

JULY 1, 2001

**MINNESOTA DEPARTMENT OF TRANSPORTATION
OFFICE OF LAND MANAGEMENT
SURVEYING AND MAPPING SECTION
PHOTOGRAMMETRY UNIT**



SPECIAL PROVISIONS FOR:

**GROUP 2: ANALYTICAL PHOTOGRAMMETRIC
PRODUCTS AND SERVICES**

AERO-TRIANGULATION

INTRODUCTION

This Specification is established to provide the Minnesota Department of Transportation (MN/DOT) with “Photogrammetry Products and Services” from Private Photogrammetric Partners (Contractor).

SCOPE OF WORK

These Specifications set forth the minimum standards to be met and general procedures to be followed to establish horizontal and vertical control for photogrammetric mapping from aerial photography. The control extension will be accomplished by applying the appropriate analytical aero-triangulation techniques to identify, mark and measure points on aerial photos and to subsequently process measurements through mathematical calculations to derive accurate ground coordinate values of selected points.

Specific photogrammetry services authorized by this specification include the following:

- Locate control on contact prints (if required).
- Evaluate project control to ensure adequate control is present to produce mapping within the specified accuracy requirements.
- Produce an aero-triangulation solution that bridges the ground survey and provides control for detail design-level photogrammetric mapping.

ITEMS PROVIDED AND/OR COMPLETED BY MN/DOT

Specific information to be supplied for each project includes the following:

- Work Order Contracts. Each Work Order Contract will include the following information:
 - Project designation or numbers.
 - Project location.
 - Project limits.
 - Computational Direction.
 - Units of measurement.
 - Coordinate Projection/Adjustment.
 - Specific Project Deliverables.
 - Deliverables Schedule/Evaluation.
 - Special Requirements.
 - Start date.
 - Completion date.
 - Invoice, Incentive/Disincentive Schedule.
 - Total project cost payable to Contractor.
- Contact Prints, if available.
- Photo control point coordinates.
- Calibration reports for aerial camera(s).
- Diapositives (on film base, emulsion up), if available.
- Photo Index.

Please be advised: it is the Contractor’s responsibility to provide safe storage and prompt return for all items supplied by MN/DOT. The Contractor is liable for lost or damaged items.

DELIVERABLES BY CONTRACTOR

Specific deliverables authorized by this specification include the following:

- Cost estimate for each project.
- Monthly progress reports.

FINAL SUBMITTAL

Materials and data to be provided include the following:

- List of ground control points with estimate of precision.
- List of refined photo image coordinates with corrections for camera lens distortion, film distortion, atmospheric refraction and earth curvature correction, as adjusted through a weighted simultaneous least squares adjustment program
- List of independent model coordinates (formed by 3 photo program).
- List of coordinates for pass points and control points, along with residuals.
- Final camera station positions from least squares adjustment, along with orientation parameters ω, ϕ, κ .
- All point marked diapositives utilized as part of the project. Diapositives will be packaged and delivered flat.
- All contact prints, annotated with control data, which were utilized as part of the project. Contact prints will be packaged and delivered flat.
- Files may be delivered on diskettes or CD's.

PERFORMANCE BASED SPECIFICATIONS

All products and services authorized under this specification will be completed in accordance with the MN/DOT MANUAL OF SURVEYING AND MAPPING, Chapter Four (current edition), the MANUAL of PHOTOGRAMMETRY (Fourth Edition) and the following performance specifications.

UNITS OF MEASURE

The default unit of measure is "English".

Files will be compiled with coordinate values to 1/1000 (ft).

Metric values shall be converted using the U.S. Survey Foot, if required.

ACCURACY STANDARDS

HORIZONTAL ACCURACY**			
PHOTO SCALE	RMSE	100%	REPORTING METHOD
VARIABLE	<1/12,000 of nominal flight height	< 1/3,000 of nominal flight height.	RMSE/ FLIGHT HEIGHT

** Scope: all horizontal control points. MN/DOT will test the accuracy of analytical aero-triangulation solutions by comparing the computed value of test control points against the field-surveyed positions.

VERTICAL ACCURACY**			
PHOTO SCALE	RMSE	100%	REPORTING METHOD
VARIABLE	<1/15,000 of nominal flight height	< 1/5,000 of nominal flight height	RMSE/ FLIGHT HEIGHT

** Scope: all vertical control points. MN/DOT will test the accuracy of analytical aero-triangulation solutions by comparing the computed value of test control points against the field-surveyed elevations.

PROCEDURAL BASED SPECIFICATIONS

All products and services authorized under this specification will be completed in accordance with the following procedural specifications and as directed by the Photogrammetric Engineer.

GENERAL

Where the Work Order Contract, contract documents and these specifications describe portions of the work in general terms, but not in complete detail, it is understood that only “Best Industry Practices” are to prevail.

EQUIPMENT/ PROCESSING SOFTWARE

The stereo plotter(s) and analytical aero-triangulation software used to produce the aero-triangulation solutions will be the instruments and software systems listed in the Contractor’s proposal unless specific permission is granted by MN/DOT to use alternate equipment and software. Any aero-triangulation solutions that are produced using non-approved equipment and software may be rejected and redone at the Contractor’s expense, as determined by the Photogrammetric Engineer.

The Contractor will validate the calibration of each analytical stereo plotter within 30 days prior to the date of compilation.

DATA FILE FORMAT/REQUIREMENTS

The Contractor is required to keep a back up of all produced electronic project files for 1 year after final acceptance is made.

PRODUCTION TECHNIQUES

Completing an aero-triangulation solution from scanned images is allowed on a case-by-case basis. Prior approval must be acquired to produce aero-triangulation solutions on a digital workstation.

POINT MARKING

Identification and marking of pass points and control points on the diapositives will be completed in accordance with the following:

- Three (3) primary pass points are required to be marked across the center of the photo exposure perpendicular to the flight line.
- Control points to tie together overlapping strips of photography will be marked as required by the project.
- All point marking is to be done with drills producing a uniform clean mark with a nominal diameter of 60-80 microns.

GROUND CONTROL REQUIREMENTS

“STRIP PHOTOGRAPHY”

- Horizontal control points will be provided in the terminal models of each flight strip. Maximum distance between intermediate horizontal control points is 7 models.
- Vertical control points, if required, will be provided in pairs in the terminal models of each flight strip. Maximum distance between intermediate vertical control points is 3 models.

“BLOCK PHOTOGRAPHY”

- Horizontal control points will be provided in the terminal models of outside flight lines and every other interior flight line. The maximum distance between horizontal control points will be 7 models for outside flight lines and 10 models for interior flight lines.
- Vertical control points, if required, will be provided in the terminal models for all flight lines. The maximum distance between vertical control points will be 3 models in outside flight lines and 4 models in interior flight lines.

INSUFFICIENT GROUND CONTROL

If the ground control is found to be inadequate or out of tolerance, the Contractor will proceed as follows:

- Determine what additional control is required.
- Mark the additional control points on the contact prints.
- Submit the following to MN/DOT:
 - Contact prints (with additional control marked).
 - Description and location of additional required control.
 - Photo index of project.

MN/DOT will review the project and determine the final course of action. In cases where additional control is required by MN/DOT survey crews, MN/DOT personnel will coordinate all field activities.