

<b>REQUEST FOR QUOTATION (THIS IS NOT AN ORDER)</b>		THIS RFQ <input checked="" type="checkbox"/> IS <input type="checkbox"/> IS NOT A SMALL BUSINESS SET-ASIDE		PAGE 1 OF 90 PAGES
1. REQUEST NO. AG-8447-S-13-0006	2. DATE ISSUED 5/22/2013	3. REQUISITION/PURCHASE REQUEST NO.	4. CERT. FOR NAT. DEF. UNDER BDSA REG. 2 AND/OR DMS REG. 1	RATING
5a. ISSUED BY USDA-FSA-APFO, 2222 W. 2300 S., Salt Lake City, UT 84119			6. DELIVER BY (Date) 01/28/2014	
5b. FOR INFORMATION CALL (NO COLLECT CALLS)			7. DELIVERY	
NAME Michelle Clifford		TELEPHONE NUMBER		<input checked="" type="checkbox"/> FOB DESTINATION <input type="checkbox"/> OTHER (See Schedule)
		AREA CODE 801	NUMBER 844-2909	9. DESTINATION
8. TO:			a. NAME OF CONSIGNEE USDA-FSA-APFO	
a. NAME		b. COMPANY		b. STREET ADDRESS 2222 West 2300 South
c. STREET ADDRESS				c. CITY Salt Lake City
d. CITY		e. STATE UT	f. ZIP CODE 84119	e. ZIP CODE 84119
10. PLEASE FURNISH QUOTATIONS TO THE ISSUING OFFICE IN BLOCK 5a ON OR BEFORE CLOSE OF BUSINESS (Date) 6/12/2013		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	30cm Aerial Imagery of Bryce Valley, UT EITHER Item No 1 OR Item No 2 will be awarded; Materials list in Section B-3 Item 1, Priority Areas 1-5 Project Area in Section B-2.1 Orthorectified DOQQQ Tiles & CPMs*	222	RA		
2	Option 1A, Priority Areas 1-7 Project Area in Section B-2.2 Orthorectified DOQQQ Tiles & CPMs*  *Ave price per DOQQQ; some partial  Submit signed quotations on or before 4:00pm MDT June 12, 2013 to address in 5a, Attn: Contracting Officer Quotations must include this form, B-4, Page 2, Attachment D, statement of technical capability and additional information necessary	346	EA		

12. DISCOUNT FOR PROMPT PAYMENT <input type="checkbox"/>	a. 10 CALENDAR DAYS (%) <input type="checkbox"/>	b. 20 CALENDAR DAYS (%) <input type="checkbox"/>	c. 30 CALENDAR DAYS (%) <input type="checkbox"/>	d. CALENDAR DAYS	
				NUMBER	PERCENTAGE

NOTE: Additional provisions and representations  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			16. SIGNER		b. TELEPHONE
b. STREET ADDRESS					
c. COUNTY			a. NAME (Type or print)		AREA CODE
d. CITY	e. STATE	f. ZIP CODE	c. TITLE (Type or print)		NUMBER

## SECTION B

SCHEDULE OF SUPPLIES AND SERVICESB-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. In accordance with FAR 52.219-6, Notice of Total Small Business Set-Aside, all supply portions of this contract must be manufactured or produced by small business concerns in the United States or its outlying areas.

1.2 Intended Use of Imagery

The imagery shall be used by the Forest Service and Natural Resources Conservation Service primarily for watershed planning purposes. In addition, it may be used for resource management, monitoring and inventory and 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 engineering infrastructure design. Aerial imagery depicting the current vegetation condition is needed to establish structural class 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), image processing and geographic information systems (GIS) technologies.

1.3 End of Performance Period and Contract Completion

**All work must be completed and delivered no later than July 24, 2013**, as the funding agreement for this contract expires on that date. Work cannot be performed on this contract beyond July 24, 2013; therefore, any portion of the work not complete at that time will be subject to partial termination. Imagery that is acquired but not completed to its intended deliverable shall be delivered as 4-band, single-point georeferenced image files (GeoTIFF). Payment will be calculated based upon imagery delivered.

**B-2 PROJECT AREA(S)**

Provide aerial imagery services and related materials for the acquisition and production of 30cm resolution, 4-band, direct digital orthorectified imagery. Areas are to be completed in the order of their priority.

**2.1 Project Item 1.** The following is the minimum project area that will be awarded:

<b>Project Item</b>	<b>Project Area</b>	<b>Square Miles</b>	<b>Approximate Acquisition Period</b>	<b>UTM Zone</b>	<b>Project Code</b>	<b>Project Identifier</b>
1	Bryce Valley, Utah Priority Areas 1 through 5	486	June 17, 2013 through July 24, 2013*	12	BRVLY	FS-7-13-1

\*The agreement for this project expires July 24, 2013; therefore, all work must be complete and delivered no later than July 24, 2013.

**2.2 Optional Project Item 1A.** The Government may consider awarding the following area in lieu of Project Item 1, described in B-2.1, if pricing and funding permit. The likelihood of completion of the larger project area indicated in technical capability statement submitted will be a key factor in this decision. EITHER the Project Area in B- 2.1 OR the Optional Project Area in B- 2.2 will be awarded.

<b>Project Item</b>	<b>Optional Project Area</b>	<b>Square Miles</b>	<b>Approximate Acquisition Period</b>	<b>UTM Zone</b>	<b>Project Code</b>	<b>Project Identifier</b>
1A	Bryce Valley, Utah Priority Areas 1 through 7	827	June 17, 2013 through July 24, 2013*	12	BRVLY	FS-7-13-1

\*The agreement for this project expires July 24, 2013; therefore, all work must be complete and delivered no later than July 24, 2013.

**B-3 MATERIALS TO BE DELIVERED**

All deliverables shall be delivered no later than July 24, 2013. The Contractor shall maintain a copy of the digital data sufficient to facilitate corrections made within the terms of the warranty offered.

**3.1 DIGITAL ORTHORECTIFIED QUARTER-QUARTER QUADRANGLES (DOQQQ)**

<b>Item 1: DOQQQ Orthorectified Imagery Deliverables</b>	<b>Format</b>	<b>Metadata Required</b>	<b>Media</b>	<b>Sample Naming (See Exhibit 2)</b>	<b>Gov't Approval Required</b>	<b>Quantity &amp; Frequency</b>
Digital Orthorectified Quarter Quadrangles (DOQQQ) Auxiliary File Pyramid File Metadata File Section C-6.1	GeoTIFF  AUX RRD TXT & XML	Yes, separate file for each DOQQQ	Internal Hard Drive	m_3311162_ne_12_30_20130721.tif  m_3311162_ne_12_30_20130721.aux m_3311162_ne_12_30_20130721.rrd m_3311162_ne_12_30_20130721.txt	Yes	One delivery of the entire project, unless partial delivery is approved.
Compressed Project Mosaic (CPM) Auxiliary File Metadata File Section C-6.2	ECW  AUX TXT	Yes, separate file for each DOQ	Internal Hard Drive	BRVLY_7-13-1_m.ecw  BRVLY_7-13-1_m.aux BRVLY_7-13-1_m.txt	Yes	One file per Priority Area; submit entire project unless partial delivery approved,
RMSE Accuracy and Quality Control Reports (included with DOQQQ) Section C-8.1	ASCII	None	Internal Hard Drive	Contractor determined	No	Include with ortho delivery
ABGPS/IMU Data in raw, projected, and ecef Section C-6.3	ASCII comma delimited text file	Yes	Internal Hard Drive	None	No	One set for project. Deliver with DOQQQs.
Progress Reports Section C-7.1	Content of email See Exhibit 4	No	Email	N/A	Progress Reports	Content of email See Exhibit 4

**B-4 PRICING**

The total cost for each item will be divided into unit pricing by the number of DOQQQs for each item in the bottom row of the table. The first three rows of each table are to show a pricing breakdown by major task. Either Item 1 or Option Item 1A will be awarded, depending upon pricing, feasibility of completion, and funding availability.

**4.1 PROJECT ITEM 1: BRYCE VALLEY, UTAH, PRIORITY AREAS 1 - 5**

<b>PROJECT ITEM 1: BRYCE VALLEY, UTAH, PRIORITY AREAS 1 - 5</b>						
<b>ITEM</b>	<b>DESCRIPTION</b>		<b>QTY</b>	<b>UNIT</b>	<b>UNIT PRICE</b>	<b>TOTAL AMOUNT</b>
Project Item 1	Acquisition of Imagery	B-2.1 B-3	486	Square Miles	\$	\$
	Orthorectified Imagery - DOQQQ	B-2.1 B-3	222	DOQQQ*	\$	\$
	Compressed Project Mosaics	B-2.1 B-3	5	CPM	\$	\$
<b>Total Pricing in Item No 1 on SF-18</b>			<b>222</b>	<b>DOQQQ*</b>	<b>\$</b>	<b>\$</b>

\* The average price of the DOQQQ, as some will be partial

**4.2 OPTION ITEM 1A: BRYCE VALLEY, UTAH, PRIORITY AREAS 1 - 7**

<b>OPTION ITEM 1A: BRYCE VALLEY, UTAH, PRIORITY AREAS 1 - 7</b>						
<b>ITEM</b>	<b>DESCRIPTION</b>		<b>QTY</b>	<b>UNIT</b>	<b>UNIT PRICE</b>	<b>TOTAL AMOUNT</b>
Option Item 1A	Acquisition of Imagery	B-2.2 B-3	827	Square Miles	\$	\$
	Orthorectified Imagery - DOQQQ	B-2.2 B-3	346	DOQQQ*	\$	\$
	Compressed Project Mosaics	B-2.2 B-3	7	CPM	\$	\$
<b>Total Pricing in Item No 2 on SF-18</b>			<b>346</b>	<b>DOQQQ*</b>	<b>\$</b>	<b>\$</b>

\* The average price of the DOQQQ, as some will be partial

## B-5 CONTRACT CLAUSES

### 5.1 52.212-4 -- Contract Terms and Conditions -- Commercial Items (Feb 2012)

### 5.2 Addendum to 52.212-4

#### (a) Post Acceptance Materials Correction

FAR 52.212-4(a), *Inspection/Acceptance*. Regarding the Government's exercise of its post-acceptance rights under this clause, a reasonable time for discovery of any defects will be considered 180 days from acceptance. Correction of defects will be required at no additional cost to the Government.

#### (b) Ownership/Title

FAR 52.212-4(n), *Title*. In addition to the cited paragraph, 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.

### 5.3 52.212-5 -- Contract Terms and Conditions Required to Implement Statutes or Executive Orders -- Commercial Items (Jan 2013)

(a) The Contractor shall comply with the following Federal Acquisition Regulation (FAR) clauses, which are incorporated in this contract by reference, to implement provisions of law or Executive orders applicable to acquisitions of commercial items:

(1) 52.222-50, Combating Trafficking in Persons (FEB 2009) (22 U.S.C. 7104(g)).

\_\_\_\_\_ Alternate I (AUG 2007) of 52.222-50 (22 U.S.C. 7104(g)).

(2) 52.233-3, Protest After Award (AUG 1996) (31 U.S.C. 3553).

(3) 52.233-4, Applicable Law for Breach of Contract Claim (OCT 2004) (Pub. L. 108-77, 108-78).

(b) The Contractor shall comply with the FAR clauses in this paragraph (b) that the contracting officer has indicated as being incorporated in this contract by reference to implement provisions of law or Executive orders applicable to acquisitions of commercial items:

*[Contracting Officer check as appropriate.]*

\_\_\_ (1) 52.203-6, Restrictions on Subcontractor Sales to the Government (Sept 2006), with Alternate I (Oct 1995) (41 U.S.C. 253g and 10 U.S.C. 2402).

\_\_\_ (2) 52.203-13, Contractor Code of Business Ethics and Conduct (Apr 2010) (Pub. L. 110-252, Title VI, Chapter 1 (41 U.S.C. 251 note)).

\_\_\_ (3) 52.203-15, Whistleblower Protections under the American Recovery and Reinvestment Act of 2009 (Jun 2010) (Section 1553 of Pub L. 111-5) (Applies to contracts funded by the American Recovery and Reinvestment Act of 2009).

X (4) 52.204-10, Reporting Executive compensation and First-Tier Subcontract Awards (Aug 2012) (Pub. L. 109-282) (31 U.S.C. 6101 note).

\_\_\_ (5) 52.204-11, American Recovery and Reinvestment Act—Reporting Requirements (Jul 2010) (Pub. L. 111-5).

X (6) 52.209-6, Protecting the Government' Interest When Subcontracting with Contractors Debarred, Suspended, or Proposed for Debarment (Dec 2010) (31 U.S.C. 6101 note).

\_\_\_ (7) 52.209-9, Updates of Publicly Available Information Regarding Responsibility Matters (Feb 2012) (41 U.S.C. 2313).

X (8) 52.209-10, Prohibition on Contracting with Inverted Domestic Corporations (May 2012) (section 738 of Division C of Public Law 112-74, section 740 of Division C of Pub. L. 111-117, section 743 of Division D of Pub. L. 111-8, and section 745 of Division D of Pub. L. 110-161).

\_\_\_ (9) 52.219-3, Notice of HUBZone Set-Aside or Sole-Source Award (Nov 2011) (15 U.S.C. 657a).

\_\_\_ (10) 52.219-4, Notice of Price Evaluation Preference for HUBZone Small Business Concerns (Jan 2011) (if the offeror elects to waive the preference, it shall so indicate in its offer)(15 U.S.C. 657a).

\_\_\_ (11) [Reserved]

X (12) (i) 52.219-6, Notice of Total Small Business Aside (Nov 2011) (15 U.S.C. 644).

\_\_\_ (ii) Alternate I (Nov 2011).

\_\_\_ (iii) Alternate II (Nov 2011).

\_\_\_ (13) (i) 52.219-7, Notice of Partial Small Business Set-Aside (June 2003) (15 U.S.C. 644).

\_\_\_ (ii) Alternate I (Oct 1995) of 52.219-7.

\_\_\_ (iii) Alternate II (Mar 2004) of 52.219-7.

\_\_\_ (14) 52.219-8, Utilization of Small Business Concerns (Jan 2011) (15 U.S.C. 637(d)(2) and (3)).

\_\_\_ (15) (i) 52.219-9, Small Business Subcontracting Plan (Jan 2011) (15 U.S.C. 637 (d)(4).)

\_\_\_ (ii) Alternate I (Oct 2001) of 52.219-9.

\_\_\_ (iii) Alternate II (Oct 2001) of 52.219-9.

\_\_\_ (iv) Alternate III (July 2010) of 52.219-9.

\_\_\_ (16) 52.219-13, Notice of Set-Aside of Orders (Nov 2011) (15 U.S.C. 644(r)).

\_\_\_ (17) 52.219-14, Limitations on Subcontracting (Nov 2011) (15 U.S.C. 637(a)(14)).

\_\_\_ (18) 52.219-16, Liquidated Damages—Subcontracting Plan (Jan 1999) (15 U.S.C. 637(d)(4)(F)(i)).

\_\_\_ (19) (i) 52.219-23, Notice of Price Evaluation Adjustment for Small Disadvantaged Business Concerns (Oct 2008) (10 U.S.C. 2323) (if the offeror elects to waive the adjustment, it shall so indicate in its offer).

\_\_\_ (ii) Alternate I (June 2003) of 52.219-23.

\_\_\_ (20) 52.219-25, Small Disadvantaged Business Participation Program—Disadvantaged Status and Reporting (Dec 2010) (Pub. L. 103-355, section 7102, and 10 U.S.C. 2323).

\_\_\_ (21) 52.219-26, Small Disadvantaged Business Participation Program—Incentive Subcontracting (Oct 2000) (Pub. L. 103-355, section 7102, and 10 U.S.C. 2323).

\_\_\_ (22) 52.219-27, Notice of Service-Disabled Veteran-Owned Small Business Set-Aside (Nov 2011) (15 U.S.C. 657f).

\_\_\_ (23) 52.219-28, Post Award Small Business Program Rerepresentation (Apr 2012) (15 U.S.C. 632(a)(2)).

\_\_\_ (24) 52.219-29, Notice of Set-Aside for Economically Disadvantaged Women-Owned Small Business (EDWOSB) Concerns (Apr 2012) (15 U.S.C. 637(m)).

\_\_\_ (25) 52.219-30, Notice of Set-Aside for Women-Owned Small Business (WOSB) Concerns Eligible Under the WOSB Program (Apr 2012) (15 U.S.C. 637(m)).

X (26) 52.222-3, Convict Labor (June 2003) (E.O. 11755).

X (27) 52.222-19, Child Labor—Cooperation with Authorities and Remedies (Mar 2012) (E.O. 13126).

X (28) 52.222-21, Prohibition of Segregated Facilities (Feb 1999).

X (29) 52.222-26, Equal Opportunity (Mar 2007) (E.O. 11246).

\_\_\_ (30) 52.222-35, Equal Opportunity for Veterans (Sep 2010) (38 U.S.C. 4212).

X (31) 52.222-36, Affirmative Action for Workers with Disabilities (Oct 2010) (29 U.S.C. 793).

\_\_\_ (32) 52.222-37, Employment Reports on Veterans (Sep 2010) (38 U.S.C. 4212).

\_\_\_ (33) 52.222-40, Notification of Employee Rights Under the National Labor Relations Act (Dec 2010) (E.O. 13496).

\_\_\_ (34) 52.222-54, Employment Eligibility Verification (Jul 2012). (Executive Order 12989). (Not applicable to the acquisition of commercially available off-the-shelf items or certain other types of commercial items as prescribed in 22.1803.)

\_\_\_ (35) (i) 52.223-9, Estimate of Percentage of Recovered Material Content for EPA-Designated Items (May 2008) (42 U.S.C. 6962(c)(3)(A)(ii)). (Not applicable to the acquisition of commercially available off-the-shelf items.)

\_\_\_ (ii) Alternate I (May 2008) of 52.223-9 (42 U.S.C. 6962(i)(2)(C)). (Not applicable to the acquisition of commercially available off-the-shelf items.)

\_\_\_ (36) 52.223-15, Energy Efficiency in Energy-Consuming Products (Dec 2007) (42 U.S.C. 8259b).

\_\_\_ (37) (i) 52.223-16, IEEE 1680 Standard for the Environmental Assessment of Personal Computer Products (Dec 2007) (E.O. 13423).

\_\_\_ (ii) Alternate I (Dec 2007) of 52.223-16.

X (38) 52.223-18, Encouraging Contractor Policies to Ban Text Messaging while Driving (Aug 2011).

\_\_\_ (39) 52.225-1, Buy American Act--Supplies (Feb 2009) (41 U.S.C. 10a-10d).

X (40) (i) 52.225-3, Buy American Act--Free Trade Agreements--Israeli Trade Act (Nov 2012) (41 U.S.C. chapter 83, 19 U.S.C. 3301 note, 19 U.S.C. 2112 note, 19 U.S.C. 3805 note, 19 U.S.C. 4001 note, Pub. L. 103-182, Pub. L. 108-77, 108-78, 108-286, 108-302, 109-53, 109-169, 109-283, 110-138, 112-41, 112-42, and 112-43).

\_\_\_ (ii) Alternate I (Mar 2012) of 52.225-3.

X (iii) Alternate II (Mar 2012) of 52.225-3.

\_\_\_ (iv) Alternate III (Nov 2012) of 52.225-3.

\_\_\_ (41) 52.225-5, Trade Agreements (Nov 2012) (19 U.S.C. 2501, *et seq.*, 19 U.S.C. 3301 note).

X (42) 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).

\_\_\_ (43) 52.226-4, Notice of Disaster or Emergency Area Set-Aside (Nov 2007) (42 U.S.C. 5150).

\_\_\_ (44) 52.226-5, Restrictions on Subcontracting Outside Disaster or Emergency Area (Nov 2007) (42 U.S.C. 5150).

\_\_\_ (45) 52.232-29, Terms for Financing of Purchases of Commercial Items (Feb 2002) (41 U.S.C. 255(f), 10 U.S.C. 2307(f)).

\_\_\_ (46) 52.232-30, Installment Payments for Commercial Items (Oct 1995) (41 U.S.C. 255(f), 10 U.S.C. 2307(f)).

X (47) 52.232-33, Payment by Electronic Funds Transfer—Central Contractor Registration (Oct. 2003) (31 U.S.C. 3332).

\_\_\_ (48) 52.232-34, Payment by Electronic Funds Transfer—Other Than Central Contractor Registration (May 1999) (31 U.S.C. 3332).

\_\_\_ (49) 52.232-36, Payment by Third Party (Feb 2010) (31 U.S.C. 3332).

\_\_\_ (50) 52.239-1, Privacy or Security Safeguards (Aug 1996) (5 U.S.C. 552a).

\_\_\_ (51) (i) 52.247-64, Preference for Privately Owned U.S.-Flag Commercial Vessels (Feb 2006) (46 U.S.C. Appx 1241(b) and 10 U.S.C. 2631).

\_\_\_ (ii) Alternate I (Apr 2003) of 52.247-64.

(c) The Contractor shall comply with the FAR clauses in this paragraph (c), applicable to commercial services, that the Contracting Officer has indicated as being incorporated in this contract by reference to implement provisions of law or executive orders applicable to acquisitions of commercial items:

[Contracting Officer check as appropriate.]

X (1) 52.222-41, Service Contract Act of 1965 (Nov 2007) (41 U.S.C. 351, *et seq.*).

X (2) 52.222-42, Statement of Equivalent Rates for Federal Hires (May 1989) (29 U.S.C. 206 and 41 U.S.C. 351, *et seq.*).

\_\_\_ (3) 52.222-43, Fair Labor Standards Act and Service Contract Act -- Price Adjustment (Multiple Year and Option Contracts) (Sep 2009) (29 U.S.C.206 and 41 U.S.C. 351, *et seq.*).

\_\_\_ (4) 52.222-44, Fair Labor Standards Act and Service Contract Act -- Price Adjustment (Sep 2009) (29 U.S.C. 206 and 41 U.S.C. 351, *et seq.*).

\_\_\_ (5) 52.222-51, Exemption from Application of the Service Contract Act to Contracts for Maintenance, Calibration, or Repair of Certain Equipment--Requirements (Nov 2007) (41 U.S.C. 351, *et seq.*).

\_\_\_ (6) 52.222-53, Exemption from Application of the Service Contract Act to Contracts for Certain Services--Requirements (Feb 2009) (41 U.S.C. 351, *et seq.*).

\_\_\_ (7) 52.222-17, Nondisplacement of Qualified Workers (Jan 2013) (E.O. 13495).

\_\_\_ (8) 52.226-6, Promoting Excess Food Donation to Nonprofit Organizations. (Mar 2009) (Pub. L. 110-247).

\_\_\_ (9) 52.237-11, Accepting and Dispensing of \$1 Coin (Sep 2008) (31 U.S.C. 5112(p)(1)).

(d) *Comptroller General Examination of Record* The Contractor shall comply with the provisions of this paragraph (d) if this contract was awarded using other than sealed bid, is in excess of the simplified acquisition threshold, and does not contain the clause at 52.215-2, Audit and Records -- Negotiation.

(1) The Comptroller General of the United States, or an authorized representative of the Comptroller General, shall have access to and right to examine any of the Contractor's directly pertinent records involving transactions related to this contract.

(2) The Contractor shall make available at its offices at all reasonable times the records, materials, and other evidence for examination, audit, or reproduction, until 3 years after final payment under this contract or for any shorter period specified in FAR Subpart 4.7, Contractor Records Retention, of the other clauses of this contract. If this contract is completely or partially terminated, the records relating to the work terminated shall be made available for 3 years after any resulting final termination settlement. Records relating to appeals under the disputes clause or to litigation or the settlement of claims arising under or relating to this contract shall be made available until such appeals, litigation, or claims are finally resolved.

(3) As used in this clause, records include books, documents, accounting procedures and practices, and other data, regardless of type and regardless of form. This does not require the Contractor to create or maintain any record that the Contractor does not maintain in the ordinary course of business or pursuant to a provision of law.

(e)

(1) Notwithstanding the requirements of the clauses in paragraphs (a), (b), (c) and (d) of this clause, the Contractor is not required to flow down any FAR clause, other than those in this paragraph (e)(1) in a subcontract for commercial items. Unless otherwise indicated below, the extent of the flow down shall be as required by the clause—

(i) 52.203-13, Contractor Code of Business Ethics and Conduct (Apr 2010) (Pub. L. 110-252, Title VI, Chapter 1 (41 U.S.C. 251 note)).

(ii) 52.219-8, Utilization of Small Business Concerns (Dec 2010) (15 U.S.C. 637(d)(2) and (3)), in all subcontracts that offer further subcontracting opportunities. If the subcontract (except subcontracts to small business concerns) exceeds \$650,000 (\$1.5 million for construction of any public facility), the subcontractor must include 52.219-8 in lower tier subcontracts that offer subcontracting opportunities.

(iii) 52.222-17, Nondisplacement of Qualified Workers (Jan 2013) (E.O. 13495). Flow down required in accordance with paragraph (1) of FAR clause 52.222-17.

(iv) 52.222-26, Equal Opportunity (Mar 2007) (E.O. 11246).

(v) 52.222-35, Equal Opportunity for Veterans (Sep 2010) (38 U.S.C. 4212).

(vi) 52.222-36, Affirmative Action for Workers with Disabilities (Oct 2010) (29 U.S.C. 793).

(vii) 52.222-40, Notification of Employee Rights Under the National Labor Relations Act (Dec 2010) (E.O. 13496). Flow down required in accordance with paragraph (f) of FAR clause 52.222-40.

(viii) 52.222-41, Service Contract Act of 1965, (Nov 2007), (41 U.S.C. 351, *et seq.*)

(ix) 52.222-50, Combating Trafficking in Persons (Feb 2009) (22 U.S.C. 7104(g)).

\_\_\_ Alternate I (Aug 2007) of 52.222-50 (22 U.S.C. 7104(g)).

(x) 52.222-51, Exemption from Application of the Service Contract Act to Contracts for Maintenance, Calibration, or Repair of Certain Equipment--Requirements (Nov 2007) (41 U.S.C. 351, *et seq.*)

(xi) 52.222-53, Exemption from Application of the Service Contract Act to Contracts for Certain Services--Requirements (Feb 2009) (41 U.S.C. 351, *et seq.*)

(xii) 52.222-54, Employment Eligibility Verification (Jul 2012).

(xiii) 52.226-6, Promoting Excess Food Donation to Nonprofit Organizations. (Mar 2009) (Pub. L. 110-247). Flow down required in accordance with paragraph (e) of FAR clause 52.226-6.

(xiv) 52.247-64, Preference for Privately-Owned U.S. Flag Commercial Vessels (Feb 2006) (46 U.S.C. Appx 1241(b) and 10 U.S.C. 2631). Flow down required in accordance with paragraph (d) of FAR clause 52.247-64.

(2) While not required, the contractor may include in its subcontracts for commercial items a minimal number of additional clauses necessary to satisfy its contractual obligations.

## 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 in GIS applications. 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.

##### 1.5 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 Section B-3.

#### 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.)

### 2.3 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

#### (a) 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 coverage of the shapefile area, including the boundaries and buffers.

#### (b) 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 DOQQQ files required in Section C-6.1; (2) the Compressed Project Mosaics required in Section C-6.2. Government provided templates will not be provided for other required metadata.

#### (c) 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-6.1. The contractor must add the required buffer to the shapefile provided.

### 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 items as 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 which defines the essential elements in securing high quality direct digital imagery.
- (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.
- (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-7.4, Photo-Center Data File).

## C-5 IMAGERY ACQUISITION REQUIREMENTS

### 5.1 Photographic Conditions

Imagery shall be acquired 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.

### 5.3 Imagery Collection Requirements

The Contractor shall obtain precise vertical digital imagery of the awarded areas contained in the shapefile provided in C-2.3(a), as well as buffers required in C-6.1, in accordance with the following technical requirements. Areas are to be flown in the order of their Priority, unless otherwise directed by the Contracting Officer.

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

## C-6 DIGITAL IMAGERY PROCESSING

### 6.1 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 awarded project areas defined in Section B-2 and C-2.3(a), Project Boundary Shapefile. The DOQQQ shall cover the entire image area of one quarter of a quarter of a USGS standard quadrant, with 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: All DOQQQs shall meet the image quality requirements specified in Attachment B, USDA Digital Image Quality Specifications. 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.
- (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) Coverage: When a DOQQQ partially covers the boundary, the Contractor may elect to submit a partial DOQQQ so that it completely covers the boundary. Any partial DOQQQ shall include a 100 meter buffer on the outside of the boundary.
- (e) Pre-Production Sample: The Contractor shall submit a sample set of four (4) DOQQQ’s that make up the same DOQQQ prior to production for Government review. If the project area has a diversified landscape, it is recommended that the contractor provide additional samples to properly reflect the overall project landscapes. The samples shall be a TIFF and meet all image requirements in this section, including TIFF and GeoTIFF tags as specified in Attachment C, submitted on a standard DVD (labeling requirements in Section E are not required). 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.
- (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) File Format. The DOQQQ tiles shall be a 4-band, 8-bits per band georeferenced tagged image file format (GeoTIFF) created in accordance with Attachment C, USDA File Format Specification. Files shall use the same file naming specified in Exhibit 2, File Naming Convention and Exhibit 5, Quarter-Quarter Quad Numbering Logic. The image files and all supporting files shall be stored on a hard drive (See Section C-9) according to the Hard Drive Directory Structure Template, Exhibit 11.
- (i) Raster Support File: The Contractor shall provide an AUX (ESRI and ERDAS compatible Auxiliary 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.
- (j) Metadata: The Contractor shall create an FGDC compliant, per FGDC-STD-001-1998 specification, metadata file for each digital image file using the Government provided template. Metadata must 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. Metadata must parse cleanly through the USGS metadata parser “mp” version 2.9.0 with Remote Sensing Extensions without any errors. The metadata file shall use the same naming convention as the DOQQQ but shall use a “.txt” extension.

## 6.2 Compressed Project Mosaic (CPM)

The Contractor shall produce a 4-band, 8-bit per band, compressed project mosaic (CPM) file for each Ranger District defined in Section B-5.1, 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-6.3(g), Horizontal Accuracy Requirements, shall be preserved when creating the CPM using the imagery associated with the quarter-quarter quadrangle tiles.
- (a) 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, paragraph 12.0, USDA File Format Specification. Files shall use the same file naming specified in Exhibit 2, File Naming Convention. The image files and all supporting files shall be stored on a hard drive (See Section C-9) according to the Hard Drive Directory Structure Template, Exhibit 11.

- (d) Metadata. The Contractor shall create an FGDC compliant, per the FGDC-STD-001-1998 specification, metadata file for each CPM generated using the Government provided template. The metadata must parse cleanly through the USGS metadata parser “mp” version 2.9.0 with Remote Sensing Extensions without any errors. The metadata files shall use the same naming convention as the CPM but shall use a “.txt” extensions.

### 6.3 ABGPS/IMU Data Files

The Contractor shall post-process Airborne Global Positioning System (ABGPS) and Inertial Measurement Unit (IMU) data. The Contractor shall submit the raw and processed data. The processed data shall be compatible with ERDAS Imagine, Leica Photogrammetry Suite (LPS), ERDAS Stereo Analyst for ArcGIS, BAE Socet Set, and ERDAS Stereo Analyst for IMAGINE.

The Contractor shall deliver the data in two coordinates systems: projected (using the same coordinates reference system as the GeoTIFF images) and earth-centered earth-fixed (.ecef) format.

- (a) File Format: The ABGPS/IMU Data shall be an ASCII text file. The ASCII text file shall be comma delimited in the following order of ABGPS/IMU post processed data:

Image File Name, X, Y, Z, Kappa, Phi, Omega

The files shall be stored on a hard drive (See Section C-9) according to the Hard Drive Directory Structure Template, Exhibit 11.

- (b) Metadata: The Contractor shall create a metadata file for each ABGPS/IMU file that includes the date of creation and a brief description of the data. A template will not be provided by the Government.

### 6.4 Supplemental GPS Ground Data

The Contractor shall provide any GPS ground data used to supplement the ABGPS positional data adjustments. For example, base stations or CORS. The data shall use the same datum and projection required for the GeoTIFF image files.

- (a) File Format: Supplemental data shall be delivered in a non-proprietary format mutually agreeable to the Government and Contractor. Contractor may use any consistent and logical naming convention. The files shall be stored on a hard drive (See Section D-1.2) according to the Hard Drive Folder Structure Template, Exhibit 11.

- (b) Metadata: The Contractor shall create a metadata file for each supplemental ground data file that was used to supplement positional data. A template will not be provided by the Government.

## 6.5 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. The project manager's contact information shall be identified, in writing, to the Contracting Officer within 21 calendar days of contract award.

### 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 Subcontract Management

If the Contractor uses subcontractors in the performance of the contract, a plan and procedure will be established to manage its subcontractors. Contractor shall give prior notification of any subcontracts to the Contracting Officer and may be required to submit information for approval of the subcontract. The Contractor is encouraged to maximize its use of partnerships and subcontractors to accomplish the requirements of this contract. However, the Contractor is solely responsible for the performance and cost control of its partnerships and subcontractors.

## 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. Any marginal photography/imagery submitted for inspection which does not meet minimum requirements may be rejected. The marginal photography may be accepted, at the Government's convenience, but shall be subject to a price reduction based on the diminished usability of the product. The nature and urgency of this project may require the Government to make equitable financial adjustments for materials deemed rejectable or where product use is adversely impacted. USDA inspection and acceptance procedures are described in Section E, Inspection and Acceptance.

#### 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) 3½ inch, 3.0 Gbit/s transfer-rate hard drives, with a minimum rotation speed of 7,200 rpm, not more than 2 Terabyte capacity.

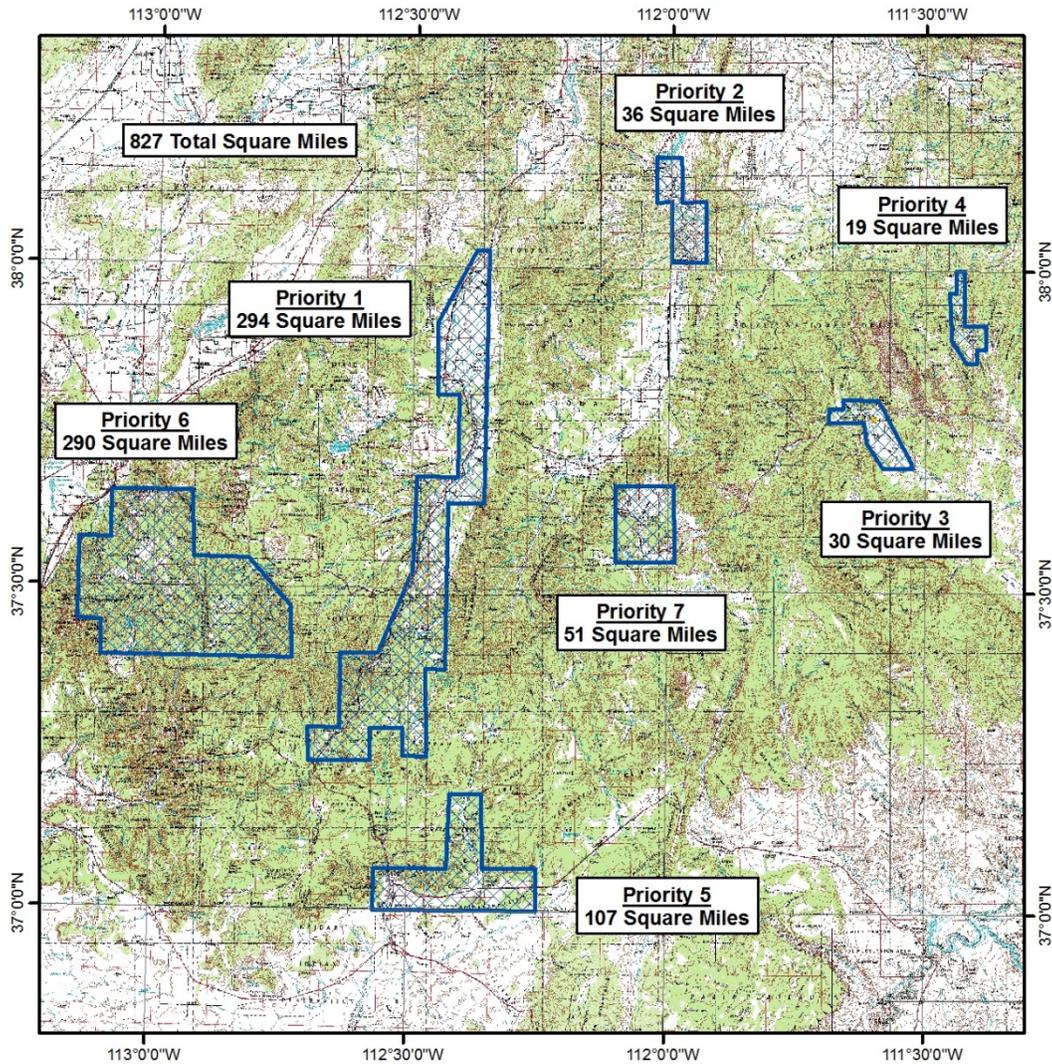
**Maximum disk space that can be used cannot exceed ninety percent (90%) of the individual hard drive capacity.** The SATA drives shall be formatted using Microsoft's NTFS file system. Each drive will be enclosed in a static bag and shall have one label attached directly to the outer surface of the static bag and on 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

<u>Exhibit</u>	<u>Description</u> .....	<u>Page</u>
Exhibit 1	Project Maps (2 pages) ..... Figure 1(a), Project Boundaries Figure 1(b), DOQQQ	24-25
Exhibit 2	File Naming Convention (1 page).....	26
Exhibit 3	Quarter-Quarter Quad Numbering Logic (1 page) .....	27
Exhibit 4	Progress Report (2 pages) .....	28-29
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Exhibit 6	Wage Determination (3 Pages) .....	32-34
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Exhibit 10	TIFF and GeoTiff Tags (2 pages).....	41-42
Exhibit 11	Hard Drive Directory Structure Template (1 page).....	43
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)	
Attachment D:	Solicitation Provisions, including Instructions to Offerors, Evaluation, and Offeror Representations and Certifications (20 pages)	

EXHIBIT 1  
Figure 1(a)  
PROJECT MAP

U.S. DEPARTMENT OF AGRICULTURE  
AERIAL IMAGERY  
SOLICITATION NO: AG-8447-S-13-0006 (USDA-FS-7-13)  
ITEM 1: Bryce Valley,  
UTAH  
GROUND SAMPLE DIST: 30cm (11.8 inches)  
IMAGERY: 4 Band Direct Digital  
PROJECT IDENTIFICATION CODE: BRVLY



**EXHIBIT 1**  
**Figure 1(b)**  
DOQQ

U.S. DEPARTMENT OF AGRICULTURE  
 AERIAL IMAGERY  
 SOLICITATION NO: AG-8447-S-13-0006 (USDA-FS-7-13)  
 ITEM 1: Bryce Valley,  
 UTAH  
 GROUND SAMPLE DIST: 30cm (11.8 inches)  
 IMAGERY: 4 Band Direct Digital  
 PROJECT IDENTIFICATION CODE: BRVLY

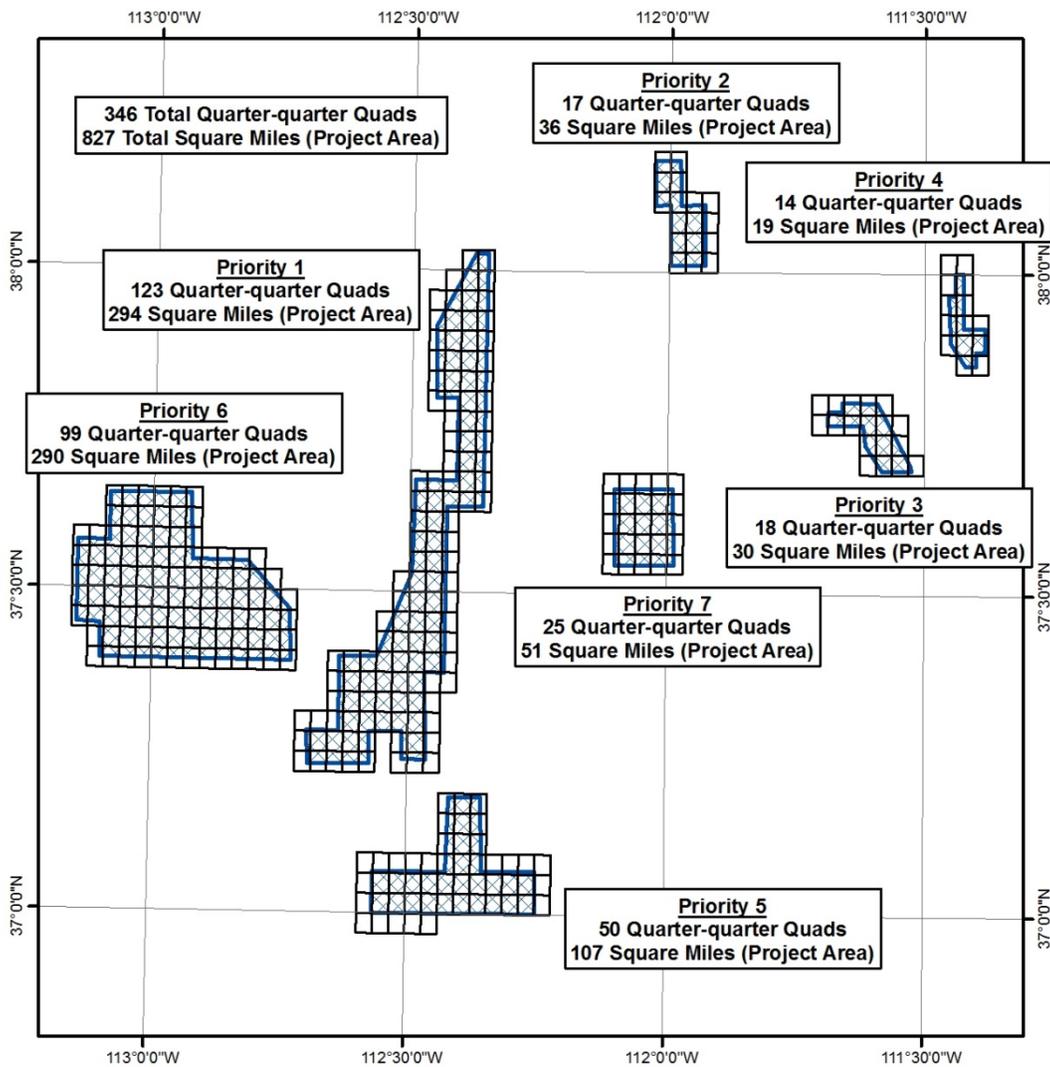


EXHIBIT 2  
FILE NAMING CONVENTION

**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 1° block

<lon> - longitude, identified by 3 digit numerical value of a 1° 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\_20130721.tif

QQ Example: m\_3311162\_ne\_12\_30\_20130721.tif

Q Example: m\_3311162\_12\_30\_20130721.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: BRVLY\_7-13-1\_m.ecw

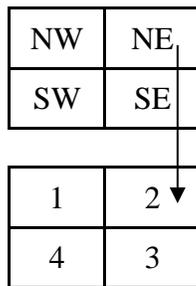
EXHIBIT 3

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"



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

PROGRESS REPORT CONVENTIONSyntax:

HEADER ITEMS: field-name “:”[field-body][CRLF]  
 BODY ITEMS: body item [CRLF]

Header Items:

All four header items are required to be submitted in each and every submittal.

<u>DESCRIPTION</u>	<u>KEYWORD</u>	<u>FORMAT</u>
Contractor Name	CONTRACTOR	Alphanumeric
Contract Award Number	CONTRACT	Numeric (N-YY)
Award Item	ITEM	Numeric (N)
Date Flown	DATE	Date (YYYYMMDD)

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 stations can be submitted as separate reports or as a combined report.

<u>DESCRIPTION</u>	<u>KEYWORD</u>	<u>FORMAT</u>
Latitude	N/A	DD.DDDDD
Longitude	N/A	-DDD.DDDDD
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

When an exposure station is rejected the exposure station will appear in a later report marked with an “R”. Each report submitted should include only one status indicator for a particular exposure station.

## EXHIBIT 4 (CON'T)

PROGRESS REPORT CONVENTION**Sample:**

CONTRACTOR: Acme Photography  
CONTRACT: 7-13  
ITEM: 1  
DATE: 20130827

64.00002,-144.18751,A  
64.04166,-144.18750,A  
64.08332,-144.18752,A  
64.12501,-144.18751,A

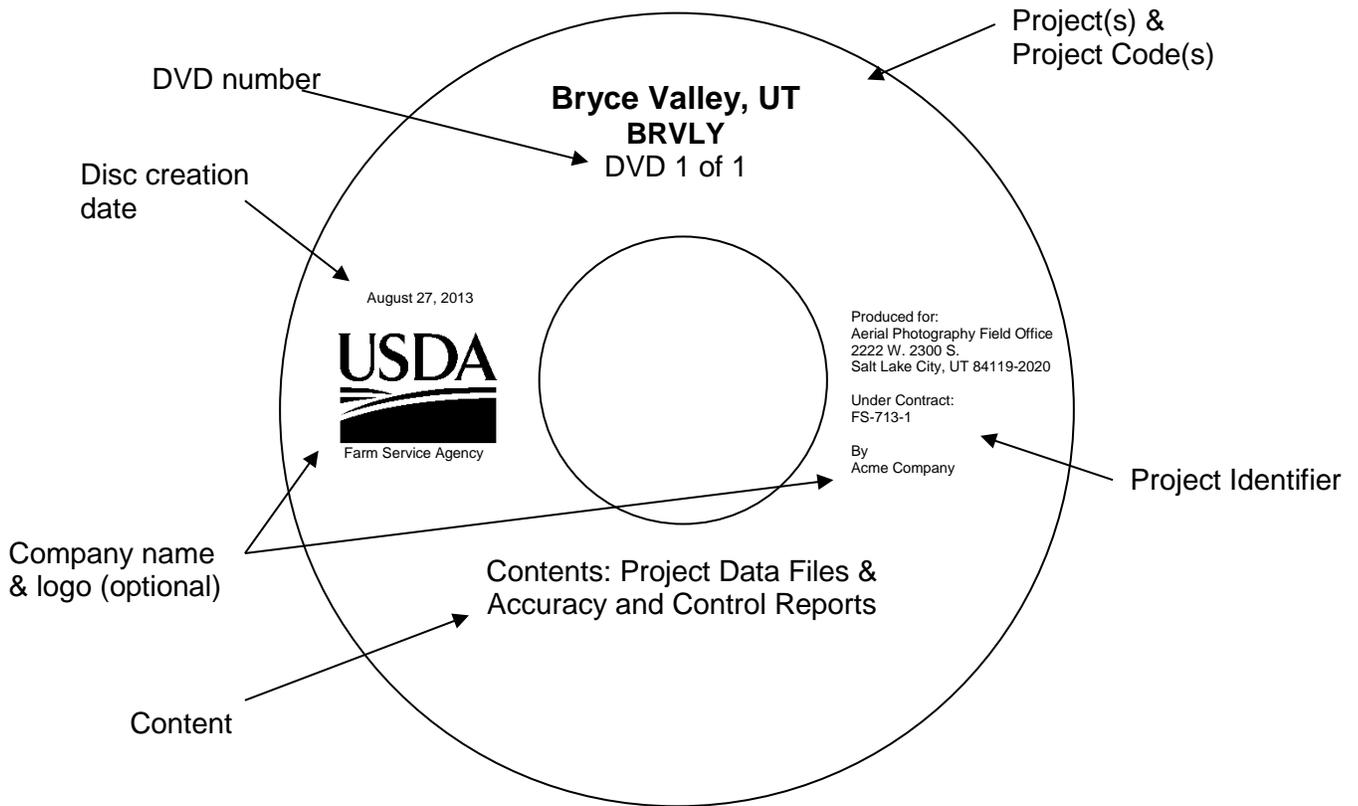
## Notes:

- 1) Text is case insensitive.
- 2) Header fields are not required to occur in any particular order.
- 3) Body items must occur after the headers.
- 4) Each header item must be on a single line (no "folding")
- 5) Keywords may not contain spaces and must be followed immediately by a colon.
- 6) The header items and body items may be separated by a NULL line (a blank line with a carriage-return/line-feed (CRLF)(ASCII 13 and 10).
- 7) Body items can only contain one data item per line and must be terminated by a carriage-return/line-feed.
- 8) Project Identifier must be sent without prefix (i.e., FS-7-13-1 should be sent as 7-13-1).
- 9) Date must be transmitted as YYYYMMDD.
- 10) No e-mail attachments.

EXHIBIT 5

Figure 1

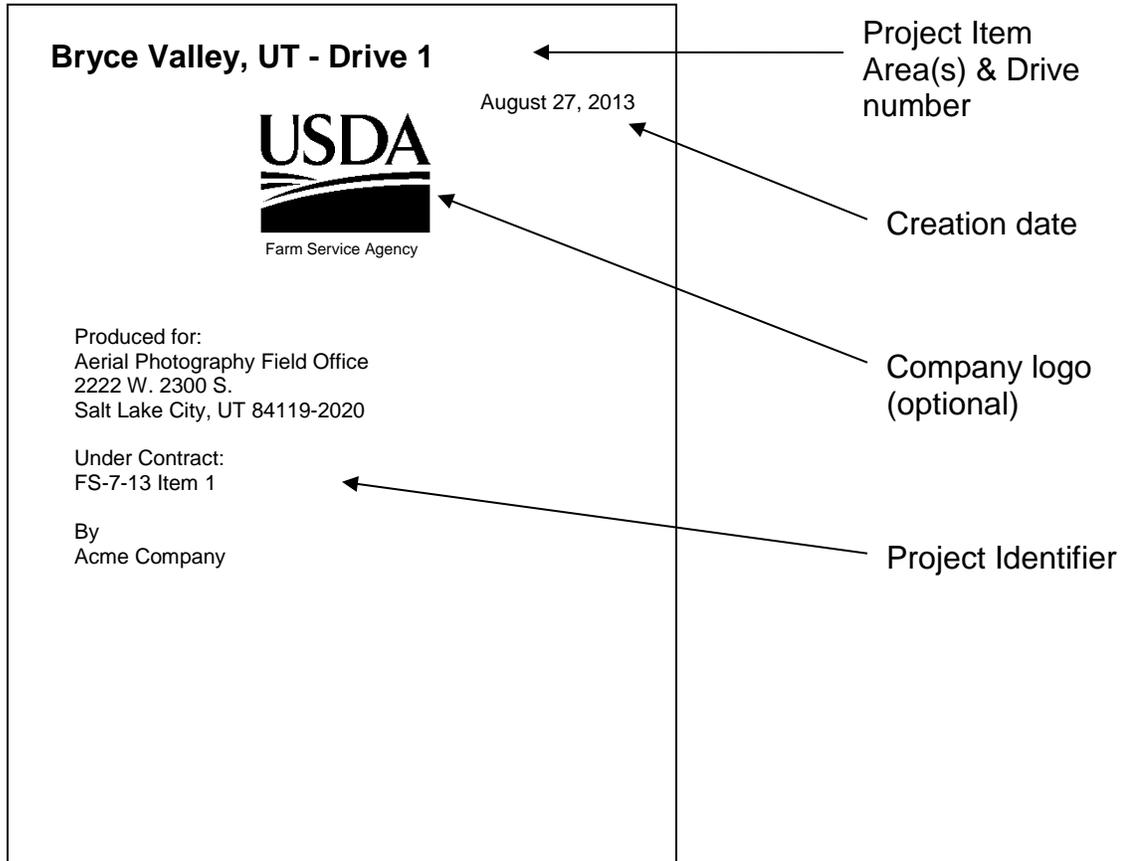
DVD Labeling Requirements



ELEMENT	EXAMPLE
DVD Number	DVD 1 of 1
Company name & logo	Acme Company
Content	Project Data Files & Accuracy and Control Reports
Project Identifier	FS-7-13-1
Creation date	August 27, 2013
Project	Bryce Valley, UT
Project Code	BRVLY

EXHIBIT 5  
**Figure 2**

Hard Drive Labeling Requirements



ELEMENT	EXAMPLE
Company name & logo	Acme Company
Project Identifier	USDA-FS-7-13-1
Creation date	August 27, 2013
Project item area & drive number	Bryce Valley, UT – 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 By direction of the Secretary of Labor	U.S. DEPARTMENT OF LABOR EMPLOYMENT STANDARDS ADMINISTRATION WAGE AND HOUR DIVISION WASHINGTON D.C. 20210
Diane C. Koplewski Director Division of Wage Determinations	Wage Determination No.: 1995-222 Revision No.: 33 Date Of Last Revision: 6/18/2012

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	MINIMUM WAGE RATE
31010 - Airplane Pilot	25.70
(not set) - First Officer (Co-Pilot)	23.40
(not set) - Aerial Photographer	12.84

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:** \$3.71 per hour or \$148.40 per week or \$643.07 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 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)

**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 4174)

**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):** \$1.50 per hour, or \$60.00 per week, or \$260.00 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 \$3.71 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 ordinance, 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

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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 regrading 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, April 2006, unless otherwise indicated. Copies of the Directory are available on the Internet. A links to the Directory may be found on the WHD home page at <http://www.dol.gov/esa/whd/> or through the Wage Determinations On-Line (WDOL) Web site at <http://wdol.gov/>.

**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. Such conforming process shall be initiated by the contractor prior to the performance of contract work by such unlisted class(es) of employees. The conformed classification, wage rate, and/or fringe benefits shall be retroactive to the commencement date of the contract. {See Section 4.6 (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).

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2) After contract award, the contractor prepares a written report listing in order 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, Employment Standards Administration, U.S. Department of Labor, for review. (See section 4.6(b)(2) of Regulations 29 CFR Part 4).

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 insure 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 AND DEFINITIONS

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.

## EXHIBIT 7 (Cont'd)

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.

.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.

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

.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.

.ige: 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 Hierarchical File Format (HFA).

.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.

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

.sup: Stands for "support file." Generally a SOCET SET file containing photogrammetric metadata associated with an image in a project file.

.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.

## EXHIBIT 8

FLIGHT LINE AND EXPOSURE NUMBERING

**Flight Line:** The Contractor shall logically number the flight lines in a consistent manner:

North-South oriented flights: Begin with flight line number 0001, for the western most flight line, and numbering each flight line consecutively moving east through the project (Contractor may choose other techniques for numbering flight lines based on specific project layouts).

East-West oriented flights: Begin with the most northern most flight line.

Flight line numbers: shall start at 0001 and not have any breaks in the consecutive numbering.

Imagery that is duplicated within a flight line due to flight breaks or datum breaks, or is being resubmitted to the Government due to reflights:

Flight breaks and reflights: shall use the original flight line number but shall be padded with a preceding number in the first digit position (consecutively numbered for each flight line). For example:

- (1) If flight line 0014 required a break due to clouds in the original flight, or a datum break, the new flight with overlapping exposures and continuing exposures, would be numbered 1014.
- (2) If flight line 0015 has a reflight, the first reflight would be numbered 1015. Subsequent breaks and reflights in the same flight line would be numbered in sequence (i.e., 2015, 3015, etc.) and would be limited to the nine available numbers as the leading digit.
- (3) Multiple flight breaks and reflights in a single flight line may share the same leading digit if they do not overlap.

**Exposure Number:** The contractor shall consecutively number exposures 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. The exposure number shall restart at 0001 for each flight line.

Imagery that has flight breaks or is being resubmitted to the Government due to reflights: shall keep the originally planned exposure number. For example:

- (1) If exposure 0006 was the last exposure before a break on flight line 0014, the overlapping exposure would be numbered the same 0006 preceded by a “padded” flight line number, for a combined number of 1014-0006
- (2) If exposure 0050 on flight line 0015 has a reflight, the reflight exposures (minimum 3 exps.) would be numbered with identical exposure numbers, preceded by the “padded” flight line number, for a combined number of 1015-0050.

## EXHIBIT 8 (Continued)

FLIGHT LINE AND EXPOSURE NUMBERING

See below for examples of numbering methods for this project.

FLIGHT BREAK:*Line No.*

0014

*Exp. No.*

0001

0002

0003

0004

0005

0006

0007

0008

0009

*Line No.*

1014

*Exp. No.*

0005

0006

- *flight break* -REFLIGHT:*Line No.*

0015

*Exp. No.*

0045

0046

0047

0048

*Exp. No.*

0049

0050

0051

0052

0053

*Reflight  
Line No.*

1015

0049

0050

0051

0052

0053

X

X

X

## 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 – 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

## TIFF and GeoTIFF Tags

Instructions in this Exhibit are intended to supplement Attachment C, USDA Digital File Format Specification.

Table 1, Required TIFF Tags

TAG NAME	DESCRIPTION
ImageDescription tag (270.d, 10e.h)	The ImageDescription tag shall contain the project item name. For example, under this contract the tag will read: "USDA-FSA-APFO-U.S. Forest Service Resource Program"

Table 2, Approved Private Tags

TAG NAME	ID
ModelPixelScaleTag	33550 (SoftDesk)
ModelTransformationTag	34264 (JPL Carto Group)
INGR Packet Data Tag	33918 (Intergraph)
INCR Flag Registers	33919 (Intergraph)
IrasB Transformation Matrix	33920 (Intergraph)
UnUsed	33921 (Intergraph)
ModelTiepointTag	33922 (Intergraph)
GeoKeyDirectoryTag	34735 (SPOT)
GeoDoubleParamsTag	34736 (SPOT)
GeoAsciiParamsTag	34737 (SPOT)

## EXHIBIT 10

## TIFF and GeoTIFF Tags (Continued)

Table 3, Required GeoTIFF MetaTags

TAG NAME	DESCRIPTION
PCSCitationGeoKey (3073.d, c01.h) (required)	<p>This is a free text field for describing the projection and datum. These fields shall describe the datum and projection using &lt;datum&gt;/&lt; projection&gt; format.</p> <p>For example: NAD83 / UTM zone 15N</p>
GTCitationGeoKey (1026.d, 402.h) (for Orthorectified Mosaic Image Tiles)	<p>This is a free text field for providing a description of the imagery. The GeoKey contents shall be in the following form.</p> <p>a. &lt;project&gt; &lt;year&gt; &lt;n&gt;_&lt;lat&gt;&lt;lon&gt;&lt;quad&gt;_&lt;loc&gt;_&lt;xx&gt;_&lt;rr&gt;_&lt;yyyymmdd&gt;</p> <p>Where:</p> <ul style="list-style-type: none"> <li><u>project</u> – Project code</li> <li><u>year</u> - Program year (i.e., 2010).</li> <li><u>m</u> – Spectral type (n=natural color, c=color infrared, or m=multispectral)</li> <li><u>lat</u> – Latitude, identified by 2 digit numerical value of a 1° block (including the leading “0” if needed).</li> <li><u>lon</u> – Longitude, identified by 3 digit numerical value of a 1° block (including the leading “0” if needed).</li> <li><u>quad</u> – Quadrangle location, identified by a 2 digit numerical value to identify the position in a one degree block.</li> <li><u>loc</u> – Quarter quadrangle location, identified by grid letters (nw,ne,sw,se).</li> <li><u>xx</u> – Two digit UTM zone.</li> <li><u>r</u> – Image resolution in centimeters</li> <li><u>yyyymmdd</u> – date of acquisition.</li> </ul> <p>b. Example: 6131202012m_3309403_nw_12_30_20120827</p>

## EXHIBIT 11

**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	<i>No data is to be stored here</i>
\gps\processed	Ecef and projected (same coordinate system as georeferenced or orthorectified imagery) ABGPS IMU data
\gps\raw	Raw ABGPS IMU data
\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). <i>Note: This directory shall only include data if a scanning sensor is used</i>
\ortho	<i>No data is to be stored here</i>
\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.
\pcf	Photo center file in ASCII comma delimited text format
\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  $\pm 5\%$ . For example, a 12-bit image shall not have more than  $\pm 205$  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.

<b>ACCEPTABLE, IMAGE BLEMISHES, SCRATCHED, AND ARTIFACTS</b>	
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	
	MAXIMUM (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  $\pm 59\%$  of the bit depth,  $\pm 4\%$  (aim point of 150,  $\pm 10$  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  $\pm 7.5\%$  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 RGB 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 that 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  $\pm 3$  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.



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# USDA Digital File Format Specification

Version 1.0  
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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 in 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 Hierarchical 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 specification's 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.

Legend for TIFF table:

- 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**

<b>TIFF 6.0 Section 8</b>	<b>Baseline Field Reference Guide</b>				
<b>Field</b>	<b>Description</b>	<b>Tag</b>	<b>Type</b>	<b>ROCN</b>	<b>Restricted Field Values</b>
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. Uncompressed CCITT 1D CCITT Group 3 CCITT Group 4 LZW JPEG Packbits (32773)	259	SHORT	R	Set to 1 (No Compression)
Copyright	Copyright notice.  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. 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. Populate with a value of 0 only if SamplesPerPixel is greater than 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.  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: 0 - WhiteIsZero 1 - BlackIsZero 2 - RGB 3 - Palette Color 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) (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  <b>No to be used if Tiling has been used.</b>	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: 1 - (monochrome or transparency mask) 3 - (RGB) 4 - (4-band data).
Software	Name and version number of the software package(s) used to create the image. 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. <b>No to be used if Tiling has been used.</b>	279	LONG or SHORT	C	Populate per TIFF specification when opting to use strips. (Not to be used if Tiling has been used)
StripOffsets	For each strip, the byte offset of that strip <b>Not to be used if Tiling has been used.</b>	273	SHORT or LONG	C	Populate per TIFF specification when opting to use strips. (Not to be used if Tiling has been used)
SubFileType	A general indication of the kind of data contained in this subfile. 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**

<b>TIFF 6.0 Section 11</b>	<b>CCITT Bilevel Encodings</b>				
<b>Field</b>	<b>Description</b>	<b>Tag</b>	<b>Type</b>	<b>ROCN</b>	<b>Restricted Field Values</b>
Compression	Compression scheme used on the image data. Uncompressed CCITT 1D CCITT Group 3 CCITT Group 4 LZW JPEG 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**

<b>TIFF 6.0 Section 12</b>	<b>Document Storage and Retrieval</b>				
<b>Field</b>	<b>Description</b>	<b>Tag</b>	<b>Type</b>	<b>ROCN</b>	<b>Restricted Field Values</b>
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 (compressed) 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 retain tonal 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. Possible values are: 1 – unsigned integer data 2 – two’s complement signed integer data. 3 – IEEE floating point data [IEEE] This field does not specify the size of data samples; the BitsPerSample field does this.	339	SHORT	R	Default value is 1.  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 Section 21	YCbCr Images				
Field	Description	Tag	Type	ROCN	Restricted Field Values
PhotometricInterpretation	The color space of the image.  For Specification: Allowed values are: 0 - WhiteIsZero 1 - BlackIsZero 2 - RGB 3 - Palette Color 4 - Transparency Mask 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.

GeoTIFF Sepcification Document: Revision 1.0 dated December 28, 2000

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.

### Legend for GeoTIFF table:

- 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:
  - o R: required
  - o O: optional
  - o C: conditional (Condition must be specified)
  - o 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 conjunction 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 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: 1 – ModelTypeProjected 2 – ModelTypeGeographic
GTRasterTypeGeoKey	<p>Establishes the raster space coordinate system – RasterPixellsPoint, RasterPixellsArea.</p> <p>a. The "PixellsArea" 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).</p> <p>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.</p> <p>c. The desired result is to have “Exact Pixel Registration,” meaning that pixels from multiple images line up exactly. This should not be</p>	1025	6.3.1.2 codes	R	The applicable codes are: 1 – RasterPixellsArea (use for imagery products ) 2 – RasterPixellsPoint (use for non-imagery discrete coverage data)

	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. Example: 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. 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. This code is provided to specify the projected coordinate system. 326zz – UTM Northern Hemisphere 327zz – UTM Southern Hemisphere Where zz is the UTM zone number.	3072	SHORT (Code from Section 6.3.3.1)	C	Use when GTModelTypeGeoKey = 1. Example: 326zz – UTM Northern Hemisphere 327zz – UTM Southern Hemisphere 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. Free text field for describing the projection and datum.	3073	ASCII	C	Use when ProjectedCSTypeGeoKey is present. Citation of Projected Coordinate System. For example: UTM zzN/UTM 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**

<b>GeoTIFF Key</b>	<b>Description</b>	<b>Key Id</b>	<b>Type</b>	<b>ROCN</b>	<b>Restricted Field Values</b>
VerticalCSTypeGeoKey	This key may be used to specify the vertical coordinate system.  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.