

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



SPECIAL PROVISIONS FOR:

**GROUP 1: AERIAL
PHOTOGRAPHY/PHOTOGRAMMETRIC LAB SERVICES**

**AERIAL PHOTOGRAPHY (ON-BOARD
AERO-TRIANGULATION SOLUTION)**

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

The intent of this specification is to provide aerial vertical photography and an aero-triangulation solution to users that require imagery for digital photogrammetric products. All photography authorized under this specification must be of a quality to be used as the basis for planning/pre-design level digital photogrammetric products.

Specific photogrammetric services authorized by this specification include the following:

- Collection of Aerial Vertical Photography (basis for planning/ pre-design level digital photogrammetric products).
- Collection and processing of aerial image positions and orientation parameters, utilizing minimal ground control.

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:

- o Project designation or numbers (Aerial Survey Project number).
- o Project location (County/District/Trunk Highway).
- o Project limits.
- o Film type.
- o Flight strip centerlines.
- o Flight strip starting points.
- o Flight strip ending points.
- o Flight height/photo scale.
- o Datum/Coordinate Projection/Adjustment.
- o Ground Control/Base Station Positions, if supplied by MN/DOT.
- o Ground Positional Accuracy Requirements.
- o Special Requirements.
- o Start date.
- o Completion date.
- o Invoice.
- o Units of measurement.
- o Total project cost payable to Contractor.

DELIVERABLES BY CONTRACTOR

Specific deliverables authorized by this specification include the following:

- Cost estimate for each project.
- Weekly progress reports.
- Original processed film negatives used to collect aerial imagery.
- Camera station parameters ((x, y, z) and (ω , ϕ , κ)) for each image.
- Ground control coordinates, if supplied by Contractor.
- 9” x 9” contact prints, 2 of each aerial image.
- Photo Index negative/digital file.
- Photo Index of each project (3 copies).

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.

ACCURACY STANDARDS

Horizontal and vertical accuracies will be specified in the Work Order Contracts. The NSSDA reporting method will be used to evaluate the data.

Stereo pairs will be free of parallax.

The image positions will be compared to the ground surveyed positions at the same feature.

STEREOSCOPIC COVERAGE

Image collection will be provided for the entire aerial project, which is end-to-end of each flight strip (stereoscopic coverage is built into the project layout based on flight height).

Photography coverage that falls short of the designed flight strip may cause the flight strip to be rejected and re-flown at the Contractor's expense, as determined by the Photogrammetric Engineer.

Photography coverage that exceeds the designed flight strip will be taken at the Contractor's expense and no direct payment will be made.

IMAGE CHARACTERISTICS

The following image characteristics will be checked for acceptance, in accordance with "Industry Best Practices" and as determined by the Photogrammetric Engineer:

- o image clarity.
- o image sharpness.
- o uniformity in range of density.
- o free and clear view from the aircraft.
- o presence of clouds or cloud shadows.
- o presence of smoke or haze.
- o presence of exhaust gasses, oil, effluence and air turbulence.
- o presence of snow.
- o static marks, tears, scratches, and other blemishes.
- o other characteristics that will prevent the media from producing acceptable photogrammetric products.

DEVIATIONS FROM "IDEAL CONDITIONS"

MN/DOT flight planning is based on the following error probabilities:

- o Scale: +/- 8% (specified film negative scale).
- o Flight Lines: deviate < 10% horizontally of specified flight height from plotted flight line on project reference map.
- o Sidelap: Target Value = 35%, Min. = 25%, Max. = 45%.
- o Endlap: Target Value = 60%, Min. = 55%, Max. = 65%.
- o Crab: < 5°.
- o Tilt/Tip: < 4°.

AERIAL RE-FLIGHT REQUIREMENTS

The Contractor is advised that images not meeting these specifications may cause rejection of the flight strip that contains the deficient images, as determined by the Photogrammetric Engineer. All rejected flight strips will be re-flown as directed by the Photogrammetric Engineer at the Contractor's expense. The Contractor is further advised that ground targeting for re-flown flight strips will be the Contractor's responsibility.

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:

TIME OF PHOTOGRAPHY

Photography will be undertaken only when the lighting and weather conditions are such that acceptable negatives can be produced in accordance with these specifications and as directed by the Photogrammetric Engineer. Any special requirements concerning foliage, snow, or other conditions will be specified in the Work Order Contract. Any questions or concerns about conditions that might obscure ground detail will be discussed with authorized MN/DOT personnel before undertaking or continuing the aerial collection.

Photography will be taken between the times of 9:00 a.m. and 3:00 p.m. (CST) during the spring and fall flying seasons, unless otherwise authorized by MN/DOT.

PRIORITIES for PHOTOGRAPHING PROJECT AREAS

A reasonable and prudent effort will be made to photograph all projects in the order directed by MN/DOT.

GROUND TARGETING

It is the Contractor's responsibility to coordinate aerial collection operations with ground targeting. The Contractor is directed to communicate directly with ground targeting crews. Images collected before ground targets are placed will be rejected and retaken at the Contractor's expense.

FLIGHT LINES

Flight lines of fifteen exposures or less will be continuous and unbroken throughout their length. Flight lines containing more than fifteen exposures may be broken provided that 100% stereoscopic overlap of at least five exposures is provided between the forward and backward section of the strip.

INDEXING AND NUMBERING

The negative for each exposure will be labeled clearly with the Aerial Survey Project number (furnished by MN/DOT) followed by the image number. The image numbers will be consecutive for each aerial project.

For East-West flights: The date of exposure will be shown in the Southwest corner. The Aerial Survey Project number, film roll number, and image number will be shown in the Northwest corner. (Orientate so that notation is right side up as read from East side of image).

For North-South flights: The date of exposure will be shown in the Northwest corner. The Aerial Survey Project number, film roll number, and image number will be shown in the Northeast corner. (Orientate so that notation is right side up as read from South side of image).

The first and last negatives of each flight strip will also contain the following (shown on the same edge as the exposure date and image number):

- o time of exposure (numerical abbreviation, 24hr clock, local standard time).
- o height above mean ground elevation (ft.).
- o camera number.
- o latitude and longitude of the center of the image (shown on opposite edge of the exposure date and image number).

All lettering and numbering will be 0.3” in height.

ORGANIZATION OF FILM SPOOLS

Aerial imagery will be delivered on 250 ft. film spools.

Original film negatives belonging to a specific project will be placed on the same film spool. Projects large enough to require two or more film spools will be divided as directed by the Photogrammetric Engineer.

A 20-inch spacing is required between all film splices and project images.

CONTACT PRINTS

Contact Prints on photographic paper shall be trimmed neatly and uniformly, leaving the camera fiducial marks.

Contact Prints will be rejected if the fiducial marks are cut off.

CAMERA EQUIPMENT

The aerial camera shall be a “calibrated precision aerial camera” capable of producing images which are compatible with MN/DOT’s current photogrammetric mapping equipment.

The Contractor will submit an approved current camera calibration report for each camera used to collect aerial imagery. Camera calibrations will be completed by an approved testing organization at least once every three years and at any time camera maintenance requires disassembly of any part of the camera cone assembly.

Each project will be flown in its entirety with one camera or as directed by the Photogrammetric Engineer.

Forward motion compensation is required for all images taken at or below 3000’ altitude.

Each camera body will be equipped with means of recording eight fiducial marks on each exposure, the marks to be located in each corner of the format and at the center of each side. All fiducial marks and other marks intended for precise measuring will be clear and well defined on the negative.

CAMERA LENS

The camera will be equipped with a lens with a calibrated focal length of 153 mm +/- 3 mm.

The camera lens will have an AWAR (Area Weighted Average Resolution) of at least 100 line pairs per millimeter, as determined by the calibration report. The minimum acceptable radial and tangential lens resolution (in line pairs per millimeter) at various field angles are: Example below Area-weighted average resolution: 105

<u>Field angle:</u>	<u>0°</u>	<u>7.5°</u>	<u>15°</u>	<u>22.7°</u>	<u>30°</u>	<u>35°</u>	<u>40°</u>
Radial	134	159	134	95	95	95	95
Tangential	134	159	113	113	113	95	95