Alberta

Environment and Sustainable Resource Development

CORPORATE SERVICES DIVISION
INFORMATICS BRANCH

GENERAL SPECIFICATIONS

FOR ACQUIRING

AERIAL PHOTOGRAPHY

MARCH 2014
EDMONTON, ALBERTA

ISSN NO. 0-827-388X

FOREWORD

These specifications are updated and distributed by Informatics Branch, Alberta Environment and Sustainable Resource Development. They are intended for general use in the procurement by Alberta government departments, of aerial photography and related data. They are not intended to address all of the technical requirements of a particular project. Project specific requirements, which may necessitate deletions from, additions to, or alterations of these technical specifications, should be clearly indicated in the contract document for the project. The Contractor is expected to use the latest and best technology to attain the highest standard quality possible.

An asterisk (*) before a section heading indicates that the section has been revised substantially since the last release (October 2012).

Informatics Branch welcomes comments on the specifications, which should be addressed to:

Antonio Balce, M.Sc., P. Eng.
Geomatics Engineer
Informatics Branch
Alberta Environment and Sustainable Resource Development
14th Floor, 9820 106 Street NW
Edmonton, Alberta
T5K 2J6
780-422-4197
Tony.Balce@gov.ab.ca

Or

Erin Grass, E.I.T.
Geomatics Engineer
Informatics Branch
Alberta Environment and Sustainable Resource Development
14th Floor, 9820 106 Street NW
Edmonton, Alberta
T5K 2J6
780-644-2174
Erin.Grass@gov.ab.ca

TABLE OF CONTENTS

Alberta

Environment and Sustainable Resource Development

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INFORMATICS BRANCH

PART 1

GENERAL SPECIFICATIONS

FOR

GROUND CONTROL SURVEYS

MARCH 2014
EDMONTON, ALBERTA

TABLE OF CONTENTS

PAGE

1. GENERAL

Ground control for aerial photography provides the basis upon which aerial triangulation and mapping is formed. Generally, this component of the mapping process has a significant impact on the resultant accuracy and, therefore, care must be taken in planning, observing and calculating control.

These specifications cover the following types of ground control points:

a) Targeted with targets shown on mapping photographs

b) Targeted with targets shown on photographs other than the mapping photography.

c) Non-targeted artificial or natural ground features.

The project specifications shall indicate which of the above types are required.

Except as amended by these specifications or stated otherwise in the project specifications, the *Specifications and Recommendations for Control Surveys and Survey Markers*, 1978 published by Canadian Geodetic Service, Geomatics Canada shall be used for equipment, measurement and test procedures. These specifications shall, hereinafter, be referred to as the GSD Specifications. This publication is available from the Canadian Geodetic Service, Room 440, 615 Booth Street, Ottawa, Ontario, K1A 0E9 (http://www.geod.nrcan.gc.ca).

2. INPUT SPECIFICATIONS

2.1 Equipment

2.1.1 Instruments

2.1.1.1 Horizontal

Electronic distance measuring (EDM) equipment shall be calibrated together with each reflector unit to be used on one of the EDM Calibration Base Lines in the province, immediately before the survey is started, after completion of the project and at least once every three months during the project. Contact Geodetic Control Unit, Land Dispositions Branch, Lands Division, Alberta Environment and Sustainable Resource Development for locations.

Global Navigation Satellite System (GNSS) receivers shall be tested using one of the GNSS Validation Basenets in the province prior to the start of the survey. The Contracting Department may require that the results of the validation be verified by Geodetic Control Unit, Land Dispositions Branch, Lands Division, Alberta Environment and Sustainable Resource Development.

2.1.1.2 Vertical

The sensitivity of the level vial or equivalent compensator shall be in the 40" to 50"/2 mm range.

GNSS receivers may be used for vertical positioning and must be tested as given in section 2.1.1.1 above.

2.1.2 Accuracy

Instruments to be used in the survey shall be capable of meeting the required accuracy per Section 3.5.

2.2 Materials

2.2.1 Aerial Photographs and Ground Control/Index Map

Contact prints shall be provided in either hardcopy or digital format. Ground control index map shall show line numbers, photo centres and numbers, distribution of existing and proposed ground control and project boundary in file geodatabase format.

2.2.2 Targets

Targets shall be suitable materials which are either black, white or coloured in such a way that maximum contrast against the background area is attainable on the photograph.

2.3 Existing Control Data

Existing control markers and benchmarks, which are at least third order accuracy in horizontal and third order in vertical, classified as such by Geodetic Control Unit, Land Dispositions Branch, Lands Division, Alberta Environment and Sustainable Resource Development or Canadian Geodetic Service, Geomatics Canada, Ottawa, shall be used. In addition, control points which have been tied to the above points with at least third order accuracy in horizontal and vertical may also be used, subject to the Contracting Department's approval.

The project specifications may specify which points shall be tied in.

3. OPERATIONAL SPECIFICATIONS

3.1 Ground Control Density

Ground control points shall be established with sufficient density to meet the required mapping accuracy. The recommended spacing for horizontal ground control is six times the photo base along the perimeter of the project area. The recommended spacing for vertical ground control is four times the photo base along the flight line. However, if airborne differential GNSS and Inertial Measurement Unit (IMU) are used, four horizontal and vertical ground control points located near the corners of the project area may suffice.

3.2 Selection of Ground Control Points

3.2.1 Horizontal

Non-targeted horizontal ground control points shall be natural or cultural features or objects resembling an artificial target with two, three or four legs which define a positively identifiable point both in nature and on the photograph. The width of such objects or features shall be in the order of 35 to 50 micrometres at image scale. Another category of acceptable natural targets consists of isolated lone objects distinctive both on the ground and on the photographs. These include small isolated trees, towers, etc. The sizes of these objects shall be in the order of 35 to 50 micrometres at image scale.

3.2.2 Vertical

Non-targeted vertical control points shall be located on relatively flat ground where possible.

3.3 Identification

3.3.1 Marking

All non-targeted ground control points selected shall be pin pricked on the contact prints or marked in the digital image.

3.3.2 Description

Descriptions of non-targeted ground control points shall be shown, either on the back of the photos or separately.

3.4 Targeting

3.4.1 Type and Size

Targets shall be of the following types in the order of preference, i.e. a) is most preferable:

a) + - 4 legs

b) Y - 3 legs

c) T - 3 legs

d) L - 2 legs

e) Annulus - 2 concentric circles

See Appendix GCS1.

Types c) to e) shall be used only in exceptional circumstances which preclude the use of target types
a) and b).

For targets a) to d), the size of each leg shall be:

a) Nominal width is 40 micrometres at image scale.

b) Minimum length is 120 micrometres at image scale.

For target e) the diameter of the circles shall be:

a) Inner circle is 60 micrometres at image scale.

b) Outer circle is 140 micrometres at image scale.

See Appendix GCS1.

3.4.2 Target Photography

If separate vertical photography is required, it shall be flown at approximately the same time, season, vegetation cover and at a scale of 2 to 3 times the mapping photography.

3.5 Accuracy

3.5.1 Framework Control

3.5.1.1 Horizontal

Horizontal framework control shall be third order or better. The semi-major axis of the 95% confidence region with respect to other stations of the network shall be less than or equal to:

12(d+0.2) centimetres,
where d=distance to any station in kilometres.

In unsurveyed areas, this means that some of the control must be measured to a higher order so that the ground control points meet third order standards.

3.5.1.2 Vertical

Vertical framework control shall be third order or better. The allowable discrepancy between forward and backward measurements between points shall be less than or equal to:

24 mm(SQRT(K)),
where K=distance between points in kilometres.

In unsurveyed areas, this means that some of the control must be measured to a higher order so that the ground control points meet third order standards.

In case of a GNSS survey or when using the results of a least squares adjustment, the accuracy may be computed using the above formula at 95% confidence interval between points.

3.5.2 Ground Control Points

3.5.2.1 Horizontal

Horizontal ground control points shall be measured by two independent angles and distances from framework horizontal control, or using GNSS in differential carrier phase mode so as to obtain a precision of better than 1:7500 (50 to 133 parts per million).

3.5.2.2 Vertical

Where the ground control point cannot form part of the framework level lines in Section 3.5.1.2 above by its inclusion as a turning point, it shall be tied into the framework control to third order precision using a closed loop.

3.6 Networks

In the case of a GNSS survey, all framework control points shall be measured at least twice utilizing differential carrier phase mode.

3.6.1 Horizontal

The horizontal framework control shall be surveyed in closed traverses, triangulation or trilateration networks, or combinations thereof using conventional surveying methods or GNSS in differential carrier phase mode.

3.6.2 Vertical

The vertical framework control shall be levelled in closed loops.

In case of a GNSS survey, elevations shall be corrected for the geoidal-ellipsoidal separation to obtain orthometric heights.

3.7 Control Marking and Descriptions

Where possible, all framework and ground control points shall be marked on the ground with materials supplied by the Contracting Department. Otherwise, they shall be properly referenced and described to facilitate recovery on the ground.

Descriptions of all the above mentioned points shall be provided to facilitate future recovery on the ground. Ground photographs of the points may also be supplied.

3.8 Computations

The horizontal and vertical control networks shall be adjusted by a least squares adjustment duly approved by the Contracting Department. However, single traverse or loop may not require this method.

4. OUTPUT SPECIFICATIONS

4.1 Original Field Notes

Original filed notes shall indicate the name of operator, date, instrument, raw measurements and reductions. Distances shall be corrected for instrumental and meteorologically induced errors. In case of a GNSS survey, validation reports shall also be included. GNSS raw data files shall be submitted on CD-ROM or DVD in RINEX (Receiver Independent Exchange) format.

Any field notes shall be properly indexed.

If Alberta Survey Control (ASC) markers were used as vertical ground control, corrections applied to published elevations shall be submitted. Correction shall be the difference between target and marker elevations with proper sign.

4.2 Closure Diagrams

In the case of a GNSS survey, the observation scheme shall be indicated.

4.2.1 Horizontal

Horizontal closure diagram shall indicate points properly numbered, reduced measurements, loops and closures. Lengths shall be shown in metres as grid distances.

4.2.2 Vertical

Vertical closure diagrams shall indicate points properly numbered, differences in elevations in metres, loops and closures.

4.3 Final Adjustments

Final adjustments shall be UTM coordinates referenced to the North American Datum 1983 (NAD83) for horizontal and Canadian Geodetic Vertical Datum 1928 (CGVD28) elevations for the vertical, unless otherwise specified. The project specifications shall indicate the datum and projection to be used. Coordinates and elevations shall be in metres.

Adjustment results shall be complete and original, at minimum showing adjusted coordinates of all points and residual errors.

4.4 Ground Control Coordinate Listing

Ground control coordinate listing shall indicate point numbers and coordinates to be used in block adjustment. If the point happens to be the same as on an ASC marker, framework control point or other existing surveyed point, the original point number and elevation shall also be indicated.

The ground control coordinate listing shall be verified and signed by the Contractor.

4.5 Ground Control/Index Map

Shall be submitted in file geodatabase format showing all ground control points properly numbered and symbolized. Photo centres, line and photo numbers and project boundary shall be shown.

5. SUMMARY OF MATERIALS

5.1 Materials to be Supplied by the Contracting Department

a) Listing of existing Alberta Survey Control markers and benchmarks

b) Contact prints or digital imagery in TIFF format (if control is to be surveyed from marked image points)

c) Photo index of mapping photography in file geodatabase format

5.2 Materials to be Delivered by the Contractor

a) All materials supplied to the Contractor

At the completion of the contract, or at reasonable intervals throughout, the Contractor shall supply to Informatics Branch the following data via CD, DVD, hard drives or FTP for digital data:

b) EDM calibration/GNSS validation reports in Microsoft Word document (.doc) or JPEG (.jpg) format

c) Original field notes (electronic field notes and/or GNSS raw data in RINEX format)

d) Closure diagrams or GNSS observation scheme in file geodatabase format

e) Least squares adjustment input file in ASCII format

f) Final adjustment results in ASCII format

g) Ground control coordinate listing in ASCII format

h) Ground control/index map in file geodatabase format

i) Sketches and descriptions in hardcopy or JPEG format

j) Target photography (negatives, film diapositives, contact prints or digital imagery in TIFF format)

k) Packing slip listing in Microsoft Word document (.doc) format:

   i. contract number

   ii. total number of ground control points broken down into:

- horizontal
- vertical
- horizontal and vertical

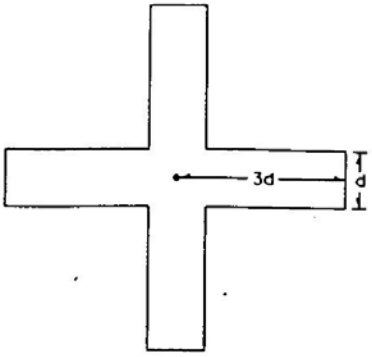
iii. materials submitted

Appendix GCS1

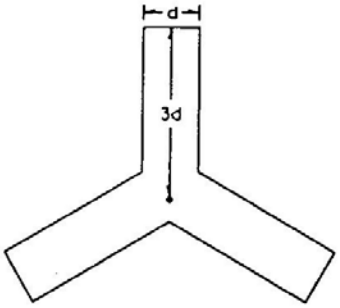
TARGETS

Type and Size
(In order of preference)

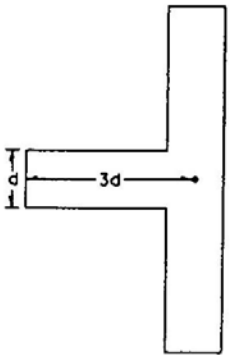
d = 40 µm at image scale



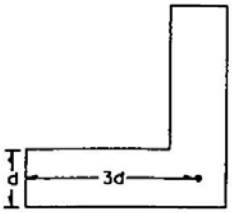
TYPE a)



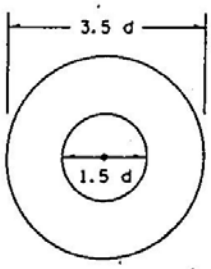
TYPE b)



TYPE c)



TYPE d)



TYPE e)

Alberta
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CORPORATE SERVICES DIVISION
INFORMATICS BRANCH

PART 2

GENERAL SPECIFICATIONS

FOR

AERIAL PHOTOGRAPHY

MARCH 2014
EDMONTON, ALBERTA

TABLE OF CONTENTS

PAGE

1. GENERAL

Except as amended by these specifications or by the project specifications, the latest versions of *Specifications for Aerial Survey Photography, 2000*, and supplemented by the *Manual of Procedures* both published by the Interdepartmental Committee on Air Surveys (ICAS), Ottawa, shall be complied with. The aforementioned specifications shall hereinafter be referred to as the ICAS Specifications. They are both available from The Canada Map Office, 615 Booth Street, Ottawa, Ontario, K1A 0E9.

An asterisk (*) before a section heading indicates that the section has been revised substantially since the last release (October 2012).

2. INPUT SPECIFICATIONS

2.1 Densitometer

All densitometric measurements shall be made using a densitometer having a 2 mm aperture. The densitometer used in the measurement of the sensitometric exposures and film densities shall read diffuse transmission density as defined in CSA Z 7.2-1973 *Specifications for Diffuse Transmission Density* for CSA Type VI-b.

This is not required if using a digital camera.

2.2 Camera Data Block

The camera shall have data blocks containing the lens number, nominal focal length, exposure counter and a clock with either a digital read-out or a sweep second hand. The illumination of the instruments shall be such that the readings are legible on the film.

Forward motion compensation (FMC) cameras shall have a legible indication of the compensation switch being on or off.

The limit of compensation shall be indicated on the data panel or present in the side frame serial data annotation.

This is not required if using a digital camera.

2.3 Camera Vacuum

A vacuum gauge or other device warning of vacuum failure shall be connected as closely as possible to the platen. The camera shall be automatically rendered inoperable if the vacuum system fails.

This is not required if using a digital camera.

2.4 Camera Focus

The camera focus setting shall be that which gives the best definition. In the case of long-focus (610 mm or greater) lenses, it may be desirable to refocus the lens for the altitude being used when the operating altitude is less than $H=0.33 (f*f/N)$
Where f = focal length, mm
N= f-number, e.g 5.6
H = altitude above ground, feet

2.5 Optical Unit

The camera shall have a rigid mechanical structure, which holds the lens, fiducial marks and the parts, which define the focal plane. This structure shall be supported in use in such a manner that strains cannot be transmitted to it from the supporting body or mount (a kinematic design).

The camera mount shall provide sufficient vibration insulation so that the camera vibration need never be a limiting factor in the selection of shutter speeds.

The camera shall be mounted so that the film transport over the focal plane is in the direction of flight. This is not required if using a digital camera.

2.6 Resolution

The resolution of the lens type shall be in accordance with the possibilities of current design knowledge. The resolution of an individual camera shall be such that its average resolving power is not less than 85% of the mean value for its type.

2.7 Stray Light Control

All lens and filter surfaces shall have anti-reflection coatings.

If a graded transmission filter is used, the side with the higher reflectivity shall be mounted toward the camera lens.

The veiling glare shall not exceed 10%.

2.8 Image Plane Illumination

2.8.1 Monochrome Photography

The lowest image illumination shall not be less than 30% of the highest illumination found up to 140 mm off-axis for wide-angle lenses or to 125 mm off-axis for super-wide-angle lenses.

2.8.2 Colour Photography

The lowest image illumination up to 140 mm off-axis shall not be less than 50% of the highest illumination found. Present super-wide-angle lenses do not meet this requirement and are not suitable for use with colour films.

It is preferable that for all colour photography, the lowest image illumination should not be less than 60% of the maximum.

2.8.3 Chromatic Lens Correction - Infrared Photography

The camera lens shall be colour corrected in the 400 to 900 nm range. (Lens type examples: Universal Aviogon and Pleogon A)

2.9 Flatness of Film

The flatness of film locating surfaces shall be within +/- 0.008 mm.

This is not required if using a digital camera.

2.10 Fiducial Marks

Fiducial marks shall be produced as precise registrations on every negative and shall provide a record of two fixed mutually perpendicular calibrated camera distances.

The lines joining opposite fiducial marks shall intersect at the fiducial centre at 90 degrees +/- 1'. Neither the principal point of autocollimation nor the centre of best symmetry shall be further from the fiducial centre than 0.10 mm. For mapping application, the tolerance shall be 0.05 mm.

For mapping applications, the fiducial marks shall contain a central dot of 80 +/- 30 micrometres in diameter.

This is not required if using a digital camera.

2.11 Camera Calibration

The camera calibration report shall be invalid when:

a) The date is more than three calendar years from the date of photography.
b) The camera has had a major overhaul that could affect the properties of the optical unit or the platen after the last calibration date.
c) The camera or platen has been subject to damage, disassembly or alteration after the last calibration date.

The camera calibration shall be done in accordance to *Recommended Procedures for Calibrating Photogrammetric Cameras and Related Optical Tests* of the International Society for Photogrammetry & Remote Sensing, Commission I to include the following:

a) Determination of lens distortion characteristics both radial and tangential with the filter.
b) Determination of the calibrated focal length.
c) Determination of the flatness of the film locating surfaces. This is not required if using a digital camera.
d) Determination of the focal plane illumination
e) Determination of total and effective shutter speeds.
f) Check of focus.
g) Measurements of fiducial distances and determination of fiducial mark locations in X, Y coordinates. This is not required if using a digital camera.

h) Test for deviation and change of deviation of the filter (s).
i) Measurements of principal points of auto-collimation and best symmetry.
j) Determination of film plane illumination for all glass filters to be used for colour photography (clear AV, sandwich, 425 nm, 525 nm, Zeiss B, D, etc.)
k) Determination of area weighted average spatial frequency (AWASF).

The calibrated focal length shall be chosen so as to minimize the departure of the measured radial distortion from the lens reference curve for the lens type or from zero distortion if no reference curve for the particular lens exists.

The measured radial and tangential distortions shall not exceed the limits below:

Field Angle	Up to 42.2 deg.	43.5 – 53.5 deg.	More than 53.5 deg.
Departure of average radial distortion from reference	(a) 0.005 mm (b) 0.010	(a) 0.010 mm (b) 0.020	(a) 0.015 mm (b) 0.040
Asymmetry about principal point of auto-collimation	(a) 0.015 (b) 0.035	(a) 0.030 (b) 0.070	(a) 0.040 (b) 0.140
Asymmetry about principal point of best symmetry	(a) 0.005 (b) 0.010	(a) 0.010 (b) 0.020	(a) 0.020 (b) 0.040
Relative tangential distortion	(a) 0.005 (b) 0.010	(a) 0.010 (b) 0.020	(a) 0.020 (b) 0.040

(a) For super wide angle and mapping applications
(b) Other

2.12 Camera Port Glass

The camera shall be mounted behind a port glass. The camera port glass shall not cause a deviation of collimated light at normal incidence by more than 10 seconds or a change in deviation by more than 2 seconds over the area of the glass.

2.13 Shutter

The shutter shall be of the between-the-lens type.

The shutter speeds, both total and effective shall be recorded.

2.14 Sensitometer

The sensitometer shall be calibrated or its calibration verified at intervals of one year.

Sensitometers designed and built by the National Research Council shall be calibrated by NRC.

Sensitometers other than the NRC-designed type can be calibrated by ICAS by comparison with a NRC-designed type. ICAS shall charge the contractor for developing the film and the calibration service.

This is not required if using a digital camera.

2.15 Altimeter

Altimeter shall be calibrated every two years in compliance with the Canada Ministry of Transport, Air Navigation Order *Altimeter and Altimeter Static Pressure System* (Series II No. 5). This is not required if using airborne Global Navigation Satellite System.

2.16 Film

The film shall be scale-stable such as the Cronar or Estar-based films, shall not have passed the expiration date and shall have been stored in accordance with the manufacturer's instructions. An emulsion such as Kodak type 2402 is acceptable for black-and-white photography.

The film and spools used shall comply with CSA Z 7.3.1.5 Table 6 defining the dimensions for films, leaders, trailers, spools and spindle holes.

This is not required if using a digital camera.

2.17 Filters

Except for gelatine filters used in a glass sandwich filter, all filters used in front of the lens shall be made of glass. The deviation produced by the filter for collimated light at normal incidence shall not exceed 10 seconds of arc and the change of deviation shall not exceed 2 seconds of arc over the area of the filter.

Provision shall be made to ensure that a single orientation for the filter on the camera can be easily maintained.

The image illumination requirements may be met by the use of a filter with a graded transmission.

Filters used to modify the colour balance or compensate for altitude when colour infrared film is used may be gelatine filters mounted in a glass sandwich filter holder in front of the lens or may be mounted inside the camera body in a frame designed to hold them flat. This is not required if using a digital camera.

2.18 *Photograph Format Size

The nominal picture format size shall be 23 cm X 23 cm.

The fiducial marks or other recording devices situated within the format shall not reduce the semi-field angle to less than 42.6 degrees (wide angle) or intrude into the side of the photograph by more than 7 mm.

For digital frame cameras, the images shall be submitted in the native camera footprint. File sizes (footprint) for non-frame cameras shall be mutually agreed upon by the Province and the Contractor.

2.19 Global Navigation Satellite System (GNSS)

2.19.1 Receivers

GNSS receivers shall be dual-frequency with 8 or more independent or parallel (non-sequenced) channels.

Receivers shall be capable of tracking the L1 C/A code and the L1/L2 P code when Anti-Spoofing (AS) is off, and producing a high quality code and full wavelength L1 and L2 carrier phase measurements when AS is on.

Receivers of the same make and model shall be used in the aircraft and at ground monitor sites.

2.19.2 Antennas

Aircraft GNSS antenna(s) shall be the dual-frequency, micro-strip type with a preamplifier. The preamplifier shall match the manufacturer's specifications for the receiver antenna input.

Ground monitor site GNSS antennas shall be dual frequency and shall be the same make and model as the antenna(s) used on the aircraft. Where appropriate, ground planes must be used to reduce and/or eliminate potential sources of multipath and/or imaging.

2.19.3 Ground Monitor Sites

Ground monitor site shall be an existing survey control of or a new survey control point surveyed to at least third order accuracy in horizontal and vertical. (See section 3.5, *Part 1 General Specifications for Ground Control Surveys.*) Descriptions of existing survey control points of at least third order accuracy in the area will be provided.

2.20 *Digital Sensor Requirements

Digital camera systems employed must be tested, stable, calibrated systems with appropriate documentation, suitable for precise photogrammetric purposes.

2.21 *Digital Sensor Spectral Requirements

Digital sensors must be capable of recording electro-magnetic radiation ranging from the blue end of the spectrum (400 +/- 65nm) to the near-infrared end of the spectrum (900 +/- 65nm). The

sensors shall be capable of segmenting or peaking their sensitivity into a minimum of 4 bands related to red, green, blue, and near-infrared (RGB, and NIR). The sensor must also be capable of reproducing a monochrome representation of the wavelengths between 400nm and 700nm (panchromatic) and between 400nm and 900nm (monochrome infrared).

2.22 *Digital Sensor Maintenance Requirements

Contractors shall perform all maintenance in accordance with the manufacturer's recommended and established procedures. Contractors shall maintain a complete history of all maintenance done to the digital camera system and have it readily available for inspection. Certification that the system has been maintained (including preventative maintenance), and calibrated to the manufacturer's requirements shall be provided.

The digital camera and mount shall be checked for proper installation and operation prior to each mission. The mount shall also be regularly serviced. The system shall be insulated against aircraft vibration.

2.23 *Flight Planning

Flight planning shall be the responsibility of the Contractor. Flight plan(s) must be submitted in shapefile format prior to commencing acquisition and include information about the planned altitude, image overlap, and exposure stations.

3. OPERATIONAL SPECIFICATIONS

3.1 *Photographic Conditions

Photography shall be taken under conditions of minimum haze and no smoke.

Solar altitude shall be at least 30 degrees.

No cloud or cloud shadow shall be present on the photography.

Skies shall be clear.

Unless otherwise specified, all photography shall be acquired during the vegetative biologically active growing season. Typically, this period is between mid-May and mid-September. Regional exceptions may occur in the extreme North or South parts of the Province where this period may contract or expand accordingly.

Unless specified, imagery with snow is not acceptable. Early morning low level ground fog can obscure ground detail and photography in these conditions must be avoided.

All efforts shall be made to avoid photography with the anti-solar point in the images, unless explicitly requested.

3.2 *Temperature

The camera shall be maintained at a temperature of 20 degrees Celsius +/- 2 degrees.

Digital cameras shall be maintained and operated within the manufacturer's recommended temperature tolerances.

3.3 *Humidity Control

If the camera compartment is not maintained at 58% +/- 2% relative humidity, additional exposures immediately prior to the start of the flight line shall be taken as follows:

Time since last exposure	Additional exposures
Less than 30 min	4
30 min or longer	8

Failure to observe the above precautions can result in dimensional inconsistency of the film.

Digital cameras shall be shall be maintained in accordance with the manufacturer's operating guidelines.

3.4 Universal Coordinated Time (UTC)

Universal Coordinated Time shall be used in the recording of time on the film report and for the camera data block. UTC is the international abbreviation for Coordinated Universal Time. It is the local time at the Greenwich meridian (0°). For the purposes of this specification, UTC=GMT.

Failure of the illumination system resulting in lack of legibility on the negatives can result in rejection of the roll. This is not required if using a digital camera.

3.5 Light Meter

The aircraft shall have a light meter suitable for photo flight conditions that can be calibrated to indicate an appropriate camera exposure.

3.6 Camera Cycling

The camera cycling shall be such that the film advance occurs immediately after camera exposure. This is not required if using a digital camera.

3.7 Image Motion

The camera shall be equipped with a forward image motion compensation device or its equivalent in case of a digital camera. Image motion due to forward motion and angular vibration shall not exceed 20 micrometres.

3.8 GNSS

3.8.1 Number and Location of GNSS Receivers

At least one GNSS antenna and receiver shall be used in the aircraft. The antenna shall preferably be located directly above the camera's perspective centre. The use of more than one system is encouraged to enhance the integrity of the position determination, as well as to serve as a back-up in case of equipment malfunction.

At least two GNSS receivers shall be set up simultaneously as ground monitor sites on points with 3rd order (or better) known three dimensional coordinates. These sites shall preferably be located at opposite ends of the flight area at a distance not to exceed 30 km. Also, they shall be located in such a way that the aircraft cannot be farther from any GNSS base station by more than 40 km.

3.8.2 Offset Between GNSS Position and the Camera Lens Centre

3.8.2.1 Offset Measurements

The locations of the antenna(s) and the camera on the aircraft shall be illustrated and explained in a sketch or photograph. Measurements between the camera's perspective centre and the GNSS

antenna phase centre and their accuracy estimates shall be provided. Details on how attitude changes between the camera's perspective centre and the antenna phase centre are handled in the processing shall be reported. This shall include discussion on whether the camera is "locked down" or uses a gyro-stabilised mount.

3.8.2.2 Interpolation of GNSS Positions

To minimize interpolation errors, data collection shall be at a frequency of at least 1 Hz and preferably 2 Hz. The type and accuracy of the timing interface between the camera and the GNSS receiver shall be stated. The method used to interpolate from the GNSS solution and the position of the camera's perspective centre at the time of exposure shall be explained.

3.8.3 Data Collection and Field Logs

3.8.3.1 Field Logs

Field logs shall be completed for each receiver, session or flight of GNSS data collection. At a minimum, the following information shall be included on field logs:

a) Date of observations
b) Start and end times of data collection
c) Station identification
d) Model and serial numbers of GNSS receiver and antenna
e) Version of firmware of GNSS receiver
f) Height of the antenna phase centre above the camera lens centre and accompanied by a sketch showing all measurements taken to derive the height
g) File name for the collected GNSS data
h) Data collection rate
i) Receiver mask angle
j) Problems or unusual behaviour with equipment or satellite tracking

3.8.3.2 Data Back-up

All raw GNSS data shall be backed up and duplicate copies of field logs shall be made.

3.8.4 Data Processing, Adjustment and Analysis

3.8.4.1 Solution from Two Ground Monitor Sites

The aircraft trajectory shall be obtained from independent solutions relative to each of the ground monitor sites. The difference between the two trajectories shall be plotted and analysed. Any trends or biases between the two data sets shall be explained. A single set of positions for each camera station from the two independent solutions shall be determined and explained.

3.8.4.2 Accuracy Estimates

Accuracy estimates of the co-ordinates for the perspective centres shall be determined and explained.

3.9 Altitude

The altitude specified is the true altitude in feet above mean sea level.

The following methods of tabulating true altitude shall be acceptable:
- The traditional method of manually applying corrections for air temperature and altimeter instrument error in the determination of the indicated height to fly. Form ICAS-2B provides a format for these computations.
- Computer assisted methods using flight management systems or true air data computers.
- Results derived from GNSS may be accepted with an explanation of the method used to derive orthometric height from the ellipsoidal height and submitted on ICAS Form-2B.

The true altitude shall not deviate by more than + / - (3% of the specified altitude + 200 feet). The true altitude shall be verified by measuring the scale over an area representing the datum specified in the project requirements.

3.10 *Flight Lines

Flight lines shall be spaced for 30% lateral overlap.

In areas of mountainous terrain where the relief exceeds 5% of the flying height, the datum chosen shall be such that the minimum lateral overlap shall not fall below 15%. In certain instances, an intermediate flight line may be added to ensure adequate lateral coverage between adjacent lines. The forward overlap shall be maintained such that the overlap over the highest ground falls neither below 55% nor above 68%.

The photographic flight shall extend far enough beyond the borders of the specified area to ensure full stereoscopic coverage of the entire area included within the border.

Flight lines shall be flown in the East-West direction, unless otherwise specified/required.

3.11 Flight Joins

A join will be accepted over long lines providing the two parts of the line overlap at the break by at least two stereo-models.

Short join lines with less than five photographs will not be accepted. These lines shall be reflown. A break in the sequence of photographs not meeting the prescribed standards may be cause for rejection of the entire line if the segments remaining are short.

3.12 Flight Deviations

The following tolerances are permissible:
Course change: +/- 3 degrees
Crab: +/- 3 degrees
Verticality: +/- 2.5 degrees
Combined limit of 5 degrees of apparent crab, which is the angle between the line joining the mid-points of the sides of the pictures in the direction of flight and the flight path as defined by the fiducial centre of the photos.
Forward overlap: 60% +/- 4%
Lateral overlap: 30% +/- 15%
True altitude: +/- (3% + 200 ft)

In case of a push-broom-scanner-type camera, the forward overlap may go as high as 100%.

3.13 Reflights

Unacceptable coverage resulting from deviation from the flight plan shall be corrected at the contractor's expense, with reflight coverage overlapping accepted coverage by at least two stereo-models. The same camera and magazine used in the original flights shall be used on the reflights.

3.14 Sensitometric Exposure

At least one sensitometric exposure shall be made on each roll of film prior to processing. The exposure shall be made on unexposed film, which shall not be subject to anomalous development effects. Ideally, sensitometric exposures shall be exposed at each end of the roll.

The sensitometer used shall provide for the determination of average gradient to an accuracy of 0.05% and shall provide for the determination of aerial film speed. The determination of average gradient shall be in accordance with methods defined in CSA Z 7.3.2.1, *Sensitometry of Monochrome Aerial Films.*

The sensitometer shall have a valid calibration.

Sensitometric exposures shall be printed with no auxiliary filter in the sensitometer, except for the particular case of colour infrared film when a Wratten # 12 or equivalent filter shall be used in the sensitometer.

The colour balance of colour infrared film shall be established by processing and evaluating a sensitometric exposure prior to commencing work. It is desirable that the infrared balance be adjusted by filtration during exposure in accordance with the methods outlined in the ICAS publication *Standardization Techniques for Aerial Colour Infrared Film.*

This section is not required if using a digital camera.

3.15 Processing Control

The sensitometric wedge used for processing control shall be physically part of the roll of aerial film and not spliced onto it. This is not required if using a digital camera.

3.16 Film Processing and Conditioning

Unexposed films shall be stored in their sealed containers at temperatures not higher than as follows:

	2 weeks	3-4 months	longer
Monochrome	20ºC	12ºC	-20ºC
Colour	20ºC	12ºC	-20ºC
Colour IR	20ºC	2ºC	-20ºC
Monochrome IR	20ºC	2ºC	-20ºC

Films stored at low temperatures shall be conditioned to ambient temperature before opening the container, loading the camera or processing. Typical conditioning time from –20 degrees Celsius to 20 degrees Celsius is 8 hours.

Exposed film shall not be subjected to temperatures exceeding 20 degrees.

All films shall be processed in a continuous processing machine.

Processing and storage shall not cause differences in dimensional change greater than 0.02% + 15 micrometres.

Average gradient shall not vary by more than 0.05 from start to end of roll.

The permanency of the photographic image shall be the best which can be obtained by normal processing and thorough washing. Films shall be tested for residual hypo content using Kodak Hypo Test Solution HT-2. A visual match with Colour patch 2 of the Kodak Hypo Estimator indicates the limit of acceptable residual hypo. Films shall be tested for residual silver using the test solution ST-1. The test shall not cause a milky strain on unexposed and processed film.

This section is not required if using a digital camera.

3.17 Density

The exposure of aerial films shall ensure recording of significant shadow and highlight details within the latitude of the film when processed in accordance with the manufacturer's recommendations.

Exposure shall be such that within a 10 cm radius of the fiducial centre, the minimum net density neither falls below 0.2 nor over 0.6. Nowhere on the image shall the density be less than 0.1 above base plus fog.

Except for the images of extremely bright spots such as specular reflections of the sun, the maximum density on the negative shall not exceed 2.0 above base plus fog.

Densities shall be read on land detail at least 5 mm in extent.

An average gradient of development shall be chosen so that the negative density range is as close as possible to 1.0. In achieving the aim density range of 1.0, the contractor shall use low-contrast processing for high-brightness-range terrain and high-contrast processing for low-brightness-range terrain. If the density range on a roll is less than 0.7 and its average gradient is less than 1.3, or if the density range on the roll is over 1.4 and its average gradient is over 1.0, then it may be assessed that the Contractor has not met the requirements of this specification.

For colour positive films, the exposure shall be such that, within a 10 cm radius of the fiducial centre, the minimum net density is not below 0.2 or above 0.4. Nowhere on the positive shall the density be less than 0.2. Densities should be read on land detail at least 5 mm in extent.

Film type	Minimum net density within 10 cm radius of fiducial centre	Minimum net density anywhere on negative	Maximum net density
Monochrome	≥ 0.2 and ≤ 0.6	Not less than 0.1	not to exceed 2.0
Colour negative	≥ 0.2 and ≤ 0.6	Not less than 0.1	not to exceed 2.0
Colour positive	≥ 0.2 and ≤ 0.4	Not less than 0.2	

This section is not required if using a digital camera.

3.18 *Radiometry

Imagery shall be captured at a minimum of 12 bits per pixel, per band. All systems that use "pan-sharpened" algorithms shall have a color to panchromatic ratio not greater that 1:5, however, native resolution colour is highly preferred.

3.19 Aerial Triangulation

Imagery shall be triangulated as per Part 4 *General Specifications for Aerial Triangulation.*

4. OUTPUT SPECIFICATIONS

4.1 Air Photography Reports

Forms ICAS-2 and 2B shall be completed for each roll of photography submitted.

If true altitude is derived from GNSS, form ICAS-2B shall be submitted with the required altitude and the listed indicated height to fly.

4.2 Photogrammetric Quality for Mapping Applications (for designated projects only)

4.2.1 *Procedure

A minimum of 10 percent of stereo-models per roll shall be checked for photogrammetric quality. Film diapositives of selected stereo-models shall be used and set up on an analytical stereo-plotter. A softcopy photogrammetry system may be used provided the negatives are scanned at an appropriate resolution for the camera/film system as per Part 3 *General Specifications for Scanning Aerial Photographs*. The stereo-models shall be selected from different parts of the roll and preferably representing different types of terrain visible within the entire roll.

In case of a digital camera, the selected stereo-models shall be set up on a softcopy photogrammetry system.

Results of inner orientation shall indicate scale changes not to exceed + or - 0.0003.

Relative orientation using a minimum of 2 x 3 points (von Gruber) in standard orientation locations, shall be carried out with RMS of Y-parallaxes not to exceed three (3) micrometres at image scale. No point anywhere in the model shall have Y-parallax exceeding six (6) micrometres.

Rotation angles, kappa (yaw), phi (pitch) and omega (roll) shall not exceed tolerances specified in section 3.12.

4.2.2 Quality Report

Reports shall be submitted indicating the following data:

a) AS (Aerial Survey) roll number and photo numbers of each stereo-model.

b) Scale errors of fiducial distances. This is not required if using a digital camera.

c) Residual Y-parallax on each point and RMS per model.

d) Rotation angles kappa, phi and omega per photo

e) Name and model of instrument used

f) Scan resolution of images if softcopy photogrammetry was used.

g) Pixel size if using a digital camera.

4.2.3 Lack of Flatness

The photography shall not contain any areas of localized lack of flatness due to dirt on the platen or vacuum failure. This is not required if using a digital camera.

4.3 Fiducial Dots

Fiducial dots shall be present in all photography. This is not required if using a digital camera.

4.4 Annotation

Each frame of an air survey film roll shall be correctly and neatly annotated in type size 4.75 mm, at the extreme bottom of the photograph. This is not required if using a digital camera.

4.4.1 Roll Number

When a roll is ready for annotation, an AS roll number shall be obtained from the Alberta Environment and Sustainable Resource Development, Informatics Branch, Information and Data Provisioning Services. This is not required if using a digital camera.

4.4.2 Numbering Sequence

Every exposure constituting part of the contract plus any usable exposures shall be annotated in numerical sequence, from the beginning to the end of the roll starting with Number 1. On east-west lines, north shall be the top of the negative and numbering shall increase from west to east. On north-south lines, west shall be the top of the negative and numbering shall increase from south to north. Annotation shall read upright and shown at the bottom of the photograph.

4.4.3 Label

Each exposure shall contain the standard Aerial Survey annotation system as follows:

a) Project number
b) Scale of photography
c) Date of photography
d) NTS 1:250K map sheet name
e) Line number
f) Roll number
g) Exposure number

e.g., 81-12 1:15,000 81/10/12 83M LN-4 AS1981B-25

This is not required if using a digital camera.

4.5 Spooling of Negatives

Cans and spools from 500 foot rolls will not be accepted.

Rolls of films shall be left uncut and submitted for storage on a spool of the same kind as that on which it was originally supplied. The container shall be a Kodak Code 3000 plastic case or equivalent.

Each roll of film shall be delivered with at least 2 m of leader and trailer containing no annotated negatives.

A roll shall be considered unique when it has no splice. Whenever a roll is cut to remove unwanted photography, the parts shall be considered as separate units and each part shall have a sensitometric exposure report. If both parts have been taken with the same camera, the roll may be spliced together again providing at least 0.5 m of unannotated film shall be retained on each side of the splice. Splices shall be a butt join using 3M No. 810 transparent tape or equivalent, applied to both sides of the film.

This section is not required if using a digital camera.

4.6 *Digital Files

Delivery of files shall be as uncompressed, original bit-depth (minimum 12 bits per pixel/band) TIFF images.

The images shall be submitted in the native camera footprint for frame cameras with the image covering the entire area of the file. File sizes (footprint) for non-frame cameras must be mutually determined by the Department and Contractor prior to project commencement.

4.6.1 *File Naming Convention

The naming convention for the files shall be the Operation Unique ID followed by the submitting contractor code, *as assigned by Informatics Branch* e.g.

2001123GLO.DOC – ASCII files and (one per project)
2001123GLO.GDB – file geodatabase (one per project)
[Calibration report unique ID].JPG – camera calibration report (one per camera)
2001123_A_GLO_DEN.JPG – density report (one per field roll) – where the ‘A’ identifies the first portion of the line and ‘B’ the second. This is not required if using a digital camera.
[Sensitometric calibration unique ID]GLO.JPG – sensitometric report (one per year). This is not required if using a digital camera.
2001123GLO_APR.XLS – flight report (one per project)

In case of a digital camera, all images shall be uncompressed and in TIFF format.

Image files shall be named as follows or in a mutually agreeable format:

a) Digital push-broom-scanner camera –

IIII_YYYYMMDD_PPPPPP_LLLL_CCCCDAAL1_0_NNNN.TIF, where IIII=camera ID, YYYY=year flown, MM=month flown, DD=day flown, PPPPPP=project number (without year), LLLL=line number, CCCC=bands, AA=angle of sensor direction, L1=standard name for this ADS product, 0_NNNN=frame number, D=F/N/B (direction of sensor), e.g.

034_20100917_043_2148_RGBB16L1_0_0.TIF. The accompanying support files shall be named as follows: *.ads, *.odf, *.odf.adj, *.sup, where *=same name as the image file without the frame number and extension.

b) Digital frame camera –

IIII_YYYYMMDD_PPPPPP_LLLL_NNNN_RRRR_CCCC.TIF, where IIII=camera ID, YYYY=year flown, MM=month flown, DD=day flown, PPPPPP=project number (without year), LLLL=line number, NNNN=frame number, RRRR = resolution (cm), CCCC=bands, e.g.

UCXp100_20070701_050_25_51_0030_PAN.TIF. The accompanying support file shall be named as follows: *.sup, where *=same as image file name without the extension.

Line numbers shall begin with one and increasing from south to north for east-west flight lines. Frame numbers for each line shall be numbered from one and increasing from west to east.

In case of north-south flight lines, line numbers shall begin from one and increasing from west to east. Frame numbers for each line shall be numbered from one and increasing from south to north.

All images and corresponding support files shall be submitted together in the same folder and drive.

All digital files shall be submitted using a method agreed to by the Department. The methods could include FTP, E-mail attachment, CD, DVD, portable hard drives with USB3 connectivity at a minimum. Drives with multiple data transfer options (USB3, FireWire, eSATA, etc) are preferred.

4.6.2 *Image Quality

Quality control shall be exercised continuously throughout a contract. Procedures shall be established by the Contractor to ensure that all materials are delivered in accordance with the delivery schedule and at the required level of accuracy and quality. The image quality and coverage shall be continuously monitored by the Contractor and correction of deficiencies shall be undertaken immediately, as feasible with respect to the individual project requirements.

a) Imagery shall be free of blemishes, scratches, and artifacts that obscure ground feature detail.
b) There shall be no artifacts which do not represent any feature on the ground.
c) There shall be no saturation of the image in large area, i.e. areas greater than 200 by 200 pixels in which the pixel value is 255 or 0.
d) Pixel values for deep shadow area shall be within 10 and 20 inclusive.
e) Pixel values for highlight area shall be within 235 and 245.
f) Images shall have minimum distortions other than those due to relief.

4.6.3 Flight Index Map

Shall be in ESRI file geodatabase format with the following feature classes:
a) points representing the photo centres for frame photography
b) polygons representing image footprints.

The attribute table shall be populated as per Appendix A.

A printable PDF file shall be submitted as per sample flight index map.

4.6.4 *Digital Report Files

This section defines the required digital file format for the four reports delivered to Informatics Branch, as per section 5.2. These do not describe the content of the report but only defines the digital file format. All scanned image files shall be delivered in uncompressed format. The digital requirements do not remove the mandatory submission of a hard copy paper print of each report.

a) The hardcopy **Densitometry Report** shall be delivered with the sample prints at the initial submission stage. The digital report shall be delivered as a JPEG image document scanned at a resolution of 200 dpi and delivered at the conclusion of each project along with other final digital deliverables. This is not required if using a digital camera.
b) One **Sensitometric Report** (including graph) shall be delivered shortly after the award of a contract with Informatics Branch. The two page report shall be delivered as one two page JPEG image scanned at a resolution of 200 dpi. Only one submission is required per contract with Informatics Branch. The delivery shall be no later than the delivery of the first project final deliverable of this contract. This is not required if using a digital camera.
c) One valid **Camera Calibration Report** shall be delivered to Informatics Branch for each camera used during the life of the contract (including extensions). The calibration report must be a JPEG image scanned at a resolution of 300 dpi and delivered no later than the first project final deliverable of a contract with Informatics Branch. The unique calibration number shall be inserted in the attribute table of the flight index map. See Appendix A.
d) **Flight Reports** shall be delivered for each mission of each project. The final air photo report must be delivered with all other project final (digital) deliverables.

e) **Progress Reports** shall be delivered as per the individual contract schedule or as requested by the Contract Manager. These reports should contain at a minimum the name of the contractor, date of report, the project/contract number, progress attained (number of exposures accepted/rejected, overall progress etc.), and concerns/issues.

Examples of these reports may be found in Appendix B.

4.6.5 Metadata File Returns

Metadata shall be submitted using the supplied metadata templates in XML format.

Collection of the metadata shall be in compliance with FGDC Content Standards for Digital Geospatial Metadata, ***CSDGM FGDC-STD-001-1998***.

The required elements to be populated shall conform to those elements presented in the ESRI ArcCatalog FGDC Classic metadata style sheet, and also shall conform with the FGDC CSGDM Synchronizer and ESRI Geography Network Synchronizer parameters available through ArcCatalog. Synchronizer settings for ISO shall not be included. More detailed description on the synchronizing parameters is provided in ESRI ArcGIS 9.2 Desktop Help Topic "Metadata Synchronization". (Note that for contractors who are using ArcCatalog for metadata creation, it is recommended to use the FGDC Classic Style Sheet to ensure the required fields are populated):
http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=Metadata_synchronization

Metadata shall include the mandatory population of fields required for publication to metadata services that facilitate organization, discovery, and distribution functions in ESRD. More detailed descriptions on these mandatory requirements are provided in ESRI ArcGIS 9.2 Desktop Help Topics "Requirements for Publishing Metadata to an ArcIMS Metadata Service" and "Adding Information Required by the ArcIMS Metadata Service". Regarding these requirements, it is important that references to ISO 19115 are populated where required and that syntax is exact:
http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=Requirements_for_publishing_metadata_to_an_ArcIMS_Metadata_Service

http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=Adding_information_required_by_the_ArcIMS_Metadata_Service

XML template will be provided by the department to the successful contractor that contains mandatory ESRD specific business metadata marked with the following delimiter; <>. The template metadata shall also be part of the deliverable metadata. Note that the template provided may slightly vary from the example template included here.

Contractors shall not modify the structure or ESRD-provided content of the template XML. Example (may vary slightly with template provided to successful contractor):

One collection metadata shall be submitted for the whole project. Here is the metadata template in text format:

Identification_Information:
  Citation:
    Citation_Information:
      Originator: <Contractor company name that flew the aerial photography>
      Title: Aerial Photography <location(County, MD, NTS or ATS)> <year(s) of photography> <bands(BW, RGB, CIR or RGBN)> <GSD(M or Cm)>
      Geospatial_Data_Presentation_Form: remote-sensing image
      Series_Information:
        Series_Name: Aerial Photography
      Publication_Information:
      Other_Citation_Details:
        Additional Contractor contact information:
        <name>
        <position>
        <company name>
        <telephone number>
        <address>
        <e-mail address>
  Description:
    Abstract: <Provide a brief summary of the collection>
    Purpose: <Purpose of the collection>
    Supplemental_Information: Acquired under: Contract #<contract number> / Method of Capture: aerial photography / Sensor Type: <Bayer matrix, film, linear array with prismatic separation, single lens, multi-lens stitched etc.> / Along-track field of view (degrees): <field of view> / Cross-track field of view (degrees): <field of view> / GPS Unit Model: <manufacturer/model> / GPS Unit Serial #: <serial number> / IMU Model: <manufacturer/model> / IMU Serial #: <serial number> / Aircraft: <aircraft model> / Airport: <airport used> / Flight Altitude (above ground level, metres): <value> / Airspeed (knots or km/h): <value with units> / Swath Width (metres): <swath width> / Distance between Flight Lines (metres): <Distance b/w lines> / Percent overlap (direction of flight): <percent overlap> / Percent sidelap (between lines): <percent sidelap> / Maximum PDOP during mission: <PDOP> / Number of Base Stations used: <# of base stations> / Maximum Distance from GPS Base Station: <Max Distance from Base> / GPS Epoch rate (Hz): <GPS rate> / Elevation Mask (degrees): <Elev. Mask> / IMU Frequency (Hz): <IMU Frequency> / IMU Accuracy (Roll/Pitch/Yaw - degrees): <Accuracy roll/pitch/yaw> / Date of Manufacturer's Calibration (YYYYMMDD): <Date> / Date of System Calibration (YYYYMMDD) : <Date YYYYMMDD> / Bands contained within image (in order as stored within image): <Band 1 = x, Band 2 = y etc.> / Spectral bandwidths: <Red: xx - xx, Green: xx - xx etc.> / Bit depth: <bit depth> / Number of ground control points used during aerial triangulation: <number of points> / File naming convention: <Describe naming convention employed>
  Time_Period_of_Content:
    Time_Period_Information:
      Range_of_Dates/Times:
        Beginning_Date: <YYYYMMDD>
        Beginning_Time: <HH:MM>

```
      Ending_Date: <YYYYMMDD>
      Ending_Time: <HH:MM>
  Currentness_Reference: ground condition
 Status:
  Progress: Complete
  Maintenance_and_Update_Frequency: Unknown
 Spatial_Domain:
  Bounding_Coordinates:
   West_Bounding_Coordinate: <geographic(-DDD.DDDDDD)>
   East_Bounding_Coordinate: <geographic(-DDD.DDDDDD)>
   North_Bounding_Coordinate: <geographic(DD.DDDDDD)>
   South_Bounding_Coordinate: <geographic(DD.DDDDDD)>
 Keywords:
  Theme:
   Theme_Keyword_Thesaurus: ISO 19115 Topic Category
   Theme_Keyword: imageryBaseMapsEarthCover
  Theme:
   Theme_Keyword_Thesaurus: none
   Theme_Keyword: stereo imagery
   Theme_Keyword: <band (PAN/RGB/CIR/RGBN)>
   Theme_Keyword: remote sensing
   Theme_Keyword: <camera name>
  Place:
   Place_Keyword_Thesaurus: none
   Place_Keyword: <project name>
   Place_Keyword: <county or MD>
   Place_Keyword: <NTS map sheet(20K, 50K or 250K)>
  Temporal:
   Temporal_Keyword_Thesaurus: none
   Temporal_Keyword: <Enter Year(s) of data collection as separate entries>
   Temporal_Keyword: <Enter Month(s) of data collection as separate entries, i.e. "July">
   Temporal_Keyword: <Season(s) of data collection as separate entries>
   Temporal_Keyword: <Leaf On/Leaf Off>
 Access_Constraints: <Data access constraints according to the contract.>
 Use_Constraints: <Data use constraints according to the contract.>
 Point_of_Contact:
  Contact_Information:
   Contact_Person_Primary:
    Contact_Person: <Name>
    Contact_Organization: <Contractor company name>
   Contact_Voice_Telephone: <phone #, AAANNNNNNN>
   Contact_Electronic_Mail_Address: <email address>
 Browse_Graphic:
  Browse_Graphic_File_Name: <File name of FGDB for flight index map.>
  Browse_Graphic_File_Description: Flight index map with photo centres and footprints.
  Browse_Graphic_File_Type: FGDB
```

Security_Information:
Native_Data_Set_Environment: <Description of dataset processing environment - software used and versions, operating system, filename/path, file size etc.>
Cross_Reference:
Citation_Information:
Originator: Informatics Branch
Publication_Date: <YYYYMMDD>
Title: General Specifications for Acquiring Aerial Photography
Data_Quality_Information:
Logical_Consistency_Report:
Camera Calibration Report: <filename of report(s)> / Ground Control Report: <filename of report> / Camera System Specifications: <filename of report> / Flight Report: <filename of report>

<State any important qualifications of the individuals involved in acquisition, processing or accuracy assessment of the data and which part(s) they were involved in (eg. Professional Engineer, Alberta Land Surveyor etc.)>
Completeness_Report: QA/QC Procedure Report: <Description of process or location/name of document where this information can be obtained>/ Anomalies Report : <Description of any anomalies/issues identified during the QC process or location/name of document where this information can be obtained> / Data Processing Report: <Description of data processing or location where this information can be obtained>
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report:
Quantitative_Horizontal_Positional_Accuracy_Assessment:
Horizontal_Positional_Accuracy_Value: <integer> metres
Horizontal_Positional_Accuracy_Explanation: Confidence level
Vertical_Positional_Accuracy:
Quantitative_Vertical_Positional_Accuracy_Assessment:
Vertical_Positional_Accuracy_Value: <integer> metres
Vertical_Positional_Accuracy_Explanation: Confidence level
Lineage:
Source_Information:
Type_of_Source_Media: CCDs
Source_Contribution: <camera name> stereo imagery
Process_Step:
Process_Description: <Enter a description of each process step involved in creating the dataset as a separate entry (within the ArcCatalog editor, use the + button below to add each additional step) e.g establishment of ground control, flying, processing, AT>
Process_Date: <Enter date of process for each step, if available>
Process_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: <Contractor company name>
Contact_Instructions:

Additional Contractor contact information:
<name>
<position>
<company name>
<address>
<telephone number>
<e-mail address>
Spatial_Data_Organization_Information:
Direct_Spatial_Reference_Method: Raster
Raster_Object_Information:
Raster_Object_Type: Pixel
Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Planar:
Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: coordinate pair
Coordinate_Representation:
Abscissa_Resolution: <value>
Ordinate_Resolution: <value>
Planar_Distance_Units: metres
Geodetic_Model:
Horizontal_Datum_Name: <Horizontal datum with epoch if applicable (i.e. NAD83 CSRS 1998)>
Ellipsoid_Name: <Ellipsoid>
Vertical_Coordinate_System_Definition:
Altitude_System_Definition:
Altitude_Datum_Name: CGVD28
Altitude_Distance_Units: metres
Altitude_Encoding_Method: Explicit elevation coordinate included with horizontal coordinates
Entity_and_Attribute_Information:
Metadata_Reference_Information:
Metadata_Date: <YYYYMMDD>
Metadata_Contact:
Contact_Information:
Contact_Organization_Primary:
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC-STD-001-1998
Metadata_Time_Convention: local time
Metadata_Extensions:
Online_Linkage: http://www.esri.com/metadata/esriprof80.html
Profile_Name: ESRI Metadata Profile

4.7 GNSS

4.7.1 *Coordinate Data

All collected data shall be in Receiver-Independent Exchange (RINEX) format, version 2 or later and recorded on CD-ROM or DVD.

If a static GNSS survey is used to establish ground control or monitor sites, then coordinate or coordinate difference observations in GHOST or GEOLAB input format with associated variance covariance matrices for each session and the resulting adjusted 3D coordinates and associated full covariance matrix from the minimally constrained adjustment shall be provided.

The aircraft trajectories computed from the two monitor sites with accuracy estimates shall be provided in digital format on CD-ROM or DVD.

The final coordinates for all perspective centres shall be in metres and in the coordinate system specified by the contract and orthometric heights based on CGVD28.

The perspective centres shall be arranged in the same order as the flying of aerial photography.

The perspective centre coordinate data shall be in ASCII format and one point per record as follows: ID, X, Y, Z, and time where ID = the final image name.

4.7.2 Hardcopies

Field logs for all GNSS observations shall be submitted. Digital format will be accepted if it is used for fixed observations.

4.7.3 Reports

4.7.3.1 Map

The report shall be accompanied by a map or map overlay showing the monitor sites occupied, all flight lines, their directions and all ground control used.

4.7.3.2 Field Operation Details

The report shall provide the following:

a) Clear description of the survey procedures.
b) Procedure for determining the camera's perspective centre positions using GNSS.
c) Procedures for establishing ground control and monitor sites.
d) Summary of equipment used including serial numbers, and a brief description of their characteristics and principles of operations.
e) Summary table indicating for each flight, the date, start and end times of GNSS data collection, line numbers with their start and end times and file names for the GNSS data.

f) Summary table for static GNSS observations indicating for each session, the date, session number, stations occupied and the start and end time of observations for each station.

4.7.3.3 Offset Measurements

a) Details on offset measurements between the GNSS antenna phase centre and the camera's perspective centre shall be provided. This includes full details on how co-ordinates of the antenna phase centre are transferred to the camera perspective centres to estimate their coordinates and their accuracies, to be used in the aerial triangulation adjustment.
b) Details on the method of interpolation of GNSS positions to time of exposure shall be provided.

4.7.3.4 Processing Details

A clear description of procedures used for data processing of both static and kinematic data shall be provided. This includes:

a) Software (name, version number, date) used in the data processing along with a description of the basic underlying principles on how the software determined accurate GNSS positions
b) Parameters adopted in the processing
c) Ephemeris used (broadcast or precise)
d) Number of satellites used and the satellite geometry
e) Problems encountered in the processing and how they were overcome
f) Software (name, version, date) used for coordinate transformations
g) Geoid model used to transform ellipsoidal heights derived from GNSS to orthometric (mean sea level) heights
h) Software used (name, version, date) to convert native GNSS receiver data to RINEX format
i) For any ground control or monitor sites used, a table showing the station name and number, coordinates used, datum, source of coordinates, coordinate accuracy estimates and source of the accuracy estimates

4.7.3.5 Analysis Details

a) Computer listings of results including processing statistical RMS of solutions, details of ambiguity resolution or other details as applicable, depending on the software used
b) Comparison of the co-ordinates of the GNSS antenna as processed from the two or more monitor sites, in graphical form indicating the differences in each coordinate axis plotted against time
c) Plot of residuals from GNSS processing against time
d) Other analysis suitable to the software and techniques employed showing the accuracy and integrity of the data.

4.8 *Media for Imagery

All files shall be delivered on hard drive(s) with a minimum capacity of 250 GB.

Drives are to be new (not previously used for other business), include USB 3.0 connectivity (they may possess other means of data transfer such as FireWire or eSATA in addition to USB 3.0), and no drive volume is to be larger than 2 TB. Hard drives larger than 2TB shall be partitioned such that this condition is met. Such drives are to be provided by the Contractor and will become the property of the Government of Alberta.

4.8.1 Media Deliverable Label

Each drive/DVD shall have two labels described below.

4.8.1.1 Drive/DVD Information

- Drive Name – Contract No. + additional information, if required. i.e.
  09RIM052
  09RIM052_# ……..._#: Sequential no. if deliverable takes multiple drives
  09RIM052_A_# …..._A_#: **A, B or C** is the contractor name, if a contract has
  …..._B_# multiple contractors
  ….._C_#
- Year(s) of imagery captured
- Band - PAN/RGB/IR/CIR/RGBN
- Imagery Type - <camera>Stereo Imagery
  <camera>: ADS40/ADS40 SH52/DiMAC/etc.
- Projection - 10TM with or without offset/UTM Zone 10, Zone 11, Zone 12
- Resolution - 0.5 m/1.0 m/etc.
- Project Name
- Contractor Name
- Re-submission No. - Has to state original drive name(s) and additional information
- Volume of data / Drive capacity i.e. 0.85 / 1 TB

The following are some sample labels.

a) First submission

09RIM051_1
2009
CIR Stereo
DiMAC Imagery
2.5 m.
10TM with offset
Southern Alberta
Pinnacle
0.75 / 1TB

b) Re-submission

2nd Submission of:

09RIM053_1, 09RIM053_2 & 09RIM053_3
2004 – 06
RGB Stereo
ADS40
0.5 m.
UTM Zone 11
North West Geomatics
0.6 / 1TB
2nd Submission Info: Metadata

c) Re-submission

3rd Submission of:

09RIM053_2 & 09RIM053_3
2004 - 06
PAN Stereo
ADS40SH52
0.5 m.
UTM Zone 11
North West Geomatics
0.87 / 1TB
3rd Submission Info: 72E to 74M

4.8.1.2 *Informatics Branch Standard Label

Property of:
Informatics Branch
Information and Data Provisioning Services
14th Floor Oxbridge Place
9820 – 106 Street Edmonton, AB Canada T5K 2J6
(780) 427 – 7374 SRD.Data@gov.ab.ca

4.8.2 Media Cables

Media cables for hard drives are part of the deliverable which shall be submitted and kept inside the media box. Cables shall be labeled with the media identification, i.e. Drive Name. See first bullet of section 4.8.1.1 above.

4.8.3 *Shipping

Materials shall be packed for shipping in such a manner that will ensure safe delivery at the destination. Damaged materials will be replaced by the Contractor at no cost to the Government. A packing slip will accompany each shipment and shall itemize all materials included in the shipment.

5. SUMMARY OF MATERIALS

5.1 *Materials to be Supplied by Informatics Branch

At the start of the contract, or at reasonable intervals throughout, Informatics Branch shall supply the Contractor with the following:

a) A list (Task Sheet) of areas to be photographed, with required scale/resolution, projection, date restrictions, and all required components.

b) A description of each area to be acquired as a map, or shapefile

c) Aerial film (This is not required if using a digital camera)

d) AS roll numbers (This is not required if using a digital camera)

e) XML metadata template (if required)

f) 1:250 000 map of the area as backdrop for the flight index map in file geodatabase format

g) Descriptions of existing survey control points

h) Digital elevation model (as required)

i) File geodatabase template

5.2 * Materials to be Delivered by the Contractor

At the completion of the contract, or at reasonable intervals throughout, the Contractor shall supply to Informatics Branch the following data:

a) Materials supplied to the Contractor (CD/DVD/hard drive)

b) Flight plan in shapefile format including exposure stations, overlap, and altitude information

c) Annotated aerial negatives (This is not required if using a digital camera)

d) ICAS-2 Air Photography Report (CD/DVD/hard drive)

e) ICAS-2B altitude computation or method used to derive mean sea level (CD/DVD/hard drive)

f) Densitometric reports (CD/DVD/hard drive) (This is not required if using a digital camera)

g) Sensitometric Reports (CD/DVD/hard drive) (This is not required if using a digital camera)

h) Camera calibration report (CD/DVD/hard drive)

i) Progress reports

j) Flight report(s) with information from each mission (see sample in Appendix B)

k) Photogrammetric check report if for mapping applications (designated projects only) (CD/DVD/hard drive)

l) GNSS data (CD/DVD/hard drive)

m) Imagery (DVD/hard drive)

n) File geodatabase with photo centres and image footprints with required attribute information (see Appendix A)

o) Metadata in XML format (if required)

p) Coordinates of perspective centres or other GNSS data required for simultaneous adjustment of GNSS and photogrammetric data (CD/DVD/hard drive)

q) If static GNSS survey is used to establish ground control or monitor sites:
   i. Coordinate or coordinate difference observations in GHOST/GEOLAB input format with variance covariance matrices for each session (CD/DVD/hard drive)
   ii. Adjusted 3D coordinates and full covariance matrix from the minimally constrained adjustment (CD/DVD/hard drive)

r) Aircraft trajectories computed from the two monitor sites with accuracy estimates (CD/DVD/hard drive)

s) Field logs for all GNSS observations (CD/DVD/hard drive)

t) Report including map, field operation details, offset measurements, processing details and analysis details (CD/DVD/hard drive)

u) Flight index map in PDF format (see sample in Appendix B)

v) Packing slip listing all materials submitted (CD/DVD/hard drive)

***Appendix A**
Attribute Table

AirPhoto.gdb in ArcGIS 9.3.1 format

Domains:

When entering data into fields that make use of coded values, the full text description shall be used rather than the code.

Domain name	Domain Properties				Coded Values	
	Field Type	Domain Type	Split Policy	Merge Policy	Code	Description
Camera_Type	Text	Coded Values	Duplicate	Default	A	Digital
					B	Film
Camera_Mode	Text	Coded Values	Duplicate	Default	A	Frame
					B	Pushbroom
Req_Agency	Text	Coded Values	Duplicate	Default	FOREST	Forest
					FORINV	Forest Inventory
					FOR SIL	Forest Silviculture
					FORPRO	Forest Protection
					TRANSP	Transportation
					PARKS	Tourism, Parks and Recreation
					AGRICU	Agriculture and Rural Development
					PUBLAN	Public Lands
					FISHWI	Fish and Wildlife
					RESDAT	Informatics Branch
					S_EAST	ESRD, Southeast Region
					S_WEST	ESRD, Southwest Region
					N_EAST	ESRD, Northeast Region
					N_WEST	ESRD, Northwest Region
					ESRD	Environment and Sustainable Resource Development
					EXTERN	Name of agency
					OTH	Name of agency
					UNK	Unknown
Vert_Datum	Text	Coded Values	Duplicate	Default	A	Orthometric
					B	Ellipsoid
Hori_Datum	Text	Coded Values	Duplicate	Default	A	NAD83
					B	NAD83(CSRS)
					C	NAD27
					D	WGS84(G1150)
Coord_Ref	Text	Coded Values	Duplicate	Default	A	Perspective Camera Centre
					B	Ground Photo Centre means that coordinates have been acquired by map digitizing.
						Perspective camera centre (coordinates have been acquired by GPS or AT).
Height_ Transformation	Text	Coded Values	Duplicate	Default	A	None
					B	GSD95
					C	CGG2000
					D	CGG2005
					E	HTv2.0
					F	Name of transformation
					G	Unknown
Hori_Coord_ Method	Text	Coded Values	Duplicate	Default	A	Single point positioning GPS
					B	Differential GPS
					C	Photogrammetric
					D	Single point positioning GPS with Inertial
					E	Differential GPS with Inertial

					F	Visual Interpretation (Scaled Off Map)
Ht_Method	Text	Coded Values	Duplicate	Default	A	Single point positioning GPS
					B	Differential GPS
					C	Photogrammetric
					D	Single point positioning GPS with Inertial
					E	Differential GPS with Inertial
					F	Altimetric
Specification	Text	Coded Values	Duplicate	Default	DC	Dual Camera
					FF	Fire Photography
					LF	Leaf Free
					MS	Main Season
					OR	Orthophotography Mapping Photography
					SP	Site Specific
					PDC	Pre-determined Photo Centre
					Oth	Name of specification
Yes_or_No	Text	Coded Values	Duplicate	Default	Y	Yes
					N	No
Scan_Media	Text	Coded Values	Duplicate	Default	N	Negative
					D	Diapositive
					P	Contact Print
AT_GPS_Projection	Text	Coded Values	Duplicate	Default	UTM-11	UTM-11
					UTM-12	UTM-12
					10TM-Forest	10TM (Forest)
					10TM-Resource	10TM (Resource)
					3TM-111	3TM-111
					3TM-114	3TM-114
					3TM-117	3TM-117
					3TM-120	3TM-120
					Geographic	Geographic
Grad_ Deg_ Rad	Text	Coded Values	Duplicate	Default	G	Grads
					D	Degrees
					R	Radians
Emulsion	Text	Coded Values	Duplicate	Default	001	Kodak Black & White Infrared 2424
					002	Kodak Black & White 2405
					003	Kodak Colour Negative 2445
					004	Kodak Colour Positive Infrared 2443
					005	Kodak Plus X Black & White 2402
					006	Kodak Tri X Black & White 2403
					007	Agfa Pan 50 PE
					008	Agfa Pan 150
					009	Agfa Pan 200
					010	Agfa Colour Negative 200
					011	Kodak Aero LX Black & White 2408
					012	Kodak Colour Positive 2448
					013	Kodak Panatomic-X Aerographic II 2412
					014	Kodak S0-359 (Colour Positive)
					015	Agfa Pan 80
					016	Kodak Aerocolor Negative 2444
					017	Kodak Aerochrome Positive 2427
					018	Kodak Aerochrome IR Positive 1443
					019	Kodak Aerochrome IR Negative 1443
					020	Kodak MX Film 2407
					021	Agfa Pan 400S
					022	Agfa Color Negative X100
					023	Agfa Color Negative H100
					024	Agfa Color Negative N400
					025	Agfa Color Negative N800
					026	Agfa Chrome Color Positive 200
					027	Kodak Super-X
					028	Digital Black & White
					029	Digital Black & White IR
					030	Digital RGB
					031	Digital NRG

					032	Digital RGBN
					033	Name of Emulsion
Flying_ Contractor	Text	Coded Values	Duplicate	Default	GLO	Global
					GEO	Geodesy
					FFL	Foto Flight
					GAS	Geographic A.S.
					PIN	Pinnacle Mapping
					NWG	North West Geomatics
					OTH	Name of Flying Contractor

Feature Dataset

Name: Airphoto_2000s
Projection Coordinate System: NAD83 10TM with 500 000 m false easting
Vertical Coordinate System: CGVD28
XY Tolerance: 0.001
Z tolerance: 0.001
M tolerance: 0.001

Feature Classes attributes:

Point: Airphoto_2000s_PhotoCentre
Polygon: Airphoto_2000s_ImageFootprint
*Means that the field has changed from previous version.

Name	Data Type	Size or Storable Range	Domain	Format/Unit	Example	Comment/Source
OBJECTID	Object ID					
SHAPE	Geometry					
CAMERA	Text	Length: 25			Wild RC30	Model/Name
CAMERA_TYPE	Text	Length: 10	Camera_Type		Film	
CAMERA_MODE	Text	Length: 10	Camera_Mode		Frame	
LENS	Text	Length: 15			13332	Lens ID
FOCAL_LENGTH_MM	Float	Storable Range: Stores up to 7 significant digits		Millimetres	152.123	
CAM_CAL_REP	Text	Length: 15			OP-2007-372	
SPECT_FILTER	Text	Length: 20			MINUS BLUE	
SPECT_WAVELENGTH_NM	Short Integer	Storable range: (-32, 768-32,767)		nm	420	
*ANTI_VIGNET_FACTOR	Float	Storable Range: Stores up to 7 significant digits			1.5	
*PROJECT_NO	Text	10			035	No year
PROJECT_YEAR	Short Integer	Storable range: (-32, 768-32,767)			1980	
PROJECT_NAME	Text	Length:50			Hinton	Location
PHOTO_SCALE	Long Integer	Storable range: (-2,147,483,648 - 2,147,483,648)			15000	scale denominator
SPECIFICATION	Text	Length: 50	Specification		Main Season	
HORI_DATUM	Text	Length: 15	Hori_Datum		NAD83	Datum

Name	Data Type	Size or Storable Range	Domain	Format/Unit	Example	Comment/Source
VERT_DATUM	Text	Length: 20	Vert_Datum		Orthometric	Datum
REQ_AGENCY	Text	Length: 26	Req_Agency		Forest	To be supplied by Informatics
*APDF_DATE	Text	Length: 8		YYYYMMDD	20090917	
FLYING_CONTRACTOR	Text	Length: 50	Flying_Contractor		Geodesy	
FILM_ROLL_NO	Text	Length: 10			AS2780	No letter at the end
LINE_NO	Text	Length: 10			1234	
LINE_NO_SUB	Text	Length: 10			A	
*PDOP	Long Integer	Storable range: (-2,147,483,648 - 2,147,483,648)			4	GPS
*NO_SATELLITES	Short Integer	Storable range: (-32, 768-32,767)			5	GPS
AVG_FLY_HT_M	Float	Storable Range: Stores up to 7 significant digits		Metres	5166.01	Above MSL
EMULSION	Text	Length: 37	Emulsion		KODAK B&W 2405	Film camera only
BANDS	Text	Length: 10			RGBN	
AZIMUTH_DECI_DEGREE	Double	Storable Range: Stores up to 14 significant digits		Degrees	123.123	Flight line
FRAME_NO	Text	50			1234	
FRAME_NO_SUB	Text	Length: 10			B	
*PHOTO_DATE	Text	Length: 8		YYYYMMDD	19800625	
PHOTO_YEAR	Short Integer	Storable range: (-32, 768-32,767)		YYYY	2000	
PHOTO_MONTH	Short Integer	Storable range: (-32, 768-32,767)		MM	06	
PHOTO_DAY	Short Integer	Storable range: (-32, 768-32,767)		DD	09	
TIME_EXPO_UTC	Text	Length: 8		HH:MM:SS	09:50:50	Time at GMT
NTS_NO	Text	Length: 6			083B01	1:50 000
LAT_DECI_DEGREE	Double	Storable Range: Stores up to 14 significant digits		Degrees	50.123123123	
LAT_ACCURACY_M	Float	Storable Range: Stores up to 7 significant digits		Metres	15.0	One standard deviation
LONG_DECI_DEGREE	Double	Storable Range: Stores up to 14 significant digits		Degrees	114.123123123	
LONG_ACCURACY_M	Float	Storable Range: Stores up to 7 significant digits		Metres	15.0	One standard deviation
HEIGHT_M	Float	Storable Range: Stores up to 7 significant digits		Metres	5166.36	
HT_ACCURACY_M	Float	Storable Range: Stores up to 7 significant digits		Metres	3.543	One standard deviation
COORD_REF	Text	Length: 25	Coord_Ref		Ground photo centre	
HORIZONTAL_COORD_METHOD	Text	Length: 50	Hori_Coord_Method		Photogrammetric	
HT_METHOD	Text	Length: 30	Ht_Method		Differential	
SOLAR_ANG_DECI_DEGREE	Double	Storable Range: Stores up to 14 significant digits		Degrees	30.542	
FIDU_UNCLEAR	Text	Length: 3	Yes_or_No		No	Film camera only
SCALE_OFF	Text	Length: 3	Yes_or_No		No	
SHORT_FORWARD_OVERL	Text	Length: 3	Yes_or_No		No	

Name	Data Type	Size or Storable Range	Domain	Format/Unit	Example	Comment/Source
EXC_CRAB	Text	Length: 3	Yes_or_No		No	
VERT_OFF	Text	Length: 3	Yes_or_No		No	
COMB_CRAB_VERT_OF F	Text	Length: 3	Yes_or_No		No	
EXC_SMOKE_HAZE	Text	Length: 3	Yes_or_No		No	
EXC_SMOKE_HAZE_PC	Short Integer	Storable range: (-32, 768-32,767)		%	15	% of frame/tile
EXC_CLOUD_SHADOW	Text	Length: 3	Yes_or_No		No	
EXC_CLOUD_SHADOW _PC	Short Integer	Storable range: (-32, 768-32,767)		%	15	% of frame/tile
ARTIFACTS	Short Integer	Storable range: (-32, 768-32,767)		%	15	% of frame/tile
EXC_BASEFOG	Text	Length: 3	Yes_or_No		No	Film camera only
EXC_BASEFOG_MAXDE N	Float	Storable Range: Stores up to 7 significant digits			2.5	Maximum density, Film camera only
LOW_SUN_ANG	Text	Length: 3	Yes_or_No		No	
OVER_UNDER_EXP	Text	Length: 3	Yes_or_No		No	
OVER_UNDER_PROC	Text	Length: 3	Yes_or_No		No	
SNOW_PRES	Text	Length: 3	Yes_or_No		No	
SNOW_PRES_PC	Short Integer	Storable range: (-32, 768-32,767)		%	15	% of frame/tile
LIGHT_LEAK	Text	Length: 3	Yes_or_No		No	
TARGET_STA_NO	Text	Length: 10			1234A	
SCAN_MEDIA	Text	Length: 11	Scan_Media		Negative	
SCAN_CONTRACTOR	Text	Length: 30			Land Data Technologies	
SCAN_DEVICE	Text	Length: 30			VX4000HT	Model/Name
SCAN_NO	Text	Length: 20			0799V1C2172	Serial ID
SCAN_DISTORT_MICRO N	Short Integer	Storable range: (-32, 768-32,767)		Micrometres	3	One standard deviation
PIXEL_SIZE	Float	Storable Range: Stores up to 7 significant digits		Micrometres	15.0	At sensor level. Scanned imagery or digital camera
GROUND_SAMPLE_DIS T	Float	Storable Range: Stores up to 7 significant digits		Metres	0.5	
SCAN_SOFTWARE	Text	Length: 30			VXSCAN	
LICENSING_CONSTRAI NT	Text	Length: 130			Subject to license agreement with ESRD	To be supplied by Informatics
COPYRIGHT	Text	Length: 40			ESRD	To be supplied by Informatics
FILE_NAME	Text	Length: 30			AS1234_007..t if	
FORMAT	Text	Length: 10			TIFF	
*SCAN_DATE	Text	Length: 8		YYYYMMDD	19800625	
SCAN_YEAR	Short Integer	Storable range: (-32, 768-32,767)		YYYY	2000	
SCAN_MONTH	Short Integer	Storable range: (-32, 768-32,767)		MM	06	
SCAN_DAY	Short Integer	Storable range: (-32, 768-32,767)		DD	06	Short Integer

Name	Data Type	Size or Storable Range	Domain	Format/Unit	Example	Comment/Source
FILESIZE_MB	Float	Storable Range: Stores up to 7 significant digits			145.23	
COMPRESSION_DETAIL	Text	Length: 30			MRSID	
COMPRESSION_RATIO	Text	Length: 20			1:10	
ARCHIVE_MEDIA	Text	Length: 25			Hard drive	
ARCHIVE_ID	Text	Length: 30			RIMB123	To be supplied by Informatics
IMAGE_PIXEL_INVERTED	Text	Length: 3	Yes_or_No		Yes	
DIGIT_ENH_AP	Text	Length: 120			Adobe Photoshop	Software name
COMMENT	Text	Length: 100			Scratch - Across Entire Image	
ROW_COUNT	Long Integer	Storable range: (-2,147,483,648 - 2,147,483,648)			18930	
COLUMN_COUNT	Long Integer	Storable range: (-2,147,483,648 - 2,147,483,648)			18930	
AT_FILE_FOLDER	Text	Length: 25			1_1.sup	AT import file/folder
*AT_GPS_PROJECTION	Text	Length: 16	AT_GPS_Projection		UTM-11	
MODEL_NO	Long Integer	Storable range: (-2,147,483,648 - 2,147,483,648)			123456	For TAPE4 file only
*X_PHOTO_CEN_M	Double	Storable Range: Stores up to 14 significant digits		Metres	350000.123	EO/GPS File
*Y_PHOTO_CEN_M	Double	Storable Range: Stores up to 14 significant digits		Metres	5400000.123	EO/GPS File
*Z_PHOTO_CEN_M	Double	Storable Range: Stores up to 14 significant digits		Metres	5000.123	EO/GPS File
*OMEGA	Double	Storable Range: Stores up to 14 significant digits			-0.53010	EO/IMU File
OMEGA_UNIT	Text	Length: 7	Grad_Deg_Rad		Grads	
*PHI	Double	Storable Range: Stores up to 14 significant digits			0.15202	EO/IMU File
PHI_UNIT	Text	Length: 7	Grad_Deg_Rad		Grads	
*KAPPA	Double	Storable Range: Stores up to 14 significant digits			178.26497	EO/IMU File
KAPPA _UNIT	Text	Length: 7	Grad_Deg_Rad		Grads	
HEIGHT_TRANSFORMATION	Text	Length: 15	Height_Transformation		HTV2.0	
GPS_TIME	Double	Storable Range: Stores up to 14 significant digits		Seconds	246532.982123	GPS File

Appendix B
Sample Reports

Sample Densitometry Report

IMAGE DENSITOMETRY DATA

JOB NUMBER: DW018
07-31-2004

FRAME #	DMIN	DMAX	DIFFERENCE
30	0.40	1.24	0.84
81	0.40	1.22	0.82
AVERAGE:	0.40	1.23	0.83

AVERAGE GRADIENT: 0.93

BASE AND FOG: 0.1100

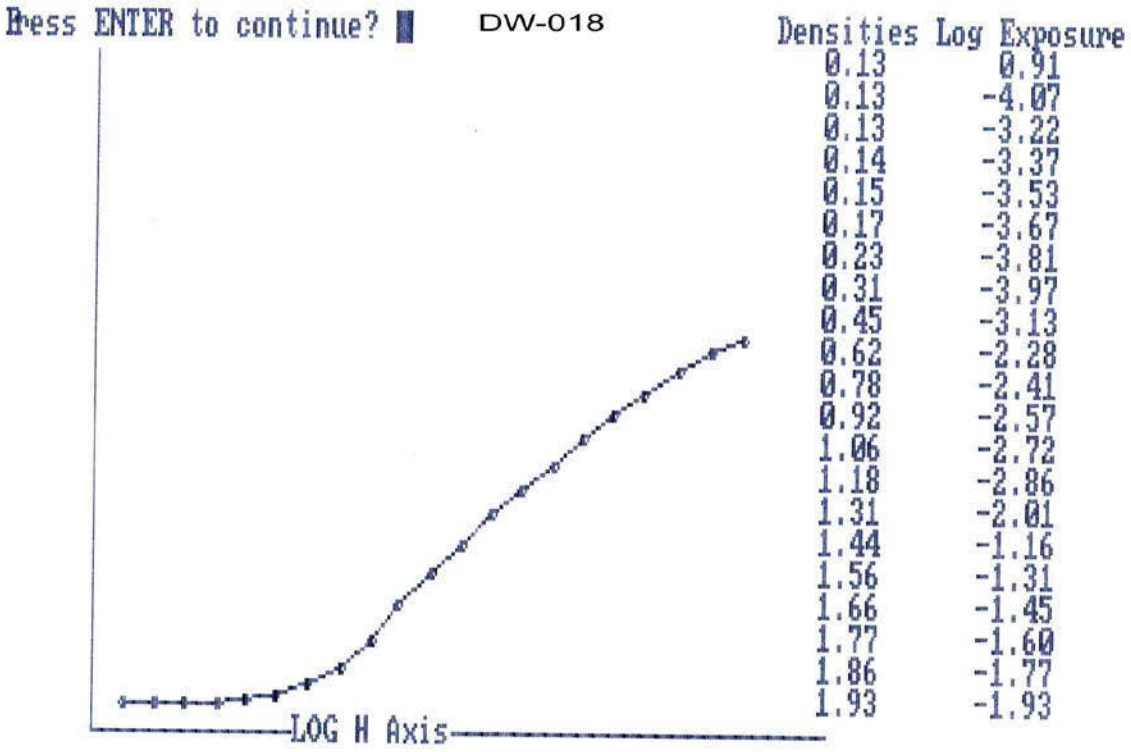
CONTRACTOR : FOTO FLIGHT
Sampling Percentage accepted is: : 100
I.C.A.S. SPEC. #27 : ***** PASSED *****
I.C.A.S. SPEC. #26 : ***** PASSED *****

Sample Sensitometry Report

```
                    ------------------
                    CONTRACTOR: FOTO FLIGHT   DW-018
Development  Racks       :2
film type : Infrared : KODAK IR
Chemical Type          :"Kodak 885"
Enter Dev. Temp.       :84
Enter Machine Speed    :8.5
Enter Machine Number   :1
Enter your initials    :sp
                BEGIN STEPWEGDE MEASURMENTS
                     Measure STEP :  1

STEP 21 : 0.1300    STEP 14 : 0.3100    STEP  7 : 1.3100
STEP 20 : 0.1300    STEP 13 : 0.4500    STEP  6 : 1.4400
STEP 19 : 0.1300    STEP 12 : 0.6200    STEP  5 : 1.5600
STEP 18 : 0.1400    STEP 11 : 0.7800    STEP  4 : 1.6600
STEP 17 : 0.1500    STEP 10 : 0.9200    STEP  3 : 1.7700
STEP 16 : 0.1700    STEP  9 : 1.0600    STEP  2 : 1.8600
STEP 15 : 0.2300    STEP  8 : 1.1800    STEP  1 : 1.9300

            Average Gradient : 0.93
                Base and Fog : .12
                EAFS :  125    PEM :  166    DIN : 18   ISO :   51
Press Enter key to continue?
```



Sample Flight Report

FOTO FLIGHT

Aerial Photography Report

Camera Type	Film Type			AENV Roll Number	
WILD RC-30	KODAK 1443 CIR			AS 5307 F	
Lens Number	Emulsion Number	Expiry Date			
13332	1271013	11/04			
Calibrated Focal Length	Magazine No.	Filter Type and Number			
153.358 mm	2877/2801	525 nm			

AENV Project Number	Date	Annotated Negative Numbers	Line Number and Direction	Exposure No. Start	Exposure No. Finish	U.T.C. Start	U.T.C. Finish	True Altitude Above Sea Level	Camera Exposure	Field Roll#	Avg. Scale
04-030	Aug 17, 04	049-054	L-1 E	0018	0013	17:10	17:06	17,800'	1/350	DW-031	1:30,000
04-030	Aug 17, 04	055-060	L-2 E	0019	0024	17:15	17:17	17,800'	1/350	DW-031	1:30,000

Comments:

04-030 T33 R19 W4 Grassland Inventory Pilot

FOTO FLIGHT JOB NUMBER: J2004-044

Total lines number for this project: 2

	Take Off	Land At	Take Off	Land At	Take Off	Land At	Take Off	Land At
Date	Aug 17, 04	Aug 17, 04						
	From		From		From		From	
Base	YYC	YYC						
Time	16:19	17:48						

Aircraft Registration	Type	Photographer
C-FFSL	PIPER NAVAJO PA-31	DALE WEIR
Camera Port Category	Altimeter Number	Navigator
A	C115743	DALE WEIR
Camera Port Number		Pilot
A		THIERRY NOBLET

Sample Camera Calibration Report

USGS Report No. OSL/2936

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192

REPORT OF CALIBRATION
of Aerial Mapping Camera

April 7, 2003

Camera type: Wild RC30*
Lens type: Wild Universal Aviogon /4-S
Nominal focal length: 153 mm

Camera serial no.: 5283
Lens serial no.: 13332
Maximum aperture: f/4
Test aperture: f/4

Submitted by: Foto Flight Surveys, Ltd.
Calgary, Alberta, Canada

Reference: Foto Flight Surveys, Ltd. purchase order No. 79903, dated March 31, 2003, signed by Mr. Dave Skelton.

These measurements were made on Kodak Micro-flat glass plates, 0.25 inch thick, with spectroscopic emulsion type 157-01 Panchromatic, developed in D-19 at 68° F for 3 minutes with continuous agitation. These photographic plates were exposed on a multicollimator camera calibrator using a white light source rated at approximately 5200K.

I. Calibrated Focal Length: 153.358 mm

II. Lens Distortion

Field angle:	7.5°	15°	22.7°	30°	35°	40°
Symmetric radial (um)	-1	-2	-2	0	2	1
Decentering (um)	0	0	1	1	2	3

Symmetric radial distortion parameters	Decentering distortion parameters	Calibrated principal point
$K_0 = 0.7748 \times 10^{-4}$	$P_1 = 0.2614 \times 10^{-7}$	$x_p = 0.007$ mm
$K_1 = -0.1521 \times 10^{-7}$	$P_2 = 0.1844 \times 10^{-6}$	$y_p = -0.007$ mm
$K_2 = 0.5966 \times 10^{-12}$	$P_3 = 0.0000$	
$K_3 = 0.0000$	$P_4 = 0.0000$	
$K_4 = 0.0000$		

The values and parameters for Calibrated Focal Length (CFL), Symmetric Radial Distortion (K_0,K_1,K_2,K_3,K_4), Decentering Distortion (P_1,P_2,P_3,P_4), and Calibrated Principal Point [point of symmetry] (x_p,y_p) were determined through a least-squares Simultaneous Multiframe Analytical Calibration (SMAC) adjustment. The x and y-coordinate measurements utilized in the adjustment of the above parameters have a standard deviation (σ) of ±3 microns.

* Equipped with Forward Motion Compensation

(1 of 4)

III. Lens Resolving Power in cycles/mm

Area-weighted average resolution: 108

Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	113	159	134	113	113	113	95
Tangential lines	113	134	134	113	113	80	80

The resolving power is obtained by photographing a series of test bars and examining the resultant image with appropriate magnification to find the spatial frequency of the finest pattern in which the bars can be counted with reasonable confidence. The series of patterns has spatial frequencies from 5 to 268 cycles/mm in a geometric series having a ratio of the 4th root of 2. Radial lines are parallel to a radius from the center of the field, and tangential lines are perpendicular to a radius.

IV. Filter Parallelism

The two surfaces of the Wild 420 filter No. 7611 and the 525 filter No. 7592 accompanying this camera are within 10 seconds of being parallel. The 525 filter was used for the calibration.

V. Shutter Calibration

Indicated time (sec)	Rise time (μ sec)	Fall Time (μ sec)	½ width time (ms)	Nom. Speed (sec.)	Efficiency (%)
1/125	1696	1684	8.18	1/140	87
1/250	880	880	4.25	1/270	87
1/500	458	454	2.17	1/530	87
1/1000	234	230	1.09	1/1060	87

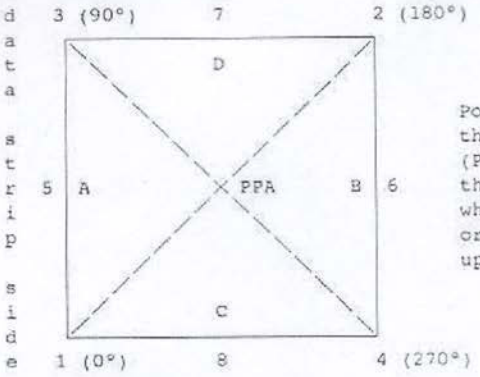
The effective exposure times were determined with the lens at aperture f/4. The method is considered accurate within 3 percent. The technique used is Method I described in American National Standard PH3.48-1972(R1978).

VI. Film Platen

The film platen mounted in Wild RC30 drive unit No. 5283-655 does not depart from a true plane by more than 13 um (0.0005 in).

This camera is equipped with a platen identification marker that will register "655" in the data strip area for each exposure.

VII. Principal Points and Fiducial Coordinates



Positions of all points are referenced to the principal point of autocollimation (PPA) as origin. The diagram indicates the orientation of the reference points when the camera is viewed from the back, or a contact positive with the emulsion up. The data strip is to the left.

	X coordinate	Y coordinate
Indicated principal point, corner fiducials	0.003 mm	0.006 mm
Indicated principal point, midside fiducials	0.003	0.007
Principal point of autocollimation (PPA)	0.0	0.0
Calibrated principal point (pt. of sym.) x_p, y_p	0.007	-0.007

Fiducial Marks		
1	-106.000 mm	-105.994 mm
2	106.003	106.003
3	-105.997	106.005
4	106.003	-105.994
5	-111.999	0.007
6	112.003	0.007
7	0.007	112.006
8	-0.002	-111.996

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.813 mm 3-4: 299.813 mm

Lines joining these markers intersect at an angle of 90° 00' 03"

Midside fiducials

5-6: 224.002 mm 7-8: 224.002 mm

Lines joining these markers intersect at an angle of 89° 59' 52"

Corner fiducials (perimeter)

1-3: 211.999 mm 2-3: 211.999 mm

1-4: 212.003 mm 2-4: 211.997 mm

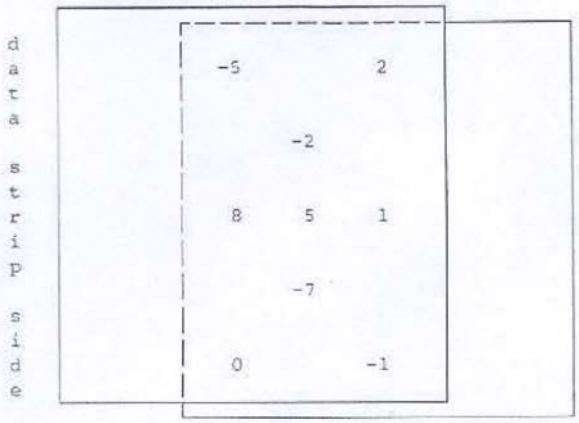
The method of measuring these distances is considered accurate within 0.003 mm

Note: For GPS applications, the nominal entrance pupil distance from the focal plane is 277 mm.

IX. Stereomodel Flatness

FMC Drive Unit No.: 5283-655 Base/Height ratio: 0.6

Platen ID: 655 Maximum angle of field tested: 40°



Stereomodel
Test point array
(values in micrometers)

The values shown on the diagram are the average departures from flatness (at negative scale) for two computer-simulated stereo models. The values are based on comparator measurements on Kodak 4425 copy film made from Kodak 2405 film exposures. These measurements can vary by as much as ± 5 μm from model to model.

X. System Resolving Power on film in cycles/mm

Area-weighted average resolution: 53 Film: Type 2405

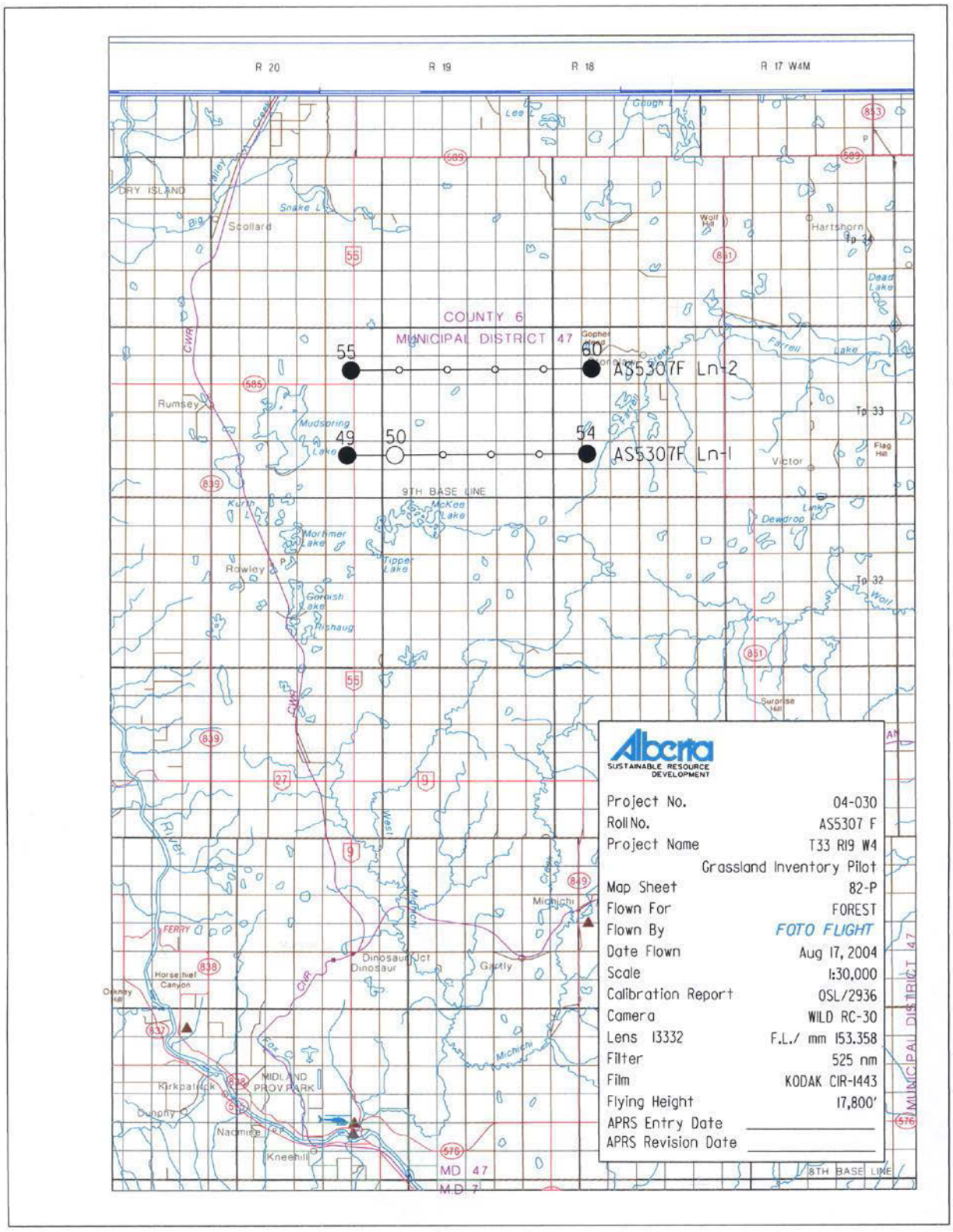
Field angle:	0°	7.5°	15°	22.7°	30°	35°	40°
Radial Lines	57	57	57	57	57	48	48
Tangential lines	57	57	57	57	57	48	48

This aerial mapping camera calibration report supersedes the previously issued USGS Report No. OSL/2631, dated March 21, 2000.

Gregory I. Snyder
Commercial Remote Sensing Project Manager
National Mapping Division

(4 of 4)

Sample Flight Index



Alberta
Environment and Sustainable Resource Development

CORPORATE SERVICES DIVISION
INFORMATICS BRANCH

PART 3

GENERAL SPECIFICATIONS

FOR

SCANNING AERIAL PHOTOGRAPHS

MARCH 2014
EDMONTON, ALBERTA

TABLE OF CONTENTS

PAGE

1. GENERAL

These specifications shall be used for scanning aerial photographs.

An asterisk (*) before a section heading indicates that the section has been revised substantially since the last release (June 2012).

2. INPUT SPECIFICATIONS

2.1 Scanner

Shall have a valid calibration report in terms of geometric and radiometric accuracies.

The geometric accuracy of the scanner shall be 3 micrometres at one standard deviation or better. There shall be no error exceeding 9 micrometres.

Only scanners that can handle uncut rolled negatives shall be used.

2.2 Aerial Photographs

The Contracting Department will provide the annotated negatives/diapositives to be scanned.

3. OPERATIONAL SPECIFICATIONS

3.1 Prior to Scanning

Negatives/diapositives produced 5 years ago or earlier shall be cleaned prior to scanning.

The scanner stage shall be cleaned and shall be routinely checked for cleanliness during the scanning of a batch of diapositives/negatives.

The introduction of scratches or other marks to the materials by the scanner or at any time during the handling and processing shall be unacceptable and cause of rejection of the scans.

The orientation of the diapositive/negative in the scanner, the position of the film emulsion surface with respect to the scanner stage, operational requirements regarding the glass or other cover plate and the residence time if any shall be noted and reported.

3.2 Scanning Parameters

The scanning parameters e.g. illumination, speed, aperture, pixel size, etc shall be noted and reported.

Scanning resolution shall be 15 micrometres unless otherwise specified in the project specifications.

For negative scanning, resulting images shall be reversed to produce positive images.

3.3 Data Re-sampling

The scanned data shall not be re-sampled to a smaller pixel size unless permission is given by the Department.

4. OUTPUT SPECIFICATIONS

4.1 Data Quality

The entire photographic image including all fiducial marks shall be scanned.

There shall be no artifacts in the image. Artifacts are objects that are not part of the original film image or the true image produced by the scanner.

There shall be no saturation of the image in an area greater than 200 X 200 pixels in which the pixel value is 255 or 0.

Pixel histograms shall be Gaussian with the mean centred at a pixel value between 118 and 127.

There shall be neither unusual spikes nor gaps in individual pixel bins.

The data shall be accurate to within one pixel at one standard deviation with respect to the camera calibration data.

4.2 Data Format

Scanned data shall be recorded with 8 bit pixel values for panchromatic images and 24 bits for colour images. Each diapositive/negative shall have one file. Files shall be uncompressed in TIFF version 6x format.

4.3 File Naming Convention

Each file shall be named as
AAAAAAA_NNNN_LLL_BBB_YY_PPP.TIF, where AAAAAAA=roll number, NNNN=frame number, LLL=line number, BBB=band, YY=year flown, PPP=project number (without year)

e.g. **AS5449N_0001_01E_RGB_08_029.TIF**

4.4 *Media

All files shall be delivered on hard drive(s) with a minimum capacity of 250 GB.
Drives are to be new (not previously used for other business), include USB 3.0 connectivity (they may possess other means of data transfer such as FireWire or eSATA in addition to USB 3.0), and no drive volume is to be larger than 2 TB. Hard drives larger than 2TB shall be partitioned such that this condition is met. Such drives are to be provided by the Contractor and will become the property of the Government of Alberta.

4.4.1 Media Deliverable Labels

Each drive/DVD shall have two labels described below.

4.4.1.1 <u>Drive/DVD Information</u>

- Drive Name – Contract No. + additional information, if required. i.e.
  09RIM052
  09RIM052_# ……..._#: Sequential no. if deliverable takes multiple drives
  09RIM052_A_# …..._A_#: **A, B or C** is the contractor name, if a contract has
  …..._B_# multiple contractors
  …._C_#
- Year(s) of imagery captured
- Band - PAN/RGB/IR/CIR/RGBN
- Imagery Type - <camera>Stereo Imagery
  <camera>: RC30/LMK/etc.
- Projection - 10TM with or without offset/UTM Zone 10, Zone 11, Zone 12, Zone 13
- Resolution - 0.5 m/1.0 m/etc.
- Project Name
- Contractor Name
- Re-submission No. - Has to state original drive name(s) and additional information
- Volume of data / Drive capacity i.e. 0.85 / 1 TB

The following are some sample labels.

a) First submission

09RIM051_1
2008
RGB Stereo
LMK Imagery
2.5 m.
UTM Zone 11
Kananaskis/Bighorn
Land Data Technologies
0.75 / 1TB

b) Re-submission

2nd Submission of:

09RIM053_1, 09RIM053_2 & 09RIM053_3
2004 – 06
PAN Stereo
RC30
0.5 m.
UTM Zone 11
AECOM
0.6 / 1TB
2nd Submission Info: Metadata

c) Re-submission

3rd Submission of:

09RIM053_2 & 09RIM053_3
2004 - 06
CIR Stereo
LMK
0.5 m.
UTM Zone 12
Orthoshop
0.87 / 1TB
3rd Submission Info: 72E to 74M

4.4.1.2 *Informatics Branch Standard Label

4.4.2 Media Cables

Media cables of hard drives are part of the deliverable which shall be submitted and kept inside the media box. Cables shall be labeled with the media identification.

i.e. Drive Name. See 1st bullet of section 4.4.1.1 above

4.5 *Attribute Table

The attribute table of the file geodatabase specified in section 4.6.3, Part 2 *General Specifications for Aerial Photography* shall be filled in with correct data for the following fields:

Air Photo Geodatabase Attribute Table

*Means that the field has changed from the last version.

Name	Data Type	Size or Storable Range	Domain	Format/Unit	Example	Comment/Source
SCAN_MEDIA	Text	Length: 11	Scan_Media		Negative	
SCAN_CONTRACTOR	Text	Length: 30			Land Data Technologies	
SCAN_DEVICE	Text	Length: 30			VX4000HT	Model/Name
SCAN_NO	Text	Length: 20			0799V1C2172	Serial ID
SCAN_DISTORT_MICRON	Short Integer	Storable range: (-32, 768-32,767)		Micrometres	3	One standard deviation
PIXEL_SIZE	Float	Storable Range: Stores up to 7 significant digits		Micrometres	15.0	
GROUND_SAMPLE_DIST	Float	Storable Range: Stores up to 7 significant digits		Metres	0.5	
SCAN_SOFTWARE	Text	Length: 30			VXSCAN	
LICENSING_CONSTRAINT	Text	Length: 130			Subject to license agreement with ESRD	To be supplied by RIMB
COPYRIGHT	Text	Length: 40			ESRD	To be supplied by RIMB
FILE_NAME	Text	Length: 30			AS1234_007.tiff	
FORMAT	Text	Length: 10			TIFF	

*SCAN_DATE	Text	Length: 8		YYYYMMDD	19800625	
SCAN_YEAR	Short Integer	Storable range: (-32, 768-32,767)		YYYY	2000	
SCAN_MONTH	Short Integer	Storable range: (-32, 768-32,767)		MM	06	
SCAN_DAY	Short Integer	Storable range: (-32, 768-32,767)		DD	09	
FILESIZE_MB	Float	Storable Range: Stores up to 7 significant digits			145.23	
COMPRESSION_DETAIL	Text	Length: 30			MRSID	
COMPRESSION_RATIO	Text	Length: 20			1:10	
ARCHIVE_MEDIA	Text	Length: 15			Hard drive	
ARCHIVE_ID	Text	Length: 30			RIMB123	To be supplied by Informatics Branch
IMAGE_PIXEL_INVERTED	Text	Length: 3	Yes_or_No		Yes	
DIGIT_ENH_AP	Text	Length: 120			Adobe Photoshop	Software name
COMMENT	Text	Length: 100			Scratch - Across Entire Image	
ROW_COUNT	Long Integer	Storable range: (-2,147,483,648 - 2,147,483,648)			18930	
COLUMN_COUNT	Long Integer	Storable range: (-2,147,483,648 - 2,147,483,648)			18930	

Domain name	Domain Properties				Coded Values	
	Field Type	Domain Type	Split Policy	Merge Policy	Code	Description
Yes_or_No	Text	Coded Values	Duplicate	Default	Y	Yes
					N	No
Scan_Media	Text	Coded Values	Duplicate	Default	N	Negative
					D	Diapositive
					P	Positive

When entering data into fields that make use of coded values, the full text description shall be used rather than the code.

5. SUMMARY OF MATERIALS

5.1 Materials to be Supplied by the Contracting Department

a) Diapositives/negatives to be scanned.
b) Flight index map
c) Metadata template in file geodatabase format

5.2 Materials to be Delivered by the Contractor

a) All materials supplied to the Contractor.
b) Scanned images on portable hard drives as per Section 4.4
c) Updated file geodatabase
d) Reports including orientation of the diapositive/negative on the scanner, and scanning parameters.

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Environment and Sustainable Resource Development

CORPORATE SERVICES DIVISION
INFORMATICS BRANCH

PART 4

GENERAL SPECIFICATIONS

FOR

AERIAL TRIANGULATION

MARCH 2014
EDMONTON, ALBERTA

TABLE OF CONTENTS

PAGE

1. GENERAL

The objective of aerial triangulation is to determine the exterior orientation of the aerial photography to ensure that each photogrammetric model can be oriented accurately as required for stereo-compilation in either vector or orthophoto mapping.

An asterisk (*) before a section heading indicates that the section has been revised substantially since the last release (June 2012).

2. INPUT SPECIFICATIONS

2.1 Instruments

Only softcopy photogrammetry systems such as Z/I Imaging, Socet Set, etc. shall be used.

2.2 Materials

2.2.1 Flight Index Map

See Section 4.6.3, Part 2 *General Specifications for Aerial Photography*.

2.2.2 Camera Calibration Report

Camera calibration report shall be specific for the camera and made within three years prior to the time of photography.

2.3 Ground Control Data

Accuracies of ground control points shall be stated in the project specifications. Coordinate data shall be provided in ASCII format.

2.3.1 Existing Ground Control

Where GPS/IMU data does not exist, ground control points may be taken from the 1:60 000 aerial triangulation which was used for the 1:20 000 base mapping program. Diapositives where points have been marked and contact prints where the points are coded may be made available upon request through Airphoto Distribution Services, Informatics Branch. Coordinates are in SPACE-M TAPE4 format available from Data Distribution, Informatics Branch.

2.3.2 Ground Control Survey

See Part 1 *General Specifications for Ground Control Surveys.*

2.4 *GPS Photo Centres

Coordinates are time-tagged and in the proper coordinate system. Heights shall be orthometric, referenced to the Canadian Geodetic Vertical Datum of 1928 (CGVD28).

3. OPERATIONAL SPECIFICATIONS

3.1 Photo IDs

Photo identification shall use the names of the image files.

3.2 Measurements and Computations

Calibrated focal length given on the camera calibration report shall be used in all computations.

3.2.1 Film Shrinkage Correction

Film shrinkage correction shall be applied to photo coordinates, based on measurement of fiducial marks and derived from a least squares adjustment.

The allowable standard deviation shall be one pixel or less. No residual errors shall exceed two pixels.

This section is not required if imagery was acquired using a digital camera.

3.2.2 Point Measurements and Model Computations

Measurements may be done automatically.

Lens distortion, earth curvature and atmospheric refraction corrections shall be applied.

Residual parallaxes shall not exceed 3 pixels. Root mean square error (RMSE) shall not exceed one pixel.

3.3 Adjustment

3.3.1 Computer Program

Any fully tested bundle adjustment program shall be used for the adjustment. The adjustment shall undergo sufficient iterations (a minimum of 3) to reduce the corrections to rotation angles to less than 0.003 degree or corrections to ground coordinates are less than 0.001 m (absolute value).

Before the final iteration, earth curvature correction shall be applied if not considered previously.

3.3.2 Weights

Weights shall be assigned to the control points depending on their accuracies computed as the inverse of standard deviation squared.

3.3.3 Adjustment Results

RMSE's (in micrometres) at image scale of residuals in the adjustment shall not exceed the following:

a) Tie and pass points: one pixel or better in XY and Z where XY = square root ((X) (X) + (Y) (Y)), with X and Y being the RMSE of the residuals in X and Y.

b) Ground control points: 1.5 pixel in XY and in Z or better.

No residual in the above points shall exceed 3.0 times RMSE in XY and 2.5 times RMSE in Z. 3.0 times RMSE is considered outside the error histogram for two-dimensional data, while 2.5 times RMSE for one-dimensional data.

4. OUTPUT SPECIFICATIONS

4.1 Model Diagram

Shall be in file geodatabase format showing the photo centres and ground control points.

4.2 Final Adjustment Output

4.2.1 Report

Shall be complete showing project number, date, photo scale, horizontal and vertical datums, projection, reference meridian, photo numbers, adjusted coordinates, residuals and RMSE's of tie points and control points. It shall indicate that at least three (3) iterations were done.

4.2.2 *Output Files

The following data shall be submitted:

a) Exterior orientation files (text format) with image IDs (final image file names), X, Y, Z, omega, phi, kappa, image time, projection/datum information at a minimum - *.eo or *.txt
b) Suitable import files for setup of the stereo model data in a digital photogrammetric software package (DATEM Summit Evolution). Examples include: .sup files, Z/I ISAT files, Leica .ads, .odf, .adj, .cam, .sup files etc.. File format must be approved by the Contracting Department prior to use.

4.3 *Attribute Table

The attribute table of the file geodatabase described in section 4.6.3, *Part 2 General Specifications for Aerial Photography* shall be updated for the following fields:

Air Photo Geodatabase Attribute Table

*Means that the field has changed since the last version.

Name	Data Type	Size or Storable Range	Domain	Format/Unit	Example	Comment/Source
AT_FILE/FOLDER	Text	Length: 25			1_1.sup	AT import file/folder
*AT_GPS_PROJECTION	Text	Length: 16	AT_Projection		UTM-11	
MODEL_NO	Long Integer	Storable range: (-2,147,483,648 - 2,147,483,648)			123456	TAPE4 file
*X_PHOTO_CEN_M	Double	Storable Range: Stores up to 14 significant digits		Metres	350000.123	EO/GPS File
*Y_PHOTO_CEN_M	Double	Storable Range: Stores up to 14 significant digits		Metres	5400000.123	EO/GPS File
*Z_PHOTO_CEN_M	Double	Storable Range: Stores up to 14 significant digits		Metres	5000.123	EO/GPS File
*OMEGA	Double	Storable Range:			-0.53010	EO/IMU File

		Stores up to 14 significant digits				
OMEGA_UNIT	Text	Length: 7	Grad_Deg_Rad		Grads	
*PHI	Double	Storable Range: Stores up to 14 significant digits			0.15202	EO/IMU File
PHI_UNIT	Text	Length: 7	Grad_Deg_Rad		Grads	
*KAPPA	Double	Storable Range: Stores up to 14 significant digits			178.26497	EO/IMU File
KAPPA _UNIT	Text	Length: 7	Grad_Deg_Rad		Grads	
HEIGHT_TRANSFORMATION	Text	Length: 15	Height_Transformation		HTV2.0	
GPS_TIME	Double	Storable Range: Stores up to 14 significant digits		Seconds	246532.982123	GPS File

Domain name	Domain Properties				Coded Values	
	Field Type	Domain Type	Split Policy	Merge Policy	Code	Description
Height _Transformation					A	None
					B	GSD95
					C	CGG2000
					D	CGG2005
					E	HTv2.0
					F	Other
					G	Unknown
AT_Projection	Text	Coded Values	Duplicate	Default	UTM-11	UTM-11
					UTM-12	UTM-12
					10TM-Forest	10TM (Forest)
					10 TM-Resource	10TM (Resource)
					3TM 111	3TM 111
					3TM 114	3TM 114
					3TM 117	3TM 117
					3TM 120	3TM 120
					Geographic	Geographic
Grad_Deg_Rad	Text	Coded Values	Duplicate	Default	G	Grads
					D	Degrees
					R	Radians

When entering data into fields that make use of coded values, the full text description shall be used rather than the code.

5. SUMMARY OF MATERIALS

5.1 *Materials to be Supplied by the Contracting Department

a) Flight index map
b) Ground control coordinates in ASCII format
c) Camera calibration report in PDF format
d) Image files for the entire project in TIFF format
e) GPS photo centre coordinates in ASCII format
f) IMU orientation information in ASCII format
g) File geodatabase template

5.2 Materials to be Delivered by the Contractor:

All materials supplied to the Contractor.

The following data shall be submitted via CD, DVD, hard drives or FTP:

a) Complete adjustment report in ASCII format
b) Exterior orientation data in a mutually agreeable format
c) Files for importing orientation data to any softcopy photogrammetry system in a mutually agreeable format
d) Updated file geodatabase
e) Packing slip listing: in ASCII format
    i. contract number
    ii. total number of photos
    iii. materials submitted

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CORPORATE SERVICES DIVISION
INFORMATICS BRANCH

PART 5

GENERAL SPECIFICATIONS

FOR

DIGITAL ORTHOPHOTO PRODUCTION

MARCH 2014
EDMONTON, ALBERTA

TABLE OF CONTENTS

PAGE

1. GENERAL

The quality of the final orthophoto product is a direct function of the photographic and photogrammetric input. Therefore, it is the Contractor's responsibility to carefully monitor all input and process parameters before, during and after the various production sequences. Production of the orthophoto products shall be carried out with the following objectives:

a) Obtaining the exact scale for the project.
b) Maximum retention of image resolution.
c) Density and tonal match between all models.

Orthophoto imagery shall be produced to cover the project area, at a scale and in a form designated by the Contracting Department.

2. INPUT SPECIFICATIONS

2.1 Aerial Triangulated Adjustment Data

The aerial triangulated adjustment data shall meet the Part 4 *General Specifications for Aerial Triangulation*.

2.2 *Source Imagery

These specifications relate to imagery captured from an aircraft as opposed to satellite data.

The original photography shall have between 60% and 80% forward overlap and between 20% and 30% lateral overlap if originating from an analogue film camera or frame-based digital sensor. The original photography shall have 100% forward overlap and between 20% and 30% lateral overlap if originating from a push-broom sensor.

If applicable, the digital image shall be created by scanning the original aerial film negative as per Part 3 *General Specifications for Scanning Aerial Photographs*. Scanning from paper prints is not acceptable.

The Contracting Department shall supply the original roll of film from which the digital data shall be created. If the Contractor is not satisfied that the orthophoto quality standards specified can be met, he/she shall communicate this in writing to the Contracting Department prior to orthophoto production.

The Contractor shall be responsible for the shipping and safety of the original rolls of aerial film and all other materials supplied by the Contracting Department.

2.3 Scanner

For details regarding Scanners see Part 3 *General Specifications for Scanning Aerial Photographs*. This is not required if imageries were acquired using a digital camera.

2.4 *Digital Elevation Model (DEM) Data

The best available elevation information shall be used for orthorectification. The Contracting Department shall advise the Contractor which DEM to use. Choices may include DEM generated from Light Detection and Ranging (LiDAR) technology, the 1:20,000 Provincial DEMs, DEMs generated through auto-correlation of stereo imagery or other sources.

Any anomalies (blunders) observed in the DEM data that will impact the final orthophoto quality or exceeding 10 m shall be corrected prior to the application of image rectification algorithms.

All contractor-generated DEM information will be provided to the Province as part of the deliverables in a mutually agreeable format.

2.5 Camera Calibration Reports

The camera calibration reports will be provided to the Contractor. These reports include fiducial distances/coordinates, radial distortions and calibrated focal length. Fiducial distances/coordinates are not required if imageries were acquired using a digital camera.

3. OPERATIONAL SPECIFICATIONS

3.1 Scanned Digital Imagery

The negatives shall be scanned as per Part 3 *General Specifications for Scanning Aerial Photographs* at the pixel size specified in the project specifications. This is not required if imageries were acquired using a digital camera.

3.1.1 Image Radiometry

Variances in image tone from photo to photo or between lines of photo shall be considered and minimized during the orthophoto production process.

The original images may have a bit-depth of 12 bits per pixel or greater (i.e. 4096 or more gray values). This data is then processed using software, which runs a logarithmic function, which transforms the original shades to 256 shades (i.e. 8 bits).

3.1.2 *Pixel Size

The final ortho pixel size shall be specified in the project specifications.

The original images or scans used in the creation of orthophotos shall not be resampled (up-sampled) by more than 5 percent of the original resolution.

Example: For the creation of a 0.6-metre orthophoto, the input imagery must have a resolution of 0.63-metres or better.

3.2 Image Rectification

The scanned aerial photography data is rectified to an orthographic projection by processing each image pixel through photogrammetric space resection equations. The inputs required to perform this rectification are:

- camera calibration report
- DEM data
- raw digital image
- triangulated exterior orientation data

3.2.1 Camera Calibration Report

The following parameters from the camera calibration report shall be factored into the rectification algorithms: fiducial distances/coordinates, radial lens distortions and calibrated focal length. Fiducial distances/coordinates are not required if imageries were acquired using a digital camera.

3.2.2 Earth Curvature and Refraction Corrections

Earth curvature and refraction corrections shall be applied during orthorectification.

3.2.3 Inner Orientation

A minimum of four fiducials on each digital image frame shall be measured. The result of the transformation shall yield a root mean square error (RMSE) of one pixel or less. No residual error shall exceed two times the RMSE. This is not required if imageries were acquired using a digital camera.

3.2.4 Exterior Orientation.

At least six control points per model or photo shall be used. The RMSE shall be less than or equal to 20 micrometres at image scale.

3.2.5 DEM Data

The DEM data shall be converted into raster format at the same sampling interval and orientation as the image.

3.2.6 Image Rectification Algorithm

Image rectification shall be carried out using cubic convolution, an equivalent, or better algorithm. Nearest neighbour and bi-linear interpolations are not acceptable.

4. OUTPUT SPECIFICATIONS

4.1 *Geographic Extent

The area of coverage for a standard orthophoto is one township. Each orthophoto requires an overlap in order to facilitate edge matching and mosaicking. For production based on the Alberta Township System (ATS), coverage shall extend a minimum of 300 metres beyond the township boundary. Production based on geographic entities other than the ATS will be stipulated in the project requirements.

If quarter-townships are to be used, the images shall be divided into the following 4 quadrants: NE (North-East), NW (North-West), SE (South-East), and SW (South-West)

Orthophotos shall be based on the coordinate envelopes of the required tiling polygons such that the resulting images are "squared" to eliminate areas of no data at the edges.

4.2 *Mosaicking

Orthophotos may be created using multiple digital images (chips) to produce the final product so long as all images are from the same type of sensor and from the same acquisition season. When a mosaic of two or more chips is made, the brightness and colour values of the other chips will be adjusted to match that of the principal chip. The join lines between multiple chips will be chosen to minimize tonal variations. Localized adjustment of the brightness and colour values will be done to reduce radiometric differences between join areas. Orthophotos shall also be radiometrically balanced across the entire project area to eliminate tone and contrast differences and to provide a uniform appearance. If feathering is used to eliminate the visibility of a join line it shall not result in image degradation such as blurring or double imagery.

Specular reflection in imagery shall be minimized by patching the area using chips from another image.

Edge-matching between image chips shall be better than +/- 3 pixels.

4.3 *Orthophoto Accuracy

All well-defined ground features shall be located within 100 micrometres at one standard deviation of their true position expressed at the scale of the aerial photography. If this standard can not be met, the Contractor shall advise the Contracting Department prior to commencing production.

In case of digital aerial photography, all well-defined ground features shall be located within three times the ground sample distance of the photography at one standard deviation.

4.4 *Image Quality

Quality control shall be exercised continuously throughout a contract. Procedures shall be established by the Contractor to ensure that all materials are delivered in accordance with the delivery schedule and at the required level of accuracy and quality. The image quality and coverage shall be continuously monitored and correction of deficiencies shall be undertaken immediately, as feasible with respect to the individual project requirements.

a) Imagery shall be free of blemishes, scratches, and artefacts that obscure ground feature detail.
b) There shall be no artifacts which do not represent any feature on the ground.
c) There shall be no saturation of the image in large area, i.e. areas greater than 200 by 200 pixels in which the pixel value is 255 or 0.
d) Pixel values for deep shadow area shall be within 10 and 20 inclusive.
e) Pixel values for highlight area shall be within 235 and 245.
f) Orthos shall be radiometrically balanced individually, and across the entire project area to give a consistent and uniform image appearance.

4.5 File Format

The format of the digital orthophotos files shall be uncompressed Geo-TIFF. Images should be delivered as 8 bits per pixel per band, unless otherwise specified.

4.6 *File Naming Convention

MRRTTT _OR_YYYYMMDD_GGGG_CCCC.TIF, where M=meridian, RR=range, TTT=township, OR=orthophoto, YYYYMMDD=date flown, GGGG=ground sample distance (cm), and CCCC=band)

e.g. **520100_OR_20060601_0100_RGBI.TIF**.

Orthophotos divided into quarter-townships shall be named as follows:

MRRTTTQQ _OR_YYYYMMDD_GGGG_CCCC.TIF, where M=meridian, RR=range, TTT=township, QQ = quadrant (NE, NW, SE, or SW), OR=orthophoto, YYYYMMDD=date flown, GGGG=ground sample distance (cm), and CCCC=band)

e.g. **520100NE_OR_20060601_0100_RGBI.TIF**.

4.7 Metadata

Metadata for each file shall be compiled by the contractor, and submitted to the department in XML format.

The metadata shall be in compliance with FGDC Content Standards for Digital Geospatial Metadata, ***CSDGM FGDC-STD-001-1998***.

The required elements to be populated shall conform to those elements presented in the ESRI ArcCatalog FGDC Classic metadata style sheet, and also shall conform with the FGDC CSGDM Synchronizer and ESRI Geography Network Synchronizer parameters available through ArcCatalog. Synchronizer settings for ISO shall not be included. More detailed description on the synchronizing parameters is provided in ESRI ArcGIS 9.2 Desktop Help Topic "Metadata Synchronization". (Note that for contractors who are using ArcCatalog for metadata creation, it is recommended to use the FGDC Classic Style Sheet to ensure the required fields are populated):
http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=Metadata_synchronization

Metadata shall include the mandatory population of fields required for publication to metadata services that facilitate organization, discovery, and distribution functions in ESRD. More detailed descriptions of these mandatory requirements are provided in ESRI ArcGIS 9.2 Desktop Help Topics "Requirements for Publishing Metadata to an ArcIMS Metadata Service" and "Adding Information Required by the ArcIMS Metadata Service". Regarding these requirements, it is important that references to ISO 19115 are populated where required and that syntax is exact:
http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=Requirements_for_publishing_metadata_to_an_ArcIMS_Metadata_Service

http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=Adding_information_required_by_the_ArcIMS_Metadata_Service

Keywords that are intended to be associated with a specific Keyword Thesaurus must be populated as such. In cases where the keywords are independent of a thesaurus, a null thesaurus entry shall be populated for the independent keywords in order to separate these from being associated with a specific thesaurus. An instance of this is shown in the enclosed example.

Where required, the format for entry of *dates* shall be YYYYMMDD. Avoid the use of slashes, dashes, or other delimiters.

Where required, the format for entry of *telephone numbers* shall be AAANNNNNNN, where AAA is the 3 digit area code, and NNNNNNN is the phone number. Avoid the use of slashes, dashes, brackets, or other delimiters.

Where required, the format for entry of *postal codes* shall be ANA NAN, where A is a capitalized alphabetic character and N is a numeric character. Leave a space between the first three characters and last three characters of the code. Avoid the use of dashes or other delimiters.

Where required, expressions of measurement shall be in the units for the dataset. For example, if the units of measure are Metres, a value shall be expressed as "0.02 Metres" rather than "2 Centimetres".

An XML template will be provided by the department to the successful contractor that contains mandatory ESRD specific business metadata marked with the following delimiter; <>. The template metadata shall also be part of the deliverable metadata. Note that the template provided may slightly vary from the example metadata record.

Contractors shall not modify the structure or ESRD provided content of the template XML. Example (may vary slightly with template provided to successful contractor).

The template and an example of the metadata will be provided in XML format to the Contractor.

The metadata shall describe the individual file. The metadata file shall be named

MRRTTT _OR_YYYYMMDD_GGGG_CCCC.tif.xml (filename.xml)

Where M=meridian, RR=range, TTT=township, OR=orthophoto, YYYYMMDD=date flown, GGGG=ground sample distance (cm), CCCC=band.

Here is a sample template in text format:

Identification_Information:
  Citation:
    Citation_Information:
      Originator: <Company name that generated the orthos>
      Title: <MRRTTT _OR_YYYYMMDD_GGGG_CCCC>
      Geospatial_Data_Presentation_Form: remote-sensing image
      Series_Information:
        Series_Name: Orthophotography
      Publication_Information:
      Other_Citation_Details:
        File naming convention:
        M = meridian
        RR = range
        TTT = township
        OR = orthophoto
        YYYY = year of photography
        MM = month of photography
        DD = day of photography
        GGGG = ground sample distance, centimetres
        CCCC = bands
  Description:
    Abstract: <Provide a brief summary of the dataset>
    Purpose: <Purpose of the dataset>
    Supplemental_Information: Project Name: <Name of project as referenced by data provider>/ Acquired under: Contract #<contract number> / Method of Capture: aerial photography / Camera Model: <manufacturer/model> / Camera Serial #: <serial number> / Camera Lens: <lens model> / Film (if applicable): <film> / Focal Length: <focal length with units> / Sensor/scanning

resolution (micrometres): <sensor/scan resolution> / Scanned Media: <negatives, diapositives or contact prints>/ Sensor Type: <Bayer matrix, film, linear array with prismatic separation, single lens, multi-lens stitched etc.> / Along-track field of view (degrees): <field of view> / Cross-track field of view (degrees): <field of view> / GPS Unit Model: <manufacturer/model> / GPS Unit Serial #: <serial number> / IMU Model: <manufacturer/model> / IMU Serial #: <serial number> / Aircraft: <aircraft model> / Airport: <airport used> / Flight Altitude (above ground level, metres): <value> / Airspeed (knots or km/h): <value with units> / Scale of photography: <scale> / Ground Sample Distance (metres): <GSD> / Swath Width (metres): <swath width> / Distance between Flight Lines (metres): <Distance b/w lines> / Percent overlap (direction of flight): <percent overlap> / Percent sidelap (between lines): <percent sidelap> / Maximum PDOP during mission: <PDOP> / Number of Base Stations used: <# of base stations> / Maximum Distance from GPS Base Station: <Max Distance from Base> / GPS Epoch rate (Hz): <GPS rate> / Elevation Mask (degrees): <Elev. Mask> / IMU Frequency (Hz): <IMU Frequency> / IMU Accuracy (Roll/Pitch/Yaw - degrees): <Accuracy roll/pitch/yaw> / Date of Manufacturer's Calibration (YYYYMMDD): <Date> / Date of System Calibration (YYYYMMDD) : <Date YYYYMMDD> / Bands contained within image (in order as stored within image): <Band 1 = x, Band 2 = y etc.> / Spectral bandwidths: <Red: xx - xx, Green: xx - xx etc.> / Bit depth: <bit depth> / Interpolation method used during resampling: <Interpolation Method> / Type of DEM used during rectification: <DTM/DSM> / Number of ground control points used during aerial triangulation: <number of points> / Presence of Snow in Dataset <Y/N> / Presence of cloud in image: <Y/N> / Percentage of image obscured by cloud: <%> / Presence of smoke/haze in image: <Y/N> / Colour balancing/correction applied (describe): <Y/N, describe> / NoData value: <NoData> / Orthophoto tiling system: <Describe orthophoto tiling system> / Naming convention: <Describe naming convention employed>

Time_Period_of_Content:

Time_Period_Information:

Range_of_Dates/Times:

Beginning_Date: <YYYYMMDD for imagery used to create orthophoto tile referenced in this record>

Beginning_Time: <HH:MM for imagery used to create orthophoto tile referenced in this record>

Ending_Date: <YYYYMMDD for imagery used to create orthophoto tile referenced in this record>

Ending_Time: <HH:MM for imagery used to create orthophoto tile referenced in this record>

Currentness_Reference: ground condition

Status:

Progress: Complete

Maintenance_and_Update_Frequency: Unknown

Spatial_Domain:

Bounding_Coordinates:

West_Bounding_Coordinate: <Western-most coordinate (longitude) in decimal degrees of single orthophoto tile>

East_Bounding_Coordinate: <Eastern-most coordinate (longitude) in decimal degrees of single orthophoto tile>

North_Bounding_Coordinate: <Northern-most coordinate (latitude) in decimal degrees of single orthophoto tile>
South_Bounding_Coordinate: <Southern-most coordinate (latitude) in decimal degrees of single orthophoto tile>
Keywords:
Theme:
Theme_Keyword_Thesaurus: ISO 19115 Topic Category
Theme_Keyword: imageryBaseMapsEarthCover
Theme:
Theme_Keyword_Thesaurus: none
Theme_Keyword: raster
Theme_Keyword: remote sensing
Theme_Keyword: aerial photography
Theme_Keyword: orthophotography
Theme_Keyword: orthophoto
Theme_Keyword: ortho
Theme_Keyword: orthorectified
Theme_Keyword: <Enter bands as separate keywords: Red, Green, Blue etc.>
Theme_Keyword: <Enter all that apply as separate keywords: Panchromatic, Black & White, Black and White, B/W, B&W, True Colour, RGB, Colour-Infrared, CIR, False Colour Infrared, FCIR, NRG etc.>
Theme_Keyword: <Camera>
Theme_Keyword: <Film, if applicable>
Theme_Keyword: imagery
Place:
Place_Keyword_Thesaurus: none
Place_Keyword: <County or Municipal District(s) that single orthophoto tile referenced by this metadata record falls within>
Place_Keyword: Township-Range-Meridian: <TTTRRM>
Place_Keyword: <NTS Mapsheet (20K, 50K or 250K)>
Temporal:
Temporal_Keyword_Thesaurus: none
Temporal_Keyword: <Enter Year(s) of data collection as separate entries>
Temporal_Keyword: <Enter Month(s) of data collection as separate entries, i.e. "July">
Temporal_Keyword: <Season(s) of data collection as separate entries>
Temporal_Keyword: <Leaf On/Leaf Off>
Access_Constraints: <Data access constraints according to the contract.>
Use_Constraints: <Data use constraints according to the contract.>
Point_of_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: <Name>
Contact_Organization: <Contract Company Name>
Contact_Voice_Telephone: <phone #, AAANNNNNNN>
Contact_Electronic_Mail_Address: <email address>
Security_Information:

Native_Data_Set_Environment: <Description of dataset processing environment - software used and versions, operating system, filename/path, file size etc.>
Cross_Reference:
Citation_Information:
Originator: <Data Provider>
Publication_Date: Unknown
Publication_Time: Unknown
Title: <Name(s) of stereo image(s) or images that orthophoto was derived from>
Geospatial_Data_Presentation_Form: remote-sensing image
Series_Information:
Series_Name: Aerial Photography
Publication_Information:
Other_Citation_Details:
For further information:
See metadata corresponding to <stereo image file name(s)>
Data_Quality_Information:
Attribute_Accuracy:
Logical_Consistency_Report:
Camera Calibration Report: <filename of report(s)> / Ground Control Report: <filename of report> / Camera System Specifications: <filename of report> / Flight Report: <filename of report>

<State any important qualifications of the individuals involved in acquisition, processing or accuracy assessment of the data and which part(s) they were involved in (eg. Professional Engineer, Alberta Land Surveyor etc.)>
Completeness_Report: QA/QC Procedure Report: <Description of process or location/name of document where this information can be obtained>/ Anomalies Report : <Description of any anomalies/issues identified during the QC process or location/name of document where this information can be obtained> / Data Processing Report: <Description of data processing or location where this information can be obtained>
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report: <Summary of findings from horizontal accuracy testing>
Quantitative_Horizontal_Positional_Accuracy_Assessment:
Horizontal_Positional_Accuracy_Value: <Overall Horizontal Accuracy of Dataset>
Horizontal_Positional_Accuracy_Explanation: <Confidence Level>.<Description of tests used to verify horizontal accuracy, including number of test points>
Vertical_Positional_Accuracy:
Quantitative_Vertical_Positional_Accuracy_Assessment:
Vertical_Positional_Accuracy_Value: <Vertical accuracy of DEM used during rectification>
Vertical_Positional_Accuracy_Explanation: <Confidence Level>.<Source of DEM vertical accuracy statement>
Lineage:
Source_Information:

Source_Citation:
Citation_Information:
Originator: <Originator of source data>
Publication_Date: Unknown
Publication_Time: Unknown
Title: <Title of any source data used including stereo imagery files, DEMs etc., as separate entries>
Geospatial_Data_Presentation_Form: <Type of Data>
Publication_Information:
Other_Citation_Details: <Contact details of originator>
Source_Scale_Denominator: <Scale denominator of source data, ex: 1:50000 is 50000, cited separately for each source dataset>
Source_Time_Period_of_Content:
Time_Period_Information:
Range_of_Dates/Times:
Beginning_Date: <start date of source data, YYYYMMDD>
Beginning_Time: <start time of source data, HH:MM>
Ending_Date: <end date of source data, YYYYMMDD>
Ending_Time: <end time of source data, HH:MM>
Source_Currentness_Reference: <Currentness Reference of source data, separate entries for each source: ground condition/publication data>
Source_Contribution: <Contribution made by the source data file to this dataset, separately for each dataset>
Process_Step:
Process_Description: <Enter a description of each process step involved in creating the orthophoto dataset as a separate entry (within the ArcCatalog editor, use the + button below to add each additional step) e.g establishment of ground control, flying, processing, AT, orthorectification, mosaicking>
Source_Used_Citation_Abbreviation: <Enter source information used in process step, if applicable>
Process_Date: <Enter date of process for each step, if available>
Source_Produced_Citation_Abbreviation: <List intermediate or final dataset produced from process if significant>
Process_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: <Enter contact organization for process step>
Contact_Address:
Address: <Enter address for contact organization for process step>
Contact_Voice_Telephone: <phone #>
Contact_Facsimile_Telephone: <fax #>
Contact_Electronic_Mail_Address: <email>
Hours_of_Service: <hours of service>
Contact_Instructions: <Instructions, if applicable>
Cloud_Cover: <Cloud cover percentage for orthophoto tile reference by this metadata record>
Spatial_Data_Organization_Information:

Indirect_Spatial_Reference: <Indicate how product is referenced, ex: Alberta Township System version <x>, by township or by quarter township; by NTS 1:20K block etc.>
Direct_Spatial_Reference_Method: Raster
Raster_Object_Information:
Raster_Object_Type: Pixel
Row_Count: <Integer value>
Column_Count: <Integer value>
Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Planar:
Map_Projection:
Map_Projection_Name: Transverse Mercator
Transverse_Mercator:
Scale_Factor_at_Central_Meridian: <Scale factor>
Longitude_of_Central_Meridian: <Longitude of Central Meridian>
Latitude_of_Projection_Origin: <Latitude of Projection Origin>
False_Easting: <False Easting>
False_Northing: <False Northing>
Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: coordinate pair
Coordinate_Representation:
Abscissa_Resolution: <value>
Ordinate_Resolution: <value>
Planar_Distance_Units: metres
Geodetic_Model:
Horizontal_Datum_Name: <Horizontal datum with epoch if applicable (i.e. NAD83 CSRS 1998)>
Ellipsoid_Name: <Ellipsoid>
Vertical_Coordinate_System_Definition:
Altitude_System_Definition:
Altitude_Datum_Name: <Vertical reference of DEM used during rectification>
Altitude_Resolution: <Resolution of DEM(s) used during rectification>
Altitude_Distance_Units: metres
Entity_and_Attribute_Information:
Detailed_Description:
Entity_Type:
Entity_Type_Label: <Orthophoto name>
Entity_Type_Definition: <Description of entity type (orthophoto)>
Overview_Description:
Entity_and_Attribute_Overview: <Brief overview of the attributes associated with this file. Example: No. of rows/columns, coordinates of origin, cell size, NoData value, bands, bit depth etc.>
Metadata_Reference_Information:
Metadata_Date: <YYYYMMDD>
Metadata_Contact:
Contact_Information:

Contact_Organization_Primary:
Contact_Organization: Alberta Environment and Sustainable Resource Development, Government of Alberta
Contact_Position: Informatics Branch, Corporate Services Division
Contact_Address:
Address_Type: mailing and physical address
Address: 14th floor, Oxbridge Place
Address: 9820 - 106 Street NW
City: Edmonton
State_or_Province: Alberta
Postal_Code: T5K 2J6
Country: Canada
Contact_Voice_Telephone: 7806442174
Contact_Facsimile_Telephone: 7804220712
Contact_Electronic_Mail_Address: SRD.GDAMetadata@gov.ab.ca
Hours_of_Service: 08:15 to 16:30 Monday to Friday
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC-STD-001-1998
Metadata_Time_Convention: local time
Metadata_Extensions:
Online_Linkage: http://www.esri.com/metadata/esriprof80.html
Profile_Name: ESRI Metadata Profile

4.8 *Media for Imagery

All files shall be delivered on hard drive(s) with a minimum capacity of 250 GB.
Drives are to be new (not previously used for other business), include USB 3.0 connectivity (they may possess other means of data transfer such as FireWire or eSATA in addition to USB 3.0), and no drive volume is to be larger than 2 TB. Hard drives larger than 2TB shall be partitioned such that this condition is met. Such drives are to be provided by the Contractor and will become the property of the Government of Alberta.

4.8.1 Media Deliverable Label

Each drive/DVD shall have two labels described below.

4.8.1.1 Drive/DVD Information

- Drive Name – Contract No. + additional information, if required. i.e.
  09RIM052
  09RIM052_# ……..._#: Sequential no. if deliverable takes multiple drives
  09RIM052_A_# …..._A_#: **A, B or C** is the contractor name, if a contract has
  …..._B_# multiple contractors
  …._C_#
- Year(s) of imagery captured
- Band - PAN/RGB/IR/CIR/RGBN
- Imagery Type - <camera>Ortho

<camera>: ADS40/ADS40 SH52/DiMAC/etc.

- Projection - 10TM with or without offset/UTM Zone 10, Zone 11, Zone 12
- Resolution - 0.5 m/1.0 m/etc.
- Project Name
- Contractor Name
- Re-submission No. - Has to state original drive name(s) and additional information
- Volume of data / Drive capacity i.e. 0.85 / 1 TB

The following are some sample labels.

a) First submission

09RIM051_1
2009
CIR Ortho
DiMAC Imagery
2.5 m.
10TM with offset
Southern Alberta
Pinnacle
0.75 / 1TB

b) Re-submission

2nd Submission of:

09RIM053_1, 09RIM053_2 & 09RIM053_3
2004 – 06
RGB Ortho
ADS40
0.5 m.
UTM Zone 11
North West Geomatics
0.6 / 1TB
2nd Submission Info: Metadata

c) Re-submission

3rd Submission of:

09RIM053_2 & 09RIM053_3
2004 - 06
PAN Ortho
ADS40SH52
0.5 m.
UTM Zone 11
North West Geomatics
0.87 / 1TB
3rd Submission Info: 72E to 74M

4.8.1.2 *Informatics Branch Standard Label

4.8.2 Media Cables

Media cables for hard drives are part of the deliverable which shall be submitted and kept inside the media box. Cables shall be labeled with the media identification, i.e. Drive Name. See first bullet of section 4.8.1.1 above.

4.8.3 *Shipping

Materials shall be packed for shipping in such a manner that will ensure safe delivery at the destination. Damaged materials will be replaced by the Contractor at no cost to the Government. A packing slip will accompany each shipment and shall itemize all materials included in the shipment.

4.9 *Orthophoto Index Map

An index map shall be submitted in ESRI shapefile format showing the individual orthophoto tiles. Each tile shall be attributed with the correct filename information.

5.0 *File Compression

Compression of ortho-images into LizardTech's MrSID format or other format may be required. Delivery of MrSID files shall include the .sid, .sdw, and .aux files. Requirements for file generation, number of bands, and compression ratio shall be provided on a per-project basis.

5. SUMMARY OF MATERIALS

5.1 *Materials to be Supplied by the Contracting Department

Prior to commencing production the Department will supply the Contractor the following materials:

(a) a project boundary map and photo index map
(b) original aerial photo film or digital images
(c) camera calibration report in PDF format
(d) township or map sheet corner data used to bound each orthophoto image
(e) aerial triangulation adjustment data in ASCII format
(f) Digital Elevation Model (as required)
(g) FGDC-standard metadata template in .xml format

5.2 *Materials to be Delivered by the Contractor

Upon completion of production, the Contractor shall supply the Contracting Department with the following:

(a) all materials originally supplied by the Contracting Department
(b) if new AT was required, all files required by Part 4 – General Specifications For Aerial Triangulation
(c) raw digital images (where applicable, all files required by Part 2 – General Specifications for Aerial Photography, and/or all files required by Part 3 – General Specifications for Scanning of Aerial Photography)
(d) final orthorectified images at specified resolutions and meeting accuracy requirements
(e) compressed orthorectified images (if required)
(f) orthophoto index map
(g) completed FGDC-standard metadata files for each submitted orthophoto in .xml format
(h) stereo-imagery generated DEM files in a mutually agreeable format
(i) detailed packing slip of all materials submitted