

## Appendix C Guide Specification For Photogrammetric Mapping and Aerial Photography Services<sup>1</sup>

### INSTRUCTIONS

1. General. This guide specification is intended for use in preparing Architect-Engineer (A-E) contracts for professional photogrammetric mapping services. These specifications are applicable to all A-E contracts used to support U.S. Army Corps of Engineers (USACE) civil works and military construction design, construction, operations, maintenance, regulatory, and real estate activities. This guide shall be used primarily for contracts obtained using Public Law (PL) 92-582 (Brooks Act) qualification-based selection procedures and for which unit prices in the contract schedule are negotiated. Limited exceptions to this contracting method are identified herein. This guide supersedes EM 1110-1-1000 Engineering and Design PHOTOGRAMMETRIC MAPPING, dated March 31, 1993.

2. Coverage. This guide specification contains the technical standards and/or references necessary to specify all phases of a photogrammetric mapping project. These include aircraft operations; aerial cameras; aerial mapping film and film processing; photographic prints and film enlargements; photogrammetric rectification and stereocompilation; map planimetric feature and topographic detailing; drafting; digital mapping; generation of Computer-Aided Drafting and Design (CADD) system, Geographic Information System (GIS), Land Information System (LIS), Automated Mapping/Facility Management (AM/FM), and other spatial databases; ground survey control support; supplemental ground topographic survey densification; and contractor quality control functions.

3. Applicability. The following types of A-E contract actions are supported by these instructions:
- a. Fixed-price photogrammetric mapping and aerial photography service contracts.
  - b. Indefinite delivery type (IDT) photogrammetric mapping contracts.
  - c. A multidiscipline surveying and mapping IDT contract in which photogrammetric services are a line item supporting other surveying, mapping, hydrography, and/or other surveying services.
  - d. A work order or task order placed against an IDT contract.
  - e. Design and design-construct contracts that include incidental surveying and mapping services (including Title II services). Both fixed-price and IDT design contracts are supported by these instructions.

4. Contract Format. The contract format outlined in this guide follows that prescribed in Appendix B of Principal Assistant Responsible for Contracting Instruction Letter 92-4 (PARC IL 94-4), dated 18 December 1992. PARC IL 92-4 incorporates changes to Part 14.201(a)(1) of the 1989 edition of the Engineer Federal Acquisition Regulation Supplement (EFARS). The PARC IL 92-4 contract format is designed to support PL 92-582 (Standard Form (SF) 252) qualification-based A-E procurement actions.

5. Photogrammetric Line Mapping Applications. This guide is intended primarily to support complete, field-to-finish type contracts written for large- scale (1 in. = 400 ft or greater) site plan mapping work, as

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<sup>1</sup> Appendix D contains a generic guide specification and two additional sample guide specifications for the collection of photogrammetric mapping data through A-E Contracts. The two sample guide specifications (Section C and Section D) are from U.S. Army Engineer Districts, Detroit and St. Louis.

would be used for design and subsequent contracted construction plans and specifications. Typical applications include building or structure design or relocation; river, harbor, floodplain, or reservoir project mapping; and installation master planning activities. Both planimetric feature detail and topographic data are generated or encoded using high-precision stereoscopic plotting instruments (or softcopy workstations). Specifying field-to-finish implies that all phases of the photogrammetric process, from aerial photography through final drafting, are performed by the professional contractor. In addition, the contractor is responsible for exercising complete quality control over all phases of the work.

6. Supplemental Aerial Photo Products. This guide may also be used to specify other associated photographic products commonly used in USACE design, planning, construction, and regulatory enforcement work. Requirements for these products would be included as supplemental line items in a professional A-E services contract intended for design mapping.

a. Air Photo Plan Drawings. These are typically film-positive, screened transparencies on standard drawing film format developed from enlarged aerial photos. They are often used for construction location reference drawings or navigation project condition reports. Since they do not have a consistent scale, they should not be used for detailed design.

b. Aerial Photography. These include standard 9- by 9-in. aerial photographs using precision aerial mapping cameras. Such photography may be intended for subsequent line mapping compilation by either USACE hired-labor forces or another A-E contractor. Alternatively, it may be intended only for regulatory enforcement or environmental interpretative purposes, or for general reconnaissance photography of a large region. Composite paper mosaics may be constructed from this photography. Either black and white, color, or infrared photography might be specified.

c. Photographic Enlargements. Aerial photo paper enlargements, either from near-vertical or oblique photography, may or may not be obtained from high-precision aerial mapping cameras. These products are normally used for display or general planning purposes.

The distinguishing factor about these supplemental items is that they are generally uncontrolled products; i.e., the photography is not converted into a base map or photograph free from scale error or relief displacement. Although these items may be included in an A-E IDT contract, they may also be procured using price competition methods, as explained in paragraph 7 below.

7. Aerial Photography Procurement Using Other than A-E Forms. This guide is also designed to support procurement of basic aerial photography by methods other than A-E service contracts. Part 36 of the EFARS prescribes that basic aerial photography may be obtained by price competition, where award is based primarily on price (i.e., low-bid), and not using professional/technical qualification-based selection criteria. This EFARS provision strictly pertains to contracting for aerial photography and delivery of raw photographic negatives or positives to the Government.

a. Strictly price-competitive (i.e., low-bid) procurement shall not be used if the photography is an integral part of a broader scoped contract that results in a map product, or if photogrammetric mensurations, mapping, rectifications, or any like realignment or rescaling is to be performed on the photography. Price-competitive procurement shall also not be used if photographic spatial data are input to any type of GIS, CADD system, LIS, or any other similar database that develops vector or raster/coordinate relationships or attributes. In all such instances, PL 92-582 qualification-based selection procedures must be used.

b. Some USACE photographic (not photogrammetric) needs may be procured using price competition methods. However, the following factors must be fully considered by USACE Commands in determining whether to use price competition or PL 92-582 methods:

(1) Price-competitive (low-bid) procurement methods may be applicable to aerial photography used for photo interpretative work, such as regulatory enforcement, where the 9- by 9-in. prints can be used as is. No subsequent mapping is intended from such photography.

(2) When aerial photography is to be compiled into line maps by a party other than the firm that flew it, a certain amount of quality control is lost over the process. Inadequacies in the photography may not be detected until stereocompilation commences, which may occur long after the aerial photography contract has been closed out. Likewise, photo control field surveys are best performed under the direct supervision and control of the firm responsible for compilation. Unless there are other compelling reasons (e.g., in-house stereocompilation), full field-to-finish mapping should be performed by the same contractor using PL 92-582 procurement. Use of low-bid procurement methods to obtain the aerial photography, and then passing such photography to another photogrammetric mapping firm for compilation, is a practice (or procurement strategy) that should be avoided if at all possible.

(3) Price-competitive procurement methods require exacting specifications and more rigorous Government quality control. Experienced in-house personnel must be capable of assessing photographic quality, coverage, and suitability for subsequent aerotriangulation and stereocompilation. Unless such activities are routinely performed within the USACE Command, evaluating contract performance is marginal, at best.

(4) When only small-scale, reconnaissance-type photography is required over a large area (e.g., an installation, watershed basin, or state), a price-competitive low-bid procurement action would be recommended.

(5) Air photo paper enlargements of a small, specific site may often be obtained by simple purchase order.

(6) Use of strictly price-competitive IDT contracts is not recommended.

c. USACE Commands must ultimately assess the project requirements, along with their in-house quality control capabilities, in deciding between the two forms of contracting. As a general rule of thumb, if the photographic products are to be used for construction contract plans and specifications, reproducible project condition drawings, boundary delineation or demarcation, or environmental/regulatory assessment or litigation, or will be encoded into some type of GIS, LIS, AM/FM, or CADD spatial database, the recommended method is to follow PL 92-582 qualification-based procurement methods.

8. General Guide Use. In adapting this guide specification to any project, specific requirements will be changed as necessary for the work contemplated. Changes will be made by deletions or insertions within this format. With appropriate adaptation, this guide form may also be tailored for direct input in the Standard Army Automated Contracting System (SAACONS). Clauses and/or provisions shown in this guide will be renumbered during SAACONS input.

9. Guide Arrangement. The work items listed in the Section B price schedule and Section C technical specifications are in the general order of performance on a typical photogrammetric mapping project. Scheduled line items in Section B follow the same general sequence as major paragraphs in Section C.

10. Insertion of Technical Specifications. Engineer Manual (EM) 1110-1-1000, Photogrammetric Mapping, should be attached to and made part of any contract for aerial photography or photogrammetric mapping services. This EM contains specifications and quality control criteria for the total (field-to-finish) execution of a photogrammetric mapping project.

a. The latest edition of the American Society for Photogrammetry and Remote Sensing's (ASPRS) Manual of Photogrammetry should also be attached by reference to any contract. This manual represents a comprehensive treatment of aerial photography and photogrammetric mapping and should be deferred to in cases of disputes over quality of services delivered.

b. Technical specifications for photogrammetric mapping that are specific to the project (including items such as the scope of work, procedural requirements, and accuracy requirements) will be placed under Section C of the SF 252 (Block 10). The prescribed format for placing these technical specifications is contained in this guide. Project-specific technical specifications shall not contain contract administrative functions—these should be placed in more appropriate sections of the contract.

c. Technical specifications for other survey functions required in a photogrammetric mapping services contract may be developed from other Civil Works Construction Guide Specifications that are applicable to the surveying and mapping discipline(s) required.

d. Standards and other specifications should be checked for obsolescence and for dates and applicability of amendments and revisions issued subsequent to the publication of this specification. Use Engineer Pamphlet (EP) 25-1-1, Index of USACE/OCE Publications. Maximum use should be made of existing EMs, Technical Manuals, and other recognized or current industry standards and specifications.

e. Many technical provisions in this guide have incorporated both traditional analytical and softcopy stereoplotting and compilation methods. The on-going developments and refinements in planimetric and topographic mapping, orthophotography, digital photography, GIS, CADD, etc. require the guide user to ensure that redundant, obsolete, or inefficient procedures in this guide are continuously updated.

11. Cost Estimates for Photogrammetric Mapping Services. General guidance on preparing independent Government cost estimates is contained in Chapter 11 of EM 1110-1-1000. The unit of measure (lump sum/job or labor interval) shown in Section B will be highly project dependent. Given the nonlinearity of many of these services, fixed unit prices in an IDT contract may be difficult to establish. In some instances, a work order placed against an IDT contract may require adjustments for services not contemplated in the initial base contract.

12. Alternate Clauses/Provisions or Options. In order to distinguish between required clauses and optional clauses, required clauses are generally shown in capital letters. Optional or selective clauses are generally in lower case. In other instances, alternate clauses/provisions may be indicated by brackets “[ ]” and/or clauses preceded by a single asterisk “\*”. A single asterisk signifies that a clause or provision that is inapplicable to the particular section may be omitted, or that a choice of clauses may be made depending upon the technical surveying and mapping requirement. Clauses requiring insertion of descriptive material or additional project-specific specifications are indicated by underlining inside brackets (e.g., “[\_\_\_\_\_]”). In many instances, explanatory notes are included regarding the selection of alternate clauses or provisions.

13. Notes and Comments. General comments and instructions used in this guide are contained in blocked asterisks. These comments and instructions should be removed from the final contract.

14. Indefinite Delivery Type (IDT) Contracts and Individual Work Order Assignments. Contract clauses pertaining to IDT contracts, or task orders thereto, are generally indicated by notes adjacent to the provision. These clauses should be deleted for fixed-price contracts. In general, sections dealing with IDT contracts are supplemented with appropriate comments pertaining to their use. Work orders against a basic IDT contract should be constructed using the general format contained in Section C of this guide. Clauses contained in the basic contract should not be repeated in work orders. Contract Section C in this guide is applicable to any type of photogrammetric mapping service contracting action.

CONTENTS

SECTION A SOLICITATION/CONTRACT FORM

SECTION B SERVICES AND PRICES/COSTS

SECTION C STATEMENT OF WORK

C.1 GENERAL

C.2 LOCATION OF WORK

C.3 TECHNICAL CRITERIA AND STANDARDS

C.4 WORK TO BE PERFORMED

C.5 AIRCRAFT FLIGHT OPERATIONS AND EQUIPMENT REQUIREMENTS

C.6 AERIAL PHOTOGRAPHY SCALE AND RELATED COVERAGE PARAMETERS

C.7 AERIAL CAMERA SPECIFICATIONS

C.8 AERIAL FILM SPECIFICATIONS AND PROCESSING REQUIREMENTS

C.9 CONTACT PRINT AND DIAPOSITIVE SPECIFICATIONS

C.10 PHOTOGRAPHIC INDEX REQUIREMENTS

C.11 UNCONTROLLED PHOTOGRAPHIC ENLARGEMENTS, AIR PHOTO PLANS, AND PHOTO  
MOSAICS

C.12 CONTROLLED/RECTIFIED PHOTO PLANS AND ORTHOPHOTOGRAPHY

C.13 GROUND PHOTO CONTROL SURVEY REQUIREMENTS

C.14 STEREOCOMPILATION, DRAFTING, AND CADD SPECIFICATIONS

C.15 QUALITY CONTROL AND QUALITY ASSURANCE STANDARDS

C.16 NONTOPOGRAPHIC PHOTOGRAMMETRY SPECIFICATIONS

C.17 SUBMITTAL REQUIREMENTS

C.18 PROGRESS SCHEDULES AND WRITTEN REPORTS

SECTION D CONTRACT ADMINISTRATION DATA

SECTION E SPECIAL CONTRACT REQUIREMENTS

SECTION F CONTRACT CLAUSES

SECTION G LIST OF ATTACHMENTS

SECTION H REPRESENTATIONS, CERTIFICATIONS, AND OTHER STATEMENTS OF OFFERERS

SECTION I INSTRUCTIONS, CONDITIONS, AND NOTICES TO OFFERERS

THE CONTRACT SCHEDULE

SECTION A

SOLICITATION/CONTRACT FORM

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NOTE: Include here SF 252 in accordance with the instructions in Appendix B of PARC IL 92-4.  
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SF 252 -- (Block 5): PROJECT TITLE AND LOCATION

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NOTE: Sample title for fixed-price contract:  
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PHOTOGRAMMETRIC SITE PLAN MAPPING SURVEYS IN SUPPORT OF PRELIMINARY CONCEPT DESIGN OF FAMILY HOUSING COMPLEX ALPHA, AND RELATED INSTALLATION MASTER PLANNING GEOGRAPHIC INFORMATION SYSTEM DATA BASE UPDATES, AT FORT \_\_\_\_\_, ALABAMA.

PHOTOGRAMMETRIC SITE PLAN MAPPING, SEMI-CONTROLLED AIR PHOTO PLAN DRAWINGS, AND AERIAL PHOTO ENLARGEMENTS FOR DREDGE DISPOSAL DESIGN, CONSTRUCTION, AND BOUNDARY DEMARCATION, OF \_\_\_\_\_ [PROJECT], \_\_\_\_\_, CALIFORNIA.

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NOTE: Sample title for indefinite delivery type contract:  
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INDEFINITE DELIVERY CONTRACT FOR PROFESSIONAL PHOTOGRAMMETRIC MAPPING, AND RELATED SURVEYING SERVICES, IN SUPPORT OF VARIOUS \*[CIVIL WORKS] [MILITARY CONSTRUCTION] PROJECTS \*[IN] [ASSIGNED TO] THE \_\_\_\_\_ DISTRICT.  
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NOTE: When other surveying services are also required as part of a broader surveying contract, the clause shown in EAL 90-1 shall be used.  
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## SECTION B

### SERVICES AND PRICES/COSTS

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NOTE: The fee schedule for photogrammetric mapping and related survey services should be developed in conjunction with the preparation of the independent Government estimate (IGE) along with the technical specifications. Two general unit of measure (U/M) methods may be used in a fee schedule for photogrammetric mapping services: (1) an Hourly or Daily Rate basis (2) a Cost per Unit Area basis.

The following tables contain sample fee schedules that may be tailored for use on most photogrammetric mapping service contracts. The guide writer should select those line items applicable to the project, or for those projects envisioned over the course of an IDT contract. Other line items may be added that are unique to the project(s). If applicable, a separate fee schedule for contract option periods should be developed and negotiated during contract negotiations and included with the contract during initial award. Unit prices (U/P) shall include direct and indirect overheads. Profit is not included on IDT contract unit prices. Profit is calculated per project or task order and is based on length of time for the work, risk, and minority participation.

Procedures for estimating line item unit prices are described in EM 1110-1-1000. Determination of these estimated unit prices must conform to the detailed analysis method, or "seven-item breakdown." The scope of each scheduled line item used in Section B must be thoroughly defined--either with the line item in Section B or at its corresponding reference in Section C of the contract. Many of the line item units of measure comprise costs from a variety of sources. These sources are combined in the IGE to arrive at the scheduled rate. For example, aircraft operation, maintenance, and labor costs are reduced to a cost per flight hour. Survey crew day rates include labor, travel, transportation, expendable materials, and numerous other items that are developed as part of the IGE.

On IDT contracts, the specification writer should strive to avoid scheduling items with little probability of being required during the contract period. Since each line item must be separately estimated and negotiated, considerable Government (and contractor) resources may be consumed in developing negotiated unit costs for unused items. For example, line items such as orthophoto map compilation or infrared photography would not be included on an IDT contract unless there is a fair degree of assurance that these items would be required on a subsequent work order.

In addition, the specification writer should attempt to include only those line items that represent a major cost activity/phase in performing photogrammetric mapping. Cost estimating emphasis and resources should be committed to major cost items such as stereocompilation, control surveys, drafting, and aerial photography, and in that order. Avoid cluttering the schedule with small and relatively insignificant (to the overall project cost) supply and material items, again minimizing the administrative costs of estimating and negotiating these items. These should be included as part of a major line item or be contained in the overhead of the firm. Examples of normal supply items that the guide user should avoid scheduling are field survey books or bundles of 2- by 2-in. survey stakes. These items would, however, be compensated for in the IGE. Care must be taken in developing these schedules with the IGE to preclude duplication of costs between line items or overheads. This is particularly important when breaking out analytical stereoplotter costs with associated computer and CADD actions. The guide user and cost estimator must have a good working knowledge of photogrammetric mapping production processes to properly allocate time and costs.

The following schedules may be tailored for either A-E fixed-price or A-E IDT contracts. For fixed-price contracts, the estimated quantities are available from the Government estimate. For IDT contracts, a unit quantity for each line item would be negotiated and included in the basic contract. Daily units of measure

**EM 1110-1-1000**  
**31 Jul 02**

may be modified to hourly or other nominal units if needed. Lump sum or areal units of measure are also included or may be developed for some of the services. For non-A-E type contracts for photography, the schedule would have to be modified for bid submittal. The item numbers shown are for reference in this guide only--they would be renumbered in the final contract.

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ITEM	DESCRIPTION	QUAN	U/M	U/P	AMT
0500	<p>Aircraft flight operations: aircraft ownership, operation, and maintenance costs; camera; GPS; pilot; cameraman; fuel; landing fees; etc., based on accumulated flight time between Contractor's home base/airfield to project site, between project sites, and/or temporary landing fields near project sites (if applicable), over project site(s), and return to home base/airfield. *[a minimum transit time of 2.5 * [ ] hours will be applicable to each task order, unless waived by the contractor.]</p> <p>{NOTE: Negotiated hourly rate is determined primarily from field pricing support audit of firm's aircraft operating costs.}</p>		FLIGHT HOUR		
0501	<p>* Additional aircraft flight crew costs: Flight crew and cameraman labor and per diem on temporary duty at project site.</p> <p>{NOTE: This line item is included only when a unique project scope, size, or location requires the aircraft and crew to temporarily locate at the project site. Normal standby time at the home base is not included in this item; it is more properly included in the firm's overhead.}</p>		C/DAY		
0502	<p>* Emergency aircraft and flight crew standby: Surcharge cost of aircraft and crew for dedicating operations exclusively to Government-directed work; during emergency operation periods.</p> <p>{NOTE: Include on IDT contracts as applicable. U/P is essentially firm's overhead rate for aircraft and crew while on nonflight status.}</p>		C/DAY		
0503	<p>* Aircraft and flight crew surcharge for *[oconus] [ ] transit, travel, and related nonstandard fees and expenses associated therewith.</p>		JOB	L/S	

ITEM	DESCRIPTION	QUAN	U/M	U/P	AMT
0503 (Continued)	{NOTE: Use, as applicable, for either nonconventional or OCONUS (outside the continental United States) sites and/or projects. Fee is in addition to those routinely covered above, and could include items such as aircraft long-distance transit modifications, customs fees, fuel surcharges, OCONUS per diem, etc.}				
0504	*[Other requirements]				
	<p>Aerial photography: Obtain stereoscopic coverage *[black and white panchromatic] [color] [ ] photography using high-precision aerial mapping camera in accordance with scale, coverage, and other applicable technical specifications contained in Section C *[and/or task order scope], and maps or attachments thereto; and perform all professional laboratory film processing and preparation functions, to include labor and materials for developing, trimming, cleaning, indexing, labeling, and shipping of negatives and positives.</p> <p>Aerial photography shall be flown with a 6-in. camera at an altitude that results in a negative scale *[of ] [indicated in Section C].</p> <p>{NOTE: For IDT contracts, add the following statement: The Contractor may waive this minimum order if he is able to consume a roll of film over several projects.}</p> <p>* A minimum delivery of thirty (30) *[ ] exposures will apply to each order placed against this contract, unless waived by the Contractor.</p> <p>Furnish *[one (1)] [ ] set(s) of preliminary check prints and *[two (2)] [ ] sets of final contact prints for each exposure. {Note: Add control prints, if needed.}</p>				

ITEM	DESCRIPTION	QUAN	U/M	U/P	AMT
(Continued)	{NOTE: Specify only those film types below that will be used on the project and/or IDT contract. Detailed material and technical specifications for each film type specified must be included in Section C of the contract.}				
0800	* BLACK AND WHITE PANCHROMATIC FILM		EXP		
0801	* COLOR AERIAL FILM		EXP		
0802	* COLOR INFRARED FILM (FALSE COLOR)		EXP		
0803	* [OTHER] {NOTE: Add material/ technical requirements at Section C}		EXP		
0900	* ADDITIONAL CONTACT PRINTS {NOTE: This item may be scheduled on IDT contracts if there is a possibility that additional contact prints (beyond the required delivery amount) may be required on one or more orders. Include a line item for each type of film scheduled above.}		EACH		
0901	Film diapositives: Black and white film transparencies Color film transparencies		EACH EACH EACH		
0902	* Obtain near-vertical and/or oblique aerial photography for *[controlled mapping] [general uncontrolled photo enlargement] uses, using *[aerial mapping camera] [hand-held camera] and in accordance with Section C specifications.		JOB		
0903	*[Other requirements]				
	Photo index: Professional labor and materials required to prepare standard photo indices in accordance with the technical specifications, sheet type/size, scales, etc., as described in Section C of the contract *[and/or as modified by task orders]; process/print ratioed contact prints; lay out, index, and orient flight strips; generation and reproduction of indices. Deliver *[one (1)] *[____ ( )] set of photo index maps per project on material/format described in Section C.		EACH INDEX SHEET	L/S	

ITEM	DESCRIPTION	QUAN	U/M	U/P	AMT
1000 (Con- tinued)	{NOTE: On IDT contracts, the U/M should be based on a nominal 20- by 24-in. index sheet with the negotiated U/P developed from a typical number of photos/flight strips.}				
1001	Line photo index map: Deliver *[one (1)] *[_ ( )] set of photo index maps per project on USGS quad map, in format described in Section C.		EACH	L/S	
	<p>Uncontrolled photographic products: For each product listed below, provide necessary labor and materials required, to include the following: Laboratory film processing and preparation functions, photographic enlargement functions, trimming, orientation, indexing, labeling, mounting, drafting, reproduction, and shipping of resultant negative and/ or positive drawings/transparencies, as applicable to the product and as defined in Section C of the contract scope of work. Furnish [one (1)] *[_ ( )] set of each required product, mounted on *[masonite] [styrofoam] [plywood] [_____], or on filmpositive transparencies as specified in Section C.</p> <p>{NOTE: Specify photo mounting and framing, as applicable, or requirements for reproducible film positives or film negatives, unless covered in Section C.}</p> <p>{NOTE: Select only the following items applicable to the contract.}</p>				
1100	Air photo enlargement, black & white, per Section C enlargement criteria.		*[JOB] [SQ IN]		
1101	Air photo enlargement, color, per Section C enlargement criteria.		*[JOB] [SQ IN]		
1102	Uncontrolled air photo plan enlargement, black and white, film positive drawing format, per Section C specifications.		*[JOB] [SQ IN] [SQ FT]		
1103	Air photo mosaic, assembled from uncontrolled photography.		[JOB]		
	* [other requirements]				

ITEM	DESCRIPTION	QUAN	U/M	U/P	AMT
	<p>Semiconrolled air photo plans, controlled air photo plans, and orthophoto products: For each product listed, provide necessary labor and materials required and to include the following: Laboratory film processing and preparation functions, photographic enlargement functions, photo control rectification, mensuration and horizontal/vertical orientation and alignment, trimming, indexing, labeling, mounting, drafting, reproduction, and shipping of resultant negative and/or positive drawings/transparencies, as applicable to the product and as defined in Section C of the contract scope of work. Furnish [one (1)] *[_ ( )] set of each required product in the format specified in Section C.</p> <p>{NOTE: Specify, for each line item, sheet size, photo mounting and framing, and other applicable requirements, including requirements for reproducible film positives or film negatives. These detailed specifications may be contained in Section C.}</p> <p>{NOTE: Select only the following items applicable to the contract.}</p>				
1200	Semiconrolled (to USGS map base) air photo plan enlargement, *[black & white] [color], on film-positive drawing format		[SHEET] or [JOB]		
1201	Controlled/rectified air photo plan enlargement, *[black & white] [color], on film-positive drawing format		[SHEET] or [JOB]		
1205	<p>Orthophotograph, black and white, color, color or film-positive or digital format.</p> <p>{NOTE: Topo or feature overlay requirements would be covered by stereoplotter line items, as would ground survey control needs.}</p>		JOB	L/S	
1210	*[Other requirements]				
1300	REGISTERED/LICENSED LAND SURVEYOR		M/DAY		
1301	SURVEY COMPUTER (OFFICE)		M/DAY		

ITEM	DESCRIPTION	QUAN	U/M	U/P	AMT
1302	[Two][three][four][____]-man photo control survey party, consisting of all labor, travel, transportation, survey equipment, and materials necessary to perform photo control surveys, including panelling, quality control, and topographic detailing, and other functions specified in Section C.		C/DAY		
	{Unit rates for individual party members}				
1303	SUPERVISORY SURVEY TECHNICIAN (FIELD)		M/DAY		
1304	SURVEYING TECHNICIAN-INSTRUMENTMAN/RECORDER		M/DAY		
1305	SURVEYING AID-RODMAN/CHAINMAN		M/DAY		
1306	STATION MONUMENTS {NOTE: Specify disc type and monument construction}		EACH		
1307	Field classification, quality control, and edit surveys: *[Two] [____]-man survey crew (sup surv tech + inst/rec)		C/DAY		
1308	Field quality assurance map testing surveys: *[Two] [____]-man crew (sup surv tech + inst/rec)		C/DAY		
	Stereocompilation, and editing: Furnish professional labor, instrumentation, and materials required to orient, control, and map topographic and/or planimetric features using stereoscopic plotting instruments; compile, edit data sets; and develop digital databases in accordance with the project technical and accuracy requirements specified in Section C of the contract.				
1400	Image scanning, model setup, and orientation		M/HOUR		
1401	Planimetric feature stereocompilation		M/HOUR		
1402	Topography stereocompilation {NOTE: The above items may be combined}		M/HOUR		
	Analytical aerotriangulation: Labor, materials, and measurement/computation instruments necessary to measure and adjust supplemental photo control using analytical bridging techniques.		PHOTO or PLATE MODEL		

ITEM	DESCRIPTION	QUAN	U/M	U/P	AMT
HARDCOPY MATERIALS AND LABOR					
1404	STABLE-BASED MYLAR *[F-SIZE]		SHEET		
1405	BOND PAPER *[F-SIZE]		SHEET		
1406	PLANIMETRIC FEATURE PLOTTING		M/HOUR		
1407	TOPOGRAPHY PLOTTING (DEM & DTM)		M/HOUR		
1408	CADD OPERATOR (EDITOR)		M/HOUR		
1409	MAP EDITING (OFFICE)		M/HOUR		
	REPRODUCTION:				
1410	Magnetic media (disks, tapes, CDs)		EACH		
1411	Film transparencies *[f-size]		EACH		
1412	CADD-generated prints (paper/b&w)		EACH		
1420	Photogrammetric project manager		M/HOUR		
1430	Chief photogrammetrist (production manager)		M/HOUR		
1440	Computer usage: (CADD computer connect time charges not included in overhead)		*[MIN] [HOUR]		
1450	*[Other requirements]				
1600	Nontopographic photogrammetry		JOB	L/S	
1601	*[Other nontopographic requirements]				

SECTION C

STATEMENT OF WORK

C.1 GENERAL. THE CONTRACTOR, OPERATING AS AN INDEPENDENT CONTRACTOR AND NOT AS AN AGENT OF THE GOVERNMENT, SHALL PROVIDE ALL LABOR, MATERIAL, AND EQUIPMENT NECESSARY TO PERFORM THE PROFESSIONAL PHOTOGRAMMETRIC MAPPING \*[AND RELATED SURVEYING WORK] \*[FROM TIME TO TIME] DURING THE PERIOD OF SERVICE AS STATED IN SECTION D, IN CONNECTION WITH PERFORMANCE OF PHOTOGRAMMETRIC MAPPING AND RELATED SURVEYS AND THE PREPARATION OF SUCH GEOSPATIAL DATA AS MAY BE REQUIRED FOR \*[ADVANCE PLANNING,] [DESIGN,] [AND CONSTRUCTION] [or other function] ON [VARIOUS PROJECTS] [specify project(s)]. THE CONTRACTOR SHALL FURNISH THE REQUIRED PERSONNEL, EQUIPMENT, SURVEYING AND PHOTOGRAMMETRIC REDUCTION/ COMPILATION INSTRUMENTS, AIRCRAFT, AND LAND TRANSPORTATION AS NECESSARY TO ACCOMPLISH THE REQUIRED SERVICES AND FURNISH TO THE GOVERNMENT HARDCOPY AND SOFTCOPY IMAGERY OR MAPS, DIGITAL DATASETS OF LAND FEATURES, DIGITAL TERRAIN DATA, CHANGE ANALYSIS, REPORTS, AND OTHER DATA TOGETHER WITH SUPPORTING MATERIAL DEVELOPED DURING THE FIELD DATA ACQUISITION PROCESS. DURING THE PROSECUTION OF THE WORK, THE CONTRACTOR SHALL PROVIDE ADEQUATE PROFESSIONAL SUPERVISION AND QUALITY CONTROL TO ASSURE THE ACCURACY, QUALITY, COMPLETENESS, AND PROGRESS OF THE WORK.

\*\*\*\*\*  
NOTE: The above clause is intended for use in an IDT contract for photogrammetric mapping services. It may be used for fixed-price photogrammetric mapping service contracts by deleting appropriate IDT language and adding the specific project survey required. This clause is not repeated on individual delivery orders.  
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C.2. LOCATION OF WORK.

\*\*\*\*\*  
**NOTE: Use the following clause for a fixed-scope contract or individual work order.**  
\*\*\*\*\*

C.2.1. PHOTOGRAMMETRIC MAPPING AND RELATED SURVEYING SERVICES WILL BE PERFORMED AT [\_\_\_\_\_] \*[List project area, state, installation, etc.]. \*[A MAP DETAILING THE WORK SITE IS ATTACHED AT SECTION G OF THIS CONTRACT.]

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**NOTE: Use the following when specifying an indefinite delivery contract for photogrammetric mapping services.**  
\*\*\*\*\*

C.2.2. PHOTOGRAMMETRIC MAPPING AND RELATED SURVEYING SERVICES WILL BE PERFORMED IN CONNECTION WITH PROJECTS \*[LOCATED IN] [ASSIGNED TO] THE [\_\_\_\_\_] DISTRICT. \*[THE \_\_\_\_\_ DISTRICT INCLUDES THE GEOGRAPHICAL REGIONS WITHIN \*[AND COASTAL WATERS] [AND RIVER SYSTEMS] ADJACENT TO:]

\_\_\_\_\_  
\*[List states, regions, etc.]



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**NOTE: Add also any local points-of-contact, right-of-entry requirements, clearing restrictions, installation security requirements, etc.**

\*\*\*\*\*

C.3 TECHNICAL CRITERIA AND STANDARDS. THE FOLLOWING STANDARDS ARE REFERENCED IN THIS CONTRACT. IN CASES OF CONFLICT BETWEEN THESE TECHNICAL SPECIFICATIONS AND ANY REFERENCED TECHNICAL STANDARD, THESE SPECIFICATIONS SHALL HAVE PRECEDENCE.

C.3.1. USACE EM 1110-1-1000, CURRENT VERSION, PHOTOGRAMMETRIC MAPPING. THIS REFERENCE IS ATTACHED TO AND MADE PART OF THIS CONTRACT. (SEE CONTRACT SECTION G.)

C.3.2. CADD/GIS Technology Center, Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE)

C.3.3. ASPRS Accuracy Standards for Large-Scale Maps, ASPRS, March 1990.

C.3.4. MANUAL OF PHOTOGRAMMETRY, AMERICAN SOCIETY OF PHOTOGRAMMETRY AND REMOTE SENSING (ASPRS), CURRENT EDITION, \*[ ] EDITION.

C.3.5. USACE EM 1110-1-1003, AUGUST 1996, NAVSTAR GLOBAL POSITIONING SYSTEM.

C.3.6. USACE EM 1110-1-1002, 14 September 1990, SURVEY MARKERS AND MONUMENTATION. \*[THIS REFERENCE IS ATTACHED TO AND MADE PART OF THIS CONTRACT. (SEE CONTRACT SECTION G.)]

C.3.7. USACE EM 1110-1-1005, 31 AUGUST 1994, TOPOGRAPHIC SURVEYS

C.3.8. USACE EM 1110-1-1004, 31 OCTOBER 1994, DEFORMATION MONITORING AND CONTROL SURVEYING.

C.3.9. \*[District CADD & GIS Standards]

C.3.10. EM-1110-1-2909, GEOSPATIAL DATA AND SYSTEM, AND SPATIAL DATA STANDARDS FOR FACILITIES, INFRASTRUCTURE AND ENVIRONMENT (SDS FOR FIE)

\*\*\*\*\*

**NOTE: List other reference standards that may be applicable to some phase of the work. Reference may also be made to other EMs or standard criteria documents. Such documents need not be attached to the Contract; if attached, however, reference should be made to their placement in contract Section G.**

\*\*\*\*\*

C.4 WORK TO BE PERFORMED. PROFESSIONAL PHOTOGRAMMETRIC MAPPING AND RELATED SURVEYING SERVICES TO BE PERFORMED UNDER THIS CONTRACT ARE DEFINED. UNLESS OTHERWISE INDICATED IN THIS CONTRACT \*[OR IN TASK ORDERS THERETO], EACH REQUIRED SERVICE SHALL INCLUDE FIELD-TO-FINISH EFFORT. ALL MAPPING WORK WILL BE PERFORMED USING PRECISE PHOTOGRAMMETRIC DATA ACQUISITION, MENSURATION, AND COMPILATION PROCEDURES, INCLUDING ALL QUALITY CONTROL

ASSOCIATED WITH THESE FUNCTIONS. THE WORK WILL BE ACCOMPLISHED IN STRICT ACCORDANCE WITH THE PHOTOGRAMMETRIC MAPPING CRITERIA CONTAINED IN THE TECHNICAL REFERENCES (PARAGRAPH C.3), EXCEPT AS MODIFIED OR AMPLIFIED HEREIN.

\*\*\*\*\*  
**NOTE: The following clauses in this section of the guide may be used for either fixed-price photogrammetric mapping contracts, IDT work orders under a photogrammetric mapping IDT contract, or IDT contracts where photogrammetric mapping services are part of a schedule of various survey disciplines.**  
\*\*\*\*\*

C.4.1. PURPOSE OF WORK. THE WORK TO BE PERFORMED UNDER THIS CONTRACT IS TO BE USED AS BASIC SITE PLAN MAPPING INFORMATION FOR \*[INSTALLATION MASTER PLANNING] [DESIGN] [CONSTRUCTION] [OPERATION] [MAINTENANCE] [REAL ESTATE] [REGULATORY ENFORCEMENT] [HAZARDOUS AND TOXIC WASTE SITE \_\_\_\_\_] [\_\_\_\_\_]; INCLUDING THOSE RELATED ACTIVITIES AND/OR ENGINEERING STUDIES COVERING SUCH PERTINENT DETAILS AS \*[RESERVOIR CAPACITIES] [CHANNEL CAPACITIES] [DAMAGE ASSESSMENT] [BENEFITS] [PROJECT LOCATION] [DESIGN OF MAIN STRUCTURE AND APPURTENANCES] [RELOCATIONS] [LAND ACQUISITION] [LAND DEVELOPMENT AND MANAGEMENT] [ENCROACHMENT] [CONSTRUCTION MEASUREMENT AND PAYMENT] [\_\_\_\_\_].

\*\*\*\*\*  
**NOTE: A brief description of the functional purpose of the photography/mapping (in the previous clause) is absolutely essential in that the Contractor can focus his efforts and quality control toward the more critical aspects of the project. The above clause should be written so that it explicitly describes the overall functional purpose of the mapping effort plus any critical design (and construction) work that will be performed using the product. This information can be used by the contractor to optimize flight alignment, ground control, stereocompilation, etc. to ensure coverage of critical areas.**  
\*\*\*\*\*

C.4.2. GENERAL MAPPING REQUIREMENTS. PHOTOGRAMMETRIC MAPPING DATA (GEOSPATIAL DATA) SHALL BE COMPILED AT A TARGET SCALE OF 1: [\_\_\_\_\_] FOR THE [\_\_\_\_\_] - ACRE SITE DELINEATED ON THE MAP ATTACHED AT SECTION G. THE MAPPING DATA SHALL MEET USACE (ASPRS) CLASS \*[\_\_\_\_\_] ACCURACY STANDARDS AS SPECIFIED IN EM 1110-1-1000. THE SITE SHALL BE FLOWN AT A PHOTO-NEGATIVE SCALE EQUAL TO OR LARGER THAN THAT SPECIFIED IN EM 1110-1-1000 TO MEET THE REQUIRED PLANIMETRIC AND TOPOGRAPHIC ACCURACY CRITERIA. FEATURE AND TERRAIN DATA SHALL BE DELIVERED IN DIGITAL FORMAT AND SHALL COMPLY WITH THE SDS FOR FIE.

\*\*\*\*\*  
**NOTE: The previous clause should be used for fixed-scope contracts or IDT contract work orders to give a brief overview of the general mapping effort, the technical requirements of which will be described in subsequent paragraphs of the contract.**

**Note that the final map compilation target scale and ASPRS accuracy class/standard are specifically and rigidly defined upfront in the scope. These parameters directly define the required, or maximum allowable, flight altitude (and negative scales) by reference to the criteria in EM 1110-1-1000.**

**IDT contracts and work orders: Since specific project scopes are indefinite at the time a basic contract is prepared, only general technical criteria and standards can be outlined. Project or site-specific criteria, in clauses similar to previous clause, will be contained in each task order, along with any deviations from technical standards identified in the basic IDT contract. The clauses contained throughout**

the rest of the contract are used to develop the general requirements for a basic IDT contract. Subsequent task orders will reference these clauses, adding project-specific work requirements as required. Task order formats should follow the outline established for the basic IDT contract.

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C.4.3. COMPLETION OF WORK. ALL WORK MUST BE COMPLETED AND DELIVERED NOT LATER THAN [\_\_\_\_\_]. \*[Add pre/partial submittal schedules, if applicable.]

C.5. AIRCRAFT FLIGHT OPERATIONS AND EQUIPMENT REQUIREMENTS.

C.5.1. AIRCRAFT AND FLIGHT CREW. THE AIRCRAFT FURNISHED OR UTILIZED UNDER THIS CONTRACT SHALL BE EQUIPPED WITH NAVIGATION AND PHOTOGRAPHIC INSTRUMENTS AND ACCESSORIES NECESSARY TO SATISFACTORILY PRODUCE THE REQUIRED PHOTOGRAPHY. THE AIRCRAFT SHALL BE MAINTAINED IN OPERATIONAL CONDITION DURING THE PERIOD OF THIS CONTRACT AND SHALL CONFORM WITH ALL GOVERNING FEDERAL AVIATION ADMINISTRATION AND CIVIL AERONAUTICS BOARD REGULATIONS OVER SUCH AIRCRAFT. THE FLIGHT CREW AND CAMERAMAN SHALL HAVE HAD A MINIMUM OF 400 HOURS EXPERIENCE IN FLYING PRECISE PHOTOGRAMMETRIC MAPPING MISSIONS.

C.5.2. CAMERA WINDOWS AND CAMERA MOUNTING. WHEN HIGH-ALTITUDE PHOTOGRAPHY IS REQUIRED, CAMERA WINDOWS MAY BE NEEDED. CAMERA WINDOWS SHALL BE MOUNTED IN VIBRATION-DAMPING MATERIAL TO AVOID MECHANICAL STRESS TO THE WINDOW. PRIOR TO PHOTOGRAPHY, ANY CAMERA WINDOW USED SHALL BE CHECKED BY THE CALIBRATION CENTER TO ENSURE THAT IT WILL NOT ADVERSELY AFFECT LENS RESOLUTION AND DISTORTION AND THAT IT IS SUBSTANTIALLY FREE OF VEINS, STRIATIONS, AND OTHER INHOMOGENEITIES. THE CAMERA ITSELF SHALL BE INSTALLED IN A MOUNTING THAT DAMPENS THE EFFECTS OF AIRCRAFT VIBRATION. AIRCRAFT EXHAUST GASES SHALL BE VENTED AWAY FROM CAMERA OPENING.

\*\*\*\*\*

**NOTE: The two previous clauses represent minimum standards possessed by most professional aerial mapping contractors and are inherent in the quality control function. Government inspection of these standards is neither practical nor expected.**

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C.5.3. FLIGHT PLAN. THE MINIMUM AREA(S) TO BE PHOTOGRAPHED ARE AS INDICATED ON MAPS \*[ATTACHED AT SECTION G] [WHICH WILL BE PROVIDED FOR EACH PHOTOGRAPHIC TASK ORDER]. GIVEN THE SPECIFIED PHOTO-NEGATIVE SCALE CRITERIA HEREIN, THE CONTRACTOR SHALL DESIGN THE FLIGHT LINES FOR THE PHOTOGRAPHY TO OBTAIN PROPER OVERLAP, SIDELAP, AND ENDLAP TO ASSURE FULL STEREOSCOPIC PHOTOGRAPHIC COVERAGE, IN ACCORDANCE WITH THE CRITERIA DEFINED IN THIS CONTRACT \*[OR TASK ORDER THERETO]. GENERALLY, THE FLIGHT LINES SHALL BE PARALLEL TO EACH OTHER AND TO THE LONGEST BOUNDARY LINES OF THE AREA TO BE PHOTOGRAPHED. FOR SINGLE STRIP PHOTOGRAPHY, THE ACTUAL FLIGHT LINE SHALL NOT VARY FROM THE LINE PLOTTED ON THE FLIGHT MAP BY MORE THAN THE SCALE OF THE PHOTOGRAPHY EXPRESSED IN FEET. FOR EXAMPLE, THE ALLOWABLE TOLERANCE FOR PHOTOGRAPHY FLOWN AT A SCALE OF 1 IN. EQUALS 1000 FT IS ABOUT 1000 FT. THE FLIGHT LINES SHALL \*[NOT] BE SUBMITTED TO THE GOVERNMENT FOR ADVANCE APPROVAL.

\*\*\*\*\*

**NOTE:** Flight planning alignment and other details are best left to the professional contractor to design, given his experience in optimizing aircraft utilization during transit and flight operations and stereoscopic coverage. In most cases, the guide writer need only reference small-scale maps or drawings depicting the area to be mapped, or provide geographical/grid coordinates defining the area/route. During the initial planning discussions with the functional user, the outline of project limits for both aerial photography and mapping should be clearly defined, preferably on the best available map. U.S. Geological Survey (USGS) quadrangle maps at scales of 1:24,000 or 1:62,500 are particularly good for this purpose.

Detailed flight maps will then be prepared by the photogrammetric contractor for his flight crew. The map on which the flight lines are drawn should be the best available map of the project area. Previously flown aerial photographs can also be used, especially when reflights of this photography are ordered. Should functional project requirements dictate a particular flight alignment, the guide writer should incorporate that into the specifications (e.g., regulatory enforcement photography being flown parallel to a shoreline). For areas having irregular boundaries or for meandering streams, block flying, that is, two or more parallel flight lines to cover the area, is preferable to many short lines designed to follow each irregularity of the project area. Also, consideration should be given to roads and trails adjacent to the project area. Incorporating these access routes into the photography frequently will facilitate the necessary ground surveys for photo control. Flight line design must recognize potential flight hazards, and lines should be parallel to the ridge lines of mountains rather than leading into them.

**USACE Commands may require that proposed flight plans be submitted to the Contracting Officer for approval. Unless there is some unusual technical or military operational purpose for this requirement, such preapprovals should not be required.**

\*\*\*\*\*

C.5.4. FLYING CONDITIONS. PHOTOGRAPHY SHALL BE UNDERTAKEN ONLY WHEN WELL-DEFINED IMAGES CAN BE OBTAINED. UNLESS OTHERWISE SPECIFIED, FLYING SHALL BE LIMITED TO THE PERIOD OF 3 HOURS AFTER LOCAL SUNRISE TO 3 HOURS BEFORE LOCAL SUNSET. \*[PHOTOGRAPHY SHALL BE ACCOMPLISHED BETWEEN THE HOURS OF \*[\_\_\_\_\_] AND \*[\_\_\_\_\_] , LOCAL SOLAR TIME.] \*[PHOTOGRAPHY SHALL NOT CONTAIN SHADOWS CAUSED BY TOPOGRAPHIC RELIEF OR SUN ANGLE OF LESS THAN \*[THIRTY (30)] [\_\_\_\_\_] ( )] DEGREES, WHENEVER SUCH SHADOWS CAN BE AVOIDED DURING THE TIME OF YEAR THE PHOTOGRAPHY MUST BE TAKEN.] PHOTOGRAPHY SHALL NOT BE ATTEMPTED WHEN THE GROUND IS OBSCURED BY HAZE, SMOKE, OR DUST, \*[SNOW] OR WHEN THE CLOUDS OR CLOUD SHADOWS WILL APPEAR ON MORE THAN \*[FIVE (5)] [\_\_\_\_\_] ( )] PERCENT OF THE AREA OF ANY ONE PHOTOGRAPH.

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**NOTE:** The previous clause should be modified based on the project requirements. For detailed large-scale line mapping, obviously no obscured areas may not be tolerable, whereas for simple small-scale photo coverage and/or enlargements, some reasonable obscuring may be allowable. Restriction of clear coverage requirements, time, tides, or dates can significantly increase the cost of a project.

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C.5.5. \*DATE OF PHOTOGRAPHY. PHOTOGRAPHY MUST BE FLOWN DURING THE PERIOD [\_\_\_\_\_] IN ORDER TO ADEQUATELY DELINEATE [\_\_\_\_\_]. \*[PHOTOGRAPHY WILL BE FLOWN DURING THE PERIODS REPRESENTED IN WORK ORDERS PLACED AGAINST THIS BASIC CONTRACT.]

\*\*\*\*\*

**NOTE: Include any dates within which photography must be taken, such as during minimum foliage, operational movement, construction excavation/placement period, certain river/reservoir stage, high/low tide, etc. Such a clause might be required when photogrammetric methods are used for measuring construction excavation or placement, and photo missions are performed at defined periods. The above clause is applicable to either fixed-scope contracts or IDT contract work orders.**

\*\*\*\*\*

C.5.6. AIRCRAFT UTILIZATION. TOTAL AIRCRAFT UTILIZATION TO, FROM, BETWEEN, AND OVER PROJECT SITES IS BASED ON THE PROVISIONS CONTAINED IN SECTION B. IN ESTIMATING AVAILABLE AIRCRAFT OPERATIONAL TIME, AVERAGE WEATHER AND CLOUD COVER CONDITIONS ARE ASSUMED FOR THE GIVEN SITE AND TIME OF YEAR, CONSISTENT WITH AIRCRAFT UTILIZATION RATES HISTORICALLY DEVELOPED. ADDITIONAL CREW COSTS WILL ACCRUE DURING DEPLOYMENT AT OR NEAR THE PROJECT SITE, WHERE APPLICABLE. AIRCRAFT AND FLIGHT CREW STANDBY AT THE HOME BASE SHALL BE CONSIDERED AS AN OVERHEAD EXPENSE AND SHALL HAVE BEEN PROPERLY FACTORED INTO THE UNIT RATE OF THE AIRCRAFT.

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**NOTE: Aircraft hourly rates are based on long-term utilizations while performing typical project/flight missions. These rates include overhead associated with normal weather delays. These utilizations should be confirmed by field audit. If the project (or task order) is not typical in scope or location, then adjustment to the established rates may be warranted. Otherwise, provide detailed requirements, conditions, notification procedures, and compensation provisions for emergency dedication of an aircraft. Direct and indirect costs must be clearly identified in establishing the crew-day rate for such an item.**

\*\*\*\*\*

C.5.7. \*EMERGENCY AIRCRAFT STANDBY.

C.5.8. \*OCONUS FLIGHT OPERATIONS. [Add other nonstandard photogrammetric aircraft and flight crew costs. Detail as required or if not fully defined in Section B.]

C.5.9. FLIGHT LOG. FOR EACH FLIGHT DAY, THE PILOT OR CAMERAMAN SHALL PREPARE A FLIGHT LOG CONTAINING THE DATE, PROJECT NAME, AIRCRAFT USED, AND NAMES OF CREW MEMBERS. IN ADDITION, THE FOLLOWING SHALL BE PREPARED FOR EACH FLIGHT LINE: ALTITUDE, CAMERA, MAGAZINE SERIAL NUMBER, F-STOP, SHUTTER SPEED, BEGINNING AND ENDING EXPOSURE NUMBERS AND TIMES, AND ANY OTHER COMMENTS RELATIVE TO THE FLIGHT CONDITIONS. THESE FLIGHT LOGS, OR COPIES THEREOF, MAY BE INCORPORATED INTO THE FILM REPORT (IF REQUIRED) AND WILL BE DELIVERED TO THE CONTRACTING OFFICER AS SPECIFIED IN THIS CONTRACT.

C.5.10. SUBCONTRACTED PHOTOGRAPHY. BEFORE COMMENCEMENT OF ANY AERIAL PHOTOGRAPHY UNDER THIS CONTRACT \*[OR WORK ORDER] BY A SUBCONTRACTOR, THE CONTRACTOR SHALL FURNISH THE CONTRACTING OFFICER, IN WRITING, THE NAME OF SUCH SUBCONTRACTOR, TOGETHER WITH A STATEMENT AS TO THE EXTENT AND CHARACTER OF THE WORK TO BE DONE UNDER THE SUBCONTRACT, INCLUDING APPLICABLE CAMERA CERTIFICATIONS.

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**NOTE: Reasonable flexibility should be provided contractors in substituting aircrafts or cameras to meet the exigencies of the operations. Ideally, potential subcontractors will have been identified during initial submittal/negotiations. In practice, unforeseen aircraft/camera substitution is often required in order to meet critical delivery dates.**

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C.6. AERIAL PHOTOGRAPHY SCALE AND RELATED COVERAGE PARAMETERS.

C.6.1. PHOTO-NEGATIVE SCALE AND FLIGHT ALTITUDE. THE REQUIRED NEGATIVE SCALE FOR THIS PROJECT \*[SHALL EQUAL OR EXCEED THE CRITERIA CONTAINED IN EM 1110-1-1000] [IS 1: \*[\_] FT] [WILL BE DEFINED IN THE SCOPE OF WORK PROVIDED WITH EACH TASK ORDER], AND SHALL BE CONSISTENT WITH THE REQUIRED MAP ACCURACY STANDARD/CLASS SPECIFIED AND THE MAXIMUM ALLOWABLE ALTITUDES SPECIFIED IN EM 1110-1-1000 FOR MAINTAINING HORIZONTAL AND VERTICAL TOLERANCES RELATIVE TO FLIGHT ALTITUDE. THE FLIGHT HEIGHT ABOVE THE AVERAGE ELEVATION OF THE GROUND IS DESIGNED SUCH THAT THE NEGATIVES HAVE AN AVERAGE SCALE SUITABLE FOR ATTAINING REQUIRED PHOTOGRAMMETRIC MEASUREMENT, MAP SCALE, CONTOUR INTERVAL, AND ACCURACY, GIVEN THE REQUIRED (FIXED) 6-IN. MAPPING CAMERA FOCAL LENGTH, STEREO PLOTTER OR SOFTCOPY WORKSTATION MODEL, AND QUALITY CONTROL CRITERIA, AS DEFINED ELSEWHERE IN THESE SPECIFICATIONS. \*[NEGATIVES HAVING A DEPARTURE FROM THE SPECIFIED SCALE OF MORE THAN 5 PERCENT BECAUSE OF TILT OR ANY CHANGES IN THE FLYING HEIGHT MAY BE CAUSE FOR REJECTION OF THE WORK.] \*[DEPARTURES FROM SPECIFIED FLIGHT HEIGHT SHALL NOT EXCEED 2 PERCENT LOW OR 5 PERCENT HIGH FOR ALL FLIGHT HEIGHTS UP TO 12,000 FT ABOVE GROUND ELEVATION. ABOVE 12,000 FT, DEPARTURES FROM SPECIFIED FLIGHT HEIGHT SHOULD NOT EXCEED 2 PERCENT LOW OR 600 FT HIGH.] ANY PROPOSED VARIATION BY THE CONTRACTOR TO CHANGE EITHER THE CAMERA FOCAL LENGTH OR NEGATIVE SCALE CONSTITUTES A MAJOR CHANGE IN SCOPE AND THEREFORE MUST BE EFFECTED BY FORMAL CONTRACT \*[TASK ORDER] MODIFICATION.

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**NOTE: No aspect of the photogrammetric mapping specification process is more critical and subject to abuse than that limiting flight altitudes or negative scales. This is because of their direct impact on photo/ model coverage, resultant planimetric/topographic accuracy, ground control requirements, and overall project cost. Therefore, the negative scale chosen does affect overall cost. As a general rule, the recommended flight altitudes and negative scales called out in EM 1110-1-1000 shall be used for all photogrammetric mapping projects. However, small adjustments to accommodate project specific requirements may be warranted. The required accuracy (horizontal and vertical) as well as the accuracy standard (i.e., ASPRS Class [ ]) should be made clear when deviations from standard negative scales are called out in contract or task order. No contract should ever be awarded with indefinite “open-ended” negative scales subject to the contractor's “expert recommendation” or “discretion.”**

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C.6.2. STEREOSCOPIC COVERAGE AND OVERLAP REQUIREMENTS. \*[UNLESS OTHERWISE MODIFIED IN TASK ORDERS] THE OVERLAP SHALL BE SUFFICIENT TO PROVIDE FULL STEREOSCOPIC COVERAGE OF THE AREA TO BE PHOTOGRAPHED, AS FOLLOWS:

\*\*\*\*\*

**NOTE: Many of the following overlap and photo orientation specifications are throwbacks to older 1950's vintage mechanical-optical train stereoplotter requirements or restrictions. Newer analytical stereoplotters and softcopy workstations are not so sensitive to excesses in these parameters. However,**

these specifications may optionally be retained as a form of contractor quality control, plus assuring that, at the least, photography is obtained that can be viewed stereoscopically by nonanalytical devices.

USACE Commands rarely have the resources, time, or equipment to check compliance with these orientation requirements; therefore, clauses are given optional enforcement/rejection provisions. In most cases, poorly flown photography will be rejected by the Contractor's internal quality control procedures and will be reflight before compilation proceeds.

\*\*\*\*\*

a. BOUNDARIES. ALL OF THE AREA APPEARING ON THE FIRST AND LAST NEGATIVE IN EACH FLIGHT LINE EXTENDING OVER A BOUNDARY SHALL BE OUTSIDE THE BOUNDARY OF THE PROJECT AREA. THE PRINCIPAL POINT OF TWO PHOTOGRAPHS ON BOTH ENDS OF EACH FLIGHT LINE SHALL BE TAKEN PAST THE BOUNDARY LINE OF THE PROJECT. EACH STRIP OF PHOTOGRAPHS ALONG A BOUNDARY SHALL EXTEND OVER THE BOUNDARY NOT LESS THAN \*[FIFTEEN (15)] [\_\_\_\_\_] (%) PERCENT OF THE WIDTH OF THE STRIP.

b. ENDLAP. \*[Unless otherwise specified in a task order,] the forward overlap shall be \*sixty (60) percent \*[ five (5)].[\_\_\_\_\_] (%) percent. Endlap of less than \*[fifty-five (55)] [\_\_\_\_\_] (%) percent in one or more negatives may be cause for rejection of the negative or negatives in which such deficiency or excess of endlap occurs.

\*\*\*\*\*

**NOTE: A maximum endlap specification is optional—it need not be restricted and is often deliberately increased to 80 percent ∇ 3 percent for analytical aerotriangulation or vertical viewing requirements. This will impact compilation cost, however.**

\*\*\*\*\*

c. SIDELAP. \*[Unless otherwise specified in a task order,] the lateral sidelap shall average \*[thirty (30)] [\_\_\_\_\_] (%) percent \*[ ten (10)].[\_\_\_\_\_] (%) percent. Any negative having sidelap less than \*[fifteen (15)] [\_\_\_\_\_] (%) percent or more than \*[fifty (50)] [\_\_\_\_\_] (%) percent may be rejected. The foregoing requirement can be varied in cases where the strip area to be mapped is slightly wider than the area that can be covered by one strip of photographs, where increase in sidelap is required for control densification purposes, or where increase or decrease in sidelap is required to reach established ground control.

d. CRAB. Absolute crab of any photograph relative to the flight line, or relative crab between any series of two or more consecutive photographs, in excess of \*[10] [\_\_\_\_\_] degrees, as indicated by displacement of the principal points of the photographs, may be considered cause for rejection of the photography. Average crab for any flight line shall not exceed \*[5] [\_\_\_\_\_] degrees. For aerotriangulation, no photograph shall be crabbed in excess of five (5) degrees as measured from the line of flight.

e. TILT. Negatives exposed with the optical axis of the aerial camera in a vertical position are desired. Tilt (angular departure of the aerial camera axis from a vertical line at the instant of exposure) in any negative of more than \*[four (4)] [\_\_\_\_\_] degrees, or an average of more than \*[two (2)] [\_\_\_\_\_] degrees for any ten (10) consecutive frames, or an average tilt of more than \*[one (1)] [\_\_\_\_\_] degree(s) for the entire project, or relative tilt between any two successive negatives exceeding \*[six (6)] [\_\_\_\_\_] degrees may be cause for rejection.

f. TERRAIN ELEVATION VARIANCES. When ground heights within the area of overlap vary by more than ten (10) percent of the flying height, a reasonable variation in the stated overlaps shall be permitted provided that the fore and aft overlaps do not fall below \*[55] [\_\_\_\_\_] percent and the lateral sidelap does not

fall below \*[10] [ ] percent or exceed \*[50] [ ] percent. In extreme terrain relief where the foregoing overlap conditions are impossible to maintain in straight and parallel flight lines, the gaps created by excessive relief may be filled by short strips flown between the main flight lines and parallel to them.

g. Strips running parallel to a shoreline may be repositioned to reduce the proportion of water covered, provided the coverage extends beyond the limit of any land feature by at least 10 percent of the strip width.

C.6.3. Where the ends of strips of photography join the ends of other strips or blocks flowing in the same general direction, there shall be an overlap of at least two stereoscopic models. In flight lines rephotographed to obtain substitute photography for rejected photography, all negatives shall be exposed to comply with original flight specifications, including scale and overlap requirements. The joining end negatives in the replacement strip shall have complete stereoscopic coverage of the contiguous area on the portion or portions not rejected.

C.6.4. \*OBLIQUE PHOTOGRAPHY.

\*\*\*\*\*  
**NOTE: Detail herein any oblique photography and/or oblique photogrammetric mapping compilation requirements. Camera tilts in excess of 5 degrees are classified as oblique photographs. These photographs are used primarily for pictorial views of large areas. They may also be used in supplementary mapping of complicated plant sites where pipelines may be obscured in vertical photographs of the plant and, as such, would be compiled on an analytical plotter. Oblique photographs are often taken using high-quality hand-held cameras, or using specially designed aerial mapping camera mounts. A high oblique aerial photograph is one in which the horizon (where the earth and sky appear to meet) is visible. Units of measure for oblique photography are typically on a lump sum (job) basis, and when no controlled compilation is involved, may be obtained by Invitation for Bids (IFB)/purchase order procedures. An example would be a high oblique of an installation for a visitor information center.**  
\*\*\*\*\*

C.7. AERIAL CAMERA SPECIFICATIONS.

C.7.1. TYPE OF CAMERA. ONLY A STANDARD 6-IN. (153mm ± 3mm) FOCAL-LENGTH SINGLE-LENS PRECISE AERIAL MAPPING CAMERA, EQUIPPED WITH A HIGH-RESOLUTION, DISTORTION-FREE LENS, AND WITH A BETWEEN-THE-LENS SHUTTER WITH VARIABLE SPEED, SHALL BE USED ON THIS CONTRACT. THE AERIAL CAMERA SHALL BE A METRIC AERIAL MAPPING CAMERA THAT WILL PRODUCE IMAGERY SUITABLE FOR MAP PRODUCTION AND ACCURACIES REQUIRED IN THE CONTRACT OR TASK ORDER \*[LICA RC-30], OR \*[Zeiss Model RMK TOP 15]. THE CAMERA SHALL FUNCTION PROPERLY AT THE NECESSARY ALTITUDE AND UNDER EXPECTED CLIMATIC CONDITIONS AND SHALL EXPOSE A 9- by 9-IN.- (228- by 228-mm) SQUARE NEGATIVE. THE LENS CONE SHALL BE SO CONSTRUCTED THAT THE LENS, FOCAL PLANE AT CALIBRATED FOCAL LENGTH, FIDUCIAL MARKERS, AND MARGINAL DATA MARKERS COMPRISE AN INTEGRAL UNIT OR ARE OTHERWISE FIXED IN RIGID ORIENTATION WITH ONE ANOTHER. \*WHEN EXTREMELY LARGE-SCALE (LOW ALTITUDE) PHOTOGRAPHY IS BEING FLOWN, THE CAMERA SHALL BE EQUIPPED WITH FORWARD IMAGE MOTION COMPENSATION.

C.7.2. CALIBRATION. THE AERIAL CAMERA(S) FURNISHED BY THE CONTRACTOR OR HIS DESIGNATED SUBCONTRACTORS SHALL HAVE BEEN CALIBRATED BY THE USGS WITHIN \*[THREE (3)] [ ] ( ) YEARS OF AWARD OF THIS CONTRACT. THE CALIBRATION REPORT SHALL BE PRESENTED TO THE CONTRACTING OFFICER PRIOR TO USE ON THIS



CONTRACT \*[AND/OR TASK ORDERS PLACED AGAINST THIS CONTRACT]. CALIBRATED TOLERANCES SHALL BE WITHIN THE STANDARDS CONTAINED IN EM 1110-1-1000. \*[Certification shall also be provided indicating that preventative maintenance has been performed within the last two (2) years.]

C.7.3. SUBSTITUTE CAMERAS. SUBSTITUTE CAMERAS THAT DO NOT MEET THE ABOVE SPECIFICATIONS MAY NOT BE USED ON THIS CONTRACT \*[OR TASK ORDERS THERETO].

\*\*\*\*\*  
**NOTE: It is critical to maintain consistency in aerial cameras used for detailed design mapping data collection and feature extraction. As a general rule, 6-in. focal length cameras are recommended in this guide. Use of different cameras with nonstandard focal lengths, other sensors (i.e. LIDAR, multispectral image sensors, thermal scanners), or digital camera systems may affect not only the quality of work but also the unit prices configured in Schedule B. The contract should not allow unlimited flexibility to substitute cameras based on a mapping contractor's recommendation. If a special type of camera or sensor is used for a particular project, then specifications for that camera or sensor and associated costs must be detailed herein or by modification.**

Numerous camera calibration specification and tolerance requirements are embodied in the contract by reference to EM 1110-1-1000. These include tolerances for focal length, magazine platen, fiducial marks, lens distortion, lens resolving power, filters, shutters, apertures, and spectral ranges. There is no need to repeat these technical specifications in this contract. Restrictions to like/similar camera models, along with the requirement for USGS calibration certification, help assure that quality photography will be obtained.

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C.8. AERIAL FILM SPECIFICATIONS AND PROCESSING REQUIREMENTS.

C.8.1. GENERAL. FILM MATERIALS AND LABORATORY PROCESSING, DEVELOPING, REPRODUCTION, AND PRINTING THEREOF SHALL CONFORM WITH RECOGNIZED PROFESSIONAL PHOTOGRAMMETRIC INDUSTRY STANDARDS AND PRACTICES, AS OUTLINED IN EM 1110-1-1000 AND IN THE CURRENT ASPRS MANUAL OF PHOTOGRAMMETRY AND OTHER NATIONAL STANDARDS OR SPECIFICATIONS REFERENCED THEREIN.

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**NOTE: For professional service “field-finish” line mapping contracts, it is necessary to include only general guidance over the quality of materials and professional photographic laboratory practices. Since the professional mapping firm is responsible for the ultimate accuracy and quality of the compiled geospatial feature and topographic data, that firm will usually strive to utilize the highest-quality materials and related processes to achieve that goal. Deficiencies in materials, coverage gaps, obscured features, etc. will be readily apparent during stereocompilation; in effect, the stereocompilation phase represents a quality control check over the initial data, both photography and ground control. However, when IFB contracts are used to obtain aerial photography (no subsequent controlled compilation), there may be far less internal quality control. In IFB contracts, film material and processing specifications, and Government quality control/quality assurance (QC/QA) efforts may need to be more detailed.**

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C.8.2. TYPE OF FILM REQUIRED. THE CONTRACTOR SHALL USE ONLY AERIAL FILM OF A QUALITY THAT WILL MEET THE NEEDS OF THE CONTRACT OR TASK ORDER REQUIREMENTS \*[4 MIL KODAK DOUBLE-X AEROGRAPHIC 2405 (ESTAR BASE) PANCHROMATIC FILM; KODAK

PLUS-X AEROGRAPHIC 2402 (ESTER BASE); 4 MIL KODAK AEROCOLOR NEGATIVE FILM 2445 (ESTAR BASE); KODAK 2448 COLOR POSITIVE FILM; KODAK 2408 BLACK AND WHITE (FINE-GRAIN) FILM; KODAK 2412 BLACK AND WHITE (FINE-GRAIN) FILM; OR 4 MIL KODAK AEROCHROME INFRARED FILM 2443 (ESTAR BASE)], AS APPLICABLE TO THOSE TYPES OF PHOTOGRAPHY SCHEDULED IN SECTION B. ONLY FRESH, FINE-GRAIN, HIGH-SPEED, DIMENSIONALLY STABLE, AND SAFETY BASE AERIAL FILM EMULSIONS SHALL BE USED. OUTDATED FILM SHALL NOT BE USED. \*[THE THICKNESS OF THE BASE SHALL NOT BE LESS THAN 0.1 MM AND THE DIMENSIONAL STABILITY SHALL BE SUCH THAT IN ANY NEGATIVE THE LENGTH AND WIDTH BETWEEN FIDUCIALS SHALL NOT VARY BY MORE THAN 0.3 PERCENT FROM THE SAME MEASUREMENTS TAKEN ON THE CAMERA, AND THAT THE DIFFERENTIAL BETWEEN THESE MEASUREMENTS SHALL NOT EXCEED 0.04 PERCENT.]

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**NOTE: Black and white panchromatic film is the most widely used type for aerial photography. There is a greater latitude in exposure and processing of black and white panchromatic films than there is with color films. Color aerial photography may enhance functional interpretation during the plotting process. Color photography requires above-average weather conditions, meticulous care in exposure and processing, and color-corrected lenses. For these reasons, color photography and color prints are more expensive than panchromatic. Use of color film for detailed line mapping will depend on the difficulty of photo interpretation (by the stereoplotter operator) needed in the project site. Infrared emulsions have greater sensitivity to red and the near infrared, which penetrate haze and smoke. Thus, infrared film can be used on days that would be unsuitable for ordinary panchromatic films. It is also useful for the delineation of water and wet areas and for certain types of forestry and land use studies. It may be used in the detection of diseased plants and trees, identification and differentiation of a variety of freshwater and saltwater growths for wetland studies, and many water pollution and environmental impact studies. A color-corrected camera lens is required. The cost of obtaining infrared color is greater than black and white. Infrared film would not be specified for detailed line mapping work.**  
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C.8.3. UNEXPOSED FILM. WHENEVER ANY PART OF AN UNEXPOSED ROLL OF FILM REMAINS IN THE CAMERA, BEFORE SUCH FILM IS USED ON A SUBSEQUENT DAY, A MINIMUM 3-FT SECTION OF THE ROLL OF FILM SHALL BE ROLLED FORWARD AND EXPOSED, IMMEDIATELY PRECEDING THE BEGINNING OF PHOTOGRAPHY.

C.8.4. QUALITY OF PHOTOGRAPHY. THE PHOTOGRAPHIC NEGATIVES SHALL BE TAKEN SO AS TO PREVENT APPRECIABLE IMAGE MOVEMENT AT THE INSTANT OF EXPOSURE. THE NEGATIVES SHALL BE FREE FROM STATIC MARKS, SHALL HAVE UNIFORM COLOR TONE, AND SHALL HAVE THE PROPER DEGREE OF CONTRAST FOR ALL DETAILS TO SHOW CLEARLY IN THE DARK-TONE AREAS AND HIGH-LIGHT AREAS AS WELL AS IN THE HALFTONES BETWEEN DARK AND LIGHT. NEGATIVES HAVING EXCESSIVE CONTRAST OR NEGATIVES LOW IN CONTRAST MAY BE REJECTED.

C.8.5. PROCESSING OF EXPOSED FILM. THE PROCESSING, INCLUDING DEVELOPMENT AND FIXATION AND WASHING AND DRYING OF ALL EXPOSED PHOTOGRAPHIC FILM, SHALL RESULT IN NEGATIVES FREE FROM CHEMICAL OR OTHER STAINS CONTAINING NORMAL AND UNIFORM DENSITY, AND FINE-GRAIN QUALITY. BEFORE, DURING, AND AFTER PROCESSING, THE FILM SHALL NOT BE ROLLED TIGHTLY ON DRUMS OR IN ANY WAY STRETCHED, DISTORTED, SCRATCHED, OR MARKED, AND SHALL BE FREE FROM FINGER MARKS, DIRT, OR BLEMISHES OF ANY KIND. EQUIPMENT USED FOR PROCESSING SHALL BE EITHER REWIND SPOOL-TANK OR CONTINUOUS PROCESSING MACHINE, AND MUST BE

CAPABLE OF ACHIEVING CONSISTENT NEGATIVE QUALITY SPECIFIED BELOW WITHOUT CAUSING DISTORTION OF THE FILM. DRYING OF THE FILM SHALL BE CARRIED OUT WITHOUT AFFECTING ITS DIMENSIONAL STABILITY.

C.8.6. THE CAMERA PANEL OF INSTRUMENTS SHOULD BE CLEARLY LEGIBLE ON ALL PROCESSED NEGATIVES. FAILURE OF INSTRUMENT ILLUMINATION DURING A SORTIE SHALL BE CAUSE FOR REJECTION OF THE PHOTOGRAPHY. ALL FIDUCIAL MARKS SHALL BE CLEARLY VISIBLE ON EVERY NEGATIVE.

C.8.7. FILM STRIP DOCUMENTATION AND LABELING. AT MINIMUM, THE FOLLOWING INFORMATION SHALL BE SUPPLIED AS LEADERS AT THE START AND THE END OF EACH FILM STRIP:

- a. CONTRACT NUMBER AND/OR DELIVERY ORDER DESIGNATION, AS APPLICABLE.
- b. FILM NUMBER.
- c. FLIGHT LINE IDENTIFICATION(S).
- d. DATES/TIMES OF PHOTOGRAPHY.
- e. EFFECTIVE NEGATIVE NUMBERS AND RUN NUMBERS.
- f. APPROXIMATE SCALE(S) OF PHOTOGRAPHY.
- g. THE CALIBRATED FOCAL LENGTH OF THE CAMERA.
- h. CONTRACTOR'S NAME.

C.8.8. NEGATIVE NUMBERING AND ANNOTATION. EACH NEGATIVE WILL BE LABELED CLEARLY WITH THE IDENTIFICATION SYMBOL AND NUMBERING CONVENTION RECOMMENDED HEREIN. THE NUMBERS WILL BE SEQUENTIAL WITHIN EACH FLIGHT LINE AND SHALL BE IN THE UPPER RIGHT-HAND CORNER OF THE NEGATIVE IMAGE EDGE TO BE READ AS ONE LOOKS NORTHERLY ALONG THE FLIGHT LINE (OR WESTERLY WHEN LINES ARE EAST-WEST). ALL LETTERING AND NUMBERING OF NEGATIVES SHALL BE APPROXIMATELY 1/5 IN. HIGH AND SHALL RESULT IN EASILY READ, SHARP, AND UNIFORM LETTERS AND NUMBERS. NUMBERING OF NEGATIVES SHALL BE CARRIED OUT USING HEAT-FOIL OR INDELIBLE INK. EACH NEGATIVE SHALL BE PROVIDED WITH THE FOLLOWING ANNOTATION, WHICH SHALL ALSO APPEAR ON THE PRINTS:

- a. YEAR, MONTH, AND DAY OF FLIGHT.
- b. \*[USACE PROJECT-SPECIFIC LOCATION/IDENTIFICATION NUMBER].
- c. PHOTO SCALE (RATIO).
- d. FILM ROLL NUMBER.
- e. NEGATIVE NUMBER.

THE DATE OF THE PHOTOGRAPHY SHALL BE IN THE UPPER LEFT CORNER OF EACH FRAME FOLLOWED BY \*[USACE PROJECT NUMBER, AND] PHOTO SCALE RATIO. THE FRAME NUMBER WILL BE IN THE UPPER RIGHT-HAND CORNER OF EACH FRAME WITH THE ROLL NUMBER PRINTED 2 IN. TO THE LEFT OF THE FRAME NUMBER.

C.8.9. FILM STORAGE AND DELIVERIES. ALL NEGATIVES AND UN CUT FILM POSITIVES SHALL BE DELIVERED TO THE CONTRACTING OFFICER ON WINDING SPOOLS IN PLASTIC OR METAL CANISTERS. ALL EXTRA AND REJECTED NEGATIVES SHALL BE INCLUDED IN THE ROLL(S). AT LEAST 3 FT OF CLEAR FILM SHALL BE LEFT ON OR SPLICED TO EACH END OF THE ROLL. ALL SPLICES SHALL BE OF A PERMANENT NATURE. EXPOSED AND UNEXPOSED FILM SHALL BE HANDLED IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS. EACH CANISTER SHOULD BE LABELED WITH THE MINIMUM INFORMATION INDICATED BELOW:

- a. NAME AND ADDRESS OF THE CONTRACTING AGENCY.
- b. NAME OF THE PROJECT.
- c. DESIGNATED ROLL NUMBER.
- d. NUMBERS OF THE FIRST AND LAST NUMBERED NEGATIVES OF EACH STRIP.
- e. DATE OF EACH STRIP.
- f. APPROXIMATE SCALE.
- g. FOCAL LENGTH OF LENS IN MILLIMETERS.
- h. NAME AND ADDRESS OF THE CONTRACTOR PERFORMING THE PHOTOGRAPHY.
- i. CONTRACT NUMBER.

C.8.10. \*FILM REPORT. A film report shall be included with each project giving the following type of information.

- a. Film number.
- b. Camera type and number, lens number, and filter type and number.
- c. Magazine number or cassette and cassette holder unit numbers.
- d. Film type and manufacturer's emulsion number.
- e. Lens aperture and shutter speed.
- f. Date of photography.
- g. Start and end time for each run in local time.
- h. Negative numbers of all offered photography.

- i. Indicated flying height.
- j. Computed flying height above sea level.
- k. Scale of photography.
- l. Outside air temperature.
- m. Weather conditions: Cloud, visibility, turbulence.
- n. Date of processing.
- o. Method of developing.
- p. Developer used and dilution.
- q. Time and temperature of development or film transport speed.
- r. Length of film processed.
- s. General comment on quality.

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**NOTE: Requirements for submitting the above film processing report are rare and should be required only under special circumstances. Normally, the Flight Log submittal (Paragraph C.5.9) is adequate.**

**All film submittal and annotation/documentation requirements should be reasonable and necessary. Many of the detailed recordation requirements listed above make sense only for large, areawide mapping projects.**

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#### C.9. CONTACT PRINT AND DIAPOSITIVE SPECIFICATIONS.

C.9.1. MATERIAL. ALL CONTACT PRINTS SHALL BE MADE ON AN ELECTRONIC PRINTER ON \*[MEDIUM-WEIGHT RESIN-COATED PAPER STOCK] \*[other], ON WHICH INK, PENCIL, GREASE PENCIL, AND OTHER COMMONLY EMPLOYED MARKERS CAN BE USED ON BOTH SIDES.

C.9.2. PROCESSING AND QUALITY. THE PROCESSING, INCLUDING EXPOSURE DEVELOPMENT, WASHING, AND DRYING, SHALL RESULT IN FINISHED PHOTOGRAPHIC PRINTS HAVING \*[GLOSS] [ ] FINISH, FINE-GRAIN QUALITY, NORMAL UNIFORM DENSITY, AND SUCH COLOR TONE AND DEGREE OF CONTRAST THAT ALL PHOTOGRAPHIC DETAILS OF THE NEGATIVE FROM WHICH THEY ARE PRINTED SHOW CLEARLY IN THE DARK-TONE AREAS AND HIGH-LIGHT AREAS AS WELL AS IN THE HALFTONES BETWEEN THE DARK AND THE HIGH LIGHT. EXCESSIVE VARIANCE IN COLOR TONE OR CONTRAST BETWEEN INDIVIDUAL PRINTS MAY BE CAUSE FOR THEIR REJECTION. ALL PRINTS SHALL BE CLEAR AND FREE OF STAINS, BLEMISHES, UNEVEN SPOTS, AIR BELLS, LIGHT FOG OR STREAKS, CREASES, SCRATCHES, AND OTHER DEFECTS THAT WOULD INTERFERE WITH THEIR USE OR IN ANY WAY DECREASE THEIR USEFULNESS.

C.9.3. TRIMMING. ALL CONTACT PRINTS SHALL BE TRIMMED TO NEAT AND UNIFORM DIMENSIONAL LINES ALONG IMAGE EDGES (WITHOUT LOSS OF IMAGE) LEAVING

DISTINCTLY THE CAMERA FIDUCIAL MARKS. PRINTS LACKING FIDUCIAL MARKS SHALL BE REJECTED.

C.9.4. DELIVERIES. ALL CONTACT PRINTS SHALL BE DELIVERED TO THE CONTRACTING OFFICER IN A SMOOTH, FLAT, AND USABLE CONDITION. THE NUMBER OF CONTACT PRINTS TO BE DELIVERED FOR EACH EXPOSURE IS \*[INDICATED IN SECTION B] [\_\_\_\_\_]. \*[ADDITIONAL SETS OF CONTACT PRINTS MAY BE ORDERED AT THE RATES INDICATED IN SECTION B.]

C.9.5. \*Preliminary Check Prints. \*[Detail requirements, if any.]

C.9.6. \*Marked Control Prints. \*[Detail requirements, if any.]

c.9.7. DIGITAL IMAGES. SOME PROJECTS MAY REQUIRE LOW- OR HIGH-RESOLUTION SCANNED IMAGES IN ADDITION TO OR IN PLACE OF PAPER PRINTS. GENERALLY, THE INTENDED USE OF THE IMAGES SHOULD BE STATED IN THE SPECIFICATION OR TASK ORDER TO ENSURE THAT THE IMAGE ACCURACY AND RESOLUTION WILL BE SUFFICIENT. THE SCANNING SOURCE MATERIAL (I.E., PROCESSED FILM OR PAPER PRINT) SHALL BE STATED ALONG WITH THE PIXEL RESOLUTION AND FILE FORMAT AND NAMING CONVENTION. DIGITAL IMAGERY THAT IS TO BE USED FOR PHOTOGRAMMETRIC MAP FEATURE COMPILATION OR ORTHOPHOTOGRAPHY CREATION WILL REQUIRE THE USE OF A METRIC HIGH RESOLUTION SCANNER. THE REQUIREMENTS FOR THESE USES ARE SPECIFIED IN EM-1110-1-1000. REQUIREMENTS FOR IMAGE ARCHIVAL MAY VARY AND SHOULD BE SPECIFIED FOR INDIVIDUAL PROJECTS.

C.9.8. DIAPOSITIVE PLATES OR TRANSPARENCIES. ALL BLACK AND WHITE DIAPOSITIVE TRANSPARENCIES USED FOR PHOTOGRAMMETRIC MEASUREMENTS, INCLUDING MAP COMPILATION, SHALL BE OF A QUALITY THAT WILL PRODUCE IMAGES SUITABLE FOR THE MAPPING PURPOSES SPECIFIED IN THE CONTRACT OR TASK ORDER \*[0.130-IN.-THICK KODAK AERIAL PLOTTING PLATES OR 0.007-IN.-THICK DUPONT DIAPOSITIVE FILM, NO. CT-7]. ALL COLOR DIAPOSITIVE TRANSPARENCIES SHALL BE OF A QUALITY THAT WILL PRODUCE IMAGES SUITABLE FOR THE MAPPING PURPOSES SPECIFIED IN THE CONTRACTOR OR TASK ORDER \*[KODAK COLOR DIAPOSITIVE FILM, NO. 4109]. DIAPOSITIVES \*[WILL] [MAY] [WILL NOT] BE DELIVERED TO THE GOVERNMENT FOR INSPECTION AND/OR QUALITY ASSURANCE TESTING. \*[DIAPOSITIVES DELIVERED TO THE GOVERNMENT FOR INSPECTION WILL BE RETURNED TO THE CONTRACTOR.]

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**NOTE: Diapositive film/plates are rarely delivered unless the Government plans to perform quality control/assurance tests on the models, using Government-owned stereoplotters or third-party contractors. This is an option which the Contracting Officer may wish to reserve.**  
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C.10. PHOTOGRAPHIC INDEX REQUIREMENTS.

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**NOTE: Not all photo mapping projects require photo index maps in the traditional (but costly) style described in the following text. For small projects with few flight lines or frames, a drafted index of photo centers plotted on a USGS quad map will often serve the same functional purpose at far less cost.**  
\*\*\*\*\*

C.10.1. GENERAL. THIS ITEM SHALL CONSIST OF ONE OR MORE PHOTOGRAPHIC NEGATIVES, AS NECESSARY, AND PHOTOGRAPHIC PRINT OR PRINTS (PAPER OR DIGITAL IMAGES) THEREOF, OF AN ASSEMBLY OF AERIAL PHOTOGRAPHS FORMING AN INDEX OF THE PROJECT AERIAL PHOTOGRAPHY. \*[THIS INDEX IS REQUIRED FOR ALL DELIVERIES PLACED UNDER THIS CONTRACT.] COSTS FOR CONTACT PRINTS (OR SCANNED IMAGES) ARE TO BE INCLUDED IN THE OVERALL UNIT COST OF THE PHOTO INDEX(ES). \*[PHOTO INDICES MAY BE COMPILED BY PLOTTING PHOTO CENTERS ON USGS QUADRANGLE MAPS \*[\\_\\_\\_\\_\\_\\_], ALONG WITH DESCRIPTIVE INFORMATION SPECIFIED BELOW.]

C.10.2. ASSEMBLY. THE PHOTO INDEX SHALL INCLUDE PHOTOGRAPHIC PRINTS (OR DIGITAL IMAGES) MADE FROM ALL NEGATIVES OF THE PHOTOGRAPHY TAKEN AND ACCEPTED FOR THE PROJECT. A PHOTO INDEX MAY BE PRODUCED FROM PAPER PRINTS OR FROM LOW-RESOLUTION SCANNED IMAGES (DIGITAL PHOTO INDEX) OF EXPOSED FILM. THE PRINTS OR SCANNED IMAGES SHALL BE TRIMMED TO A NEAT AND UNIFORM EDGE ALONG THE PHOTOGRAPHIC IMAGE WITHOUT REMOVING THE FIDUCIAL MARKS. THE PHOTOGRAPHS OR SCANNED IMAGES SHALL BE OVERLAP-MATCHED BY CONJUGATE IMAGES ON THE FLIGHT LINE WITH EACH PHOTOGRAPH IDENTIFICATION NUMBER CLEARLY SHOWN. THE PHOTOGRAPHS OR SCANNED IMAGES FOR EACH ADJACENT FLIGHT LINE STRIP SHALL OVERLAP IN THE SAME DIRECTION. AIRBASE LENGTHS SHALL BE AVERAGED IN THE IMAGE MATCHING OF SUCCESSIVE PAIRS OF PHOTOGRAPHS ON FLIGHT LINES, AND ADJOINING FLIGHT LINE ASSEMBLIES SHALL BE ADJUSTED IN LENGTH BY INCREMENTAL MOVEMENT ALONG THE FLIGHT LINE AS NECESSARY. DIGITAL PHOTO INDEXES ARE PRODUCED BY USING THE SCANNED IMAGES IN MOSAICING TECHNIQUES PROVIDED IN CADD SOFTWARE.

C.10.3. LABELING AND TITLING. FOR GEOGRAPHIC ORIENTATION, APPROPRIATE NOTATIONS SHALL APPEAR ON THE INDEX, NAMING OR OTHERWISE IDENTIFYING IMPORTANT AND PROMINENT GEOGRAPHIC AND LAND USE FEATURES. ALL OVERLAY LETTERING AND NUMBERING SHALL BE DRAFTING QUALITY. IN ADDITION, A NORTH ARROW, SHEET INDEX, IF APPLICABLE, AND A TITLE BLOCK SHALL APPEAR ON EACH INDEX. THE TITLE BLOCK SHALL CONTAIN PROJECT NAME, CONTRACTOR'S NAME, CONTRACT AGENCY NAME, DATE OF PHOTOGRAPHY, AND AVERAGE SCALE OF PHOTOGRAPHY.

C.10.4. SCALE AND SIZE. THE STAPLED OR TAPED ASSEMBLY OF PHOTOGRAPHY SHALL BE PHOTO-REDUCED TO A SCALE OF ABOUT ONE-THIRD (1/3) OF THE ORIGINAL NEGATIVE SCALE, EXCEPT THAT A LARGER PHOTO INDEX SCALE CAN BE USED IF ALL EXPOSURES FOR ONE PROJECT FIT THE REQUIRED FORMAT ON A SINGLE SHEET. EACH PHOTO INDEX SHEET SHALL BE \*[20 BY 24 IN.] [\\_\\_\\_\\_\\_\\_] IN SIZE. DIGITAL PHOTO INDEXES ARE PRODUCED IN THE CADD SYSTEM AT FULL PHOTOGRAPHY SIZE (9"X9") AND CAN BE PRODUCED IN HARD COPY AT ANY REQUIRED SCALE.

C.10.5. \*Photographic Copying and Printing. The photo index shall be copied on photographic film so that prints can be made by contact or projection method (digital files may be stored as a digital mosaic). Digital photo indexes can be stored on magnetic media (disk, tape, or CD-ROM) and produced on photographic paper or bond paper. The method used shall be the option of the Government and specified in the contract or task order.

C.10.6. PROCESSING AND QUALITY. ALL PHOTOGRAPHIC PRINTS OF THE INDEX SHALL COMPLY WITH THE STIPULATIONS GIVEN FOR CONTACT PRINTS IN THIS CONTRACT.

C.10.7. DELIVERIES. \*[ONE] [ ] FILM NEGATIVE OR NEGATIVES OF THE PHOTOGRAPHIC INDEX, \*[ONE \*[Continuous Tone] [specify screen size] SCREENED MYLAR FILM POSITIVE] [AND \*[TWO] [ ] PHOTOGRAPHIC PRINTS THEREOF] SHALL BE FURNISHED TO THE CONTRACTING OFFICER \*[FOR EACH TASK ORDER UNDER THIS CONTRACT].

C.11. UNCONTROLLED PHOTOGRAPHIC ENLARGEMENTS, AIR PHOTO PLANS, AND PHOTO MOSAICS.

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**NOTE: Uncontrolled photographic enlargements or air photo plan drawings and photo mosaics are usually prepared from 9- by 9-in. format film. They may also be prepared from film taken by any type of camera, even by a camera held by hand out the window of an aircraft. Photography may be near-vertical or oblique. These types of products are distinguished by the fact that they are “uncontrolled,” that is, no photogrammetric rectification is performed to remove camera nonvertical orientation or vertical relief distortion. The scale of these products is therefore only approximate and will vary from point to point.**

**Because of their uncontrolled nature, such products are used only for general feature reference or location. Detailed design or grid coordinate points/lines should not be superimposed on these images except for general reference.**

**Uncontrolled photographic products may, at times, be more economically procured by using standard purchase order (IFB) methods. They may also be included as line items in A-E IDT contracts when such products are required in addition to controlled line mapping of a particular site/project.**

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C.11.1 PHOTOGRAPHIC PAPER ENLARGEMENTS. \*[BLACK AND WHITE] [COLOR] PHOTOGRAPHIC ENLARGEMENT IS REQUIRED OF THE AREA DESIGNATED \*[ON THE ATTACHED MAP] [ ]. AERIAL PHOTOGRAPHY SHALL BE \*[NEAR-VERTICAL] [OBLIQUE] USING A \*[PRECISE AERIAL MAPPING CAMERA] [HAND-HELD TYPE CAMERA]. THE PHOTOGRAPH SHALL BE MOUNTED ON A [ ] BY [ ]-IN. FORMAT, MOUNTED ON A \*[PLYWOOD] [STYROFOAM] [MASONITE] [ ] BASE, CONTAINING A [ ]- IN. TRIMMED BORDER, A [ ] FRAME WITH WALL MOUNTING HARDWARE. A TITLE BLOCK SHALL BE PLACED IN THE [ ] CORNER AND CONTAIN THE FOLLOWING DATA: \*[ ]. \*[ ] COPIES OF THIS PRODUCT ARE REQUIRED.

C.11.2. UNCONTROLLED AIR PHOTO MAP PLAN SHEETS/DRAWINGS. AIR PHOTO PLAN SHEETS, AT AN APPROXIMATE SCALE OF [ ], PROJECTED ON \*[F] [ ]-SIZE FILM-POSITIVE DRAWING FORMAT, ARE REQUIRED FOR THE AREA DESIGNATED \*[ON THE ATTACHED MAP] [ ]. A TOTAL OF [ ] PHOTO PLAN SHEETS ARE REQUIRED TO COVER THE PROJECT AREA. \*THESE SHEETS SHALL BE ORIENTED AND LAID OUT AS SHOWN ON THE ATTACHED MAP. \*A [ ]-IN. OVERLAP SHALL BE USED BETWEEN SHEETS. NEAR-VERTICAL AERIAL PHOTOGRAPHY TAKEN AT A SCALE OF [ ] SHALL BE ENLARGED TO THE REQUIRED DEVELOPMENT SCALE OF THE PHOTO PLAN SHEETS. DRAFTING AND OTHER LABELING DETAILS ARE DESCRIBED ELSEWHERE IN THIS \*[CONTRACT] [ORDER]. [ ] TRANSPARENCIES ARE REQUIRED FOR EACH SHEET. FILM POSITIVES SHALL BE SCREENED TO [ ]. UNCONTROLLED AIR PHOTO MAP PLAN SHEETS MAY ALSO BE CREATED IN A DIGITAL ENVIRONMENT BY CREATING LOW RESOLUTION SCANS OF SELECTED IMAGES AND MERGING/MOSAICING THEM UTILIZING



SOFTCOPY WORKSTATIONS. THE OPTION IS (HARDCOPY OR DIGITAL) AND SHOULD BE SPECIFIED IN THE CONTRACT OR TASK ORDER.

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**NOTE: Uncontrolled air photo plan overlays may be economical products that may be used to show planning developments or contemplated changes in an area. For example, an air photo plan can show the planned location of a proposed structure, canal, highway, etc. Care must be taken to ensure that these products are not misused. They are not orthophoto products and will not have the horizontal accuracy of a properly designed orthophoto. Orthophoto technology today has made these uncontrolled image products not as cost effective as they once were. A small-scale orthophoto product may often be developed at the same cost as that to produce a uncontrolled air photo plan.**  
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C.11.3. AERIAL MOSAICS. AN ASSEMBLED UNCONTROLLED PHOTO MOSAIC SHALL BE PREPARED AT AN APPROXIMATE SCALE OF [\_\_\_\_\_]. THE MOSAIC SHALL BE ASSEMBLED FROM [\_\_\_\_\_] -SCALE PHOTOGRAPHY AND ENLARGED/REDUCED AS REQUIRED. THE MOSAIC SHALL BE MOUNTED ON A [\_\_\_\_\_] BY [\_\_\_\_\_] -IN. FORMAT, MOUNTED ON A \*[PAPER] [PLYWOOD] [STYROFOAM] [MASONITE] [\_\_\_\_\_] BASE, CONTAINING A [\_\_\_\_\_] -IN. TRIMMED BORDER, A [\_\_\_\_\_] FRAME WITH WALL MOUNTING HARDWARE. \*A FILM \*[POSITIVE] [NEGATIVE] OF THE FINAL MOSAIC IS ALSO REQUIRED. MOSAIC ASSEMBLY, MOUNTING, BLENDING, AND OTHER PROCESSES SHALL FOLLOW STANDARD PROCEDURES SET FORTH IN THE MANUAL OF PHOTOGRAMMETRY (REFERENCE C.3.[\_\_\_\_]). AERIAL MOSAICS MAY ALSO BE CREATED IN A DIGITAL ENVIRONMENT BY CREATING LOW-RESOLUTION SCANS OF SELECTED IMAGES AND MERGING/MOSAICING THEM UTILIZING SOFTCOPY WORKSTATIONS. THE OPTION IS (HARDCOPY OR DIGITAL) AND SHOULD BE SPECIFIED IN THE CONTRACT OR TASK ORDER.

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**NOTE: Add other specifications as required. Aerial mosaics, air photo plans, enlargements, and other uncontrolled image products add cost to photogrammetric map data compilation projects and are rarely used in current USACE practice. The use of hardcopy products is often limited. For most USACE purposes, properly designed digital orthophoto products are the image data of choice. See EM-1110-1-1000 for orthophoto design requirements. Engineering, GIS, design, planning, and environmental assessment software often requires or can make use of these digital, spatially accurate products.**  
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C.12. CONTROLLED/RECTIFIED PHOTO PLANS AND ORTHOPHOGRAPHY.

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**NOTE: The process of rectification can be generally defined as the projective transformation of a tilted photograph into one that is tilt-free and of a desired scale. Rectification is accomplished by creation of a suitable elevation model, scanning required images and utilizing softcopy workstation hardware and software to merge the elevation models and scanned images into an orthogonal image file (orthophotograph).**

The need for rectified photo plans (or orthophotographs), as opposed to uncontrolled air photo plans should be discouraged. Design work may be accurately and cost effectively referenced to and superimposed over digital orthophotographs.

The cost and labor required to produce an orthophotograph and a simple uncontrolled or semi-controlled photograph does not have to be significantly different. The cost difference can be the elevation model. Small-scale orthophotographs can be created using USGS DEM data sets with current imagery. The cost using this technique (when applicable) can be very competitive with a simple uncontrolled or semicontrolled photograph. Current technology generally leans toward digital imagery for products such as mosaics, photo indices, rectified images, etc. Orthophotos should always be considered for any image requirements that may be used for engineering design, planning, or GIS.

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C.12.1. \*[CONTROLLED/RECTIFIED] [SEMICONTROLLED] DIGITAL AERIAL IMAGE MOSAICS. RECTIFIED DIGITAL AERIAL IMAGE MOSAICS, AT A HORIZONTAL SCALE OF [\_\_\_\_], WITH A PIXEL RESOLUTION OF [\_\_\_\_], ARE REQUIRED FOR THE AREA DESIGNATED \*[ON THE ATTACHED MAP] [\_\_\_\_]. AERIAL PHOTOGRAPHY TAKEN AT A SCALE OF [\_\_\_\_] SHALL BE SCANNED AND RECTIFIED USING A HIGH-RESOLUTION SCANNER AND SOFTCOPY WORKSTATION AND SHALL BE CONTROLLED BY PHOTO-IDENTIFIABLE \*[GROUND SURVEY CONTROL] [USGS QUAD MAP FEATURES]. THE IMAGES SHALL BE MOSAICED, CHECKED, AND CORRECTED FOR RADIOMETRIC ERRORS AND BLEMISHES. SHEETING AND LABELING DETAILS ARE DESCRIBED ELSEWHERE IN THIS \*[CONTRACT] [ORDER]. [\_\_\_\_] TRANSPARENCIES ARE REQUIRED FOR EACH SHEET. REFERENCE ALSO EM 1110-1-1000.

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**NOTE:** The rectification process requires a visual fit between the aerial image and points identifiable either on a map or surveyed ground control points plotted on a manuscript base. When only approximate scale/ orientation is needed, a USGS quad map (or other larger-scale map) may be used to orient/rectify the photographs. When warranted, such a product might be classified as “semicontrolled.” This method is far more economical than using ground surveys to control the photos, a controlled product. Digital image plan sheets produced in this way may be printed on bond paper as required.

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#### C.12.2. ORTHOPHOTOGRAPHY AND ORTHOPHOTOMAPS.

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**NOTE:** An orthophotograph or orthophotomap is made from an aerial photograph by removing the effects of tilt, relief, lens, and other inherent distortions. Only when relief displacement must be removed is an orthophotograph required. Relief displacement usually need not be removed unless large-scale (e.g., 1 in. = 100 ft or larger) design drawings are involved, and the use of orthophotos as opposed to line maps at these design scales must to be justified.

An orthophotomap is almost equivalent to a planimetric feature map, except for features having sudden, significant elevation changes (e.g., buildings and other like vertical structures). Proposed designs of engineering projects may be directly superimposed on the orthophoto map to detail the understanding of work to be accomplished, primarily for the benefit of laymen not versed in interpreting traditional site plan map products. Orthophotographs are prepared from pairs of overlapping aerial photographs using specially designed orthoplotting workstations. The photographs are oriented in the instrument and an elevation model is produced. Scanned images are also produced from the photography at a ground pixel resolution that is compatible with the imagery negative scale and horizontal map scale. See EM-1110-1-1000 for detailed information regarding orthophoto design. Software then merges the elevation model and the scanned images and eliminates the distortion resulting from relief displacement. The requirements for ground control or control to be established by aerotriangulation are the same as for photogrammetric mapping. Tilt and other distortions are

**corrected in the orientation of the stereomodel. An orthophotomap differs from an orthophotograph in that planimetric and/or topographic detail is added to the scanned photo base.**

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a. GENERAL. [ ] SETS OF DIGITAL (AND HARDCOPY) ORTHOPHOTOGRAPHS [WITH CARTOGRAPHIC FEATURE DETAIL ADDED] [WITH TOPOGRAPHIC CONTOURS SUPERIMPOSED] ARE REQUIRED. THE ORTHOPHOTOGRAPH SHALL COMPRISE A DIGITAL IMAGE OF THE PROJECT AREA TO THE BOUNDARIES AS DESCRIBED ON MAPS ATTACHED TO THE TASK ORDER OR CONTRACT. THE PROCESSES USED TO GENERATE THE ORTHOPHOTO COVERAGE SHALL BE OF A QUALITY AND PRECISION THAT WILL EFFECTIVELY REMOVE THE IMAGE DISPLACEMENTS CAUSED BY GROUND RELIEF AND TILT. UNLESS SPECIFIED IN AN INDIVIDUAL TASK ORDER OR AS A MODIFICATION TO THIS CONTRACT DISPLACEMENT OF TOPS OF VEGETATION, BUILDINGS, ELEVATED ROADS AND BRIDGES, AND OTHER ELEVATED FEATURES WILL NOT BE CORRECTED.

b. MATERIALS. IMAGE SCANNING FOR ORTHOPHOTOS SHALL BE FROM ORIGINAL FILM OR CLEAN DIAPOSITIVES. FILM AND DIAPOSITIVES SHALL BE FREE OF DUST AND SCRATCHES THAT MAY BE SEEN IN THE FINAL ORTHOPHOTO IMAGE.

c. EQUIPMENT. THE COMPILATION OF THE ORTHOPHOTOGRAPH SHALL BE ACCOMPLISHED USING A HIGH-RESOLUTION METRIC SCANNER AND SOFTCOPY WORKSTATION CAPABLE OF PRODUCING ORTHOPHOTOGRAPHS AT THE ACCURACY AND GROUND RESOLUTION SPECIFIED IN THE CONTRACT OR TASK ORDER.

d. CONTROL. UNLESS OTHERWISE SPECIFIED, ALL ESSENTIAL BASIC AND SUPPLEMENTAL CONTROL OF REQUIRED ACCURACY SHALL BE OBTAINED BY THE CONTRACTOR FROM AVAILABLE SOURCES, OR PROJECT CONTROL SURVEYS SHALL BE MADE BY THE CONTRACTOR, AS NECESSARY, FOR CONTROLLING THE COMPILATION OF THE ORTHOPHOTOGRAPH(S).

e. ACCURACY. PLANIMETRIC FEATURE DETAIL SHOWN ON THE ORTHOPHOTOGRAPH SHALL BE ACCURATE TO THE CRITERIA SPECIFIED IN THE CONTRACT OR TASK ORDER.

f. QUALITY. THE DIGITAL ORTHOPHOTOGRAPH SHALL HAVE UNIFORM COLOR TONE AND SHALL HAVE THE DEGREE OF CONTRAST TO CAUSE ALL DETAILS TO SHOW CLEARLY IN THE DARK-TONE AREAS AND IN THE HIGH LIGHT AREAS AS WELL AS IN THE HALFTONES BETWEEN THE DARK AND HIGH LIGHT. DIGITAL IMAGERY SHALL BE FREE FROM DUST MARKS, SCRATCHES, OUT-OF-FOCUS IMAGERY, AND ANY OTHER INCONSISTENCIES IN TONE AND DENSITY BETWEEN INDIVIDUAL ORTHOPHOTOS AND/OR ADJACENT MAP SHEETS. ORTHOPHOTO IMAGES HAVING EXCESSIVE CONTRAST OR NEGATIVES LOW IN CONTRAST MAY BE REJECTED.

g. CONTOURS. CONTOURS AND SPOT ELEVATIONS \*[WILL] [WILL NOT] BE ADDED TO THE ORTHOPHOTOGRAPHS BY SETTING THE ORIGINAL STEREO MODELS AND GENERATING A SUITABLE ELEVATION MODEL AND CONTOURS AND SUPERIMPOSING THEM OVER THE ORTHOPHOTO IMAGE FILE USING SOFTCOPY METHODS.

h. FINAL IMAGES. FINAL ORTHOPHOTOS AND ORTHOPHOTO MAPS SHALL BE DIGITAL PRODUCTS ALONG WITH NECESSARY HARDCOPY PRODUCTS AS SPECIFIED IN THE CONTRACT OR INDIVIDUAL TASK ORDERS. HARDCOPY PLOTS SHALL BE ON BOND PAPER UNLESS SPECIFIED DIFFERENTLY IN THE CONTRACT OR TASK ORDER. THE HORIZONTAL

SCALE AND PIXEL RESOLUTION AND ACCURACY REQUIREMENTS SHALL BE STATED FOR FINAL ORTHOPHOTO AND ORTHOPHOTO MAP PRODUCTS.

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i. DELIVERIES. ALL MATERIALS, INCLUDING THE FINAL ORTHOPHOTOGRAPH DATA DIGITAL FILES IN ([ ] FORMAT), THE CONTROL PRINTS, NECESSARY SCANNED IMAGES, AND NECESSARY DIAPOSITIVES SHALL BE FURNISHED TO THE CONTRACTING OFFICER.

C.13. GROUND PHOTO CONTROL SURVEY REQUIREMENTS.

C.13.1. GENERAL. ALL HORIZONTAL AND VERTICAL CONTROL SURVEYS REQUIRED FOR PHOTOGRAMMETRIC MAPPING SHALL, UNLESS OTHERWISE INDICATED HEREIN, BE PERFORMED USING PROCEDURES AND/OR ACCURACY STANDARDS CONSISTENT WITH PROFESSIONAL SURVEYING PRACTICES. ALL SURVEYING AND PHOTO MAPPING WORK SHALL BE REFERENCED TO EXISTING PROJECT CONTROL, WHICH IS ON NAD \*[27] [83] (HORIZONTAL DATUM) AND \*[NGVD 29] [NAVD 88] [ ] (VERTICAL DATUM). THE LOCAL GRID REFERENCE SYSTEM SHALL BE \*[SPCS 27 ZONE ] [SPCS 83 ZONE ] [UTM ZONE ] [ other ]. ALL GRID COORDINATES SHOWN ON MAP PRODUCTS SHALL BE EXPRESSED IN, OR CONVERTED TO \*[U.S. SURVEY FEET] [INTERNATIONAL FEET] [METERS]. THE CONTRACTOR SHALL PROVIDE SURVEY CREWS WITH PROFESSIONAL SURVEY PERSONNEL AND EQUIPMENT CAPABLE OF PERFORMING OBSERVATIONS AND MEASUREMENTS THAT MEET THE REQUIRED ACCURACY NEEDED FOR THE WORK. ALL FIELD OBSERVATIONAL DATA SHALL BE PERFORMED IN ACCORDANCE WITH STANDARD ENGINEERING SURVEY PRACTICES, \*[AS SPECIFIED IN REFERENCE \*C.3.\*[ ]]. SURVEY DATA SHALL BE RECORDED IN BOUND SURVEY BOOKS OR IN DIGITAL FILES (AS SPECIFIED IN THE CONTRACT OR TASK ORDER) WHICH WILL SUBSEQUENTLY BE DELIVERED TO THE GOVERNMENT. ALL SURVEY WORK WILL BE PERFORMED UNDER THE SUPERVISION AND CONTROL OF A LICENSED PROFESSIONAL LAND SURVEYOR. \*[ALL SURVEY WORK, INCLUDING OFFICE COMPUTATIONS AND ADJUSTMENTS, IS SUBJECT TO GOVERNMENT REVIEW AND APPROVAL FOR CONFORMANCE WITH PRESCRIBED ACCURACY STANDARDS.]

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**NOTE: The above clause should reference the particular survey procedural manual that should be followed in performing conventional engineering surveying, including note-keeping and record-keeping requirements. This reference may be a District manual, Technical Manual, EM, or other recognized standard.**

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C.13.2. PHOTO CONTROL SURVEYS. SURVEYS PERFORMED TO CONTROL HORIZONTAL OR VERTICAL LOCATIONS OF POINTS USED IN CONTROLLING STEREOSCOPIC MODELS SHALL BE PERFORMED USING RECOGNIZED ENGINEERING AND CONSTRUCTION CONTROL SURVEY METHODS, AS NECESSARY TO MEET THE ULTIMATE MAPPING STANDARDS REQUIRED IN PARAGRAPH C.15. THIS USUALLY REQUIRES, AT MINIMUM, THIRD-ORDER PROCEDURES PERFORMED RELATIVE TO EXISTING NETWORK OR PROJECT CONTROL, USING STANDARD ENGINEERING SURVEY TRAVERSE, DIFFERENTIAL LEVELING, GPS, OR ELECTRONIC TOTAL STATION MEASUREMENT TECHNIQUES.

a. UNLESS OTHERWISE INDICATED, PHOTO CONTROL POINTS OR PANELLED POINTS MAY BE TEMPORARILY MARKED (2- by 2-IN. STAKES, NAILS, ETC.). THESE TEMPORARY MARKS

SHOULD REMAIN IN PLACE FOR AT LEAST THE DURATION OF THE CONTRACT AND MAY BE USED FOR PERFORMING QUALITY CONTROL OR ASSURANCE SURVEYS.

b. EXISTING PROJECT/NETWORK CONTROL. A TABULATION AND/OR DESCRIPTION OF EXISTING PROJECT/NETWORK CONTROL POINTS \*[IS SHOWN BELOW] [IS SHOWN IN ATTACHMENT G] [WILL BE PROVIDED WITH EACH TASK ORDER]. THE SOURCE AGENCY, COORDINATES, DATUM, AND ESTIMATED ACCURACY OF EACH POINT IS INDICATED ON THE DESCRIPTION. PRIOR TO USING ANY CONTROL POINTS, THE MONUMENTS SHOULD BE CHECKED TO ENSURE THAT THEY HAVE NOT BEEN MOVED OR DISTURBED.

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**NOTE: List each existing control station(s) or, alternately, refer to a map, tabulation attachment, and/or descriptions that would be attached at contract Section G.**  
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c. \*The contractor shall perform surveys connecting existing project control to assure that such control has sufficient relative accuracy to control the overall project. Should these surveys indicate deficiencies in the existing control, the Contractor shall advise the Contracting Officer, and appropriate modification may be made to the contract to perform resurveys of the existing network.

d. All horizontal and vertical control points will be occupied as a station within a closed traverse or closed level loop. If it is not possible to occupy an individual control point or photo target, thus requiring spur shots, all angles shall be read at least three times and averaged, and all distances measured twice and averaged.

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**NOTE: The following clauses would be used only when permanent project control monuments need to be established for future design or construction work, when existing control is found to be deficient, when existing project control is distant from the project site necessitating extensive traversing or leveling work, or when there is no existing project control. Procedural methods for horizontal or vertical control extension should follow either USACE Command standards or FGCC criteria, which should be referenced/attached to the contract, and specifically noted for each type of work. FGCC standards are intended for national geodetic network densification and would normally be used only if no other local standards are available.**

**Therefore, there is no need to reiterate basic surveying techniques, procedures, methods, standards, etc. in the contract. Few USACE mapping or construction projects require X-Y or Z relative accuracies in excess of those obtainable by Third-order methods/standards. Specifying higher levels of accuracy must be thoroughly justified relative to the impact on relative mapping accuracies and other factors. Refer also to the guidance contained in EM 1110-1-1000.**

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C.13.3. \*New station monumentation, marking, and other control requirements. Permanently monumented control stations shall be surveyed as at the locations shown in the attachment in Section G. \*[Note specific locations where permanent control points are required.] A total of [ ] horizontal points and [ ] vertical points are required.

C.13.4. \*Horizontal accuracy requirements. New or permanent control monuments/stations shall be established to a \*[Third] [ ]-order, Class \*[I] [ ] relative accuracy classification, or 1 part in \*[10,000] [ ]. \*Supplemental control stations shall be established to a \*[Third] [ ]-order, Class \*[II] [ ] relative accuracy classification, or 1 part in \*[5,000] [ ]. See Reference C.3.\*[ ].

C.13.5. \*Vertical accuracy requirements. New or permanent vertical control shall be performed to \*[Third] [\_\_\_\_\_] -order standards. See Reference C.3.\*[\_\_\_\_].

a. \*All stations shall be monumented in accordance with EM 1110-1-1002, "Survey Markers and Monumentation." Monumentation for this project shall be Type \*[\_\_\_\_\_] for horizontal and Type \*[\_\_\_\_\_] for vertical per EM 1110-1-1002 criteria. \*[Monumentation shall be defined to include the required reference marks and azimuth marks required by EM 1110-1-1002.]

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**NOTE: Deviations from EM 1110-1-1002 should be indicated as required. USACE project control rarely requires supplemental reference/azimuth marks—the optional specification clauses below should be tailored accordingly.**  
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b. \*At each station, angle and distance measurements shall be made between a network station and reference marks/azimuth marks established in accordance with the requirements set forth in EM 1110-1-1002. All observations shall be recorded in a standard field book.

(1) \*For reference marks, two (2) directional positions are required (reject limit  $\pm 10$ -sec arc) and with steel taping performed to the nearest  $\pm 0.01$  ft.

(2) \*Four directional positions are required to azimuth marks. The reject limit for a 1-sec theodolite is  $\pm 5$  sec. Azimuth mark landmarks shall be easily defined/described natural features or structures of sufficient distance to maintain a  $[\pm \text{____}]$ -second angular accuracy.  $[\text{____}]$ -order astronomic azimuths shall be observed to azimuth marks.]

(3) \*A compass reading shall be taken at each station to reference monuments and azimuth marks.

C.13.6. \*Station Description and Recovery Requirements.

a. \*Station descriptions and/or recovery notes shall be written in accordance with the instructions contained in EM 1110-1-1002. [Form \*[\_\_\_\_\_] shall be used for these descriptions.] Descriptions shall be \*[written] [typed].

b. \*Descriptions \*[are] [are not] required for \*[existing] [and/or newly established] stations.

c. \*Recovery notes \*[are] [are not] required for existing stations.

d. \*A project control sketch \*[is] [is not] required.

C.13.7. PREMARKED PHOTO CONTROL TARGETS. UNLESS OTHERWISE SPECIFIED HEREIN \*[OR IN TASK ORDER INSTRUCTIONS], ALL GROUND CONTROL USED AS PHOTOGRAPHIC CONTROL POINTS UNDER THIS CONTRACT WILL BE PREMARKED PRIOR TO OBTAINING AERIAL PHOTOGRAPHY. TARGETS SHALL BE OF ADEQUATE SIZE AND PROVIDE GOOD PHOTOGRAPHIC CONTRAST SO THEY WILL BE CLEARLY DISTINCT IN STEREOSCOPIC MODELS. PANELS WILL BE MADE USING COLORED FABRIC (UNBLEACHED MUSLIN), PLASTIC, OR IN SOME INSTANCES, PAINT ON ROADS. THE COLOR TO BE USED SHOULD BE IN SHARP CONTRAST TO THE BACKGROUND AREA, I.E., BLACK ON A WHITE BACKGROUND, ETC. PANELS ARE IN THE FORM OF CROSSES, T'S, V'S, OR Y'S. THE LONG DIMENSION OF THE PANEL SHOULD BE A MINIMUM OF 0.015 OF THE NEGATIVE SCALE IN FEET. FOR

PHOTOGRAPHS AT A SCALE OF 1 IN. = 500 FT, THIS WOULD BE 7.5 FT. THE MINIMUM WIDTH SHOULD BE 0.01 OF THE PHOTO SCALE IN INCHES. LARGER TARGETS WILL BE MORE EASILY VISIBLE, WHILE ANYTHING SMALLER MAY NOT BE SEEN ON THE PHOTOGRAPHS. THE CONTROL POINT IS LOCATED DIRECTLY UNDER THE CENTER OF THE CROSS OR THE INTERSECTION OF THE LINES OF THE T OR V AND MAY BE MARKED IN A TEMPORARY MANNER. THE PANELS SHOULD BE SECURED TO THE GROUND.

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**NOTE:** The location of the photo control points on the photography should be selected by the contractor, either by designation of an area in which a specific control point should be obtained or by actually identifying the point on the photograph. The former method is to be preferred since the surveyor should be required to make the most reliable selection in the field. For small mapping projects, or where good judgment and economy dictate, photo control should be obtained for each of the stereomodels to be used in the mapping. An ideal situation requires at least three horizontal and four vertical photo control points for each stereomodel. Refer also to EM 1110-1-1000.  
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C.13.8. \*Full Photo Model Control. The Contractor shall establish a minimum of \*[three (3)] [\_\_\_\_\_] ( )] horizontal and \*[four (4)] [\_\_\_\_\_] ( )] vertical control points for each stereoscopic model by field survey methods. The horizontal points shall be as far apart as feasible within each model. Each point shall be an image of an existing object or be a finite photographic pattern that is clearly identifiable both on the ground and on the photographs, or be the photographic target. The vertical points shall be spaced for optimum use of the model, preferably in or near each corner of the model. The accuracy of all supplemental control surveys shall be the same as that stipulated for all control surveys required under this contract. Where pretargeting is to be utilized, sufficient targets must be established so that each model contains the specified number of control points, even though the starting point of flight lines may shift from the intended position.

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**NOTE:** The above clause is used in instances when analytical aerotriangulation extension methods are not used. Aerotriangulation is a method of extending and increasing the density of photo control. It may be performed using a precision type stereoplotting instrument or softcopy workstation. Aerotriangulation is used most successfully on large projects, on jobs where existing basic control is found at each end of a mapping area, or when the requirements of the job do not include the establishment of ground control points within the mapping area. When two or more adjacent flight lines are involved, a block system of aerotriangulation is used. Analytical aerotriangulation bridging techniques are especially applicable to small-scale mapping work covering relatively large areas. For large-scale site plan mapping of relatively small areas (i.e., only one or two models may be involved), which are intended for detailed design, use of analytical aerotriangulation bridging techniques should be limited; sufficient ground photo control should be set to cover each model within the project. As with all phases of photogrammetric map compilation, the decision to use full ground photo control or aerotriangulation bridging is a function of the project requirements and resources available. See also guidance contained in EM 1110-1-1000.  
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C.13.9. CONTROL PHOTOGRAPHS. ALL HORIZONTAL AND VERTICAL CONTROL POINTS INCLUDING SUPPLEMENTAL CONTROL POINTS SHALL BE MARKED AND LABELED WITH APPROPRIATE POINT IDENTIFICATION NUMBERS. ALL CONTROL POINTS NOT PREMARKED SHALL BE NEATLY PIN-PRICKED, CLEARLY IDENTIFIED, AND BRIEFLY DESCRIBED ON THE BACK OF THE PHOTOGRAPH. \*[COORDINATES AND BRIEF DESCRIPTIONS OF MARKED CONTROL POINTS SHALL BE WRITTEN ON THE BACK OF EACH PHOTO.] (FULL STATION DESCRIPTIONS WILL BE WRITTEN FOR NEWLY SET, PERMANENTLY MONUMENTED POINTS.)

THE MARKED-UP CONTROL PRINTS \*[WILL] [WILL NOT] BE DELIVERED TO THE GOVERNMENT.

C.13.10. FIELD TOPOGRAPHIC SURVEY DENSIFICATION. CONSISTENT WITH THE PLANIMETRIC FEATURE, TOPOGRAPHIC, AND UTILITY DETAILING REQUIREMENTS CONTAINED IN PARAGRAPH C.14, ADDITIONAL DETAIL SURVEYS BY \*[PLANE TABLE] [TOTAL STATION] METHODS SHALL BE PERFORMED AS NECESSARY TO ASSURE MAPPING COVERAGE.

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**NOTE: Add here any requirements for highway/stream sections, overbank surveys, hydrographic surveys, FEMA/Flood Insurance Study sections, etc.**  
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C.13.11. FIELD CLASSIFICATION AND MAP EDIT SURVEYS. FIELD CLASSIFICATION, INSPECTION, AND/OR EDIT SURVEYS \*[WILL] [WILL NOT] BE PERFORMED \*[ON THIS PROJECT] [AS REQUIRED IN THE SCOPE OF DELIVERY ORDERS]. A \*[TWO] [\_\_\_\_\_] -MAN SURVEY CREW WILL PERFORM SURVEYS NECESSARY TO CLASSIFY CULTURAL FEATURES, CLARIFY OBSCURED DETAIL; ADD TO OR CORRECT INCOMPLETE, CRITICAL FEATURE, OR TOPOGRAPHIC DETAIL BY CONVENTIONAL FIELD SURVEY METHODS; AND PERFORM MAP STANDARD INTERNAL QUALITY CONTROL TESTING AS REQUIRED BY THE CONTRACTOR.

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**NOTE: Field inspection and editing of map feature compilation may be necessary to fill in details required by the specifications that may have been obscured on the aerial photography and are too small to be recognized on the photographs or for GIS data attribution. The project's functional requirement will dictate the need for and scope of subsequent field classification/edit surveys. For map scales of 1:2,400 and smaller, the field edit takes the form of classification of data. This might include names of landmark buildings, highways, trails, cemeteries, identification of major features, and similar general data. Occasionally, classification surveys can be made before the mapping feature data sets are compiled, and it is desirable to use enlarged photographs for this purpose. For maps of larger scales, particularly 1 in. = 60 ft and larger, the field edit becomes an essential part of the mapping process. Since large-scale data sets are used for the design of engineering projects, complete feature details are essential. In urban areas, parked cars may hide manholes and catch basins; invert elevations or other underground utility data may be required; utility poles and outlets should be checked and identified; property corners and the names of owners should be provided; and trees and bushes and such other details as may be needed by the map user should be identified. Field edits should ensure that the field data collected is merged accurately with the photogrammetrically compiled data sets.**  
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C.13.12. \*FINAL MAP QUALITY ASSURANCE TEST SURVEYS. THE CONTRACTOR WILL FIELD A \*[TWO] [\_\_\_\_\_] -MAN SURVEY CREW TO PERFORM QUALITY ASSURANCE TESTS IN ACCORDANCE WITH THE CRITERIA CONTAINED IN SECTION C.15 OF THIS CONTRACT. THESE TEST SURVEYS \*[MAY] [SHALL] BE CONDUCTED WITH A GOVERNMENT REPRESENTATIVE PRESENT.

C.14. STEREOCOMPILATION, DRAFTING, AND CADD SPECIFICATIONS.

C.14.1. ANALYTICAL AEROTRIANGULATION SPECIFICATIONS. WHEN AUTHORIZED WITHIN THIS CONTRACT \*[AND/OR TASK ORDER], THE X-, Y-, AND Z-COORDINATES FOR SUPPLEMENTAL PHOTO CONTROL POINTS MAY BE DERIVED USING FULLY ANALYTICAL, SIMULTANEOUS, BLOCK AEROTRIANGULATION ADJUSTMENT METHODS. INDUSTRY-



STANDARD ADJUSTMENT SOFTWARE, OR THAT SUPPLIED WITH ANALYTICAL PLOTTERS AND SOFTCOPY WORKSTATIONS, MUST BE USED TO PERFORM THE COMPUTATIONS. USE OF DIFFERENT ALTITUDE PHOTOGRAPHY IS NOT ALLOWED. THE PHOTOGRAPHY SPECIFIED IN PARAGRAPH C.6 SHALL BE USED TO PERFORM ALL MEASUREMENTS.

a. EQUIPMENT. THE PHOTOGRAMMETRIC MENSURATION INSTRUMENTS SHALL HAVE SUFFICIENT ACCURACY AND UTILITY FOR MEASURING THE X AND Y PHOTOGRAPHIC COORDINATES OF THE FIDUCIAL OR OTHER PHOTOGRAPHIC REFERENCE MARKS, TARGETS, PHOTOGRAPHIC IMAGES, AND ARTIFICIALLY MARKED POINTS TO ACHIEVE THE REQUIRED ACCURACIES.

b. GROUND AND SUPPLEMENTAL CONTROL REQUIREMENTS AND EXTENSION LIMITS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR DETERMINING THE OPTIMUM LOCATION, QUALITY, AND ACCURACY OF ALL GROUND SURVEYED CONTROL POINTS USED FOR CONTROLLING THE AEROTRIANGULATION ADJUSTMENT. UNLESS OTHERWISE SPECIFIED, THERE SHALL BE AT LEAST ONE (1) GROUND VERTICAL CONTROL POINT FOR EVERY \*[TWO (2)] [\_\_\_\_\_] STEREOSCOPIC MODELS AND ONE (1) GROUND HORIZONTAL CONTROL POINT FOR EVERY \*[FOUR (4)] [\_\_\_\_\_] STEREOSCOPIC MODELS. AT LEAST SIX PHOTO CONTROL POINTS MUST APPEAR ON EACH STEREO MODEL. SUPPLEMENTAL POINTS INCLUDE A POINT NEAR THE PRINCIPAL POINT OF EACH PHOTO WITH THE OTHER FOUR (4) POINTS LOCATED NEAR EACH CORNER OF THE MODEL, PREFERABLY IN THE OVERLAP AREA BETWEEN ADJACENT MODELS AND STRIPS. A GROUND CONTROL POINT MAY BE SUBSTITUTED FOR A SUPPLEMENTARY CONTROL POINT IF IT IS LOCATED IN THE SAME GENERAL AREA OF ONE OF SIX (6) POSITIONS DESCRIBED HEREIN. UNLESS OTHERWISE DIRECTED, ALL SUPPLEMENTAL CONTROL POINTS WILL BE PHYSICALLY DRILLED (PUGGED) ON THE AERIAL PHOTO. AIRBORNE GLOBAL POSITIONING (ABGPS) TECHNOLOGY ALLOWS FOR THE COLLECTION OF THE X,Y,Z LOCATION OF THE CENTER OF EVERY PHOTOGRAPH COLLECTED IN A MISSION USING ON-THE-FLY GPS TECHNIQUES. THIS METHOD OF PHOTO CONTROL MAY GENERALLY BE USED FOR PROJECTS THAT REQUIRE MAP SCALES OF 1"=100' WITH 2-FT CONTOURS OR SMALLER (I.E., 1"=400' WITH 8-FT CONTOURS). ADDITIONAL GROUND CONTROL IS GENERALLY REQUIRED WHEN ABGPS METHODS ARE EMPLOYED. HOWEVER, THE NUMBER, TYPE AND LOCATION IS MUCH LESS THAN CONVENTIONAL GROUND CONTROL FOR BLOCK ADJUSTMENTS. THE SOW FOR A PROJECT SHOULD STATE THE ACCURACY OF THE FINAL MAPPING \*[1"=100' WITH 2-FT CONTOURS] AND THE ASPRS ACCURACY REQUIRED \*[ASPRS CLASS I STANDARD]. THE NUMBER AND TYPE OF SUPPLEMENTAL GROUND CONTROL SHOULD BE REVIEWED BY THE GOVERNMENT BUT NOT DIRECTED IN THE SOW. ABGPS TECHNOLOGY IS DISCUSSED IN DETAIL IN EM 1110-1-1000.

c. RESULTANT ACCURACY OF AEROTRIANGULATION ADJUSTMENT. FOR CLASS 1 MAPS, THE ROOT MEAN SQUARE (RMS) ERROR FOR THE X-, Y-, AND Z-COORDINATES OF ALL SUPPLEMENTAL CONTROL POINTS DETERMINED BY ANALYTICAL AEROTRIANGULATION SHALL NOT BE IN ERROR BY MORE THAN \*[1:10,000] [\_\_\_\_\_] IN HORIZONTAL POSITION (X AND Y) AND \*[1:8,000] [\_\_\_\_\_] IN ELEVATION (Z), WHEN EXPRESSED AS A RATIO FRACTION OF THE FLYING HEIGHT. THESE ADJUSTMENT STATISTICS MUST BE CLEARLY IDENTIFIED ON THE ADJUSTMENT SOFTWARE OUTPUT THAT SHALL BE DELIVERED TO THE GOVERNMENT \*[PRIOR TO COMMENCEMENT OF STEREO PLOTTING]. A SHORT WRITTEN REPORT \*[SUBMITTED TO THE CONTRACTING OFFICER PRIOR TO COMPILATION] EXPLAINING ANY ANALYTICAL CONTROL PROBLEMS ENCOUNTERED SHALL ACCOMPANY THIS PRINTOUT. AEROTRIANGULATION ACCURACY CRITERIA FOR OTHER MAP CLASSES ARE CONTAINED IN EM 1110-1-1000.

d. CONTROL PRINTS. THE IMAGE OF ALL GROUND CONTROL AND SUPPLEMENTAL CONTROL POINTS SHALL BE APPROPRIATELY MARKED AND IDENTIFIED ON A SET OF CONTACT PRINTS. THE IDENTIFYING NUMBER FOR EACH SUPPLEMENTAL CONTROL POINT SHALL BE RELATED TO THE PHOTOGRAPH ON WHICH IT APPEARS.

e. DELIVERIES. ALL MATERIALS, INCLUDING THE X-Y-Z COORDINATE LISTING OF SUPPLEMENTAL CONTROL POINTS, FINAL ADJUSTMENT COMPUTATIONS WITH ERROR OF CLOSURE, CONTROL PRINTS \*[THE MARKED/DRILLED DIAPOSITIVES], COPIES OF THE CAMERA CALIBRATION REPORTS FOR AERIAL CAMERAS USED FOR THE PHOTO COLLECTION AND ANY ROLLS-FILM NEGATIVES USED BY THE CONTRACTOR, SHALL BE PROVIDED TO THE GOVERNMENT.

C.14.2. STEREOPLOTTER OR SOFTCOPY WORKSTATION SPECIFICATIONS. TOPOGRAPHIC AND/OR PLANIMETRIC FEATURE LINE MAPS ARE TO BE DEVELOPED/GENERATED ON AN ANALYTICAL STEREOPLOTTER \*[Wild BC2,] \*[Zeiss P-3,] \*[Kern DSR1,] \*[LEICA SD 2000] OR SOFTCOPY WORKSTATION \*[KLT SOFTCOPY WORKSTATION,] \*[INTERGRAPH Z111 IMAGE STATION,] \*[AUTOMETRIC 1<sup>ST</sup> ORDER SOFTCOPY WORKSTATION,]. THE FEATURE COLLECTION SYSTEM MUST BE CAPABLE OF AUTOMATICALLY PERFORMING/ADJUSTING INTERIOR, RELATIVE, AND ABSOLUTE ORIENTATIONS, AND OUTPUT STATISTICAL DATA THEREOF, AND GENERATING DIGITAL DATA OF OBSERVED TOPOGRAPHIC/FEATURE INFORMATION INTO GEOSPATIAL LAYERS DIRECTLY COMPATIBLE WITH TWO-DIMENSIONAL/THREE-DIMENSIONAL GIS AND DESIGN FILE CRITERIA (SDS for FIE OR OTHER STANDARDS AS SPECIFIED IN TASK ORDERS OR AS A MODIFICATION TO THE CONTRACT). \*Photogrammetric technicians should have demonstrated experience on the machine and in the type of terrain being compiled.

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**NOTE: All geospatial feature compilation under this guide is intended to be performed using high-accuracy analytical stereoplotters or softcopy workstations. Direct digital output according to the requirements of SDS for FIE is a requirement unless otherwise specified as a modification to this contract or task orders. Production levels, and thus unit costs in Section B, will be a function of the feature compilation system used; therefore, unit prices should be based on a specific system or systems. Since the guide user will specify photo-negative scale, final mapping target scale, there should be no conflict over system capabilities, assumed C-Factors, etc.**  
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C.14.3. MAP COMPILATION SCALE. THE CONTRACTOR SHALL FURNISH TO THE CONTRACTING OFFICER STEREOPLOTTER-DERIVED OR SOFTCOPY WORKSTATION \*[DIGITAL DATA SETS] [AND/OR FINISHED MAPS] AT A SCALE OF 1 IN. = \*[ ] FT, IN FULL COMPLIANCE WITH SDS for FIE (or other standards when required) OR AS INDICATED IN SECTION H ATTACHMENTS.

C.14.4. FINAL MAP DATA MEDIA. \*[DIGITAL MAPPING DATA SETS DIRECTLY FROM THE STEREOPLOTTER OR SOFTCOPY WORKSTATION SHALL BE COPIED TO DISK, TAPE, OR CD-ROM AND PLOTTED ON \*[PAPER] [HIGH-GRADE, STABLE BASE MYLAR NOT LESS THAN 0.004-IN. IN THICKNESS] ON STANDARD \*[F] [ ]-SIZE SHEETS.] AS REQUESTED.

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**NOTE: The digital mapping data sets are the initial medium in the preparation of the final map. In some instances, it is requested that hardcopy prints be provided on bond paper or on a stable base**

**material (polyester sheets). Current industry practice today considers the original digital data sets as the final mapping data set and hardcopy prints are by-products.**

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C.14.5. MODEL SETUP AND ORIENTATION DATA. ANALYTICAL PLOTTER ORIENTATION PARAMETERS AND STATISTICAL OUTPUTS FOR EACH BOCK ADJUSTMENT OR MODEL SETUP MAY BE REQUESTED AND SUBMITTED WITH EACH PROJECT. THESE COMPUTER CALCULATIONS SHALL BE PROVIDED ALONG WITH A TEXT DESCRIPTION OF THE RESULTS, ERRORS ENCOUNTERED, HOW ERRORS WERE RESOLVED, UNITS OF MEASURE, AND GENERALLY, HOW TO READ THE REPORT.

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**NOTE: Receipt of these computer printouts is a partial QA check that the work was compiled from the required negative scale using established photo control. It is not necessarily a 100-percent assurance against a contractor using bootleg higher-altitude photography and/or USGS quad maps for control, a far too common practice in the past when photogrammetric mapping was obtained by other than competitively negotiated A-E contracting methods.**

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C.14.6. PLANIMETRIC FEATURE DATA DETAILING. THE MAPS SHALL CONTAIN ALL THE PLANIMETRIC FEATURES VISIBLE OR IDENTIFIABLE ON OR INTERPRETABLE FROM THE AERIAL PHOTOGRAPHS, AND COMPATIBLE WITH TYPE OF PROJECT INVOLVED (I.E., MILITARY MASTER PLANNING, DETAILED SITE PLAN MAPPING, ETC.) THESE SHALL INCLUDE, BUT NOT BE LIMITED TO, BUILDINGS, ROADS, FARM LANES, TRAILS, DRIVEWAYS, SIDEWALKS, CATCH BASINS, RIVERS, SHORELINES, DITCHES, DRAINAGE LINES, EROSION AREAS, PONDS, MARSHES, LAKES, RESERVOIRS, RAILROADS, FENCE LINES, POWER POLES, PIPELINES, WOODED AREAS, TIMBER LINES, TREE CLUMPS, ORCHARDS, VINEYARDS, INDIVIDUAL TREES THAT CAN BE RECOGNIZED AS SUCH, BRIDGES, CULVERTS, PIERS, SPILLWAYS, TUNNELS, DAMS, ROCK OUTCROPS, QUARRIES, RECREATION AREAS, CEMETERIES, \*                    ], ETC. \*[LEVEL OF DETAIL REQUIRED FOR EACH PROJECT WILL BE PROVIDED IN DETAILED SPECIFICATIONS FOR THE WORK ORDER.] REFER ALSO TO EM 1110-1-1000.

- a. \*Features such as quarries, gravel pits, log piles, coal piles, sand piles, slag piles, open pit mines, etc. shall be shown by symbols identified in TRI-SERVICE STANDARDS, SPATIAL DATA STANDARDS, FACILITY MANAGEMENT STANDARDS, AND CURRENT VERSION, unless otherwise specified.
- b. \*Surface utility data. Locate and identify all utilities such as culverts (pipes or box drains); water systems including valves and meters; catch basins; manholes (storm, sanitary, telephone, gas, and electric); meter/valve boxes; overhead electrical pole location and type; low wire elevations; towers; and transformers. Except in urban or heavy industrial areas, locate only main trunk aerial and surface lines; identify size and capacities and measure invert elevations as applicable to project. Obtain ground photographs as designated. \*[Specify controlling limits and/or elevations within which utility details are required.]
- c. \*Underground utilities. For designated subsurface utilities, provide pipe/conduit alignment, type, size, nomenclature, depth below surface, junction points, etc.; obtain top and invert elevations of all                     ].
- d. \*Highways, roads, and streets. Obtain names, descriptions, classifications; center-line profiles or sections as designated; route classification; pavement width and construction.
- e. \*Railroads. Obtain names, locations (and stationing) of mileposts, bridges, culverts, semaphores, culverts, yard limits, etc. Obtain center-line profiles or sections as designated.

f. \*Bridges and culverts greater than [ ] ft wide. Measure deck, flow line, and clearance elevations; horizontal clearances between abutments and piers, if any; and width of piers. Include detailed plan and elevation sketches; ground photographs upstream and downstream with lens axis normal to opening; names or other designations of structures; abutment/pier materials, condition, etc.

g. \*Buildings and other structures. Obtain proper names of all buildings or landmarks; proper names, installation numbering, and/or descriptions of all buildings and other structures affected or possibly affected by the project; foundation and first-floor elevations of those structures within designated limits and/or elevations below [ ] ft; basement elevations; sewer/drain outlet information below elevation [ ]; and ground photographs of buildings and structures.

h. \*Boundary and right-of-way data. Locate all right-of-way markers/monuments for existing roads/projects/structures. Connect any prominent property corners, installation boundaries, or Section Corners encountered.

i. \*Vegetation. Obtain general identification and description of clusters, as would be of interest in preliminary value appraisals or in clearing operations.

j. \*[Requirements for overlay (layer) sheets.]

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**NOTE: Describe any special requirements for overlay drawings, e.g., sanitary, storm, electrical, mechanical, etc. Add to and elaborate on any of the above instructions on feature detail or utility data that may be critical to the particular project, especially if relocation work is to be performed. Specify any sectors within the map where planimetric/utility feature detail is especially important, or where it may be deemphasized. Since most of the above items will be obtained by ground survey forces, they could represent a sizable cost in an overall mapping project. Therefore, precise specifications and scope are critical for this portion of the work, and the functional need for each item must be carefully considered in particular, underground utility surveys. The amount of ground detail required may also determine whether photogrammetric methods are cost-effective, or if the full project should be mapped using ground survey methods (plane table, total station, etc.).**

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C.14.7. TOPOGRAPHIC DATA DETAILING. THE MAP DATA SET SHALL CONTAIN ALL REPRESENTABLE AND SPECIFIED TOPOGRAPHIC FEATURES VISIBLE OR IDENTIFIABLE ON OR INTERPRETABLE FROM THE AERIAL PHOTOGRAPHY. TOPOGRAPHIC DATA MAY BE GENERATED BY \*[CONTOUR TRACING] OR \*[MASS POINTS AND BREAKLINES] TECHNIQUES.

a. CONTOUR TRACKING/TRACING. \*[THE CONTOUR INTERVAL FOR THIS PROJECT IS \_\_\_\_\_ FT.] EACH CONTOUR SHALL BE COLLECTED DIGITALLY AS A SOLID LINE, EXCEPT THROUGH DENSELY WOODED AREAS WHERE THE GROUND CANNOT BE SEEN AND WHERE IT IS OBSCURED BY AN OVERHANGING BLUFF OR LEDGE. IN SUCH GROUND HIDDEN PLACES, THE CONTOURS SHALL BE SHOWN AS DASHED (BROKEN) LINES. EVERY \*[FIFTH] [ ] CONTOUR (INDEX CONTOUR) SHALL BE ACCENTUATED AS A HEAVIER LINE THAN THE INTERMEDIATE FOUR AND SHALL BE NUMBERED ACCORDING TO ITS ACTUAL ELEVATION ABOVE MEAN SEA LEVEL. WHENEVER INDEX CONTOURS ARE CLOSER THAN ONE-QUARTER (1/4) IN AT FINAL MAP SCALE AND THE GROUND SLOPE IS UNIFORM, THE INTERMEDIATE FOUR MAY BE OMITTED.

(1) \*[HALF-INTERVAL CONTOURS SHALL BE ADDED IN ALL SIZEABLE FLAT AREAS WHERE GENERAL SLOPES ARE 1 PERCENT OR LESS.] LABELING OR NUMBERING OF CONTOURS

SHALL BE PLACED SO THAT THE ELEVATION IS READILY DISCERNABLE. LABELING OF INTERMEDIATE CONTOURS MAY BE REQUIRED IN AREAS OF LOW RELIEF.

(2) THE TURNING POINTS OF CONTOURS THAT DEFINE DRAINAGE CHANNELS, DITCHES, RAPIDS, FALLS, DAMS, SWAMPS, SLOUGHS, ETC. SHALL BE CONSISTENT IN DEPICTING THE CORRECT ALIGNMENT OF THE CHANNEL AND IN REFLECTING THE CONTINUATION OF THE DRAINAGE.

(3) PARTICULAR CARE MUST BE TAKEN TO SHOW THE OUTLINE OF SHORELINES OR OTHER WATER LIMITS AT THE TIME PHOTOGRAPHY IS TAKEN. WHERE THE WATER DEMARKATION LINE CANNOT BE DEFINITELY ESTABLISHED, THE APPROXIMATE POSITION SHALL BE SHOWN BY A BROKEN LINE SO AS TO INDICATE THE CONTINUITY OF DRAINAGE.

b. DIGITAL TERRAIN MODEL (DTM) GENERATION. ELEVATION MODELS SHALL BE GENERATED ON A PRESET GRID INTERVAL OF \*] FT, AS TRACKED AUTOMATICALLY IN THE ANALYTICAL PLOTTER OR SOFTCOPY WORKSTATION KNOWN AS A DIGITAL ELEVATION MODEL (DEM), OR ON A NETWORK OF RANDOM POINTS SUPPLEMENTED WITH BREAK-LINE POINTS TO PROPERLY ESTABLISH THE HYPGOMETRY OF THE TERRAIN KNOWN AS A DTM. INTERMEDIATE BREAKS, HIGHS, LOWS, ETC. ARE ADDED INDEPENDENTLY. SOFTWARE IS USED TO GENERATED A TRIANGULATED IRREGULAR NETWORK (TIN) FROM A PROPERLY GENERATED DTM. CONTOURS MAY THEN BE GENERATED FROM THE TIN MODEL UTILIZING SPECIFIC CONTOURING SOFTWARE.

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**NOTE: With the automated scanning features on analytical plotters and softcopy workstations, systematic DTM/DEM topographic generation may prove more efficient than conventional tracing of individual contours. Contours can later be generated from TIN models created from the DTM/DEM.**  
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c. SPOT ELEVATIONS. SPOT ELEVATIONS DETERMINED PHOTOGRAMMETRICALLY SHALL BE COLLECTED IN PROPER POSITION AT WATER LEVEL ON THE SHORELINE OF LAKES, RESERVOIRS, PONDS, AND THE LIKE; ON HILLTOPS; IN SADDLES; AT THE BOTTOM OF DEPRESSIONS; AT INTERSECTIONS AND ALONG CENTER LINES OF WELL-TRAVELED ROADS; AT PRINCIPAL STREETS IN CITIES, RAILROADS, LEVEES, AND HIGHWAYS; AT TOPS AND BOTTOMS OF VERTICAL WALLS AND OTHER STRUCTURES; AND AT CENTER LINE OF END OF BRIDGES. IN AREAS WHERE GENERATED CONTOURS ARE MORE THAN \*] IN. APART AT FINAL MAP SCALE, SPOT ELEVATIONS SHALL ALSO BE SHOWN AND THE HORIZONTAL DISTANCE BETWEEN THE CONTOURS AND SUCH SPOT ELEVATIONS OR BETWEEN THE SPOT ELEVATIONS SHALL NOT EXCEED \*] IN. AT SCALE OF DELIVERED FINAL MAP DATA SETS. SPOT ELEVATIONS SHALL BE MEASURED TO THE ]—ON 1-FT CONTOUR DRAWINGS THEY SHALL BE SHOWN TO THE 0.1-FT LEVEL.

d. \*WHEN THE CONTRACT STIPULATES THE COLLECTION AND DELINEATION OF SPECIFIED FEATURES (PLANIMETRY AND CONTOURS), REGARDLESS OF WHETHER SUCH FEATURES ARE VISIBLE FROM OR OBSCURED ON THE AERIAL PHOTOGRAPHY AND ON STEREOSCOPIC MODELS FORMED THEREFROM, THE CONTRACTOR SHALL COMPLETE COMPILATION OF THE REQUIRED GEOSPATIAL DATA SETS BY FIELD SURVEYS ON THE GROUND.

e. DASHED CONTOURS. WHEN THE GROUND IS OBSCURED BY VEGETATION TO THE DEGREE THAT STANDARD ACCURACY IS NOT OBTAINABLE, \*[CONTOURS SHALL BE SHOWN BY DASHED LINES] [FIELD SURVEY TOPOGRAPHIC DENSIFICATION SHALL BE PERFORMED] [\_\_\_\_\_].

C.14.8. COMPILATION HISTORY. WHEN REQUESTED, A COMPILATION HISTORY (MODEL DIAGRAM OR MODEL SETUP SHEET) SHALL BE PREPARED FOR EACH STEREOSCOPIC MODEL USED TO ACCOMPLISH THE MAPPING. HISTORY SHALL INCLUDE BUT NOT BE LIMITED TO THE FINAL PHOTOGRAPHIC FIT TO X-, Y-, AND Z-COORDINATES OF GROUND AND SUPPLEMENTAL CONTROL POINTS AND ANY OTHER PROBLEMS ENCOUNTERED IN THE MODEL ORIENTATION AND COMPILATION PROCESS. HISTORY SHALL ALSO INCLUDE THE PROJECT NAME, FLIGHT DATE, PHOTO SCALE, MAP SCALE, STEREO PLOTTER OR SOFT COPY WORKSTATION USED, AND THE OPERATOR NAME.

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**NOTE: With the completion of the map compilation by the photogrammetric technician, a thorough review and edit shall be made before final data formatting and submittal. This element of quality control is designed to check for discernible errors (unusual topographic features can be checked by examining the contact prints stereoscopically or comparing withheld ground control to the elevation data); to ensure that the feature collection database is accurate and follows the SDS for FIE; that the user's specifications have been followed (designated mapping limits, symbology, amount and type of details shown, names, format, and content); that ties have been made and referenced to adjacent sheets; that control has been labeled; and that the digital geospatial database is complete with respect to content, standards, and appearance.**

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C.14.10. FINAL SITE PLAN MAPS AND/OR DIGITAL DATABASE CONTENTS.

a. COORDINATE GRID. UNLESS OTHERWISE SPECIFIED, GRID TICKS OF THE APPLICABLE STATE PLANE COORDINATE SYSTEM (SPCS) \*[UNIVERSAL TRANSVERSE MERCATOR (UTM)] SHALL BE PROPERLY ANNOTATED AT THE TOP AND RIGHT EDGE OF EACH MANUSCRIPT SHEET. SPACING OF THE GRID TICKS SHALL BE SPECIFIED IN THE CONTRACT OR TASK ORDER. \*[THE SPCS TO BE USED FOR THIS PROJECT IS \_\_\_\_\_.] \*[Specify SPCS/UTM and local zone, if applicable.]

b. CONTROL. ALL HORIZONTAL AND VERTICAL GROUND CONTROL AND ALL SUPPLEMENTAL CONTROL DETERMINED BY EITHER FIELD OR AEROTRIANGULATION METHODS SHALL BE SHOWN ON THE MAP DATA SET.

c. SHEET LAYOUT AND MATCH LINES. THE \*[CONTRACTOR SHALL DESIGN] [GOVERNMENT WILL PROVIDE] THE SHEET LAYOUT THAT PROVIDES OPTIMUM COVERAGE OF THE PROJECT. MATCH LINES SHALL BE PROVIDED AND PROPERLY LABELED SO THAT EACH SHEET MAY BE JOINED ACCURATELY TO ADJACENT SHEETS. (SEE \*[DISTRICT] DRAFTING STANDARDS SPECIFIED IN SECTION \*[C.3.\_\_\_\_] OF THIS CONTRACT.)

d. SYMBOLS AND NAMES. THE SYMBOLS TO BE USED FOR MAJOR PLANIMETRIC AND TOPOGRAPHIC FEATURES SHALL BE IN ACCORDANCE WITH SYMBOLS PROVIDED IN REFERENCE \*[C.3.\_\_\_\_]. THE NAMES OF CITIES, TOWNS, VILLAGES, RIVERS, STREAMS, ROADS, STREETS, HIGHWAYS, AND OTHER FEATURES OF IMPORTANCE SHALL BE OBTAINED BY THE CONTRACTOR. ALL NAMES AND NUMBERS SHALL BE LEGIBLE AND CLEAR IN MEANING AND SHALL NOT INTERFERE WITH MAP FEATURES. NAMES OF TOWNS, RIVERS,

STREAMS, ETC., WILL GENERALLY BE THOSE APPEARING ON THE EXISTING USGS, DEFENSE MAPPING AGENCY (DMA), OR STATE HIGHWAY PUBLISHED MAPS. \*[THE U.S. BOARD OF GEOGRAPHICAL NAMES MAY ALSO BE CONSULTED.]

e. TITLE AND SHEET INDEX. A TITLE AND BORDER DATA FILE SHALL BE PROVIDED AND PLACED ON EACH MAP DATA SET AS DIRECTED BY THE CONTRACTING OFFICER. THE TITLE AND BORDER DATA SHALL INCLUDE THE NAME OF THE CONTRACTING AGENCY, THE PROJECT NAME, THE DATE OF PHOTOGRAPHY USED, THE STRIP AND PHOTOGRAPH NUMBERS, THE MAP SCALE, THE DATE OF THE MAPPING, SHEET OR FILE NUMBER OR NAME, AND THE NAME OF THE CONTRACTOR. IF MORE THAN ONE (1) MAP SHEET IS PREPARED, A SMALL-SCALE SHEET INDEX SHALL BE DRAWN ON EACH MANUSCRIPT/MAP SHEET SHOWING THE POSITION AND THE RELATIONSHIP OF ALL MAP SHEETS TO EACH OTHER. THE TITLE BLOCK CONTENTS \*[AND SHEET INDEX REQUIREMENTS] FOR FINISHED MAPS WILL BE FURNISHED BY THE CONTRACTING OFFICER. \*THE CONTRACTOR'S NAME/ADDRESS, CONTRACT/TASK ORDER NUMBER, AND LOGO WILL ALSO BE PLACED ON EACH MAP SHEET. \*[Add applicable professional certification requirements.]

f. VERTICAL DATUM. UNLESS OTHERWISE SPECIFIED, ELEVATIONS ARE BASED ON NAVD 88.

C.14.11. FINAL PLOTTING MEDIA. THE FINISHED LINE MAPS SHALL BE \*[ELECTROSTATICALLY PRINTED FROM THE CADD DATABASE] ON STANDARD \*[F] [ ]-SIZE [ ] - BY [ ]-IN.] DIMENSIONALLY STABLE, STATIC-FREE POLYESTER DRAFTING FILM (E.G., MYLAR), OF AT LEAST 0.004-IN. THICKNESS. \*THE MAP BORDER WILL NOT EXCEED [ ] BY [ ] IN. AND THE SHEET WILL BE ORIENTED NORTH-SOUTH, UNLESS OTHERWISE SPECIFIED. LOCATIONS OF TITLE BLOCKS, REVISION BLOCKS, BORDER DETAIL, LINE WEIGHTS, ETC. ARE CONTAINED IN REFERENCE \*[C.3. ]. \*[MASTER BORDERED FORMAT SHEETS WILL BE PROVIDED BY THE GOVERNMENT FOR CONTRACTOR REPRODUCTION.]

C.14.12. DRAFTING QUALITY. THE PROFESSIONAL STANDARDS OF DRAFTSMANSHIP AND SCRIBING SHALL BE MAINTAINED THROUGHOUT THE MAPPING PROCESS. ALL SYMBOLS, LINES, LETTERS, AND NUMBERS SHALL BE CLEAR AND LEGIBLE AND CONFORM WITH THE \*[DISTRICT] DRAFTING STANDARDS SPECIFIED IN REFERENCE \*[C.3. ].

C.14.13. MAP EDITING. ALL MAP PRODUCTS WILL BE REVIEWED BY AN EXPERIENCED EDITOR DURING APPLICABLE STAGES OF PRODUCTION.

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**NOTE: The amount of time required for office map editing and review will vary with the project type, scope, and topographic/planimetric feature complexity. Not all projects require extensive editing. This line item is separate from field classification surveys or field edit work, which may also be required after initial manuscript compilation.**  
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C.14.14. DIGITAL DATA DESIGN FILE SUBMITTALS.

a. PRODUCTS. DIGITAL DATA PRODUCTS TO BE FURNISHED BY THE CONTRACTOR SHALL INCLUDE, BUT NOT BE LIMITED TO, TOPOGRAPHIC DRAWINGS, CROSS SECTIONS, PROFILES, AND DIGITAL ELEVATION/TERRAIN MODELS.

b. ACCURACIES. THE HORIZONTAL AND VERTICAL ACCURACIES FOR DIGITAL PRODUCTS SHALL BE AS STIPULATED IN SECTION C.15 OF THIS CONTRACT.

c. FORMAT. DIGITAL FILES, ETC., SHALL BE FULLY OPERATIONAL, BY TRANSLATION OR OTHER PROCESS, ON THE \*[INTERGRAPH] [AUTOCAD] [ ] OPERATING SYSTEM UTILIZED BY THE [ ] DISTRICT AT THE TIME THE DATA SETS ARE DELIVERED. DATA SETS SHALL BE FULLY COMPATIBLE WITH THE SDS for FIE UNLESS SPECIFIED OTHERWISE.

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NOTE: Add any specific GIS, layer or file requirements, such as contour string limits, unique layer requirements, and data translation or transfer standards. Add project-specific deviations from the SDS for FIE. Include also any requirements for file translation or transfer with/between specific GIS, LIS, AM/FM systems.  
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d. ALL DESIGN FILES, INCLUDING DRAWINGS AND/OR MODELS, SHALL BE FURNISHED ON \*[HIGH-DENSITY 3-1/2 IN. FLOPPY DISKETTES OR CD-ROM DISKS AS SPECIFIED IN THE CONTRACT OR TASK ORDER]. THE CONTRACTOR SHALL FURNISH A COPY OF THE CELL LIBRARY USED IN PREPARING THESE DRAWINGS AND COMPILATION HISTORY AS DESCRIBED ABOVE. ALL DATA SHALL BECOME THE PROPERTY OF THE GOVERNMENT UPON SUBMITTAL.

C.14.15. DOCUMENTATION/METADATA. FEDERAL GEORAPHIC DATA COMMITTEE (FGDC) COMPLIANT METADATA FILES SHALL BE GENERATED FOR ALL PHOTOGRAMMETRICALLY DERIVED GEOSPATIAL DATA SETS. RELATIVELY SMALL (AREA SIZE AND TIME FRAME) PHOTOGRAMMETRIC MAPPING PROJECTS MAY ALLOW FOR ONLY ONE METADATA FILE THAT ADEQUATELY DESCRIBES THE DATA SETS. LARGE COMPLEX DATA COLLECTION EFFORTS OVER DIFFERENT GEOGRAPHIC AREAS AND CALLING FOR COLLECTION OVER LONGER PERIODS OF TIME MAY REQUIRE MULTIPLE METADATA FILES TO ADEQUATELY DESCRIBE THE DATA. ACCURACY OF DATA SETS SHALL ALSO BE COMPLETELEY AND THOROUGHLY NOTED IN THE METADATA. THE NATIONAL STANDARD FOR SPATIAL DATA ACCURACY PROVIDES GUIDELINES IN SECTION 3.2.3, ACCURACY REPORTING, FOR REPORTING POSITIONAL ACCURACY IN METADATA. THE CONTRACTOR SHALL ENSURE THAT THE METADATA IS COMPLIANT WITH THE FGDC STANDARD CONTENT FOR DIGITAL GEOSPATIAL METADATA, fgdc-std-001-1998, WHICH IS DOWNLOADABLE FROM <http://www.fgdc.gov/metadata/contstan.html>.

C.14.16. DELIVERIES. ALL COMPLETED PHOTOGRAMMETRIC MAPPING DATA SETS (SOFTCOPY AND HARDCOPY), DIAPOSITIVES, MODEL DIAGRAMS, COMPILATION HISTORIES, AND ANY OTHER DIGITAL OR HARDCOPY GEOSPATIAL DATA SHALL BE DELIVERED TO THE CONTRACTING OFFICER IN ACCORDANCE WITH TASK ORDER REQUIREMENTS.

C.15. QUALITY CONTROL AND QUALITY ASSURANCE STANDARDS.

C.15.1. CONTRACTOR QUALITY CONTROL.

a. GENERAL. ALL PHOTOGRAMMETRIC MAPPING DATA SUBMITTED UNDER THIS CONTRACT SHALL CONFORM TO THE ACCURACY STANDARDS OUTLINED IN EM 1110-1-1000 UNLESS MODIFIED OR SUPPLEMENTED BELOW. THE CONTRACTOR SHALL BE RESPONSIBLE FOR INTERNAL QUALITY CONTROL FUNCTIONS INVOLVED WITH FIELD SURVEYING,



PHOTOGRAPHY AND LABORATORY PROCESSING, STEREOCOMPILATION, DRAFTING, FIELD CHECKING, AND EDITING OF THE PHOTOGRAMMETRICALLY MADE MEASUREMENTS AND COMPILED MAPS TO ASCERTAIN THEIR COMPLETENESS AND ACCURACY. ALSO, THE CONTRACTOR SHALL MAKE THE ADDITIONS AND CORRECTIONS NECESSARY TO COMPLETE THE MAPS AND PHOTOGRAMMETRICALLY MADE MEASUREMENTS.

b. MATERIALS. ALL MATERIALS, SUPPLIES, OR ARTICLES REQUIRED FOR WORK THAT ARE NOT COVERED HEREIN, OR BY WORK ORDER SPECIFICATIONS, SHALL BE STANDARD PRODUCTS OF REPUTABLE MANUFACTURERS AND ENTIRELY SUITABLE FOR THE INTENDED PURPOSE. UNLESS OTHERWISE SPECIFIED, THEY SHALL BE NEW, UNUSED, AND SUBJECT TO THE APPROVAL OF THE CONTRACTING OFFICER.

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**NOTE: Accuracy standards for most USACE projects shall conform to the standards set forth in the FGDC Standards. The FGDC has five parts to its accuracy standard. Which ever part of the standard is applicable to the collection effort shall be referenced in the contract. All standards are available at <http://www.fgdc.gov>. Geospatial Positioning Accuracy Standard, Part 4: Architecture, Engineering, Construction, and Facilities Management is consistent with accuracy information described in EM 1110-1-2909 and EM 1110-1-1000. Both of the following map accuracy standards are referenced in the FGDC, Geospatial Positioning Accuracy Standard, Part 4, and shall be specified by the guide user and the others deleted. Alternatively, the standards set forth in EM 1110-1-1000 may be used and simply referenced in this contract. The ASPRS standard is recommended for USACE large-scale mapping work.**  
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C.15.2. \*NATIONAL MAP ACCURACY STANDARDS (LARGE-SCALE MAPS). Unless specified otherwise, all photogrammetric mapping will meet the following horizontal and vertical accuracy requirements for scales of 40, 50, 100, 200, and 400 ft to 1 in.

a. Contours. Not more than 10 percent of the elevations tested shall be in error more than one-half contour interval. In checking elevations taken from the map, the apparent vertical error may be decreased by assuming a horizontal displacement of 1/30 in.

b. Planimetric features. Not more than 10 percent of well-defined points or features tested shall be in error by more than one-thirtieth (1/30) of an inch as measured at the map/manuscript publication scale. Well-defined features are those that may be plotted within 1/100 in. at the map/manuscript scale.

C.15.3. \*ASPRS ACCURACY STANDARDS FOR LARGE-SCALE MAPS.

a. Vertical accuracy. Vertical map accuracy is defined as the 1-sigma (RMS) error in elevation in terms of the project's evaluation datum for well-defined points only. The limiting RMS error shall be one-third (1/3) the contour interval for well-defined points and one-sixth the indicated contour interval for spot heights placed on the map/manuscript. The map position of the ground point may be shifted in any direction by an amount equal to twice the limiting RMS error in position (defined below). Statistical tests shall be made in accordance with ASPRS procedures.

b. Horizontal accuracy. Horizontal map accuracy is defined as the 1-sigma RMS error in terms of the project's planimetric survey coordinates (x-y) for checked well-defined points as determined by full (ground) scale of the map/manuscript. The limiting RMS errors in x or y (feet) for each scale (in feet/inch) are as follows:

Error <u>ft</u>	Scale <u>ft/in.</u>
0.2	20
0.3	30
0.4	40
0.5	50
1.0	100
2.0	200
4.0	400

c. Blunders. Discrepancies between the x-, y-, or z-coordinates of the ground point, as determined from the map by the check survey, that exceed three (3) times the limiting RMS error shall be interpreted as blunders and will be corrected.

C.15.4. USACE PHOTOGRAMMETRIC MAPPING ACCURACY STANDARDS. UNLESS SPECIFIED OTHERWISE, ALL PHOTOGRAMMETRIC MAPPING WILL MEET THE HORIZONTAL AND VERTICAL ACCURACY REQUIREMENTS SPECIFIED FOR CLASS \* MAPPING, IN CHAPTER 2 OF EM 1110-1-1000.

C.15.5. \*SMALL-SCALE ACCURACY REQUIREMENTS. FOR LINE MAPS OF SCALES SMALLER THAN 1 IN. PER 400 FT (1:4,800), THE UNITED STATES NATIONAL MAP ACCURACY STANDARDS (REFERENCE C.3.) SHALL BE FOLLOWED.

C.15.6. METHODS FOR EVALUATING MAP ACCURACY. ALL MAPS COMPILED SHALL BE SUBJECT TO MAP TESTING BY THE GOVERNMENT, BY INDEPENDENT THIRD-PARTY FORCES, OR BY CONTRACTOR FORCES WORKING UNDER DIRECT GOVERNMENT REVIEW, TO ENSURE THAT THEY COMPLY WITH THE APPLICABLE ACCURACY REQUIREMENTS LISTED ABOVE. THE MAP TEST RESULTS WILL BE STATISTICALLY EVALUATED RELATIVE TO THE DEFINED ACCURACY CRITERIA, AND PASS/FAIL DETERMINATION MADE ACCORDINGLY. THE DECISION OF WHETHER OR NOT TO PERFORM RIGID MAP TESTING ON ANY PROJECT, DELIVERY ORDER, OR PORTION OF A PROJECT RESTS WITH THE CONTRACTING OFFICER. IN ALL CASES, THE CONTRACTOR WILL BE ADVISED IN WRITING WHEN SUCH ACTION WILL BE TAKEN.

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**NOTE: For fixed-scope contracts, indicate herein the degree of formal map testing contemplated and by whom. If performed by contractor survey forces, then adequate field survey time must be allocated in Section B. On IDT contracts, formal map accuracy tests are optional for each task order. The need for map tests is a function of the ultimate or intended use of the maps. For large-scale site plan mapping, being intended for detailed foundation design, map testing is critical, as well as for maps containing critical utility and drainage detail. However, map testing would not be as necessary for general, smaller-scale map products on which no design effort is foreseen. Master plan mapping might fall in this category. The availability of Government survey resources to perform the testing must also be considered. If contractor forces are needed to perform the tests, then a Government representative must be present to select test points and review the actual field observations. A separate A-E contractor may also be selected to perform such work. Given the resources involved in performing map testing, the costs of such efforts must not be disproportionate to the overall photogrammetric mapping effort—the benefits of photogrammetric mapping over conventional plane table or total station survey methods might be eliminated.**

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a. OFFICE AND FIELD CHECKS. THE PARTY RESPONSIBLE FOR MAP TESTING MAY, DURING THE COURSE OF THE PROJECT, INSPECT MAP COMPILATION IN THE CONTRACTOR'S FACILITY BY COMPARISON WITH AERIAL PHOTOGRAPHS. HOWEVER, THE FINAL MAP COMPILATION SHALL BE CHECKED BY FIELD INSPECTION AND A HORIZONTAL AND VERTICAL ACCURACY CHECK BY CONVENTIONAL FIELD SURVEY CHECKS, USING TRAVERSE, TRIANGULATION, AND DIFFERENTIAL LEVELING METHODS TO TEST SELECTED POINTS OR FEATURES ON THE COMPLETED DRAWINGS.

b. TEST PROFILES FOR TOPOGRAPHY. IN ORDER TO CHECK FOR COMPLIANCE WITH THE VERTICAL CONTOUR ACCURACY REQUIREMENTS, TEST PROFILE TRAVERSES SHALL BE MADE IN THE FIELD. PROFILES TO CHECK CONTOURS AND SPOT ELEVATIONS SHOULD BE AT LEAST FIVE (5) IN. LONG AT THE MAP SCALE, AND SHOULD CROSS AT LEAST TEN (10) CONTOUR LINES. PROFILES SHOULD START AND CLOSE UPON MAP FEATURES OR PREVIOUSLY ESTABLISHED CONTROL POINTS. IN FLAT AREAS AND AT PRINCIPAL ROAD AND RAIL INTERSECTIONS, SPOT ELEVATIONS SHALL BE CHECKED. IN GENERAL, ONE PROFILE \*[PER MAP SHEET] [PER \*{3} [ ] STEREO MODELS] IS SUFFICIENT.

c. SPOT ELEVATION TESTS. TESTING FOR VERTICAL ACCURACY MAY ALSO BE PERFORMED BY COMPARING THE ELEVATIONS AT WELL-DEFINED POINTS AS DETERMINED FROM THE MAP TO CORRESPONDING ELEVATIONS DETERMINED BY A SURVEY OF HIGHER ACCURACY. A MINIMUM OF 20 POINTS SHALL BE CHECKED AND SHALL BE DISTRIBUTED THROUGHOUT THE SHEET, OR CONCENTRATED IN CRITICAL AREAS.

d. TEST POINTS FOR PLANIMETRIC FEATURES. THE ACCURACY OF THE PLANIMETRIC MAP FEATURE COMPILATION SHALL BE TESTED BY COMPARING THE GROUND COORDINATES (X AND Y) OF AT LEAST 20 POINTS (WELL-DEFINED MAP FEATURES) PER TEST PER MAP SHEET, AS DETERMINED FROM MEASUREMENTS ON THE MAP AT PUBLICATION SCALE, TO THOSE FOR THE SAME POINTS, AS PROVIDED BY A CHECK SURVEY OF HIGHER ACCURACY. THE CHECK SURVEY SHALL HAVE AN ORDER OF ACCURACY EQUAL TO OR EXCEEDING THAT SPECIFIED FOR ESTABLISHING THE MAPPING CONTROL. MAPS WILL ALSO BE EXAMINED FOR ERRORS AND/OR OMISSIONS IN DEFINING FEATURES, STRUCTURES, UTILITIES, AND OTHER NOMENCLATURE, OR FOR TOTAL GAPS IN COMPILATION/COVERAGE. THE MINIMUM OF 20 POINTS SHALL BE DISTRIBUTED THROUGHOUT THE SHEET OR CONCENTRATED IN CRITICAL AREAS.

e. SELECTION OF WELL-DEFINED TEST POINTS. THE TERM "WELL-DEFINED MAP FEATURES" PERTAINS TO FEATURES THAT CAN BE SHARPLY DEFINED AS DISCRETE POINTS. POINTS THAT ARE NOT WELL-DEFINED ARE EXCLUDED FROM THE ACCURACY TEST. THE SELECTION OF WELL-DEFINED POINTS SHALL BE MADE THROUGH AGREEMENT BETWEEN THE CONTRACTING OFFICER AND THE CONTRACTOR. GENERALLY, IT MAY BE MORE DESIRABLE TO DISTRIBUTE THE POINTS MORE DENSELY IN THE VICINITY OF IMPORTANT STRUCTURES OR DRAINAGE FEATURES AND MORE SPARSELY IN AREAS THAT ARE OF LESSER INTEREST. FURTHER DEFINITIONS AND REQUIREMENTS FOR SELECTION OF WELL-DEFINED PHOTO/MAP POINTS ARE FOUND IN THE REFERENCE STANDARD USED. THE LOCATIONS AND NUMBERS OF MAP TEST POINTS AND/OR TEST PROFILES SHALL BE MUTUALLY AGREED TO BY THE CONTRACTOR AND CONTRACTING OFFICER'S REPRESENTATIVE (COR).

C.15.7. CORRECTION OF UNSATISFACTORY WORK. FAILURE TO MEET MAP TEST CRITERIA WILL REQUIRE RECOMPILATION OF THE PROJECT AT THE CONTRACTOR'S EXPENSE. WHEN A SERIES OF SHEETS ARE INVOLVED IN A MAPPING PROJECT, THE EXISTENCE OF ERRORS

(I.E., MAP TEST FAILURE) ON ANY INDIVIDUAL SHEET WILL CONSTITUTE PRIMA FACIE EVIDENCE OF DEFICIENCIES THROUGHOUT THE PROJECT (I.E., ALL OTHER SHEETS ARE ASSUMED TO HAVE SIMILAR DEFICIENCIES), AND FIELD MAP TESTING WILL CEASE. AFTER CORRECTION OF THE WORK, THE CONTRACTOR WILL BE RESPONSIBLE FOR PAYMENT OF MAP TESTING REQUIRED ON THE CORRECTED DRAWINGS. WHEN SUCH EFFORTS ARE PERFORMED BY GOVERNMENT SURVEY FORCES, THESE COSTS WILL BE DEDUCTED FROM CONTRACT/DELIVERY ORDER PAYMENT ESTIMATES.

\*\*\*\*\*

**NOTE: The purpose of the above clause is to preclude the Government from performing contractor quality control functions to the extent that the map testing effort becomes a field classification/edit function. However, the Government COR must exercise reasonable judgment in assessing map test results, given the fact that no map is perfect and minor errors or omissions can be expected. For this reason, the specification writer must clearly define critical parameters in the scope of work in order for the contractor to ensure quality control is performed in these areas. For instance, if top of curb elevations are important, these should be emphasized in the scope. Conveying such information is best accomplished by clearly noting the intended functional/project use of the maps in the scope (e.g., foundation design, spillway design, runway construction, general installation masterplanning, etc.). With such information, the contractor can concentrate his resources on the more critical feature elements and not spend undue time on feature detail superfluous to the design/construction effort.**

\*\*\*\*\*

C.16. NONTOPOGRAPHIC PHOTOGRAMMETRY SPECIFICATIONS.

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**NOTE: Specifications for close-range photogrammetric measurements on structures or mechanical devices should be developed from or referenced to the Manual of Photogrammetry.**

\*\*\*\*\*

C.17. SUBMITTAL REQUIREMENTS.

C.17.1. SUBMITTAL SCHEDULE. THE COMPLETED WORK, MAPS, DIGITAL MAP FILES, AND REPORTS SHALL BE DELIVERED WITHIN \*[\_ DAYS AFTER NOTICE TO PROCEED IS ISSUED]  
\*[BY calendar date].

\*\*\*\*\*

**NOTE: Include a more detailed submittal schedule breakdown if applicable to project. Note any preliminary, priority, or partial delivery requirements, with reference to specific Section B line items.**

\*\*\*\*\*

C.17.2. PACKAGING AND MARKING. PACKAGING OF COMPLETED WORK SHALL BE ACCOMPLISHED SUCH THAT THE MATERIALS WILL BE PROTECTED FROM HANDLING DAMAGE. EACH PACKAGE SHALL CONTAIN A TRANSMITTAL LETTER OR SHIPPING FORM, IN DUPLICATE, LISTING THE MATERIALS BEING TRANSMITTED, BEING PROPERLY NUMBERED, DATED, AND SIGNED. SHIPPING LABELS SHALL BE MARKED AS FOLLOWS:

U.S. ARMY ENGINEER DISTRICT, \_\_\_\_\_  
ATTN: \_\_\_\_\_  
\*[include office symbol and name]  
CONTRACT NO. \_\_\_\_\_  
\*[DELIVERY ORDER NO. \_\_\_\_\_]  
[STREET/PO BOX] \_\_\_\_\_  
\*[complete local mailing address]

\*HAND-CARRIED SUBMISSIONS SHALL BE PACKAGED AND MARKED AS ABOVE,  
AND DELIVERED TO THE FOLLOWING OFFICE ADDRESS:

\_\_\_\_\_  
\*[insert office/room number as required]

\*\*\*\*\*

**NOTE: In this section, also reference any unique data transmittal/submittal requirements for digital data, if applicable.**

\*\*\*\*\*

C.18. PROGRESS SCHEDULES AND WRITTEN REPORTS.

C.18.1. \*PREWORK CONFERENCE.

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**NOTE: Detail any requirements for a prework conference after contract award, including requirements for preparing written reports for such conferences.**

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SECTION D

CONTRACT ADMINISTRATION DATA

SECTION E

SPECIAL CONTRACT REQUIREMENTS

SECTION F

CONTRACT CLAUSES

\*\*\*\*\*  
**NOTE: See instructions in Appendix B of PARC IL 92-4.**  
\*\*\*\*\*

SECTION G

LIST OF ATTACHMENTS

G.1. U.S. ARMY CORPS OF ENGINEERS EM 1110-1-1000, PHOTOGRAMMETRIC MAPPING. THIS REFERENCE IS ATTACHED TO AND MADE PART OF THIS CONTRACT.

\*\*\*\*\*  
**NOTE: List any other attachments called for in contract Section C or in other contract sections. This may include such items as:**

- a. **Marked-up project sketches/drawings.**
- b. **Station/Monument descriptions or Recovery Notes.**
- c. **Drafting standards.**
- d. **CADD standards.**

\*\*\*\*\*

SECTION H

REPRESENTATIONS, CERTIFICATIONS, AND OTHER STATEMENTS OF OFFERERS

SECTION I

INSTRUCTIONS, CONDITIONS, AND NOTICES TO OFFERERS

\*\*\*\*\*  
**NOTE: See PARC IL 92-4 for guidance in preparing these clauses/provisions.**  
\*\*\*\*\*

# SAMPLE

## SECTION C

### DESCRIPTION/SPEC./WORK STATEMENT

#### PHOTOGRAMMETRIC MAPPING AND AERIAL PHOTOGRAPHY SERVICES

C.1. GENERAL. The contractor, operating as an independent contractor and not as an agent of the government, shall provide all labor, material, and equipment necessary to perform professional photogrammetric mapping, related surveying work and photo interpretation (landuse/landtype) from time to time during the period of service as stated in Section E. The services requested will be in connection with performance of photogrammetric mapping, related surveys, and the preparation of maps as may be required for advance planning, design, and construction for various U.S. Army Corps of Engineers projects. The contractor shall furnish the required personnel, equipment, surveying and photogrammetric reduction/compilation instruments, aircraft, and land transportation as necessary to accomplish the required services and furnish to the government maps, digital terrain data, reports, and other data together with supporting material developed during the field data acquisition process. During the prosecution of the work, the contractor shall provide adequate professional supervision and quality control to assure the accuracy, quality, completeness, and progress of the work.

#### C.2. LOCATION OF WORK.

C.2.1. Photogrammetric mapping and related surveying services will be performed for U.S. Army Corps of Engineers (District Symbol).

C.2.2. Photogrammetric mapping and related surveying services will be performed in connection with projects located within the boundaries of (District Symbol).

C.3. TECHNICAL CRITERIA AND STANDARDS. The following standards are referenced in this contract. In cases of conflict between these technical specifications and any referenced technical standard, these specifications shall have precedence.

C.3.1. United States Army Corps of Engineers (USACE) Engineering Manual (EM) 1110-1-1000, 31 March 1993, Photogrammetric Mapping.

C.3.2. Tri-Services Spatial Data Standards (TSSDS), Version 1.80.

C.3.3. USACE EM 1110-1-1807, 30 July 1990, Standards Manual for USACE Computer-Aided Design and Drafting (CADD) Systems.

C.3.4. Manual of Photogrammetry, American Society for Photogrammetry and Remote Sensing (ASPRS), March 1990 Edition.

C.3.5. ASPRS Accuracy Standards for Large-Scale Maps, ASPRS, March 1990.

C.3.6. USACE EM 1110-1-1002, 14 September 1990, Survey Markers and Monumentation.

C.3.7. USACE EM 1110-1-1003, December 1994, NAVSTAR Global Positioning System.

C.3.8. USACE EM 1110-1-1005, 31 August 1994, Topographic Surveys.

C.3.9. United States Army Corps of Engineers, St. Louis District Computer Aided Drafting and Design (CADD) Standards Manual.

C.4. WORK TO BE PERFORMED. Professional photogrammetric mapping and related surveying services to be performed under this contract are defined below. All mapping work will be performed using precise photogrammetric data acquisition, mensuration, and compilation procedures, including all quality control associated with these functions. The work will be accomplished in strict accordance with the photogrammetric mapping criteria contained in the technical references (paragraph C.3 above), except as modified or amplified herein or task orders scope of work.

C.4.1. PURPOSE OF WORK. The work to be performed under this contract is to be used as basic site plan mapping. The work may be performed for use in installation master planning, design, construction, operation, maintenance, real estate, regulatory enforcement, and hazardous and toxic waste sites. The projects may include related activities and/or engineering studies covering such pertinent details as reservoir capacities, channel capacities, damage assessment, benefits, project location, design of main structure and appurtenances, relocations, land acquisition, land development and management, encroachment, and construction measurement and payment.

C.4.2. GENERAL MAPPING REQUIREMENTS. Project locations, scales, and accuracy requirements will be stated in each task order. Planimetric feature detail will be compiled based on horizontal mapping standards as stated in task orders. Contours shall be developed at increments in accordance with the vertical accuracy standards as stated in each task order. Sites requiring new aerial photography shall be flown at a photo-negative scale equal to or larger than that specified in EM 1110-1-1000 to meet the required planimetric and topographic accuracy criteria unless otherwise stated in the task orders. Feature and terrain data shall be delivered in digital format and/or hardcopy as described in task orders.

C.4.3. COMPLETION OF WORK. All work must be completed and delivered not later than dates specified in the scope of work for each task order.

C.5. AIRCRAFT FLIGHT OPERATIONS AND EQUIPMENT REQUIREMENTS.



C.5.1. AIRCRAFT AND FLIGHT CREW. The aircraft furnished or utilized under this contract shall be equipped with navigation and photographic instruments and accessories necessary to satisfactorily produce the required photography. Aircraft may be required to have airborne global positioning system (ABGPS) software and hardware capability for real time aircraft positioning and navigation. The ABGPS must also have the capability to capture and store spatial positioning information for determining exterior orientation of the camera and geographic location of the photo center at the instant of exposure. The Contractor's ABGPS hardware and software must incorporate the ability to spot process the airborne data in order to provide a computer derived GPS photo control point at each exposure center to supplement ground surveys in accomplishing aerotriangulation procedures. The aircraft shall be maintained in operational condition during the period of this contract, and shall conform to all governing Federal Aviation Administration and Civil Aeronautics Board regulations over such aircraft. The flight crew and cameraman shall have had a minimum of 400 hours experience in flying precise photogrammetric mapping missions.

C.5.2. CAMERA WINDOWS AND CAMERA MOUNTING. When high-altitude photography is required, camera windows may be needed. Camera windows shall be mounted in vibration-damping material to avoid mechanical stress to the window. Prior to photography, any camera window used shall be checked by the calibration center to ensure that it will not adversely affect lens resolution and distortion and that it is substantially free of veils, striations, and other inhomogeneities. The camera itself shall be installed in a mounting that dampens the effects of aircraft vibration. Aircraft exhaust gases shall be vented away from camera opening.

C.5.3. FLIGHT PLAN. The minimum area(s) to be photographed are as indicated on maps or photographs that will be provided for each photographic task order. Given the specified photo-negative scale criteria herein, the contractor shall design the flight lines for the photography to obtain proper overlap, sidelap, and endlap to assure full stereoscopic photographic coverage, in accordance with the criteria defined in task orders scopes of work. Generally, the flight lines shall be parallel to each other and to the longest boundary lines of the area to be photographed. For single strip photography, the actual flight line shall not vary from the line plotted on the flight map by more than the scale of the photography expressed in feet. For example, the allowable tolerance for photography flown at a scale of 1 in. equals 1000 ft is about 1000 ft. The flight lines shall be submitted to the government for advance approval.

C.5.4. FLYING CONDITIONS. Photography shall be undertaken only when well-defined images can be obtained. Unless otherwise specified, flying shall be limited to the period of 3 hours after local sunrise to 3 hours before local sunset. Photography shall not contain shadows caused by topographic relief or sun angle of less than thirty (30) degrees, whenever such shadows can be avoided during the time of year the photography must be taken. Photography shall not be attempted when the ground is obscured by haze, smoke, or dust, snow or when the clouds or cloud shadows will appear on more than five (5) percent of the area of any one photograph unless specified in the task order.

C.5.5. DATE OF PHOTOGRAPHY. Photography will be flown during the periods represented in task orders placed against this basic contract.

C.5.6. AIRCRAFT UTILIZATION. Total aircraft utilization to, from, between, and over project sites is based on the rates shown in Appendix A. In estimating available aircraft operational time, average weather and cloud cover conditions are assumed for the given site and time of year, consistent with aircraft utilization rates historically developed. Additional crew costs will accrue during deployment at or near the project site, where applicable. Aircraft and flight crew standby at the home base shall be considered as an overhead expense and shall have been properly factored into the unit rate of the aircraft.

C.5.7. FLIGHT LOG. For each flight day, the pilot or cameraman shall prepare a flight log containing the date, project name, aircraft used, and names of crew members. In addition, the following shall be prepared for each flight line: altitude, camera, magazine serial number, f-stop, shutter speed, beginning and ending exposure numbers and times, and any other comments relative to the flight conditions. These flight logs, or copies thereof, may be incorporated into the film report (if required) and will be delivered to the contracting officer as specified in this contract.

C.5.8. SUBCONTRACTED PHOTOGRAPHY. Before commencement of any aerial photography under this contract or task order by a subcontractor, the contractor shall furnish the contracting officer, in writing, the name of such subcontractor, together with a statement as to the extent and character of the work to be done under the subcontract, including applicable camera certifications.

## C.6. AERIAL PHOTOGRAPHY SCALE AND RELATED COVERAGE PARAMETERS.

C.6.1. PHOTO-NEGATIVE SCALE AND FLIGHT ALTITUDE. The required negative scale for projects shall be as stated in each task order. The flight height above mean terrain (AMT) will be designed such that the negatives will have an average scale suitable for attaining required photogrammetric measurement, map scale, contour interval, and accuracy, given the required mapping camera focal length, stereoplotter model, and quality control criteria, as defined elsewhere in these specifications. Negatives having a departure from the specified scale of more than 5 percent because of tilt or any changes in the flying height may be cause for rejection of the work. Departures from specified flight height shall not exceed 2 percent low or 5 percent high for all flight heights up to 12,000 ft above ground elevation. Above 12,000 ft, departures from specified flight height should not exceed 2 percent low or 600 ft high. Any proposed variation by the contractor to change either the camera focal length or negative scale as specified in a task order constitutes a major change in scope and therefore must be effected by formal task order modification.

C.6.2. STEREOSCOPIC COVERAGE AND OVERLAP REQUIREMENTS. Unless otherwise modified in task orders the overlap shall be sufficient to provide full stereoscopic coverage of the area to be photographed, as follows:

a. BOUNDARIES. All of the area appearing on the first and last negative in each flight line extending over a boundary shall be outside the boundary of the project area. The principal point of two photographs on both ends of each flight line shall be taken past the boundary line of the project. Each strip of photographs along a boundary shall extend over the boundary not less than fifteen (15) percent of the width of the strip.

b. ENDLAP. Unless otherwise specified in a task order, the forward overlap shall be sixty (60) percent.

c. SIDELAP. The lateral sidelap shall average thirty (30) percent unless specified in a task order. Any negative having sidelap less than fifteen (15) percent or more than fifty (50) percent may be rejected. The foregoing requirement can be varied. Variation may be acceptable in cases where the strip area to be mapped is slightly wider than the area that can be covered by one strip of photographs, where increase in sidelap is required for control densification purposes, or where increase or decrease in sidelap is required to reach established ground control. Any variation must be specified in the task order.

d. CRAB. Absolute crab of any photograph relative to the flight line, or relative crab between any series of two or more consecutive photographs, in excess of 10 degrees, as indicated by displacement of the principal points of the photographs, may be considered cause for rejection of the photography. Average crab for any flight line shall not exceed 5 degrees. For aerotriangulation, no photograph shall be crabbed in excess of five (5) degrees as measured from the line of flight.

e. TILT. Negatives exposed with the optical axis of the aerial camera in a vertical position are desired. Tilt (angular departure of the aerial camera axis from a vertical line at the instant of exposure) in any negative of more than four (4) degrees, or an average of more than two (2) degrees for any ten (10) consecutive frames, or an average tilt of more than one (1) degree for the entire project, or relative tilt between any two successive negatives exceeding six (6) degrees may be cause for rejection.

f. TERRAIN ELEVATION VARIANCES. When ground heights within the area of overlap vary by more than ten (10) percent of the flying height, a reasonable variation in the stated overlaps shall be permitted provided that the fore and aft overlaps do not fall below 55 percent and the lateral sidelap does not fall below 10 percent or exceed 50 percent. In extreme terrain relief where the foregoing overlap conditions are impossible to maintain in straight and parallel flight lines, the gaps created by excessive relief may be filled by short strips flown between the main flight lines and parallel to them.

g. Strips running parallel to a shoreline may be repositioned to reduce the proportion of water covered, provided the coverage extends beyond the limit of any land feature by at least 10 percent of the strip width.

C.6.3. Where the ends of strips of photography join the ends of other strips or blocks flowing in the same general direction, there shall be an overlap of at least two

stereoscopic models. In flight lines rephotographed to obtain substitute photography for rejected photography, all negatives shall be exposed to comply with original flight specifications, including scale and overlap requirements. The joining end negatives in the replacement strip shall have complete stereoscopic coverage of the contiguous area on the portion or portions not rejected.

#### C.7. AERIAL CAMERA SPECIFICATIONS.

C.7.1. TYPE OF CAMERA. Unless specified otherwise in a task order only a standard 6-in. (153mm + 3mm) focal length single-lens precise aerial mapping camera, equipped with a high resolution, distortion-free lens, and with a between-the-lens shutter with variable speed, shall be used on this contract. The aerial camera used shall be of like/similar quality to a Wild model RC30, Leica RC-30, Zeiss RMK A 153mm, or better. The camera shall function properly at the necessary altitude and under expected climatic conditions, and shall expose a 9 by 9 inch (228 by 228mm) square negative. The lens cone shall be so constructed that the lens, focal plane at calibrated focal length, fiducial markers, and marginal data markers, comprise an integral unit or are otherwise fixed in rigid orientation with one another. When extremely large scale (low altitude) photography is being flown, the camera shall be equipped with forward image motion compensation (FMC). Some projects may require that the camera system be equipped with ABGPS for precise locations of photo exposures. Details will be described in detail in task order scopes of work.

C.7.2. CALIBRATION. The aerial camera(s) furnished by the contractor or his designated subcontractors shall have been calibrated by the United States Geological Service (USGS) within three (3) years of award of this contract. The calibration report shall be presented to the contracting officer prior to use on this contract and/or task orders placed against this contract. Certification shall also be provided indicating that preventative maintenance has been performed within the last two (2) years.

C.7.3. SUBSTITUTE CAMERAS. Substitute cameras that do not meet the above specifications may not be used on this contract unless specified in the task order.

#### C.8. AERIAL FILM SPECIFICATIONS AND PROCESSING REQUIREMENTS.

C.8.1. GENERAL. Film materials and laboratory processing, developing, reproduction, and printing thereof, shall conform with recognized professional photogrammetric industry standards and practices, as outlined in EM 1110-1-1000 and the ASPRS Manual of Photogrammetry unless stated in task orders scope of work.

C.8.2. TYPE OF FILM REQUIRED. The contractor shall use only aerial film of a quality that will produce imagery that is suitable for specific project requirements, as applicable to those types of photography scheduled in individual task orders. Only fresh, fine-grain, high-speed, dimensionally stable, and safety base aerial film emulsions shall be used. Outdated film shall not be used. The thickness of the base shall not be less than 0.1 mm and the dimensional stability shall be such that in any negative the length and width between fiducials shall not vary by more than 0.3 percent

from the same measurements taken on the camera, and that the differential between these measurements shall not exceed 0.04 percent.

C.8.3. UNEXPOSED FILM. Whenever any part of an unexposed roll of film remains in the camera, before such film is used on a subsequent day, a minimum 3-ft section of the roll of film shall be rolled forward, and exposed, immediately preceding the beginning of photography.

C.8.4. QUALITY OF PHOTOGRAPHY. The photographic negatives shall be taken so as to prevent appreciable image movement at the instant of exposure. The negatives shall be free from static marks, shall have uniform color tone, and shall have the proper degree of contrast for all details to show clearly in the dark-tone areas and high-light areas as well as in the halftones between dark and light. Negatives having excessive contrast or negatives low in contrast may be rejected.

C.8.5. PROCESSING OF EXPOSED FILM. The processing, including development and fixation and washing and drying of all exposed photographic film, shall result in negatives free from chemical or other stains, containing normal and uniform density, and fine-grain quality. Before, during, and after processing, the film shall not be rolled tightly on drums or in any way stretched, distorted, scratched, or marked, and shall be free from finger marks, dirt, or blemishes of any kind. Equipment used for processing shall be either rewind spool-tank or continuous processing machine, and must be capable of achieving consistent negative quality specified below without causing distortion of the film. Drying of the film shall be carried out without affecting its dimensional stability.

C.8.6. The camera panel of instruments should be clearly legible on all processed negatives. Failure of instrument illumination during a sortie shall be cause for rejection of the photography. All fiducial marks shall be clearly visible on every negative.

C.8.7. FILM STRIP DOCUMENTATION AND LABELING. At minimum, The following information shall be supplied as leaders at the start and the end of each film strip:

- a. Flight line identification(s).
- b. Dates of photography.
- c. Effective negative numbers and run numbers.
- d. Approximate scale(s) of photography.
- e. The calibrated focal length of the camera.

C.8.8. NEGATIVE NUMBERING AND ANNOTATION. Each negative will be labeled clearly with the identification symbol and numbering convention recommended herein. The numbers will be sequential within each flight line and shall be in the upper

right-hand corner of the negative image edge to be read as one looks northerly along the flight line (or westerly when lines are east to west). All lettering and numbering of negatives shall be approximately 1/5 in. high and shall result in easily read, sharp, and uniform letters and numbers. Numbering of negatives shall be carried out using heat-foil or indelible ink. Each negative shall be provided with the following annotation, which shall also appear on the prints unless otherwise stated in task orders:

- a. Year, month, and day of flight (placed in upper left corner of each frame).
- b. Project-specific location/identification information (placed immediately after date).
- c. Photo scale (ratio) (placed next to project locations/identification information on each frame).
- d. Film roll number (placed in upper right-hand corner of each frame).
- e. Negative number (placed to the left of the roll number for each frame).

**C.8.9. FILM STORAGE AND DELIVERIES.** All negatives and uncut film positives shall be delivered to the contracting officer on winding spools in plastic or metal canisters. All extra and rejected negatives shall be included in the roll(s). At least 3 ft of clear film shall be left on or spliced to each end of the roll. All splices shall be of a permanent nature. Exposed and unexposed film shall be handled in accordance with manufacturer's recommendations. Each canister should be labeled with the minimum information indicated below:

- a. Name and address of the contracting agency.
- b. Name of the project.
- c. Designated roll number.
- d. Numbers of the first and last numbered negatives of each strip.
- e. Date of each strip.
- f. Approximate scale.
- g. Focal length of lens in millimeters.
- h. Name and address of the contractor performing the photography.
- i. Contract number.

**C.9. CONTACT PRINT AND DIAPOSITIVE SPECIFICATIONS.**

C.9.1. MATERIAL. All contact prints shall be made on an electronic printer on medium-weight resin-coated stock, upon which a grease pencil, and other commonly employed markers can be used on both sides.

C.9.2. PROCESSING AND QUALITY. The processing, including exposure development, washing, and drying, shall produce fine-grained quality matte or semi-matte finish photographic contact prints with normal uniform density and such color tone and degree of contrast that all photographic details of the negative from which they are printed show clearly in the darktone areas and high-light areas as well as in the halftones between the dark and the high light. Excessive variance in color tone or contrast between individual prints may be cause for their rejection. All prints shall be clear and free of stains, blemishes, uneven spots, air bells, light fog or streaks, creases, scratches, and other defects that would interfere with their use or in any way decrease their usefulness.

C.9.3. TRIMMING. All contact prints shall be trimmed to neat and uniform dimensional lines along image edges (without loss of image) leaving distinctly the camera fiducial marks. Prints lacking fiducial marks shall be rejected.

C.9.4. DELIVERIES. All contact prints shall be delivered to the contracting officer in a smooth, flat, and usable condition. The number of contact prints to be delivered for each exposure will be specified in individual task orders.

C.9.5. PRELIMINARY CHECK PRINTS. Preliminary check prints may be requested in a task order. Unless stated otherwise in the task orders the quality and processing shall be as stated in paragraphs C.9.1 through C.9.5.

C.9.6. MARKED CONTROL PRINTS. Marked control prints may be requested in a task order scope of work. Unless stated otherwise in the task orders the quality and processing shall be as stated in paragraphs C.9.1. through C.9.5.

C.9.7. DIAPOSITIVE and TRANSPARENCIES. All black and white and color diapositive transparencies used for photogrammetric measurements, including map compilation, shall be of a quality that will produce the imagery that is suitable for specific project requirements, as applicable to those types of photogrammetry scheduled in individual task orders. Outdated diapositives or transparencies shall not be used.

#### C.10. PHOTOGRAPHIC INDEX REQUIREMENTS.

C.10.1. GENERAL. Photographic indexes may be requested in task orders scopes of work. The requirement for horizontal scale, base map type, type of media (hardcopy and/or softcopy) shall be stated in the task orders. A flight line index shall generally show all flight line and photo center locations. Each flight line shall be labeled with the identifying flight line number at each end of the flight line along with beginning and ending photograph numbers respectively.

## C.11. PHOTO CONTROL SURVEY REQUIREMENTS.

C.11.1. GENERAL. All horizontal and vertical control surveys required for photogrammetric mapping shall, unless otherwise indicated herein, be performed using procedures and/or accuracy standards consistent with professional surveying practices. Ground control may be minimized by the use of ABGPS technology. Details for utilization of ABGPS technology will be described in task order scopes of work. All surveying and photo mapping work shall be referenced to horizontal and vertical datums as stated in task orders scopes of work. The contractor shall provide survey crews with professional survey personnel and equipment capable of performing observations and measurements that meet the required accuracy needed for the work.

Mapping personnel will provide properly marked control photos to survey crews indicating control points to be surveyed. All ground control points required shall be noted on control photos and the survey data shall be obtained by ground survey crews.

All field observational data shall be performed in accordance with standard engineering survey practices, as specified in reference C.3. Survey data shall be recorded in bound survey books or digital format that will subsequently be delivered to the government as specified in each task order. All survey work will be performed under the supervision and control of a licensed professional land surveyor. All survey work, including office computations and adjustments, is subject to government review and approval for conformance with prescribed accuracy standards.

C.11.2. PHOTO CONTROL SURVEYS. Surveys performed to control horizontal or vertical locations of points used in controlling stereoscopic models shall be performed using recognized engineering and construction control survey methods, as necessary to meet the ultimate mapping standards required in paragraph C.15. This usually requires, at minimum, third-order procedures performed relative to existing network or project control using standard engineering survey traverse, differential leveling, global positioning system (GPS), or electronic total station measurement techniques.

a. Unless otherwise indicated, photo control points or panelled points may be temporarily marked (2 by 2 in. stakes, nails, etc.). These temporary marks should remain in place for at least the duration of the contract, and may be used for performing quality control or assurance surveys.

b. EXISTING PROJECT/NETWORK CONTROL. A tabulation and/or description of existing project/network control points may be provided with each task order request or may be a deliverable in a task order. The source agency, coordinates, datum, and estimated accuracy of each point is indicated on the description. Prior to using any control points, the monuments should be checked to ensure that they have not been moved or disturbed.

c. The contractor shall perform surveys connecting existing project control to assure that such control has sufficient relative accuracy to control the overall project. Should these surveys indicate deficiencies in the existing control, the contractor shall advise the contracting officer, and appropriate modification may be made to the contract to perform resurveys of the existing network.



d. All horizontal and vertical control points will be occupied as a station within a closed traverse or closed level loop. If it is not possible to occupy an individual control point or photo target, thus requiring spur shots, all angles shall be read at least three times and averaged, and all distances measured twice and averaged.

C.11.3. FULL PHOTO MODEL CONTROL. The contractor shall establish the minimum horizontal and vertical control points required for each stereoscopic model by field survey methods. Each point shall be an image of an existing object or be a finite photographic pattern that is clearly identifiable both on the ground and on the photographs, or be the photographic target. The accuracy of all supplemental control surveys shall be the same as that stipulated for all control surveys required under this contract

C.11.4. CONTROL PHOTOGRAPHS. All horizontal and vertical control points including supplemental control points shall be marked and labeled with appropriate point identification numbers. All control points not premarked shall be neatly pin-pricked and clearly identified and briefly described on the back of the photograph. Coordinates and brief descriptions of marked control points shall be written on the back of each photo. Full station descriptions will be written for newly set, permanently monumented points. The marked-up control prints will be delivered to the Government.

C.11.5. CERTIFIED SURVEYOR. All surveying will be directed, approved and certified by a Professional Engineer or Registered Land Surveyor.

C.11.6. COORDINATE SYSTEM. The horizontal control shall be tied to the North American 1983 Datum Network and to the appropriate State Plane Coordinate System by a survey connection to existing triangulation station(s) as established by the National Geodetic Survey unless otherwise stated in each task order. In areas where the spacing of these triangulation stations are so wide that a survey connection would not be practicable, the horizontal control will be surveyed by observing satellite stations using a Global Positioning System (or equivalent). Global Positioning System (GPS) technology may be employed to acquire horizontal point location data providing accuracies obtained are within those obtained by conventional traversing methods described above. GPS equipment, planning techniques, and anticipated accuracies are noted in the reference text noted in C.3.7. Plans and GPS equipment specifications for GPS implementation shall be reviewed by the COR during task order negotiations.

C.11.7. ELEVATIONS. The Contractor shall be responsible for all elevations necessary for satisfactory completion of all work. The Contractor will be responsible for checking bench marks and level lines for accuracy. Global Positioning System (GPS) may be used for elevation data providing the equipment and techniques to be used provide data at accuracies required by conventional level loops. The use of GPS acquired elevation data is at the discretion of the COR. Conventional level loops may be required exclusively. Use of GPS technology for acquiring elevation data will require a review, by the COR, of the plans proposed during negotiations for a task

order. Some conventional level loops may be required in addition to GPS acquired data. GPS equipment, planning techniques, and anticipated accuracies are noted in the reference text noted in C.3.7.

C.11.8. FIELD NOTES. Field notes shall be neat, complete, numbered, indexed and accurate; and every page shall be appropriately identified. Only original field notes will be accepted. Field note books must be kept in good condition and sent to the Corps of Engineers at the end of the project.

C.11.9. MINIMUM ACCURACY.

a. The survey traverse established by the Contractor within the Project Area used to provide horizontal control shall have a minimum closure before adjustments of 1:10,000, and the survey traverse shall be tied to the North American 1983 Datum network and the appropriate State Plan Coordinate System unless otherwise noted in each task order. The final traverse adjustment will include sea level and grid correction factors applied to measured distances before adjustments. The Contractor shall provide copies of the traverse closures.

b. Level circuits used for primary vertical control within the project area will originate and end on bench marks established by National Geodetic Vertical Datum of 1929 unless otherwise noted in each task order. All level circuits used to establish basic project control will close within .05 feet times  $m$ , where  $m$  is the distance in miles. Levels to establish supplementary photogrammetric controls shall originate from a primary level bench mark and close on a primary level line bench mark, and shall establish elevations with maximum errors no greater than 1/10 of the contour interval of the map being prepared. No side shots to the vertical control points will be allowed; either turn through the point or establish elevation on point from two (2) setups. Preference shall be given to taking off one (1) primary benchmark and closing on a second (2<sup>nd</sup>) primary bench mark. If, in order to comply with this, level loops are several miles in length, discussions with Contracting Officers Representative (COR) shall determine the appropriate route for level loops.

C.11.10. STADIA ELEVATIONS. No stadia work or trigonometric levels will be permitted in ground control work.

C.11.11. TRANSFER OF RECORDS AND MATERIALS. All data compiled for the completion of ground control will be given to Corps of Engineers. All original manuscripts will be delivered to Corps of Engineers upon completion of the project.

C.11.12. CONTROL LOCATION MAP. Contractor shall provide Corps of Engineers with a location map showing the physical location of all required horizontal and vertical points on or adjacent to the project area.

C.11.13. BENCH MARKS. Permanent bench marks may be required as per specifications in a task order. When this is the case the number and location parameters will be specified in the task order. Level lines shall be run along routes that have the least fluctuation in elevation and in as direct a line as possible compatible with

the area to be mapped. When possible, bench marks shall be established no more than one U.S. mile apart. Reference drawings shall also be prepared showing locations of all bench marks set.

## C.12. IMAGE SCANNING

C.12.1. GENERAL. Scanning may be required under this contract. Uses of scanning may include creating digital files of existing hardcopy map data, scanning of aerial photographs into raster images for utilization in softcopy workstations for development of topographic and planimetric mapping and orthophoto development. Resolutions expected and processes required for scanning projects will be specified in each task order. All projects will require "high resolution" scanners unless otherwise stated in task orders.

C.12.2. HIGH RESOLUTION SCANNERS. High resolution scanners will be of a quality that will meet the photogrammetry requirements stated in task orders. The level of precision shall be +/- 2 microns. All scanners must be capable of pixel size of 10 x 10 microns for black and white images and transparencies and 15-20 microns for color photographs and transparencies. All scanners must be able to scan color and black and white photographs.

## C.13. SOFTCOPY PHOTOGRAMMETRY.

C.13.1. GENERAL. Softcopy photogrammetry is the use of digital raster images and softcopy mapping systems instead of photographs and analytical stereoplotters for map production. The sources of digital images can range from digitized photographs, to digital cameras, to electro-optical scanners. Systems required under this contract must be capable of performing all the tasks of a fully analytical first order stereo-plotter, automated generation of digital terrain models, computation of digital orthophotos (for subsequent output on a raster plotter), preparation of perspective views (singly or in a series of fly-throughs) and capture of data for direct entry into a geographic information system. The system also must provide linkages to image processing software, making it amendable to the analysis of virtually any source of digital image data (e.g., Landsat or SPOT satellite data).

C.13.2. SOFTCOPY TOPOGRAPHIC/PLANIMETRIC AND ORTHOPHOTO MAPPING. Softcopy data requests under this contract may require the development of topographic, planimetric and/or orthophoto mapping. The specifications and accuracies are the same as stated in paragraphs C.13 and C.14.

## C.14. STEREOCOMPILATION, DRAFTING, AND CADD SPECIFICATIONS.

C.14.1. Analytical aerotriangulation specifications. When authorized within this contract and/or task order, the x-, y-, and z-coordinates for supplemental photo control points may be derived using fully analytical, simultaneous block aerotriangulation adjustment methods. Industry-standard adjustment software, or that supplied with analytical plotters or softcopy workstations, must be used to perform the computations.

Use of different altitude photography is not allowed. The photography specified in paragraph C.6 shall be used to perform all measurements.

a. **EQUIPMENT.** The photogrammetric mensuration instruments shall have sufficient accuracy and utility for measuring the x and y photographic coordinates of the fiducial or other photographic reference marks, targets, photographic images, and artificially marked points to achieve the required accuracies.

b. **GROUND CONTROL REQUIREMENTS.** The contractor shall be responsible for determining the optimum location, quality, and accuracy of all ground surveyed control points used for controlling the aerotriangulation adjustment. Ground control requirements are dependent upon many factors specific to each individual project. The number and spacing of horizontal and vertical ground control points for a project shall be within general industry standards and shall be approved by the Contracting Officers Representative for each task order.

c. **RESULTANT ACCURACY OF AEROTRIANGULATION ADJUSTMENT.** For class 1 maps, the root mean square (RMS) error for the x, y, and z coordinates of all supplemental control points determined by analytical aerotriangulation shall not be in error by more than 1:10,000 in horizontal position (x and y) and 1:8,000 in elevation (z), when expressed as a ratio fraction of the flying height. These adjustment statistics must be clearly identified on the adjustment software output that shall be delivered to the government prior to commencement of stereoplotting. A short written report submitted to the contracting officer prior to compilation explaining any analytical control problems encountered shall accompany this printout. Aerotriangulation accuracy criteria for other map classes are contained in EM1110-1-1000.

d. **CONTROL PRINTS.** The image of all ground control and supplemental control points shall be appropriately marked and identified on a set of contact prints (control prints). The identifying number for each supplemental control point shall be related to the photograph on which it appears.

e. **DELIVERIES.** All materials, including the x-y-z coordinate listing of supplemental control points, final adjustment computations with error of closure, control prints, the marked/drilled diapositives, and any rolls of film negatives used by the contractor, shall be provided to the government.

**C.14.2. STEREOPLOTTER SPECIFICATIONS.** Topographic and/or planimetric feature line maps are to be developed/generated on a softcopy workstation (as specified in section C.13 or equivalent) or an analytical stereoplotter. The plotter system must be capable of automatically performing/adjusting interior, relative, and absolute orientations, and output statistical data thereof, and generating digital data of observed topographic/feature information into spatial layers directly compatible with three-dimensional design file criteria (standards manual for USACE COMPUTER-AIDED DESIGN AND DRAFTING (CADD) SYSTEMS EM 1110-1-1807 (Reference C.3.3). Stereoplotter operators should have demonstrated experience on the machine and in the type of terrain being compiled.

C.14.3. MAP COMPILATION SCALE. The contractor shall furnish to the contracting officer stereoplotter-derived manuscripts and/or finished maps at scales referenced in task orders scope of work.

C.14.4. Manuscript plotting media. **RESERVED.**

C.14.5. MODEL SETUP AND ORIENTATION DATA. The stereoplotter orientation parameters and statistical outputs for each model setup may be requested for specific task orders. These sheets shall be fully annotated by date, time, operator name, compilation dates/times, photo numbers, and other data that confirm that the mapping was compiled from the required negative scale.

C.14.6. PLANIMETRIC FEATURE DATA DETAILING. Mapping data shall contain all the planimetric features visible or identifiable on or interpretable from the aerial photographs, and compatible with type of project involved (i.e., military master planning, detailed site plan mapping, etc.) These shall include, but not be limited to, buildings, roads, farm lanes, trails, driveways, sidewalks, catch basins, rivers, shorelines, ditches, drainage lines, erosion areas, ponds, marshes, lakes, reservoirs, railroads, fence lines, power poles, pipelines, wooded areas, timber lines, tree clumps, orchards, vineyards, individual trees that can be recognized as such, bridges, culverts, piers, spillways, tunnels, dams, rock outcrops, quarries, recreation areas, and cemeteries. The level of detail required for each project will be provided in detailed specifications for the task order.

a. Features such as quarries, gravel pits, log piles, coal piles, sand piles, slag piles, open pit mines, etc., shall be shown by symbols identified in USGS Photogrammetric Compilation Symbols -- Chapter 3F1, Preliminary Edition, March 1981, unless otherwise specified.

b. Surface Utility Data. Locate and identify all utilities such as culverts (pipes or box drains); water systems including valves and meters; catch basins; manholes (storm, sanitary, telephone, gas, and electric); meter/valve boxes; overhead electrical pole location and type; low wire elevations; towers; and transformers. Except in urban or heavy industrial areas, locate only main trunk aerial and surface lines; identify size and capacities and measure invert elevations as applicable to project as requested in task orders scopes of work.

c. Underground Utilities. For designated subsurface utilities, provide pipe/conduit alignment, type, size, nomenclature, depth below surface, junction points, etc. as requested in task orders scopes of work.

d. Highways, Roads, and Streets. Obtain names, descriptions, classifications; center-line profiles or sections as designated; route classification; pavement width and construction as requested in task orders scopes of work.

e. Railroads. Obtain names, locations (and stationing) of mileposts, bridges, culverts, semaphores, culverts, yard limits, etc. Obtain center-line profiles or sections as designated as requested in task orders scopes of work.

f. **RESERVED.**

g. Buildings and Other Structures. Obtain proper names of all buildings or landmarks; proper names, installation numbering, and/or descriptions of all buildings and other structures affected or possibly affected by the project; foundation and first-floor elevations of those structures within designated limits and/or elevations.

h. Boundary and Right-of-Way Data. Locate all right-of-way markers/monuments for existing roads/projects/structures. Connect any prominent property corners, installation boundaries, or section corners encountered.

i. Vegetation. Obtain general identification and description of clusters, as would be of interest in preliminary value appraisals or in clearing operations.

C.14.7. Topographic Data Detailing. The map shall contain all representable and specified topographic features visible or identifiable on or interpretable from the aerial photography. Topographic data may be generated by contour tracing or digital terrain modeling (mass points and breaklines) techniques.

a. Contour tracking/tracing. The contour interval for each project will be stated in each task order. Each contour shall be drawn sharp and clear as a solid line, except through densely wooded areas where the ground cannot be seen and where it is obscured by an overhanging bluff or ledge. In such ground hidden places, the contours shall be shown as dashed (broken) lines. Every fifth contour (index contour) shall be accentuated as a heavier line than the intermediate four and shall be numbered according to its actual elevation above mean sea level. Whenever index contours are closer than one-quarter (1/4) inch, and the ground slope is uniform, the intermediate four may be omitted.

(1) Half-interval contours shall be added in all sizeable flat areas where general slopes are 1 percent or less. Labeling or numbering of contours shall be placed so that the elevation is readily discernable. Labeling of intermediate contours may be required in areas of low relief.

(2) The turning points of contours that define drainage channels, ditches, rapids, falls, dams, swamps, sloughs, etc., shall be consistent in depicting the correct alignment of the channel and in reflecting the continuation of the drainage.

(3) Particular care must be taken to show the Outline of shorelines or other water limits at the time photography is taken. Where the water demarcation line cannot be definitely established, the approximate position shall be shown by a broken line so as to indicate the continuity of drainage.

b. Terrain Model Generation. Terrain model generation is accomplished using a softcopy workstation or analytical stereoplottter to derive accurate ground point (horizontal and vertical) location data. Digital elevation models

(DEM) consist of a preset grid interval of ground points specified in a task order. A Digital Terrain Model (DTM) shall consist of a network of random points supplemented with break-line points to properly establish the Hypsography of the terrain. Intermediate break, highs, lows, etc., are added independently. Triangulated irregular networks (TIN) and contours will be generated off-line using standard DTM/CADD software as specified in task orders.

c. Spot elevations. Spot elevations determined photogrammetrically shall be shown on the maps in proper position at water level on the shoreline of lakes, reservoirs, ponds, and the like; on hilltops; in saddles; at the bottom of depressions; at intersections and along center lines of well traveled roads; at principal streets in cities, railroads, levees, and highways; at tops and bottoms of vertical walls and other structures; and at center line of end of bridges. In areas where the contours are more than 3 in. apart at hardcopy map scale, spot elevations shall also be shown and the horizontal distance between the contours and such spot elevations or between the spot elevations shall not exceed 2 in. at scale of delivered maps. Spot elevations shall be measured to an accuracy consistent the accuracies stated in C.3.1 or with the accuracy standards stated in each task order.

d. When the contract stipulates the delineation of specified features (planimetry and contours) and the specified features are not visible from or obscured on the aerial photography and on stereoscopic models formed therefrom, the contractor shall attempt to compile the features and note the obscured areas with a predetermined line code denoting obscured areas unless otherwise stated in the task order. Areas marked as such will not be required to meet the accuracy standard specified in the task order.

e. Dashed contours. When the ground is obscured by vegetation to the degree that standard accuracy is not obtainable, contours shall be shown by dashed lines.

C.14.8. ORTHOPHOTOS AND ORTHOPHOTO MAPS. Orthophotos are orthographic photographs. They do not contain scale, tilt and relief distortions. Orthophotographs within the purview of this contract will be generated from overlapping conventional photos or digital images in a process called differential rectification. The result of this process is the elimination of photo scale variation and image displacement resulting from relief and tilt. Orthophotos and orthophoto maps will be prepared by digital softcopy methods within this contract and will be specified in task orders. Digital orthophotographs and maps will be generated by utilizing software and hardware that will support image scanning, rectification of scans and digital rectified images. Raster scans will be produced of the images required. The digital imagery will be set up on a softcopy workstation and the image file oriented using the camera calibration parameters and ground control. A spatial resection will be performed to re-establish the focal plane of the camera in space at the instant of exposure. A coordinate transformation based on the camera fiducial corners will be undertaken. This transformation will allow the conversion of every pixel in the image from a sample/line location to an x,y, position. Then a differential rectification will be performed. This procedure will place each pixel into the correct coordinate space as defined. Digital orthophoto files will be delivered in TIFF format on CDROM unless

otherwise specified in task orders. Hardcopy may be required from this type data and will involve hardware and software that will produce a film negative of the digital files suitable for positive production on paper and mylar (Black and White orthophotos only). All orthophotographs and maps shall be compiled on instruments with software capable of making direct enlargements up to eight diameters between original negative scale and compilation scale. All orthophotos and orthophoto maps will meet the accuracy stated in C.3.1 unless specified otherwise in a task order.

C.14.9. MANUSCRIPT DRAFTING. All drafting on the manuscripts shall be sufficiently neat and complete as to eliminate or minimize errors of misinterpretation on the part of the draftsman preparing the finished line maps. Manuscript drafting shall be sufficiently dark and adequately edited so as to afford good and usable prints, if required. Either pencil or ink will be specified in each task order.

C.14.10. COMPILATION HISTORY. A compilation history (model diagram or model setup sheet) may be requested in a task order for each stereoscopic model used to accomplish the mapping. History shall include but not be limited to the final photographic fit to x-, y-, and z-coordinates of ground and supplemental control points and any other problems encountered in the model orientation and compilation process. History shall also include the project name, flight date, photo scale, map scale, stereoplotter system used, and the operator name.

C.14.11. FINAL SITE PLAN MAPS AND/OR DIGITAL DATA BASE CONTENTS.

a. Coordinate Grid. Unless otherwise specified, grid ticks of the applicable coordinate system (SPCS) shall be properly annotated at the top and right edge of each manuscript sheet. Spacing of the grid ticks shall be approximately five (5)in. The coordinate system to be used will be noted in each task order.

b. Control. All horizontal and vertical ground control and all supplemental control determined by either field or aerotriangulation methods shall be included in the final mapping data.

c. Sheet layout and match lines. The Government will provide the sheet layout for each task order. Match lines shall be provided and properly labeled so that each sheet may be joined accurately to adjacent sheets.

d. Symbols and Names. The symbols to be used for major planimetric and topographic features shall be in accordance with symbols provided in reference C.3.3 unless stated otherwise in each task order. The names of cities, towns, villages, rivers, streams, roads, streets, highways, and other features of importance shall be obtained by the contractor. All names and numbers shall be legible and clear in meaning and shall not interfere with map features. Names of towns, rivers, streams, etc., will generally be those appearing on the existing USGS, National Imagery and Mapping Agency (NIMA), or state highway published maps unless other data is furnished by the Government as per task orders.



e. Title and Sheet Index. A title shall be placed on each map manuscript to the size and arrangement directed by the Contracting Officer, and shall include the name of the contracting agency, the project name, the date of photography used, the strip and photograph numbers, the map scale, the date of the mapping, manuscript number, and the name of the contractor. If more than one (1) manuscript/map sheet is prepared, a small-scale sheet index shall be drawn on each manuscript/map sheet showing the position and the relationship of all map sheets to each other. The title block contents and sheet index requirements for finished maps will be furnished by the Contracting Officer. The contractor's name/address, contract/task order number, and logo will be placed on each map sheet.

f. Vertical datum. Vertical data required will be specified in each task order.

C.14.12. FINAL PLOTTING MEDIA. The finished line maps shall be electrostatically printed from the CADD database on dimensionally stable, static-free polyester drafting film, of at least 0.004-in. thickness to a final map size specified in each task order unless otherwise specified in each task order. The sheets will be oriented north-south, unless otherwise specified. Locations of title blocks, revision blocks, border detail, line weights, etc., are contained in reference C.3.3 unless otherwise stated in each task order.

C.14.13. DRAFTING QUALITY. The professional standards of draftsmanship and scribing shall be maintained throughout the mapping process. All symbols, lines, letters, and numbers shall be clear and legible and conform with the District drafting standards specified in reference C.3.3 unless otherwise noted in each task order.

C.14.14. MAP EDITING. All map products will be reviewed by an experienced editor during applicable stages of production.

#### C.14.15. DIGITAL DATA DESIGN FILE SUBMITTALS.

a. Products. Digital data products to be furnished by the contractor shall include, but not be limited to, topographic drawings, cross sections, profiles, and digital elevation/terrain models.

b. Accuracies. The horizontal and vertical accuracies for digital products shall be as stipulated in section C.15 of this contract unless stated otherwise in each task order.

c. Format. The completed drawings, digital files, etc., shall be fully operational, by translation or other process, on the operating system stated in each task order at the time the drawings are delivered.

d. All design files, including drawings and/or models, shall be furnished on 3-1/2 in. Floppy Diskettes, 8 mm tapes, CDROM or optical rewritable disks formatted as stated in each task order. The contractor shall furnish a copy of the cell library used in preparing these drawings and compilation history as described above.

All data shall become the property of the Government upon submittal.

C.14.16. DELIVERIES. All completed manuscripts, maps, and any reproductions thereof, diapositives, model diagrams, compilation histories, and digital data shall be delivered to the Contracting Officer in accordance with task order requirements.

C.15. QUALITY CONTROL AND QUALITY ASSURANCE STANDARDS.

C.15.1. Contractor Quality Control.

a. General. All photogrammetric mapping data submitted under this contract shall conform to the accuracy standards outlined in EM 1110-1-1000 unless modified in each task order or supplemented below. The contractor shall be responsible for internal quality control functions involved with field surveying, photography and laboratory processing, stereo compilation, drafting, field checking, and editing of the photogrammetrically made measurements and compiled maps to ascertain their completeness and accuracy. Also the contractor shall make the additions and corrections necessary to complete the maps and photogrammetrically made measurements.

b. Materials. All materials, supplies, or articles required for work that are not covered herein, or by work order specifications, shall be standard products of reputable manufacturers and entirely suitable for the intended purpose. Unless otherwise specified, they shall be new, unused, and Subject to the approval of the contracting officer.

C.15.2. ASPRS ACCURACY STANDARDS FOR LARGE-SCALE MAPS.

a. Vertical Accuracy. Vertical map accuracy is defined as the 1 sigma (RMS) error in elevation in terms of the project's evaluation datum for well-defined points only. The limiting RMS error shall be one-third (1/3) the contour interval for well-defined points and one-sixth the indicated contour interval for spot heights placed on the map/manuscript. The map position of the ground point may be shifted in any direction by an amount equal to twice the limiting RMS error in position (defined below). Statistical tests shall be made in accordance with ASPRS procedures.

b. Horizontal Accuracy. Horizontal map accuracy is defined as the 1-sigma RMS error in terms of the project's planimetric survey coordinates (x-y) for checked well-defined points as determined by full (ground) scale of the Map/manuscript. The limiting RMS errors in x or y (feet) for each scale (in feet/inch) are as follows:

Error ft	Scale ft/in.
0.2	20
0.3	30

0.4	40
0.5	50
1.0	100
2.0	200
4.0	400

c. Blunders. Discrepancies between the x-, y-, or z-coordinates of the ground point, as determined from the map by the check survey, that exceed three (3) times the limiting root mean square error shall be interpreted as blunders and will be corrected.

**C.15.3. RESERVED.**

**C.15.4. USACE PHOTOGRAMMETRIC MAPPING ACCURACY STANDARDS.** Unless specified otherwise, all photogrammetric mapping will meet the horizontal and vertical accuracy requirements specified for the "Class" mapping stated in each task order, in Chapter 2 of EM 1110-1-1000.

**C.15.5. SMALL-SCALE ACCURACY REQUIREMENTS.** For line maps of scales smaller than 1 in. Per 400 ft (1:4,800), The United States National Map Accuracy Standards shall be followed.

**C.15.6. NATIONAL MAP ACCURACY STANDARDS (LARGE-SCALE MAPS).** Unless specified otherwise, all photogrammetric mapping will meet the following horizontal and vertical accuracy requirements for scales of 40, 50, 100, 200, and 400 ft to 1-in.

a. Contours. Not more than 10 percent of the elevations tested shall be in error more than one-half contour interval. In checking elevations taken from the map, the apparent vertical error may be decreased by assuming a horizontal displacement of 1/30 in.

b. Planimetric features. Not more than 10 percent of well-defined points or features tested shall be in error by more than one-thirtieth (1/30) of an inch, measured at the map/manuscript publication scale. Well-defined features are those that may be plotted within 1/100 in. at the map/manuscript scale.

**C.15.7. METHODS FOR EVALUATING MAP ACCURACY.** All maps compiled may be subject to map testing by the government, by independent third-party forces, or by contractor forces working under direct government review, to ensure that they comply with the applicable accuracy requirements listed above. The map test results will be statistically evaluated relative to the defined accuracy criteria, and pass/fail determination made accordingly. The decision of whether or not to perform rigid map testing on any project, task order, or portion of a project rests with the contracting officer.

a. Office and Field Checks. The party responsible for map testing may, during the course of the project, inspect map compilation in the Contractor's facility by

comparison with aerial photographs. However, the final map compilation shall be checked by field inspection and a horizontal and vertical accuracy check by conventional field survey checks, using traverse, triangulation, and differential leveling methods to test selected points or features on the completed drawings.

b. Test Profiles for Topography. In order to check for compliance with the vertical contour accuracy requirements, test profile traverses may be made in the field. Profiles to check contours and spot elevations should be at least five (5) in. long at the map scale, and should cross at least ten (10) contour lines. Profiles should start and close upon map features or previously established control points. In flat areas and at principal road and rail intersections, spot elevations shall be checked. In general, one profile per map sheet is sufficient.

c. Spot elevation tests. Testing for vertical accuracy may also be performed by comparing the elevations at well-defined points as determined from the map to corresponding elevations determined by a survey of higher accuracy. A minimum of 20 points shall be checked and shall be distributed throughout the sheet, or concentrated in critical areas.

d. Test Points for Planimetric Features. The accuracy of the planimetric map feature compilation shall be tested by comparing the ground coordinates (x and y) of at least 20 points (well-defined map features) per test per map sheet, as determined from measurements on the map at publication scale, to those for the same points, as provided by a check survey of higher accuracy. The check survey shall have an order of accuracy equal to or exceeding that specified for establishing the mapping control. Maps will also be examined for errors and/or omissions in defining features, structures, utilities, and other nomenclature, or for total gaps in compilation/coverage. A minimum of 20 points shall be distributed throughout the sheet or concentrated in critical areas.

e. Selection of Well-Defined Test Points. The term "well-defined map features" pertains to features that can be sharply defined as discrete points. Points that are not well-defined are excluded from the accuracy test. The selection of well-defined points shall be made through agreement between the contracting officer and the contractor. Generally, it may be more desirable to distribute the points more densely in the vicinity of important structures or drainage features and more sparsely in areas that are of lesser interest. Further definitions and requirements for selection of well-defined photo/map points are found in the reference standard used. The locations and numbers of map test points and/or test profiles shall be mutually agreed to by the Contractor and Contracting Officer's Representative (COR).

C.15.8. CORRECTION OF UNSATISFACTORY WORK. Failure to meet map test criteria will require recompilation of the project at the Contractor's expense. When a series of sheets are involved in a mapping project, the existence of errors (i.e., map test failure) on any individual sheet will constitute prima facie evidence of deficiencies throughout the project (i.e., all other sheets are assumed to have similar deficiencies), and field map testing will cease. After correction of the work, the contractor will be responsible for payment of map testing required on the corrected drawings. When

such efforts are performed by government survey forces, these costs will be deducted from contract/task order payment estimates.

C.16. SUBMITTAL REQUIREMENTS.

C.16.1. SUBMITTAL SCHEDULE. The completed work, maps, and reports shall be delivered by calendar date specified in each task order.

C.16.2. PACKAGING AND MARKING. Packaging of completed work shall be accomplished such that the materials will be protected from handling damage. Each package shall contain a transmittal letter or shipping form, in duplicate, listing the materials being transmitted, being properly numbered, dated, and signed. Shipping labels shall be marked as shown in Section D.

C.17. PROGRESS SCHEDULES AND WRITTEN REPORTS. Progress schedules and written report requirements will be stipulated in each task order.

SAMPLE

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

C.1 GENERAL

The Contractor, shall furnish the required personnel, material, and equipment, necessary to perform the aerial photography or remote sensing data collection, survey support, photogrammetric mapping, image processing, GIS design and development, technical support, and product output as described herein, as the Government may request during the contract period as specified. Work may be required anywhere within the boundaries of the U. S. Army Corps of Engineers Great Lakes and Ohio River Division, or elsewhere as directed. During completion of all assigned work, the Contractor shall provide adequate professional supervision and quality control to assure that accuracy, quality, completeness, and progress of work is sufficient to meet the Government's expressed project objectives.

The scope of this contract includes: image data collection or acquisition (via conventional and/or digital aerial photography, airborne remote sensing systems such as multi- or hyperspectral scanners, thermal sensors, laser profilers or radar sensors, and satellite remote sensing systems); survey support, including conventional and Global Positioning Systems (GPS) ground control, airborne GPS, and quality control field studies; analytical and softcopy photogrammetric mapping, including aerotriangulation, digital orthophotography production, terrain mapping and modeling, and stereo and/or digital ortho feature compilation; analytic image processing, including image registration, enhancement, classification, and interpretation services using aerial or satellite imagery and ancillary information for land use/ land cover, wetland delineation, and similar tasks; GIS database design, population (scanning, encoding, and digitizing), attribution, and analytic modeling; product output, including generation of hard copy (photos, plots, reports, etc.) and digital files in specified formats, including USGS Digital Elevation Models (DEM), Digital Orthophotography Quadrangles (DOQ) and Digital Line Graphs (DLG); and, training and technical on-site support services required from time to time during the period of this contract at locations determined by the government.

The Contractor shall provide all necessary remote sensing, surveying, photogrammetric instruments, aircraft, and ground equipment necessary to accomplish the required services.

The Contractor is expected to furnish to the Government all imagery, photogrammetric mapping, remote sensing data, GIS products, and all other supporting materials and reports, specified under each Task Order under this contract. Products that may be required include negatives, positive, diapositives, digital photo indexes, photo reproductions, paper contact prints, mylar maps, digital elevation models, digital orthophotographs, survey control information, analytical adjustments, compilation histories, planimetric and topographic manuscripts, remote sensing image products and/or GIS files in specified data formats.

C.2 LOCATION OF WORK

All work under this contract will be performed in connection with projects assigned within the Great Lakes and Ohio River Division as may be determined by the Contracting Officer. The Great Lakes and Ohio River Division jurisdiction includes drainage areas within the States of Michigan, Illinois, Indiana, Wisconsin, Minnesota, Ohio, Pennsylvania, New York, Kentucky, Tennessee, West Virginia, Virginia, Maryland, Mississippi, Alabama, Georgia, South Carolina and North Carolina.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

C.3 CRITERION, REGULATIONS, MANUALS AND STANDARDS

The following criterion, regulations, manuals and standards are referenced in this contract and shall take precedence over any other items employed in the conduct of this contract, unless superseded by specifications contained or referenced within Task Orders under this contract. Current versions of these documents can be acquired through the Contracting Officer, or his/her designated representative. The Contractor is expected to keep abreast of changes and updates to these documents.

C.3.1 USACE EM 1110-1-1000, Photogrammetric Mapping, 31 Mar 93;  
<http://www.usace.army.mil/inet/usace-docs/>

C.3.2 USACE EM 1110-1-1002, Survey Markers and Monumentation, 14 Sep 90;  
<http://www.usace.army.mil/inet/usace-docs/>

C.3.3 USACE EM 1110-1-1003, Navstar Global Positioning System Surveying, 01 Aug 96;  
<http://www.usace.army.mil/inet/usace-docs/>

C.3.4 USACE EM 1110-1-1004, Deformation Monitoring and Control Surveying, 31 Oct 94;  
<http://www.usace.army.mil/inet/usace-docs/>

C.3.5 USACE EM 1110-1-1005, Topographic Surveying, 31 Aug 94;  
<http://www.usace.army.mil/inet/usace-docs/>

C.3.6 USACE EM 1110-2-1003, Hydrographic Surveying, 31 Oct 94;  
<http://www.usace.army.mil/inet/usace-docs/>

C.3.7 USACE EM 1110-1-2909, Engineering and Design, Geospatial Data and Systems, 01 Aug 96 (original), 01 Jul 98 (change 2); <http://www.usace.army.mil/inet/usace-docs/>

C.3.8 Tri-Service Spatial Data Standards (TSSDS), Release 1.8, February 1999;  
<http://tsc.wes.army.mil/products>

C.3.9 Tri-Service Facility Management Standards (TSFMS), Release 1.9, December 1999;  
<http://tsc.wes.army.mil/products>

C.3.10 Tri-Service A/E/C CADD Standard; <http://tsc.wes.army.mil/products>

C.3.11 ASPRS Draft Aerial Photography Standards, ASPRS, 1995,  
<http://www.asprs.org/resources.html>

C.3.12 ASPRS Interim Accuracy Standards for Large-Scale Maps, ASPRS, March 1990,  
<http://www.asprs.org/resources.html>

C.3.13 United States National Map Accuracy Standards, US Bureau of the Budget, June 1947,  
<http://mapping.usgs.gov/standards/index.html>

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

C.3.14 Content Standards for Digital Geospatial Metadata, Federal Geographic Data Committee, version 2.0, FGDC-STD-001-1998 ( Use CORPSMET 95, Digital Geospatial Metadata File Generator, down-loadable via the Internet at <http://corpsgeo1.usace.army.mil/>)

C.3.15 Spatial Data Transfer Standards (SDTS) FGDC-STD-002,  
<http://www.fgdc.gov/standards/status/textstatus.html>

C.3.16 Cadastral Data Content Standard FGDC-STD-003,  
<http://www.fgdc.gov/standards/status/textstatus.html>

C.3.17 Classification of Wetlands and Deep Water Habitats FGDC-STD-004,  
<http://www.fgdc.gov/standards/status/textstatus.html>

C.3.18 Vegetation Classification Standard, Vegetation Subcommittee FGDC-STD-005,  
<http://www.fgdc.gov/standards/status/textstatus.html>

C.3.19 Soils Geographic Data Standard, Soils Subcommittee FGDC-STD-006,  
<http://www.fgdc.gov/standards/status/textstatus.html>

C.3.20 Geospatial Positioning Accuracy Standard,  
<http://www.fgdc.gov/standards/status/textstatus.html>

C.3.21 *Content Standard for Digital Orthoimagery, FGDC-STD-008-1999,*  
<http://www.fgdc.gov/standards/status/textstatus.html>

C.3.22 *Content Standard for Remote Sensing Swath Data, FGDC-STD-009-1999,*  
<http://www.fgdc.gov/standards/status/textstatus.html>

C.3.23 *Utilities Data Content Standard, FGDC-STD-010-2000,*  
<http://www.fgdc.gov/standards/status/textstatus.html>

C.3.24 U.S. Geological Survey, Standards for Digital Elevation Models, January 1998,  
<http://mapping.usgs.gov/standards/index.html>

C.3.25 U.S. Geological Survey, Standards for Digital Line Graphs, September 1999,  
<http://mapping.usgs.gov/standards/index.html>

C.3.26 U.S. Geological Survey, Standards for Digital Orthophotography Quadrangles,  
December 1996, <http://mapping.usgs.gov/standards/index.html>

C.3.27 U.S. Geological Survey, National Aerial Photography Program (NAPP) Specifications,  
<http://edc.usgs.gov/glis/hyper/guide/napp>

C.3.28 Flood Insurance Study-Guidelines and Specifications for Study Contractors, Federal  
Emergency Management Agency (FEMA), Federal Insurance Administration, Publication FEMA  
37, March 1991, [http://www.fema.gov/mit/tsd/DL\\_SCg.htm](http://www.fema.gov/mit/tsd/DL_SCg.htm)



SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

C.3.29 The Manual of Remote Sensing, 3rd Edition ( a series), American Society for Photogrammetry and Remote Sensing, <http://www.asprs.org/publications.html>

C.3.30 The Manual of Photogrammetry, 4th Edition (and addendums), American Society for Photogrammetry and Remote Sensing, <http://www.asprs.org/publications.html>

C.4 WORK TO BE PERFORMED

The work to be conducted includes: collection of remotely sensed data from various sources, including but not limited to conventional and digital aerial photography, multi- and hyper-spectral scanners, thermal sensors, radar sensors, laser profilometers, and/or satellite imagery; photogrammetric mapping; related surveying; GIS database development and analyses; and consulting services. Unless otherwise indicated in this Scope of Work or in Task Orders thereto, each required service shall include field-to-finish effort. All mapping work will be performed using precise aerial and remote sensing acquisition techniques, photogrammetric aero-triangulation, mensuration, and/or compilation procedures, and GIS topology and database development and mapping methods, including quality control associated with these functions. The work will be accomplished in strict accordance with the mapping criteria contained in the technical references (paragraph C.3), except as modified within Task Orders.

C.4.1 GENERAL REQUIREMENTS

Typical projects assigned under a Task Order may include any or all of scales and tasks below.

a. Large scale (1"=10' to 1"=50'), low altitude photogrammetric mapping for detailed design and construction of engineering projects. Typical 1-foot contour intervals with detailed surface planimetry and utility mapping would be required. This mapping would be used for design/construction of bridges, highways, major hydraulic structures (gates, intake structures, dams, concrete channels, etc), real estate acquisition (property boundary delineation), marine structure location (piers, bulkheads, levees, dikes, breakwaters, groins, etc). Photomapping compilation would require use of high precision analytical or soft-copy stereoplotters for mapping to detailed specifications given in Section C.3.

b. Moderate scale (1"=50' to 1"=500') planimetric and topographic mapping for general site plan maps used for design, construction, operations and/or maintenance of large engineering projects. Photogrammetric mapping typically could include planimetric features (shorelines, transportation networks, hydrology, topography (including elevation models), and structure mapping. Compilation would require high precision analytical or soft-copy stereoplotters and would require usage of established specifications and/or standards outlined in Section C.3.

c. Small scale (1"=1,000' or above) planimetric and topographic line mapping for general planning, operations and/or maintenance of large area projects. Photogrammetric mapping typically could include planimetric features (shorelines, transportation networks, hydrology, topography (including elevation models), and structure mapping. Compilation would require high precision analytical or soft-copy stereoplotters and would require usage of established specifications and/or standards outlined in Section C.3.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

d. Remote Sensing Collection:

- 1) Aerial photography collection (film or digital) typically will require vertical collection, however oblique or other non-standard types of image collection may be required on particular projects. For the purpose of these specifications, they shall be considered as nonstandard or project-specific photography if they include oblique photography, non-standard film sizes (35mm, etc.), motion pictures, or videography. These data collections could be stand-alone deliveries or support of other required analysis. Products could include hardcopy or digital media, or both.
- 2) Aerial remote sensing collection could include multi- or hyperspectral scanner imagery, thermal sensors, radar imagery or laser profiler measuring techniques. These activities may be required to be collected individually or in combination, depending upon detailed requirements contained in a Task Order. These activities could be stand-alone or a part of other analysis and could include hardcopy or digital media, or both.
- 3) Satellite data collection typically would require that the Contractor research the availability of, contract for, acquire, and process datasets generally available through commercial or governmental means. These activities could be stand-alone or part of other analyses. Products could include hardcopy or digital media, or both.

e. The Contractor will be required to plan, conduct, and execute all data collection activities, including establishment of flight line networks to obtain project photography, imagery, and/or elevation data coverage.

f. The Contractor may be required to produce various photography products and digital maps including, diapositives and contact prints, enlargements, large format photographic prints, digital image prints (vector overlays on raster backdrops), and photomosaics. The contractor will also provide services related to high resolution, precision photo scanning, particularly in support of generation of digital orthophotos.

g. Survey support will include conventional, GPS ground control, and/or airborne GPS. Typically the recovery and establishment of all necessary vertical or horizontal ground control, including deployment of aerial photo panels and/or other photo identifiable points will be assigned to the Contractor. The Contractor may also be tasked to provide skilled staff for conduction quality control and/or ancillary field surveys, particularly for land use interpretation, wetland delineation and economic impact assessment studies.

h. Typical photogrammetric mapping and image processing projects will include, but not be limited to, analytical feature collection in the areas of planimetric, topographic, land use, land cover, wetland assessment, and others as assigned. The contractor may be assigned work for generation of image processing products such as, but not limited to; digital orthorectified products, digital elevation models, digital terrain models, and analytic or human interpreted image classifications. The Contractor will be expected to furnish the Contracting Officer as part of the project deliverables, all observations, calculations, and /or analytical adjustment reports used in production of specified datasets and/or maps.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

i. The Contractor will be required to develop functional GIS products in specified file formats (Intergraph MGE, Bentley MicroStation, ESRI Arc-Info, ESRI Arc-View, Autocad, etc.), associated SQL relational data base files (typically Oracle), SDTS format, and a variety of image formats (i.e., .tif .tfw, .rgb, .cot, .geotif, .bil, .bip), as directed under a given Task Order. All digital spatial data will also be required to be suitably self-documented with required metadata, according to the specifications included in Section C.3.

j. The Contractor may be required to provide technical training and on-site support, including but not limited to any of the following: hardware/software operating system training; gis, remote sensing, image processing application software training; on-site GIS requirements analysis and system design; GIS database design, population and implementation; and Internet web page design and development for GIS data distribution.

#### C.4.2 TASK ORDERS

Task Orders will contain individual scopes of work, and the types of services to be performed. At the completion of each order, all data required shall be delivered to the address designated in the Task Order and shall be accompanied by a properly numbered, dated and signed letter or shipping form, in duplicate, listing the materials being transmitted. Deliverables will be specified within each Task Order.

### C.5 CONTRACTOR REQUIREMENTS

#### C.5.1 CONTRACTOR SUPERVISION AND INSPECTION

The Contractor shall designate a Project Manager with full supervisory authority over all personnel assigned under this contract. The Project Manager shall be responsible for maintaining fully staffed and equipped forces to meet the Task Order requirements and to act as a liaison between the Contractor and the Contracting Officer or his/her authorized representative.

During completion of the work, the Contractor shall provide adequate professional supervision to assure accuracy, quality, completeness, and progress of the work. The Contractor is expected to review work in progress to ensure meeting established completion dates. The Contractor shall furnish timely notification in the event that it is found that work cannot be completed within the timeframes set forth in the Task Order.

#### C.5.2 PERFORMANCE

The Contractor's personnel, plant, equipment, facilities, and supply of materials shall be sufficient to ensure compliance with all provisions and instructions furnished with each Task Order, and suitable to meet all needs of any concurrent Task Orders.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

C.5.3 PROFESSIONAL SERVICES

All ground survey work required under this contract shall be accomplished by or under the direct supervision of a Land Surveyor registered in the respective state where surveys are being conducted. Photogrammetry services provided by the Contractor shall be performed by or under the supervision of a Photogrammetrist, with current ASPRS Certification. The Contractor will utilize ASPRS Certified Mapping Specialists whenever relevant to the tasks assigned for remote sensing and GIS.

C.5.4 QUALITY OF MATERIALS

All materials, supplies, or articles required for work which are not addressed by the general requirements contained within this Scope of Work, or detailed within individual Task Orders, shall meet industry standards, be from reputable manufacturers, and be entirely suitable for the intended purpose. All materials shall be new and unused, unless otherwise specified, and will be subject to the approval of the Contracting Officer, or his/her designated representative.

C.5.5 PERSONNEL REQUIREMENTS

Personnel required in performance of Task Orders under this contract may include any, or all, of the disciplines listed below. Following this list are brief descriptions expected for each of these disciplines.

- a. Project Coordinator;
- b. Project Manager(s);
- c. Fixed Wing and/or Helicopter Pilot(s);
- d. Airborne Instrumentation Specialists(s);
- e. Photographic Laboratory Supervisor;
- f. Photographic Laboratory Technicians;
- g. Registered Land Surveyor(s);
- h. Surveying Party Chief(s);
- i. Surveying Technicians(s);
- j. Certified Photogrammetrist(s);
- k. Compilation Specialist(s);
- l. CADD Technician(s);
- m. Image Analyst(s);
- n. GIS Specialist(s);
- o. Computer Programmer(s);
- p. Database Analyst(s); and,
- q. Engineering and Scientific Specialists.

The Project Coordinator shall be thoroughly familiar with all phases of remote sensing data acquisition, photogrammetric mapping, GIS database design and development, product production and the interrelationships of these disciplines in meeting the objectives of each individual Task Order under this contract. The Project Coordinator will exercise full managerial and quality control required to efficiently, economically, and technically administer all Contractor forces assigned to work performed under this contract.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

Project Manager(s) shall be responsible for work conducted under major facets of a complex project. The Project Manager(s) shall be experienced in supervision and administration of their respective workforce(s) and quality control procedures required for a particular Task Order.

Fixed-Wing and Helicopter Pilot(s) shall be well qualified, be experienced in aerial photography and/or remote sensing collection and shall have all required Federal Aviation Administration (FAA) and Civil Aeronautics Board (CAB) Certifications in current status. Per USACE EM 1110-1-1000, Photogrammetric Mapping (C.3.1 previously) pilots shall have a minimum of 400 hours experience in flying precise photogrammetric or remote sensing mapping missions.

Airborne Instrumentation Specialists(s) shall be thoroughly experienced in conducting airborne remote sensing assignments, including precise controlled vertical photography, digital camera operations, multi- or hyperspectral scanner operations, radar sensor operations, airborne laser profiling, and/or airborne GPS data collection operations.

Photographic Laboratory Supervisor(s) shall be thoroughly familiar with all facets of photo lab operations, including the operation and maintenance of all instrumentation and associated equipment needed to provide hardcopy products for each Task Order awarded under the contract. They should be experienced in designing and maintaining exacting quality control procedures and in supervising technical staff in completion of assigned work within timelines and in accordance with standard procedures.

Photographic Laboratory Technician(s) shall have experience in a wide range of photo lab operations including but not limited to aerial film processing and titling, production of contact prints, analytical and orthophoto diapositives, enlargements, photo indexes, orthoimage composites, and mylar reproducibles.

Registered Land Surveyor(s) shall be thoroughly familiar with all phases of cadastral and photogrammetric surveying with particular emphasis on defining horizontal and vertical control networks. The individual(s) shall be thoroughly experienced in supervision of ground survey crews and in the administration of quality control surveys related to work required under individual Task Orders under this contract. Supervises subordinate Survey Party Chief(s) and Surveying Technician(s) involved in these operations. Proof of registration will be furnished to the Contracting Officer or his/her authorized representative upon request. Land surveyors shall be registered in the respective state where land/boundary survey services are required.

Surveying Party Chief(s) shall be thoroughly familiar with all phases of cadastral and photogrammetric surveys. Anticipated tasks include the design of horizontal and vertical control for second- and third-order surveys. Surveys could include any or all of the following: cadastral, topographic, construction layout, profiles, cross sections, and quantity takeoffs. Each party chief shall be qualified to make field computations for accomplishment of work assigned and be capable of planning the work for his party to obtain work efficiently and cost effectively.

Surveying Technician(s), including Instrument Person, Rod Person and Recorders shall be capable of operating semi-precise instruments, including total stations, GPS backpack receivers, theodolites, transits, levels, alidades, electronic distance meters and sonic depth recorders. They shall be experienced in keeping all forms of notes in a firm and legible hand.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

Certified Photogrammetrist(s) shall be responsible for the technical management of all photogrammetric operations, specifically aerial photography project design, stereo-compilation, aerotriangulation, digital elevation / terrain model development and/or digital orthophoto production. Supervises subordinate Compilation and Digital Ortho Specialist(s), CADD Technicians and other specialists involved in these operations. Reviews all photogrammetric products to insure compliance with required specifications, accuracies, and completeness.

Compilation and Digital Ortho Specialist(s) shall be responsible for data capture using first-order analytical stereo-compilation or softcopy workstations. This includes planimetric and contour feature collection, development of digital elevation/terrain models, and support of aerotriangulation adjustments (pugging, etc.). These specialists shall be responsible for performing input scanning, ortho-rectification, image enhancement and formatting of digital orthophoto data sets. They are also responsible for ensuring that quality control procedures are maintained throughout their assigned processes.

CADD Technician(s) are typically responsible for performing a variety of editing, encoding, scanning, digitizing and plotting tasks. Cartographic tasks may involve development and registration of map grids, margin data, and title block annotation for final map sheet production. CADD tasks may involve significant levels of digitizing of historic mapped data, including some minor, or on occasion major, adjustments linework positions and additions of new features based upon specified methods. Other tasks may include encoding new data into established data schema and the production of map products generated from a GIS.

Image Analyst(s) shall be responsible for conducting interpretative analyses of stereo aerial photography or digital orthophotography for land use analyses, wetland delineation and special feature determinations. These tasks may not require computer functions in some cases, but frequently require substantial expertise in feature discrimination. These specialists are expected to be thoroughly trained and experienced in the use of state-of-the science digital image processing techniques, including image registration, resampling, enhancements and supervised and unsupervised classification methodologies.

GIS Specialist(s) shall be responsible for the design, development, and implementation of GIS schema to meet specific project objectives outlined in each Task Order. They are also responsible for analytical modeling using GIS data themes in either vector or raster formats and should be thoroughly experienced in, but not limited to, current versions of ESRI's Arc/Info, ESRI's ArcView, Intergraph's MGE, and/or ERDAS software topologies. These specialists should have current ASPRS Certification as a Mapping Specialist – GIS.

The Computer Programmer(s) shall be responsible for providing system design, coding, and testing support for any Task Order that requires substantial new software development or adaptation/customization of currently available commercial proprietary GIS software and Internet delivery applications. The programmers should have had substantial experience in coding in Java, C++, and Fortran.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

The Database Analyst(s) shall be responsible for providing substantial design, quality control, and implementation support for tasks associated with complex multi-user GIS and SQL relational database software, particularly Oracle and distributed database networking.

Engineering and Scientific Specialist(s) – This category includes a variety of disciplines listed hereafter, depending upon specialized requirements outlined in individual Task Orders under this contract. This category includes Civil, Hydrologic, Hydraulic, Coastal and/or Electrical Engineers, Geologists, Geophysicists, Hydrologists, Geodesists, Oceanographers, Hydrographers, Biologists, Foresters, Landscape Architects, Economists and Urban/Regional Planners. The qualifications and expertise required for such specialties will be described in each individual Task Order and costs for these personnel will be negotiated accordingly.

C.6 REMOTE SENSING DATA COLLECTION - CONVENTIONAL AERIAL PHOTOGRAPHY

C.6.1 FLIGHT OPERATIONS AND EQUIPMENT REQUIREMENTS

- a. Aircraft. The aircraft used for work shall be capable of stable performance in the given geographical locale, at the necessary altitude and air speeds, and shall be equipped with all essential navigational and photographic instruments and accessories. When required by the project, the aircraft must have an onboard GPS system. Costs are to include image collection, clearances, and all other factors, including standard mapping cameras specified elsewhere and will be computed on an hourly basis. Mobilization will be negotiated per Task Order.
- b. Emergency Aircraft Standby. Under selected natural or national emergency conditions, the Government may outline requirements and conditions for emergency dedication of an aircraft for conventional aerial photography collection under a Task Order. The Contractor shall identify direct and indirect costs in establishing the crew-day rate for this line item under this contract.
- c. Subcontract Photography. Before commencement of any aerial photography mission under this contract by a Subcontractor, the Contractor shall furnish in writing to the Contracting Officer the name of such Subcontractor, together with a statement on the scope and extent of the work to be done under the subcontract, including applicable camera certifications and calibrations.
- d. Flight Plan. The minimum area(s) to be photographed are to be indicated on maps that will be provided for each Task Order. Based upon Task Order specifications, the Contractor shall design a flight line network to obtain proper overlap, sidelap, and endlap for full stereoscopic photographic coverage. Maps of the flight lines to be flown shall be submitted to the Government for advance approval, unless prior consent is given to exclude this action.
- e. Flight Log. For each flight day, the pilot or cameraman shall prepare a flight log containing the date, project name, aircraft used, and names of crewmembers. The following shall be recorded for each flight line: altitude, camera, magazine serial number, f-stop, shutter speed, beginning and ending exposure numbers and times, and any other comments relative to the flight conditions. These flight logs, or copies thereof, may be required to be included in reports delivered to the Contracting Officer or designated representative.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

d. Flying Conditions. Photography shall be undertaken only when well-defined images can be obtained. Photography shall not be attempted when the ground is obscured by haze, smoke, or dust or when the clouds or cloud shadows will appear on more than 5 percent of the area of any one photograph without the permission of the Contracting Officer or delegated representative. Unless otherwise specified, flying shall be limited to the period of 3 hours after local sunrise to 3 hours before local sunset or specified under a given Task Order. Photography shall not contain shadows caused by topographic relief or sun angle of less than 30 degrees, whenever such shadows can be avoided during the time of year the photography must be taken. Photography of coastal areas shall be taken during lighting conditions that maximize detail of bluff faces and minimized light reflections from the water surface. Photography collected that obscures bluff detail because of excessive shadow will be rejected. It is also desirable to show bottom features in submerged areas if this can be accomplished without affecting the aforementioned requirements. Photography shall not be collected during periods of excessive wind conditions or turbulence that causes excess tilt, crab, or drift.

e. Ground Conditions. Photography collected for mapping or digital orthophoto production will normally be collected in leaf-off season conditions in areas of deciduous vegetation (late November through early April). Leaf-off photography will normally be collected when there is no snow on the ground nor ice on the lakes and beaches. The season and/or any special requirements concerning foliage, snow, or other conditions will be specified in the Task Order. If questions or concerns about conditions exist, consultation with the Contracting Officer or designated representative before undertaking or continuing the work is required.

#### C.6.2 AERIAL CAMERA SPECIFICATIONS

a. Types of Cameras. Only a standard 6" (153mm + 3mm) focal length single-lens precise aerial mapping camera, equipped with a high resolution, distortion-free lens, and with a between-the-lens shutter with variable speed, shall be used. The aerial camera shall meet or exceed minimum specifications outlined in the Task Order. When large-scale (low altitude) photography is flown, the camera shall be equipped with forward image motion compensation.

b. Calibration. The aerial camera(s) furnished by the Contractor, or its Subcontractors shall have been calibrated by the USGS within three (3) years of the acceptance of each Task Order. The calibration report shall be presented to the Contracting Officer or designed representative prior to use under this contract. Calibrated tolerances shall be within the standards contained in EM 1110-1-1000. Certification shall also be provided indicating that preventative maintenance has been performed within the last two-(2) years.

#### C.6.3 AERIAL FILM SPECIFICATIONS AND PROCESSING REQUIREMENTS

a. General. Film materials and laboratory processing, developing, reproduction, and printing thereof, shall conform with recognized professional photogrammetric industry standards and practices, as outlined in EM 1110-11000 and in Chapter 6 of the ASPRS Manual of Photogrammetry, and other national standards or specifications referenced herein. For the purpose of negotiating prices, the cost of the film and processing thereof, will be computed on a per frame basis based upon an agreed mission plan negotiated under each Task Order.



SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

- b. Type of Film Required. The Contractor shall use only aerial film of a quality that is equal or superior to that specified in a Task Order. Only fresh, fine-grain, high-speed, dimensionally stable, and safety base aerial film emulsions shall be used. Outdated film shall not be used.
- c. Unexposed Film. Whenever any part of an unexposed roll of film remains in the camera, before such film is used on a subsequent day, a minimum 3' section of the roll of film shall be forwarded and exposed, immediately preceding the beginning of photography.
- d. Quality of Photography. The photographic negatives shall be taken so as to prevent appreciable image movement at the instant of exposure. The negatives shall be free from static marks, scratches, have uniform color tone, and have the proper degree of contrast for all details to show clearly in the dark-tone areas and highlight areas as well as in the halftones between dark and light. Negatives having excessive high or low contrast, scratches or other blemishes may be rejected.
- e. Processing of Exposed Film. The processing, including development and fixation and washing and drying of all exposed photographic film, shall result in negatives free from chemical or other stains, containing normal and uniform density, and fine-grain quality. Before, during, and after processing, the film shall not be rolled tightly on drums or in any way stretched, distorted, scratched, or marked, and shall be free from finger marks, dirt, or blemishes of any kind. Equipment used for processing shall be either rewind spool-tank or continuous processing machine, and must be capable of achieving consistent negative quality specified below without causing distortion of the film. Drying of the film shall be carried out without affecting its dimensional stability.
- f. The Camera Panel. The camera panel of instruments should be clearly legible on all processed negatives. Failure of instrument illumination during a sortie shall be cause for rejection of the photography. All fiducial marks shall be clearly visible on every negative.
- g. Film Strip Documentation and Labeling. At minimum, the following information shall be supplied as leaders at the start and the end of each film strip:
- 1) Contract Number and/or Task Order designation;
  - 2) film number;
  - 3) flight line identification(s);
  - 4) dates/times of photography;
  - 5) effective negative numbers and run numbers;
  - 6) approximate scale(s) of photography;
  - 7) calibrated focal length of the camera; and,
  - 8) Contractor's name.
- h. Negative Numbering and Annotation. Each negative will be labeled clearly with the identification symbol and numbering convention recommended herein. The numbers will be sequential within each flight line and shall be in the upper right-hand corner of the negative image edge to be read. All lettering and numbering of negatives shall be approximately 1/5" high and shall result in easily read, sharp, and uniform letters and numbers. Numbering of

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

negatives shall be carried out using heat-foil or indelible ink. Each negative shall be provided with the following annotation, which shall appear on all prints:

- 1) year, month, and day of flight;
- 2) USACE project-specific location/identification number;
- 3) photo scale (ratio);
- 4) film roll number; and,
- 5) negative number.

The date of the photography shall be in the upper left corner of each frame followed by USACE project number, and photo scale ratio. The frame number will be in the upper right-hand corner of each frame with the roll number printed 2" left of the frame number.

i. Film Storage and Deliveries. All negatives and uncut film positives are Government property and shall be archived by the Contractor unless otherwise specified in the Task Order. All negatives and/or uncut film positives will be stored on winding spools in plastic or metal canisters. All extra and rejected negatives shall be included in the roll(s). At least 3' of clear film shall be left on or spliced to each end of the roll. All splices shall be of a permanent nature. Exposed and unexposed film shall be handled in accordance with manufacturer's recommendations. Each canister should be labeled with the following minimum information:

- 1) name and address of the contracting agency;
- 2) name of the project;
- 3) designated roll number;
- 4) numbers of the first and last numbered negatives of each strip;
- 5) date of each strip;
- 6) approximate scale;
- 7) focal length of lens in millimeters;
- 8) name and address of the Contractor performing the photography; and,
- 9) contract number.

The Contractor may use negatives and/or film positives for its use, only with the express written consent of the Contracting Officer, or designated representative.

#### C.6.4 SCALE AND RELATED COVERAGE PARAMETERS

a. Photo-negative Scale and Flight Altitude. The required negative scale for these projects will be defined in each Task Order, and shall be consistent with the required map accuracy standard/class specified and the maximum allowable altitudes specified in EM 1110-1-1000 for maintaining horizontal and vertical tolerances relative to flight altitude. The flight height above the average ground elevation shall be designed such that the negatives have an average scale suitable for attaining required photogrammetric measurement, map scale, contour interval, and accuracy, given a fixed 6" mapping camera focal length, stereoplotter model, and quality control criteria. Any variation by the Contractor to change either the camera focal length or negative scale will constitute a change in the Scope of Work and therefore must be approved by the Contracting Officer or designated representative prior to utilization.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

b. Stereoscopic Coverage Requirements. Unless otherwise modified in a Task Order, the overlap shall provide full stereoscopic coverage of the area to be photographed, as follows:

- 1) Boundaries. All of the area appearing on the first and last frame in each flight line extending over a boundary shall be outside the boundary of the project area. The principal point of two photographs on both ends of each flight line shall be taken past the boundary line of the project. Each strip of photographs along a boundary shall extend over the boundary not less than 15% of the strip width.
- 2) Endlap. Unless otherwise specified in a Task Order, the forward overlap shall be 60%. Endlap of less than 55%, may cause rejection of the photography.
- 3) Sidelap. The lateral sidelap shall average 30%. Any frame having sidelap less than 15% or more than 50% may be rejected. Variances to this requirement would be specified in the individual Task Order.
- 4) Crab. Absolute crab of any photograph relative to the flight line, or relative crab between any series of two or more consecutive photographs, in excess of 10 degrees, as indicated by displacement of the principal points of the photographs, may be considered cause for rejection of the photography. Average crab for any flight line shall not exceed 5 degrees. For aerotriangulation, no photograph shall be crabbed in excess of five (5) degrees as measured from the line of flight.
- 5) Tilt. Frames exposed with the optical axis of the aerial camera in a vertical position are desired. Tilt (angular departure of the aerial camera axis from a vertical line at the instant of exposure) in any frame of more than four (4) degrees, or an average of more than two (2) degrees for any ten (10) consecutive frames, or an average tilt of more than one (1) degree for the entire project, or relative tilt between any two successive frames exceeding six (6) degrees may be cause for rejection.
- 6) Terrain elevation variances. When ground heights within the area of overlap vary by more than 10% of the flying height, a reasonable variation in the stated overlaps shall be permitted provided that the fore and aft overlaps do not fall below 55% and the lateral sidelap does not fall below 10% or exceed 50%. In extreme terrain relief where the foregoing overlap conditions are impossible to maintain in straight and parallel flight lines, the gaps created by excessive relief may be filled by short strips flown parallel and between the main flight lines.
- 7) Shoreline variances. Strips running parallel to a shoreline may be repositioned to reduce the proportion of water covered, provided the coverage extends beyond the limit of any land feature by at least 10% of the strip width. For specific applications in bluff erosion studies, flight lines may be required to be further offshore to provide ensure photo coverage of the bluff face. These conditions will be specified in the Task Order.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

c. Adjoining Photo Strips. Where the ends of strips of photography join the ends of other strips or blocks flowing in the same general direction, there shall be an overlap of at least two stereoscopic models. In flight lines re-photographed to obtain substitute photography for rejected photography, all negatives shall be exposed to comply with original flight specifications, including scale and overlap requirements. The joining end frames in the replacement strip shall have complete stereoscopic coverage of the contiguous area on the portions not rejected.

C.6.5 PHOTOGRAPHIC INDEX REQUIREMENTS

a. General. Two hardcopy photo indexes, and one digital file thereof, are required for each Task Order under this contract. Additional index sheets may be required and priced accordingly. The photographic indexes shall be prepared as a vector overlay of photo corners overprinted on a U.S. Geological Survey (USGS) Digital Raster Graphic (DRG) covering the project area, normally on E-size sheets, unless specified otherwise under the Task Order. These indexes shall be plotted from a digital file in a vector format specified in the Task Order and in a GeoTIFF raster format for the DRG. These sheets shall be laid out in such a fashion that all photo identification numbers are clearly visible. Each photo index sheet shall have the following: a north arrow; a sheet index, if applicable; and, a title block in the lower right corner. The title block will contain, at a minimum, the following information: project name; Contractor's name; contract number; date of photography; scale of photography; and, scale of index.

C.6.6 CONTACT PRINT AND DIAPOSITIVE SPECIFICATIONS

a. Materials. All contact prints shall be made on an electronic printer on double-weight fiber-based paper or medium-weight resin-coated paper stock, on which ink, pencil, grease pencil, and other markers can be used on both sides, unless otherwise specified in the Task Order. All panchromatic, color, and color infrared diapositive transparencies generated shall be on a dimensionally stable base, equal or superior in quality to media specified in the Task Order. All diapositives will be clear of stains, blemishes, uneven spots, air bells, light streaks or fog, dust and other defects that would make them unacceptable.

b. Processing and Quality. The processing, including exposure development, washing, and drying, shall result in finished photographic prints having gloss finish, fine-grain quality, normal uniform density, and color tone and contrast that provide photographic details which show clearly in the darktone areas and highlight areas as well as in the halftones between the dark and the highlight. Excessive variance in color tone or contrast between individual prints may be cause for their rejection. All prints shall be clear and free of stains, blemishes, uneven spots, air bells, light fog or streaks, creases, scratches, and other defects that would interfere with their use or in any way decrease their usefulness.

c. Trimming and Packaging. All contact prints shall be trimmed to neat and uniform dimensional lines along image edges (without loss of image) leaving distinctly the camera fiducial marks. Prints lacking fiducial marks shall be rejected. All diapositive will be cut and inserted into appropriate plastic sleeves, unless specified otherwise in the Task Order.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

C.7 REMOTE SENSING DATA COLLECTION - AIRBORNE DIGITAL SYSTEMS

C.7.1 AIRCRAFT AND FLIGHT SPECIFICATIONS

- a. Aircraft. The aircraft used for work under this contract shall be capable of stable performance in the given geographical locale, at the necessary altitude and air speeds, and shall be equipped with all essential navigational and remote sensing instrumentation and accessories needed to accomplish the mission parameters. When required by the project, the aircraft must have an onboard GPS system. Costs are to include data collection, clearances and all other incumbent factors, and will be computed on a per-job basis. Since these missions may vary in type, scope, and range, mobilization will be negotiated per Task Order as well.
- b. Flight Plan. The minimum area(s) to be covered by an airborne remote sensing mission shall be indicated on maps that will be provided for each Task Order. Based upon these specifications, the Contractor shall design a flight line network to obtain proper overlap, sidelap, and endlap for full project coverage. Maps of the flight lines to be flown shall be submitted to the Government for advance approval, unless prior consent is given to exclude this action.
- c. Flying Conditions. Data collection shall be undertaken only when well-defined imagery, radar data collection or laser profilometry can be obtained as required by the Task Order. The flying period shall be specified in each Task Order. Generally, airborne multispectral and hyperspectral data collection shall not contain shadows caused by topographic relief or sun angle of less than 30 degrees, whenever such shadows can be avoided during the time of year the imagery is collected. Image collection shall normally not be attempted when there is substantial atmospheric haze, moisture, smoke, or dust, or when the clouds or cloud shadows will appear on more than 5% of the area of any one image. Imagery shall also not be collected when snow cover exists unless otherwise specified in the Task Order. Imagery collected of coastal areas shall be taken during lighting conditions that minimize ground shadow of bluff areas and reflectance from the water surface. Airborne laser profiling surveys shall not be attempted when the ground or water body is obscured by haze, smoke, or dust. Data collection shall be taken only during lighting conditions that maximize water clarity for bathymetric LIDAR surveys.
- d. Flight Log. For each flight day, the pilot or airborne instrumentation specialist shall prepare a flight log containing, at the minimum, the date, project name, aircraft used, and names of crewmembers. The following shall be recorded for each flight line: altitude, sensor type, serial number, beginning and ending time for each data file, and any other comments relative to the flight conditions. These flight logs, or copies thereof, may be required to be included in reports delivered to the Contracting Officer or designated representative.
- e. Aircraft Transit Costs. Aircraft mobilization costs will be negotiated per Task Order, and will be computed by cost per statute mile distance.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

C.7.2 INSTRUMENTATION SPECIFICATIONS

a. Types of Systems. All airborne digital cameras, multispectral or hyperspectral scanners, thermal sensors, radar systems, and laser profilers shall meet or exceed minimum specifications outlined in individual Task Orders under this contract.

- 1) Digital Cameras. Typically, digital cameras will be required for collection of image data across the visible and near infrared spectrum using a sensor array in lieu of photographic film.
- 2) Multispectral and Hyperspectral. Typically, airborne multispectral or hyperspectral scanners will be required for the collection of imagery from the ultraviolet through near infrared reflective energies. The specific scanner or radiometer to be used shall be specified in the individual Task Order.
- 3) Infrared and Thermal Sensors. Airborne infrared and thermal sensors may be required, as specified in an individual Task Order, to collect reflective and emissive energies, typically dealing with measuring heat losses or temperature differences across landscapes.
- 4) Radar. Airborne collection of radar imagery may be required to collect digital elevation model data for large landscape areas, especially under adverse atmospheric conditions. Specific Task Orders may require access to interferometric synthetic aperture radar (IFSAR), or similar, for these type of data collection exercises.
- 5) LIDAR. Airborne collection of elevation profiles or regular spaced postings will be required under this contract using Light Detection and Ranging (LIDAR) profilers. These LIDAR profile surveys could require collection of topographic or bathymetric detail.

b. Calibration. The Contractor shall be capable of providing appropriate calibration data for any airborne remote sensing system utilized under this contract to insure that horizontal, vertical, and/or radiometric thresholds are maintained in accordance with Task Order details. Documentation may be requested on maintenance and repair records performed on any instrument within the last two-years.

C. 7.3 RESOLUTION, SCALE, COVERAGE AND DATUMS

The required resolution, scale and coverage will be defined in each Task Order. Overlap and sidelap and/or seamless coverage of digital data collection will be specified in the Task Order. Aircraft crab and tilt tolerances may also be specified in the Task Order. Horizontal and vertical datums will also be specified in the Task Order.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

C.7.4 DIGITAL IMAGE INDICES

Two indexes are required for each airborne remote sensing mission and must be delivered under each Task Order. The photographic indexes shall be prepared as a vector overlay of image corners overprinted on a U.S. Geological Survey (USGS) Digital Raster Graphic (DRG) covering the project area, unless specified otherwise under the Task Order. These indices shall be delivered in both hard copy and digital format. The hard copy sheets shall be laid out in such a fashion that all swaths (or digital files) and labeling are clearly legible. Each index sheet shall have the following: a north arrow; a sheet index, if applicable; and, a title block in the lower right corner. The title block will contain, at a minimum, the following information: project name; Contractor's name; contract number; date of photography; scale of photography; and, scale of index. These indexes shall be delivered in an ArcView shape file format and in a GeoTIFF raster format for the DRG.

C.8 REMOTE SENSING DATA ACQUISITION - SATELLITE DATA

C.8.1 PRODUCT REQUIREMENTS

- a. General. The government anticipates that various technological advances in spaceborne sensors will occur over the life of this contract. Datasets to be acquired by the Contractor may include any of the following systems: LANDSAT, SPOT, IRS, IKONOS, NOAA, DMSP, RADARSAT, etc. The Contractor would normally be responsible for the acquisition, conversion, and processing of all spaceborne remote sensing data. Individual Task Orders will include information on the specific sensor required, spectral bandwidths, desired resolution, temporal requirements, coverage, product scale and/or cloud cover and ground conditions. The Government anticipates that the Contractor will act as its agent in the identification of available image datasets, programming of data collection, purchase and acquisition of the same, and identification and coordination of any particular licensing and ownership considerations.
- b. Hard Copy Deliverables and Reports. The Contractor shall provide large format output plots of the satellite remote sensing data in accordance with detailed instructions contained in the Task Order. The Contractor also will provide a report on procedures, calibration data, metadata, and other ancillary information, unless directed otherwise per Task Order.

C.9 SURVEY SUPPORT

- a. All horizontal and vertical control surveys required for photogrammetric mapping shall be performed using procedures and/or accuracy standards consistent with professional surveying practices. Project-specific projection control will be detailed in each Task Order including the horizontal datum, the vertical datum, the local grid reference system, projections, and units of measurement. The Contractor shall provide survey crews with professional survey personnel and equipment capable of performing observations and measurements that meet the required accuracy needed for the work. All field observational data shall be performed in accordance with standard survey practices, as specified under references outlined in Section C.3.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

b. Survey data shall be recorded in bound survey books that will subsequently be delivered to the USACE. All survey work will be performed under the direct supervision and control of a licensed professional land surveyor. All survey work, including office computations and adjustments, is subject to USACE review and approval for conformance with prescribed accuracy standards.

c. Before commencement of any surveying under this contract by a Subcontractor, the Contractor shall furnish in writing to the Contracting Officer the name of such Subcontractor, together with a statement on the scope and extent of the work to be done.

#### C.9.1 PHOTO CONTROL SURVEYS

a. Surveys performed to establish horizontal or vertical locations of points used in controlling stereoscopic models shall be performed using recognized engineering and construction control survey methods, as necessary to meet mapping standards required in each Task Order. This usually requires, at minimum, third-order procedures performed relative to existing network or project control, using standard engineering survey traverse, differential leveling, GPS, Airborne GPS, or electronic total station measurement techniques.

b. Unless otherwise indicated, photo control points or paneled points may be temporarily installed by the Contractor according to their standard procedures. Any temporary control point should be adequately marked such that they would remain in place for at least the duration of the Task Order if quality control or assurance surveys are deemed necessary. If the USACE determines that existing project/network control should be utilized, the Contractor will check the adequacy of these points based on ground reconnaissance/recovery. The Contractor shall maintain adequate documentation on all existing control points utilized, including the name of the source agency, coordinates, datum, and estimated accuracy for each point.

c. The Contractor shall perform surveys connecting existing project control to assure that such control has sufficient relative accuracy to control the overall project. Should these surveys indicate deficiencies in the existing control, the Contractor shall advise the Contracting Officer, or designated representative, and appropriate modification may be made by the USACE to the Task Order to direct the Contractor to perform resurveys of any existing point in the network.

d. All horizontal and vertical control points will be occupied as a station within a closed traverse or closed level loop. If it is not possible to occupy an individual control point or photo target, thus requiring spur shots, all angles shall be read at least three times and averaged, and all distances measured twice and averaged.

#### C.9.2 CONTROL PHOTOGRAPHS

All horizontal and vertical control points including supplemental control points shall be marked and labeled with appropriate point identification numbers. All control points not premarked shall be neatly pin-pricked and clearly identified and described on the back of the photograph. Coordinates and brief descriptions of marked control points shall be written on the back of each photo. Complete descriptions will be written for newly set, permanently monumented points. The marked-up control prints will be delivered to the USACE.



SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

C.9.3 FIELD CLASSIFICATIONS AND QUALITY CONTROL SURVEYS

Field classification, inspection, and/or edit surveys may be required under a Task Order. This requirement may include field surveys to add topographic detail. A two-man survey crew will normally be required to perform field surveys to confirm cultural features, to clarify obscured detail, to add or correct incomplete features, to add topographic detail by conventional field survey methods or other acceptable measures (DGPS, etc.), and/or to perform internal quality control testing. Quality assurance / quality control (QA/QC) field tests may be required with a USACE representative present, if specified in the Task Order.

C.10 PHOTOGRAMMETRIC MAPPING SPECIFICATIONS

C.10.1 AEROTRIANGULATION SPECIFICATIONS

- a. General. When authorized within this contract and/or specified in the Task Order, the x-, y-, and z-coordinates for supplemental photo control points may be derived using fully analytical simultaneous block aerotriangulation adjustments or digital aerotriangulation methods. Industry-standard adjustment software, or that supplied with analytical or digital plotters, must be used to perform the computations. Use of different altitude photography is not allowed.
- b. Equipment. The photogrammetric mensuration instruments shall have sufficient accuracy and utility for measuring the x and y photographic coordinates of the fiducial or other reference marks, targets, photographic images, and artificial points to achieve the required accuracies.
- c. Ground and Supplemental Control Requirements. The Contractor shall be responsible for determining the optimum location, quality, and accuracy of all ground control points used for controlling the aerotriangulation adjustment, unless otherwise specified in the Task Order.
- d. Resultant Accuracy of Aerotriangulation Adjustments. For class 1 maps, the root mean square (rms) error for the x-, y-, and coordinates of all supplemental control points determined by analytical aerotriangulation shall not be in error by more than 1:10,000 in horizontal position (x and y) and 1:8,000] in elevation (z), when expressed as a ratio fraction of the flying height. These adjustment statistics must be clearly identified on the adjustment software output that shall be delivered to the USACE prior to commencement of stereoplottting. A written report shall be submitted to the Contracting Officer or designated representative explaining any analytical control problems encountered prior to compilation. Aerotriangulation accuracy criteria for other map classes are contained in EM 1110-1-1000 and the ASPRS Manual "Digital Photogrammetry: An Addendum to the Manual of Photogrammetry."
- e. Control Prints. The image of all ground control and supplemental control points shall be appropriately marked and identified on a set of contact prints. The identifying number for each supplemental control point shall be related to the photograph on which it appears.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

f. Deliveries. All materials, including the x-y-z coordinates for control points, final adjustment computations with error of closure, control prints, the marked/drilled diapositives, and any rolls or film negatives used by the Contractor, shall be provided to the USACE.

#### C.10.2 STEREOPLOTTER SPECIFICATIONS

Topographic and/or planimetric feature line maps are to be generated on an analytical or softcopy stereoplotter as specified in the Task Order. The stereoplotter must be capable of automatically performing/adjusting interior, relative, and absolute orientations, and output statistical data thereof, and generating digital data of observed topographic/feature information into spatial layers directly compatible with three-dimensional (3-D) design file criteria outlined in EM 1110-1-1807 (Reference C.3). Optical-mechanical terrain stereoplotters, of similar or equal design to a Wild A-10, may be used when upgraded or modified for direct digital data output. Stereoplotter operators shall have experience on the machine and types of terrain being compiled.

#### C.10.3 MAP COMPILATION SCALES

The Contractor shall furnish to the Contracting Officer, or designated representative, stereoplotter-derived drawings and/or finished maps at scales specified in the Task Order.

#### C.10.4 MODEL SETUP AND ORIENTATION DATA

Analytical and/or digital plotter orientation parameters and statistical outputs for each model setup shall be submitted with each project. These sheets shall be fully annotated by date, time, operator name, compilation dates/times, photo numbers, and other data, and confirmation that the mapping was compiled from the required negative scale.

#### C.10.5 COMPILATION HISTORY

A compilation history report (model diagram or model setup sheet) shall be prepared for each stereoscopic model used to accomplish the mapping. The report shall include at a minimum the final photographic fit of x, y, and z-coordinates to ground control and any problems encountered in model orientation and compilation. The report shall include the project name, flight date, photo scale, map scale, stereoplotter used, and the operator's name.

#### C.10.6 FEATURE COLLECTION

The maps shall contain all the planimetric, cultural, land use, land cover, and/or wetland features visible or identifiable on/or interpretable from the aerial photographs, and compatible with the type of project involved (i.e., detailed site mapping, planimetric and/or land use mapping, etc.) Since this work is typically highly specialized and dependant upon local conditions and/or various local/state/federal classification strategies, the detailed requirements will be contained within each Task Order requiring these services.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

C.10.7 TOPOGRAPHIC DATA

If required in the Task Order, output maps shall contain all specified topographic features visible or identifiable on/or interpretable from the aerial photography. Topographic data may be generated by contour tracing and/or other digital terrain modeling techniques. The level of detail required for topographic mapping for each project and information on the required contour interval(s) will be specified in each Task Order.

C.10.8 METHODS FOR EVALUATING MAP ACCURACIES

a. General. All maps compiled shall be subject to map testing by the USACE, by independent third-party forces, or by Contractor forces working under direct USACE review to ensure that they comply with the applicable accuracy requirements specified in the Task Order. The map test results will be statistically evaluated relative to the defined accuracy criteria and pass/fail determination made accordingly. The decision of whether or not to perform rigid map testing on any project, Task Order, or portion of a project rests exclusively with the Contracting Officer or designated representative. In all cases, the Contractor will be advised in writing when such action will be taken.

b. Office and Field Checks. The party responsible for map testing may, during the course of the project, inspect map compilation in the Contractor's facility by comparison with aerial photographs. However, if QA/QC tests require it, final map compilation shall be checked by field inspection and a horizontal and vertical accuracy check by conventional or GPS field survey checks to test selected points or features on the completed drawings.

c. Test Profiles for Topography. Whenever required, test profile traverses shall be made in the field to check for compliance with the vertical contour accuracy requirements. Such field profile checks should be at least 5" long at the map scale, and should cross at least 10 contour lines. Profiles should start and close upon map features or previously established control points. In flat areas and at principal road and rail intersections, spot elevations shall be checked. In general, one profile per map sheet or 3 per stereo models will be sufficient.

d. Spot Elevation Tests. Whenever required in the Task Order, spot elevation field tests may need to be performed. Such tests for vertical accuracy may be performed by comparing the elevations at well-defined points as determined from the map to corresponding elevations determined by a survey of higher accuracy. A minimum of 20 points shall be checked in these tests and shall be distributed throughout the sheet, or concentrated in critical areas.

e. Test Points for Planimetric Features. Whenever required in the Task Order, the accuracy of the planimetric map feature compilation shall be tested. These tests shall be conducted by comparing the ground coordinates (x and y) of at least 20 points (well-defined map features) per test per map sheet, as determined from measurements on the map at publication scale, to those for the same points, as provided by a check survey of higher accuracy. The check survey shall have an order of accuracy equal to or exceeding that specified for establishing the mapping control. Maps will also be examined for errors and/or omissions in defining features, structures, utilities, and other nomenclature, or for total gaps in compilation/coverage. The minimum of 20 points shall be distributed throughout the sheet or concentrated in critical areas.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

f. Selection of Well-Defined Test Points. The term "well-defined map features" pertains to features that can be sharply defined as discrete points. Points that are not well-defined are excluded from any required accuracy test. The selection of well-defined points shall be made through agreement between the Contracting Officer and the Contractor. Generally, it may be more desirable to distribute the points more densely in the vicinity of important structures or drainage features and more sparsely in areas that are of lesser interest. Further definitions and requirements for selection of well-defined photo/map points may be found in the reference standard used. The locations and numbers of map test points and/or test profiles shall be mutually agreed to by the Contractor and the Contracting Officer.

C.10.9 CHECK PLOT MEDIA

Check plots shall be sufficiently neat and complete as to eliminate or minimize errors of misinterpretation on the part of the Quality Assurance Reviewer. Check plots shall be plotted on paper, on standard E-size sheets, or as specified in the Task Order.

C.10.10 FINAL MAP PRODUCT

a. Project Control Coordinates. Project specific projection control coordinates will be specified in the Task Order, including horizontal datum, vertical datum, the local grid reference system, projections, and units of measurement.

b. Control. All horizontal and vertical ground control and all supplemental control determined by either field or aerotriangulation methods shall be shown on the final map. All control points should be plotted in accordance with specifications contained in the Task Order.

c. Sheet Layout and Match Lines. The individual project will determine whether the Contractor shall design, or the USACE will provide, the sheet layout that provides optimum coverage of the project. This will be specified in the Task Order. Match lines shall be provided and properly labeled so that each sheet may be joined accurately to adjacent sheets.

d. Symbols and Names. The symbols to be used for major planimetric and topographic features shall be in accordance with symbols specified in the Task Order. The USACE will normally provide to the Contractor any cell libraries necessary for preparation of the final map product via digital input; Contractor developed cell libraries may be used with prior approval from the Contracting Officer or delegated representative. The names of cities, towns, villages, rivers, streams, roads, streets, highways, and other features of importance shall be obtained by the Contractor. All names and numbers shall be legible and clear and shall not interfere with map features. Names of towns, rivers, streams, etc., will generally be those appearing on USGS topographic quadrangles or contained in the Geographic Names Inventory System (GNIS) maintained by the USGS.

e. Title and Sheet Index. A title shall be placed on each final map to the size and arrangement specified in the Task Order, and shall include the name of the contracting agency, the project name, the date of photography used, the strip and photograph numbers, the map scale, the date of the mapping, the map number, and the name of the Contractor. If more than one map sheet is prepared for the project, a small-scale sheet index shall be drawn on each map sheet

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

showing the position and the relationship of all map sheets to each other. The title block contents and sheet index requirements for finished maps will be furnished by the Contracting Officer or designated representative. The Contractor's name/address, contract /Task Order number, and logo will be placed on each map sheet.

f. All map products will be reviewed by an experienced editor for quality control during applicable stages of production.

C.10.11 FINAL PLOTTING MEDIA

The finished line maps shall be electronically printed from an acceptable industry standard digital file format onto standard E-size dimensionally stable, static-free polyester drafting film (e.g., mylar), of at least 0.004" thickness, unless specified differently in the Task Order. The map border will not exceed specifications contained in the Task Order and the sheet will be oriented north-south, unless otherwise specified. Locations of title blocks, revision blocks, border detail, line weights, etc., will normally be specified in the Task Order.

C.11 IMAGE PROCESSING

C.11.1 SCANNING

a. Scanning tasks under this contract is anticipated to be the encoding of panchromatic, color, or color-infrared aerial photography, although other tasks such as document scanning or scanning of large-format engineering drawings may be required. Scanning may be part of another project or stand-alone. Scanning projects include document or image preparation, scanning, clean-up, indexing, quality control, conversion, editing, and report completion.

b. Document and drawing preparation shall include unpacking, sorting, staple removal, labeling, taping damaged areas, and erasures of extraneous marks. Scanning shall include feeding documents through the scanning device, setting up scanning parameters such as resolution (microns or dots-per-inch(dpi)), contrast, image file format, and file size requirements, based upon Task Order specifications.

c. In the case of large format documents such as engineering drawings and/or maps, scanning settings may require a significant level of clean-up. Clean-up includes some level of speckle removal, deskewing and cropping of images to final size specifications.

d. Indexing shall include assigning meaningful codes to images based on the information in the documents and/or images. Indexing determines how images are located by a retrieval system and can vary from simple naming conventions to assigned values for key fields in a database record. The indexing specifications will be outlined in the Task Order.

e. Conversion could include changing digital formats for scanned files, raster to vector conversions, optical character recognition (OCR), intelligent character recognition (ICR), or document assembly and page definitions (tagging) for compound documents. Editing tasks could include performing detailed file modifications to create a clean final file.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

C.11.2 IMAGE REGISTRATION

Image registration tasks under this contract could include image-to-map registration, image-to-image registration and a variety of image transformations, such as helmert, affine, projective, single- or multi-order polynomial, and finite elements. Image registration operations include translations from one projection system to another, as well as changes in rotation, skew, and scale. Image registration specifications will be outlined in the Task Order.

C.11.3 IMAGE ENHANCEMENT

Image enhancement tasks could include any of the following:

- a. radiometric corrections, including scan line correction, destriping, radiometric correction, and atmospheric corrections;
- b. contrast enhancements, including linear and equalization functions, thresholding, histogram matching, gamma corrections, and density slicing;
- c. color enhancements/analyses such as RGB-to-HIS and HIS-to-RGB transformations, principal component analyses, and decorrelation stretches;
- d. various filtering operations such as convolution, edge and texture detection, Fourier transforms, and user-defined operations;
- e. radar image processing; and
- f. mosaicking, collages, and splicing.

C.11.4 IMAGE CLASSIFICATIONS

Image classification tasks that may be required under this contract include standard arithmetic operations, band ratioing, vegetation indices, or more complex logical analyses such as resampling using nearest neighbor, bilinear, or cubic convolution techniques, unsupervised training, supervised training, or minimum distance, parallelepiped, maximum likelihood classifications.

C.11.5 RASTER TO VECTOR CONVERSIONS

The contractor should be capable of converting raw or processed raster datasets to vector themes for incorporation in GIS topologic themes. The specifications for this operations will either be included under the Task Order or generated under a consulting function provided by the Contractor or its Subcontractor.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

C.11.6 RASTER MODELING AND ANALYSES

The Contractor shall be capable of conducting a variety of raster modeling/analyses operations. These include coincidency, proximity, and adjacency analyses, and other complex boolean operations. The level of detail required for these tasks will be included in the Task Order, or negotiated with the Contractor prior to proceeding.

C.11.7 THEMATIC MAP PRODUCTION

The Contractor shall be capable of generating a variety of different thematic map products as final products from the aforementioned processing, analyses and modeling operations. The detailed specifications of these thematic maps will be contained in the Task Order or negotiated with the Contractor prior to proceeding.

C.12 GIS DESIGN AND IMPLEMENTATION

- a. The Contractor shall supply all necessary labor, material, and equipment to perform work under various phases of the design, development, implementation of a GIS. Each Task Order will vary. The Contractor may be required to perform all of the above mentioned phases together or a portion of these phases in a complex project as outlined in the Task Order.
- b. The Contractor may be required to perform various user needs assessments and/or implementation planning in accordance with the specifications contained in the Task Order. Typically, the Contractor would evaluate prospective uses of the GIS, analyze and document all existing operations or business practices, and recommend data, software and systems requirements thereof.
- c. As specified in the Task Order, the Contractor normally would conduct a system design study, including any or all of the following:
  - 1) Database - how and where the data will be stored, who will have access to it, and how the data itself will interact;
  - 2) Software - which versions and modules of the GIS software and/or CAD software are required for the GIS to be fully functional;
  - 3) Hardware – what hardware configuration is required to provide appropriate system performance within the database and software design framework;
  - 4) Applications - what programming that will be needed to automate or convert many of the routine and often requested GIS functions; and,
  - 5) Personnel Requirements - who is responsible for maintaining and updating the data, who will use it; and how much training of staff will be required.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

d. The Contractor may be required to implement the GIS, either directly under a Task Order or in combination with Government inhouse resources. This includes, but is not limited to the following: planning implementation steps, digitizing, encoding, data conversion, QA/QC procedure development, and technical training.

C.13 DIGITAL FILE SPECIFICATIONS

a. General. All digital data shall become the exclusive property of the USACE upon submittal.

b. Formats. The contractor shall deliver all digital files in accordance with specific formats specified in a given Task Order.

1) Vector Data. All final vector data are to be delivered in a format specified in the Task Order, typically being the most current versions of Bentley 3D Microstation, ESRI point, line, and polygon formats. The Contractor shall provide all cell libraries used in preparing drawings and a digital version of all compilation history required for photogrammetric tasks. On occasion digital files may be required to be delivered in the SDTS format (see Section C.3.15) or in the USGS Digital Line Graph, Level 3 format.

2) Raster Data. Normally all raster or grid cell data formats will be specified in the Task Order. Typical formats would include ASCII, BIP, BIL, BSQ, TIFF, BMP, PCX, GeoTIFF, GIF and others. The Contractor shall be capable of importing the following industry standard remote sensing formats including Landsat, SPOT, IRS, ERS, RADARSAT, AVHRR and others. The Contractor also shall be capable of compressing / decompressing digital image files formats including JPEG, RLE, MrSid, etc. Other required formats for USGS products could include DOQQ and DEM specifications. On occasion digital files may be required to be delivered in the SDTS format (see Section C.3.15). Typically output formats would need to be readily importable and fully functional into the most current version of ERDAS IMAGINE, Intergraph Image Analyst or ESRI ArcView and Arc/Info.

c. Media. Datasets are to be delivered typically on a CD-ROM, or other suitable media specified in the Task Order.

C.14 METADATA REQUIREMENTS

The Contractor shall provide metadata file(s) using Corpsmet95 for all geospatial data produced under this contract, unless otherwise specified in the Task Order. Geospatial data are defined as information that identifies the geographic location and characteristics of natural or constructed features and boundaries on the earth and includes aerial photography. Metadata includes descriptions of the content, quality, condition, and other characteristics of data provided. The metadata file(s) must comply with the Federal Geographic Data Committee (FGDC) Content Standards for Digital Geospatial Metadata Version 1.0 or higher (see Reference C.3.14). The Corpsmet95 metadata generator can be download from the Internet by the Contractor from: <http://corpsgeo1.usace.army.mil>.



SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

C.15 TECHNICAL SUPPORT & SERVICES

a. As described in a Task Order, the Contractor may be required to provide technical support to the Government, including consultation and training. This support may include short term or long term assignments, located at Government facilities, Contractor facilities or at third-party locations.

b. Typically, consultation can include but not limited to project aid in the areas of GIS product development, GIS system administration, GIS database development and/or analysis, data encoding and digitizing, imagery processing and analysis, file management, and Internet web page development and maintenance. Typical training may be required for GIS application software, image processing techniques, and system integration.

c. Under this contract, a short-term assignment away from the Contractor's normal work site is considered less than 60 days, and a long-term assignment is considered greater than 60 days. This distinction will determine the amount of per diem that the Government will negotiate for under a Task Order. Short-term assignments will constitute 100% of normal per diem paid for by the Government under the Joint Travel Regulations (JTR). Long-term TDY will equate to 55% of normal per diem rates for the locations involved.

C.16 QA/QC REQUIREMENTS

C.16.1 CONTRACTOR QUALITY CONTROL

a. General. All photogrammetric mapping data submitted under this contract shall conform to the accuracy standards outlined in EM 1110-1-1000 unless modified or supplemented below. The Contractor shall be responsible for internal quality control functions involved with field surveying, photography, laboratory processing, stereocompilation, feature collection, field checking, and editing of photogrammetric measurements and compiled maps, to ascertain their completeness and accuracy. Also, the Contractor shall make all additions and corrections necessary to complete the maps and photogrammetric measurements based upon USACE review comments. All GIS schema (graphics and attributes) submitted under this contract shall conform to reference C.3.8, the Tri-Service Spatial Data Standards (TSSDS), Release 1.8, February 1999 or most current version thereof, unless specified otherwise in the Task Order.

b. Materials. All materials, supplies, or articles required for work that are not covered specifically herein, or by work order specifications, shall be standard products of reputable manufacture and entirely suitable for the intended purpose. Unless otherwise specified, they shall be new and unused; otherwise, use of these materials is subject to the approval of the Contracting Officer.

C.16.2 CORRECTION OF UNSATISFACTORY WORK

Failure to meet map test criteria will require recompilation of the project at the Contractor's expense. When a series of sheets are involved in a mapping project, the existence of errors (i.e., map test failure) on any individual sheet will constitute prima facie evidence of deficiencies

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

throughout the project (i.e., all other sheets are assumed to have similar deficiencies), and field map testing will cease. The Contractor will be responsible for all costs for correction of the work and for map testing on the corrected drawings. When such efforts are performed by USACE survey crews, these costs will be deducted from the Task Order payment estimates.

C.17 CONTRACTOR-FURNISHED MATERIALS

The Contractor shall furnish all transportation, instruments, plant equipment, tools, materials, and related survey and office equipment necessary to perform the work, including, but not limited to the following:

- a. vehicular transportation, including gas, oil, tires, and repairs;
- b. all necessary field photo control for each assignment;
- c. all survey equipment required for the work;
- d. all necessary photogrammetric equipment and photo reproduction equipment;
- e. all necessary plotting equipment, supplies, and materials;
- f. all necessary software for survey control reduction, photogrammetric processing, image processing, feature collection, GIS database development, and report product development; and,
- g. all necessary supplies.

C.18 SUBMITTAL REQUIREMENTS

C.18.1 REVIEW SUBMITTALS

- a. Photographic Acceptance. Upon completion of the aerial photography phase for each assignment, the Contractor shall submit a representative sample of contact prints/diapositives to the Contracting Officer or designated representative for review of exposure quality, color balances, and reproduction quality. Review comments will be relayed to the Contractor telephonically and/or by letter within prescribed time period outlined in the Task Order. This review is necessary to preclude non-acceptance by the USACE of photographic submittals due to unacceptable exposure/print qualities and to reduce potential delays in any subsequent photogrammetric mapping phases of the Task Order.
- b. Photogrammetric Acceptance. Upon completion of the photogrammetric phase for each assignment, the Contractor shall submit a check plot of all mapping for review to the Contracting Officer or representative. Review comments will be relayed to the Contractor telephonically and/or by letter within prescribed time period outlined in the Task Order.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION C - DESCRIPTION / SPECIFICATIONS / WORK STATEMENT

c. Digital File Acceptance. Upon completion of any digital file creation phases, the Contractor will submit advance versions of these files to the Contracting Officer or designated representative. This review may be conducted in conjunction with the above hardcopy review. Review comments will be related to the Contractor telephonically and/or by letter within prescribed time period(s) outlined in the Task Order.

d. Hard Copy Acceptance. The advance reviews of hardcopy and digital products are intended to determine that all materials conform to the technical requirements and specifications of the Contract / Task Order. This review is also intended to preclude against having to return final submittals for minor errors or omissions.

#### C.18.2 CORRECTIONS

All review comments are to be addressed by the Contractor in a timely manner and within accuracy specifications. When such errors need to be corrected by USACE staff or by another Contractor, these costs will be charged to the Contractor.

#### C.18.3 PROFESSIONAL CERTIFICATION REQUIREMENTS

Per ER 1110-1-8152, all A-E Contract deliverables require that the Contractor provide all final submittals with Professional Engineering, Registered Land Surveying, and/or Certified Photogrammetrist annotation, whenever relevant and required by the Task Order, including:

- a. a cover document showing, for each discipline involved, the name and stamp or seal of the professional who supervised the work, and the date each stamp or seal was affixed;
- b. one set of properly signed, stamped or sealed and dated final maps; and,
- c. an electronic equivalent that indicates for each discipline involved, the name of the professional who supervised the work, his/her certification/ registration number and the date each stamp or seal was affixed.

#### C.18.4 COMPLETION OF WORK

The Contractor shall furnish all work completed in an accurate and thorough manner within the time schedules specified in the Task Order. The Contractor's personnel, plant, equipment, transportation facilities, and supply of materials shall be sufficient to ensure compliance with all provisions and instructions furnished with each Task Order, and suitable to meet all needs of any concurrent Task Orders. Completion of work shall include satisfactory performance on all facets of negotiated work for the Task Order.

SOLICITATION NO. DACW-  
REMOTE SENSING, PHOTOGRAMMETRIC MAPPING AND  
GEOGRAPHIC INFORMATION SYSTEMS SERVICES

SECTION D - PACKAGING AND MARKING

D.1 PACKAGING AND MARKING INSTRUCTIONS

Packaging of completed work shall be accomplished such that the materials will be protected from handling damage. Each package shall contain a transmittal letter or shipping form, in duplicate, listing the materials being transmitted, being properly numbered, dated, and signed. Shipping labels shall be marked as follows:

U.S. Army Corps of Engineers - Detroit District  
Great Lakes Hydraulics and Hydrology Branch  
ATTN: David M. Gerczak, Physical Scientist, CELRE-ETS-HW  
Contract No. \_\_\_\_\_  
Task Order No. \_\_\_\_\_  
P.O. Box 1027  
Detroit, Michigan 48231-1027

(b) Hand carried submissions shall be marked as follows:

U.S. Army Corps of Engineers - Detroit District  
Great Lakes Hydraulics and Hydrology Branch  
ATTN: David M. Gerczak, Physical Scientist, CELRE-ETS-HW  
Contract No. \_\_\_\_\_  
Task Order No. \_\_\_\_\_  
477 Michigan Avenue  
Detroit, Michigan 48226

(End of Clause)

END OF SECTION D