasterPixellsArea (use for imagery products )<br>2 – RasterPixellsPoint (use for non-imagery discrete coverage data) |

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|---|---|---|---|---|---|
| | confused with overlaps or gaps, but the cells have to fall on an even multiple of the cell width and height from one another, and adjacent images cannot have cells starting halfway, or partially into the cells of the original image | | | | |
| GTCitationGeoKey | Provided to give an ASCII reference to published documentation on the overall configuration of this GeoTIFF file. | 1026 | ASCII | R | This key contains detailed product identification and is used to define the imagery file. (ie file name). |

**Geographic CS Parameter Keys**

In general, the coordinate system used will be implied by the projected coordinate system code (Table A.2.3). However, If the model type was chosen to be Geographic (GTModelTypeGeoKey = 2), then the system must be explicitly defined with the following keys.

## Table 2.3: Geographic CS Parameter Keys

| GeoTIFF Key | Description | Key Id | Type | ROCN | Restricted Field Values |
|---|---|---|---|---|---|
| GeographicTypeGeoKey | This key may be used to specify the code for the geographic coordinate system used to map lat-long to a specific ellipsoid over the earth. | 2048 | SHORT (Code from Section 6.3.2.1) | C | Use when GTModelTypeGeoKey = 2 and ProjectedCSTypeGeoKey is absent.<br>Example:<br>4326 (ie GCS_WGS84) |
| GeogCitationGeoKey | This key provides a general citation and reference for all Geographic CS parameters. | 2049 | ASCII | C | Use when GeographicTypeGeoKey is present.<br>Example: WGS84 |
| GeogGeodeticDatumGeoKey | This key may be used to specify the horizontal datum, defining the size, position and orientation of the reference ellipsoid used in userdefined geographic coordinate systems. | 2050 | SHORT (code from Section 6.3.2.2) | N | Do not use this key. |
| GeogPrimeMeridianGeoKey | This key allows specification of the location of the Prime meridian for user-defined Geographic coordinate systems. The default standard is Greenwich, England. | 2051 | SHORT (Code from Section 6.3.2.4) | N | Do not use this key. |
| GeogLinearUnitsGeoKey | This key allows the definition of geocentric CS linear units for user-defined GCS. | 2052 | DOUBLE Code from Section 6.3.1.3) | N | Do not use this key. |
| GeogLinearUnitSizeGeoKey | Allows the definition of user-defined linear geocentric units, as measured in meters. | 2053 | DOUBLE | N | Do not use this key. |

| | | | | | |
|---|---|---|---|---|---|
| GeogAngularUnitsGeoKey | This key Allows the definition of geocentric CS Linear units for user-defined GCS and for ellipsoids | 2054 | SHORT (Code from Section 6.3.1.4) | N | Do not use this key. |
| GeogAngularUnitSizeGeoKey | Allows the definition of user-defined angular geographic units, as measured in radians. | 2055 | DOUBLE | N | Do not use this key. |
| GeogEllipsoidGeoKey | This key may be used to specify the coded ellipsoid used in the geodetic datum of the Geographic Coordinate System. | 2056 | SHORT (Code from Section 6.3.2.3) | N | Do not use this key. |
| GeogSemiMajorAxisGeoKey | This key allows the specification of user-defined Ellipsoid Semi-Major Axis (a). | 2057 | DOUBLE | N | Do not use this key. |
| GeogSemiMinorAxisGeoKey | This key allows the specification of user-defined Ellipsoid Semi-Minor Axis (b). | 2058 | DOUBLE | N | Do not use this key. |
| GeogInvFlatteningGeoKey | This key Allows the specification of the inverse of user-defined Ellipsoid's flattening parameter (f). | 2059 | DOUBLE | N | Do not use this key. |
| GeogAzimuthUnitsGeoKey | This key This key may be used to specify the angular units of measurement used to defining azimuths, in geographic coordinate systems. These may be used for defining azimuthal parameters for some projection algorithms, and may not necessarily be the same angular units used for lat-long. | 2060 | SHORT (Codes from Section 6.3.1.4) | N | Do not use this key. |
| GeogPrimeMeridianLongGeoKey | This key allows definition of user-defined Prime Meridians, the location of which is defined by its longitude relative to Greenwich. | 2061 | DOUBLE | N | Do not use this key. |

**Projected CS Parameter Keys**

## Table 2.4: Projected CS Parameter Keys

| GeoTIFF Key | Description | Key Id | Type | ROCN | Restricted Field Values |
|---|---|---|---|---|---|
| ProjectedCSTypeGeoKey | This key contains a coded value for the projection, datum, and possibly plane coordinate zone. Legal values for this key are listed in section 6.3.3.1 of the GeoTIFF 1.0 standard.<br>This code is provided to specify the projected coordinate system.<br>326zz – UTM Northern Hemisphere<br>327zz – UTM Southern Hemisphere<br>Where zz is the UTM zone number. | 3072 | SHORT (Code from Section 6.3.3.1) | C | Use when GTModelTypeGeoKey = 1.<br>Example:<br>326zz – UTM Northern Hemisphere<br>327zz – UTM Southern Hemisphere<br>Where zz is the UTM zone number. |
| PCSCitationGeoKey | This key is provided to give an ASCII reference to published documentation on the Projected Coordinate System.<br>Free text field for describing the projection and datum. | 3073 | ASCII | C | Use when ProjectedCSTypeGeoKey is present.<br>Citation of Projected Coordinate System.<br>For example:<br>UTM zzN/UTM<br>Where zz is the UTM zone number. |
| ProjectionGeoKey | This key allows specification of the coordinate transformation method and projection zone parameters. | 3074 | SHORT (Code from Section 6.3.3.2) | N | Do not use this key. |
| ProjCoordTransGeoKey | This key allows specification of the coordinate transformation method used. | 3075 | SHORT (Code from Section 6.3.3.3) | N | Do not use this key. |

| | | | | | |
|---|---|---|---|---|---|
| ProjLinearUnitsGeoKey | This key defines the linear units used by the projection | 3076 | SHORT (Code from Section 6.3.1.3) | N | Do not use this key. |
| ProjLinearUnitSizeGeoKey | This key defined the size of user-defined linear units in meters. | 3077 | DOUBLE | N | Do not use this key. |
| ProjStdParallel1GeoKey | This key specifies the latitude of the primary standard parallel. | 3078 | DOUBLE | N | Do not use this key. |
| ProjStdParallel2GeoKey | This key specifies the latitude of the second standard parallel. | 3079 | DOUBLE | N | Do not use this key. |
| ProjNatOriginLongGeoKey | This key defines the longitude of the map projection natural origin. | 3080 | DOUBLE | N | Do not use this key. |
| ProjNatOriginLatGeoKey | This key defines the latitude of the map projection natural origin. | 3081 | DOUBLE | N | Do not use this key. |
| ProjFalseEastingGeoKey | This key provides the easting coordinate of the map projection natural origin. | 3082 | DOUBLE | N | Do not use this key. |
| ProjFalseNorthingGeoKey | This key provides the northing coordinate of the map projection natural origin. | 3083 | DOUBLE | N | Do not use this key. |
| ProjFalseOriginLongGeoKey | This key provides the longitude of the false origin. | 3084 | DOUBLE | N | Do not use this key. |
| ProjFalseOriginLatGeoKey | This key provides the latitude of the false origin | 3085 | DOUBLE | N | Do not use this key. |
| ProjFalseOriginEastingGeoKey | This key provides the easting coordinate of the false origin. | 3086 | DOUBLE | N | Do not use this key. |
| ProjFalseOriginNorthingGeoKey | This key provides the northing coordinate of the false origin. | 3087 | DOUBLE | N | Do not use this key. |
| ProjCenterLongGeoKey | This key provides the longitude of the center of the projection (not necessarily the origin). | 3088 | DOUBLE | N | Do not use this key. |
| ProjCenterLatGeoKey | This key provides the latitude of the center of the projection (not necessarily the origin). | 3089 | DOUBLE | N | Do not use this key. |

| | | | | | |
|---|---|---|---|---|---|
| ProjCenterEastingGeoKey | This key provides the easting coordinate of the center. | 3090 | DOUBLE | N | Do not use this key. |
| ProjCenterNorthingGeoKey | This key provides the northing coordinate of the center. | 3091 | DOUBLE | N | Do not use this key. |
| ProjScaleAtNatOriginGeoKey | This key provides the scale at the origin. This is a ratio, so no units are required. | 3092 | DOUBLE | N | Do not use this key. |
| ProjScaleAtCenterGeoKey | This key provides the scale at the projection center as a ratio. | 3093 | DOUBLE | N | Do not use this key. |
| ProjAzimuthAngleGeoKey | This key provides the azimuth angle east of true north of the central line passing through the projection center. | 3094 | DOUBLE | N | Do not use this key. |
| ProjStraightVertPoleLongGeoKey | This key provides the longitude at the straight vertical pole for Polar Stereographic projections. | 3095 | DOUBLE | N | Do not use this key. |

**Vertical CS Parameter Keys**

## Table 2.5: Vertical CS Parameter Keys

| GeoTIFF Key | Description | Key Id | Type | ROCN | Restricted Field Values |
|---|---|---|---|---|---|
| VerticalCSTypeGeoKey | This key may be used to specify the vertical coordinate system.<br><br>Note: The 'user defined' code shall be used for the EGM 2008 geoid case, or when using a hydrographic datum. The VerticalCitationGeoKey shall be used to identify the coordinate system/datum for the user defined case. | 4096 | SHORT (Code from Section 6.3.4.1) | N | Do not use this key. |
| VerticalCitationGeoKey | This key may be used to document the vertical coordinate system used, and its parameters. | 4097 | ASCII | N | Do not use this key. |
| VerticalDatumGeoKey | This key may be used to specify the vertical datum for the vertical coordinate system. | 4098 | SHORT (Codes from Section 6.3.4.2) | N | Do not use this key. |
| VerticalUnitsGeoKey | This key may be used to specify the vertical units of measurement used in the geographic coordinate system, in cases where geographic CS's needs to reference the vertical coordinate. This, together with the Citation key, comprises the only fully implemented keys in this section, at present. | 4099 | SHORT (Code from Section 6.3.1.3) | N | Do not use this key. |