
A composite image for a presentation slide. It features a silhouette of a person's head and shoulders on the left, looking through a surveying instrument. In the background, there is a large, semi-transparent circular scale with numbers, and a close-up of an airplane's engine. The overall color palette is dark with blue and yellow accents.

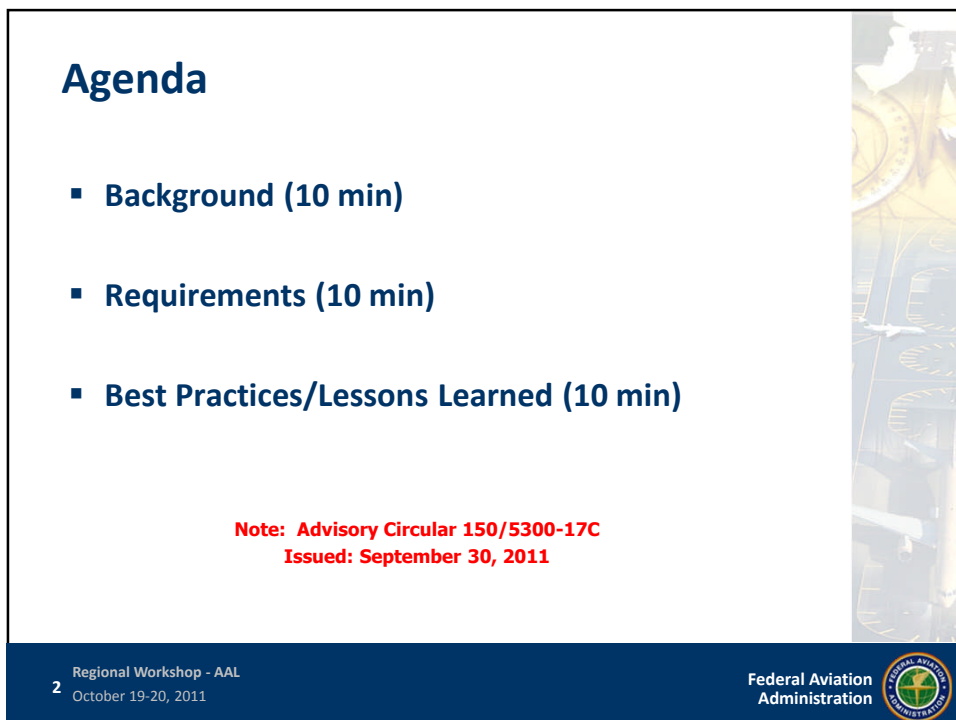
Airports GIS

AC 150/5300-17
Imagery

Presented to | FAA Regions | Alaskan
By | Gil Neumann, APP 400 | Thomas Wade, ASW 611
Date | October 19 20, 2011

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A presentation slide with a white background and a dark blue footer. The title 'Agenda' is in a large, bold, dark blue font. Below it is a bulleted list of three items, each in a dark blue font. A red note is centered below the list. The right side of the slide features a vertical strip of the same composite image seen in the first slide.

Agenda

- **Background (10 min)**
- **Requirements (10 min)**
- **Best Practices/Lessons Learned (10 min)**

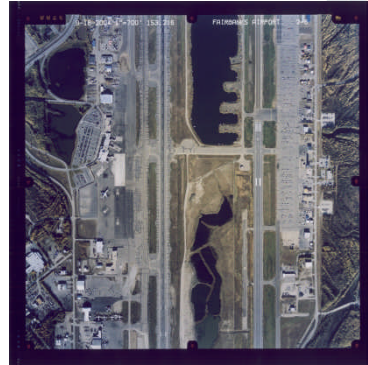
Note: Advisory Circular 150/5300-17C
Issued: September 30, 2011

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Why do we require imagery?

- Current initiatives within aviation industry (moving maps, electronic flight information, advanced avionics, GIS base map) require a data centric airport environment, as opposed to the traditional product based environment
- For projects involving obstacles and other safety-critical data, imagery is collected to ensure the quality of the aeronautical information collected (independent verification)
- Imagery is an accurate and cost effective method of collecting this type of data



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Aerial Imagery Data VERIFICATION



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Aerial Imagery | Flying Heights

Table 1. Federal Geographic Data Committee Spatial Data Accuracy Standards (ASPRS) Class II Mapping accuracy for large scale maps) Map Accuracies as a function of Photo/Map Scale

Map Scale 1" = -ft.	Photo Scale 1" = -ft.	Minimum Contour Interval in feet	Accuracy XY RMSE in feet	Accuracy Z RMSE in feet
20	200	0.5	0.4	0.33
40	320	1.0	0.8	0.66
50	400	1.0	1.0	0.66
100	800	2.0	2.0	1.32
200	1600	4.0	4.0	2.64
250	2000	5.0	5.0	3.30
400	3200	8.0	8.0	5.28
500	4000	10.0	10.0	6.60
800	6400	16.0	16.0	10.56
1000	8000	20.0	20.0	13.20
1667	12800	32.0	33.3	21.12

- The imagery should be flown at an altitude providing for usability of the imagery beyond the scope of the current project, such as future engineering or planning.
- Flying height less than 12,000 feet Above Ground Level
- Ground Sample Distance (GSD) – 10-30 cm (4-12 in./pixel)
- Generally, Multiple flight levels if project includes off-airport obstacle analysis

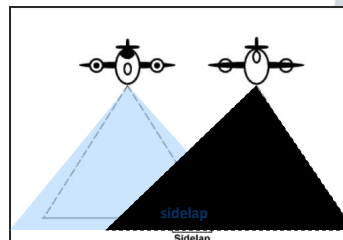
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Flightline Navigation and Guidance

- For frame imaging systems, forward overlap must average 60% between consecutive exposures, while forward overlap must not be greater than 68% or less than 55% in any pair of consecutive images
- The flight must be planned to minimize imagery sidelap. Planning for the appropriate sidelap normally equates to 50% overlap for a film-based system with the acceptable range being 30 to 60%
- A sidelap of 50% is recommended to ensure that objects may be seen in stereo from multiple views (50% sidelap is critical in forested areas)



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Image Control Points

- **Image control points are used to geo-reference the imagery**
 - The proposed number and location of ground image control points must be in the Imagery Plan
 - The number and placement of the image control points must be sufficient to geo-reference the imagery within the accuracy requirement of the proposed survey to be conducted



Examples of “well defined” control:

- Junctions of intersecting features (sidewalks, abutments, and roads)
- Corner points of clear features (a parking lot, tennis court, x-section)
- Center of a small isolated bush
- A pre-marked point that can be identified on the imagery

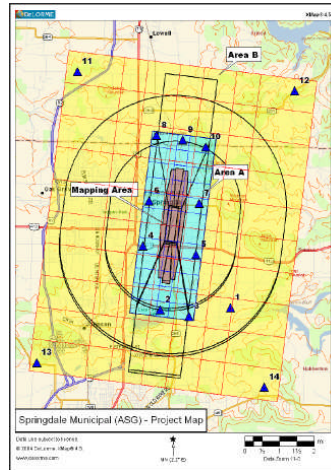
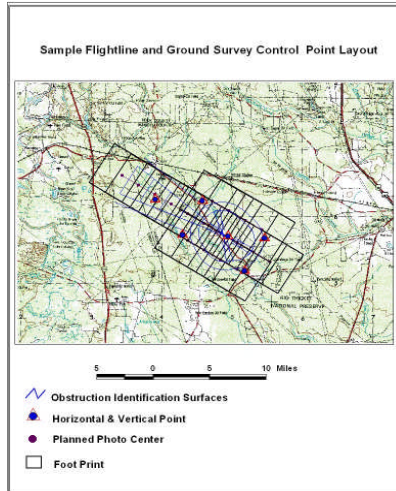


Image Check Points

- **In addition to ground image control points, a minimum of 5 check points are required in the project area**
- **Check points shall meet the same standards as control points:**
 - **Note: check points shall not be used in controlling imagery**
 - **A position determined through the NGS OPUS program is required for each check point**



Flight Line and Control Diagram



Combined Flight Line and Imagery Control Point Diagram

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Image Quality Requirements

- High Quality Color film or digital imagery
- Image quality must meet the highest professional standards
- Dark areas must not bleed together and individual objects must be readily discernable
- Detail must be sufficiently sharp to allow photogrammetric measurement of tree heights, compilation of runway/taxiway edges and other fine map features, and accomplishment of other intended uses for the imagery
- Image products must be free of abrasions, blemishes, scratches, tears, and irregularities
- Fiducial marks must be clearly visible and sharp on every image

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Imagery and Environmental Considerations

- **Clouds or cloud shadows must not appear on the imagery**
 - High, thin overcast is permitted above the flying altitude if it does not cause ground mottling or a discernable reduction in light levels and/or shadows
- **Collect imagery to show full tree leaf coverage**
 - This facilitates photogrammetric tree height determination
 - This requirement limits the acquisition window depending on season and geographic location
- **Collect imagery to obtain well-defined images**
 - Do not attempt imagery acquisition where the ground is obscured by haze, smoke, smog, dust, or falling snow, sleet, rain, or other obscuring phenomena
 - Do not collect imagery when the airport ground area is covered by water (flood), snow, or ice obscuring airport features

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Imagery and Environmental Considerations (cont'd)

- **Minimum visibility at the time of exposure must be 10 miles or greater**
 - If the visibility is satisfactory, details of ground objects will be clearly defined at the edge of the view through the drift sight
- **Ideally, the sun angle should be between 40 and 60 degrees above the horizon because of the intermediate-size shadows produced**
 - Sun angle must be greater than 30 degrees above the horizon
 - In mountainous areas with steep terrain and/or areas with tall trees, increase the minimum sun angle to horizon.
- **Extreme shadowing may be cause for imagery rejection**

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Required Imagery Deliverables for NGS

- **Digital Stereo Imagery**
 - The airport sponsor must provide NGS ASP with digital stereo imagery of the area of analysis
 - The dimensions of this area depend on the type of survey the contractor is requested to perform
 - Acquire the imagery within at most 6 months prior to the ground survey (AC 150/5300-18 survey)
 - Submit the imagery well in advance of the survey deliverables for NGS review and approval. Upon imagery approval, the final survey deliverables may be submitted
- **Submit the imagery and associated deliverables directly to NGS for review**
 - Use FedEx/UPS with tracking (enter tracking Number in Airports GIS)

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Required Imagery Deliverables for FAA

- **Provide the FAA with digital orthoimagery of the area(s) flown**
 - Develop the orthoimagery using the specifications defined by the Federal Geographic Data Committee in FGDC-STD-008-1999, except the imagery should not be resampled, they should be developed at the resolution of the original imagery used for analysis
 - Provide metadata for the orthoimagery as described in the FGDC standard
 - Submit the digital orthoimagery to the FAA on similar media used to provide the imagery to NGS (hard drive)
 - Include on the delivery media FGDC compliant metadata for the orthoimagery
- **The Orthoimagery (-17 submittal, to FAA) only requires one metadata file for the entire set of images not a separate metadata file for each single file**
- **Submit to FAA via FedEx/UPS with Tracking**

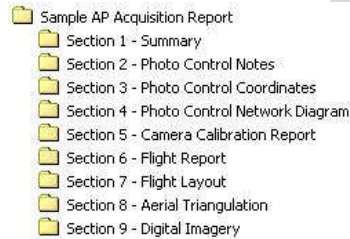
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Delivery Medium and Setup

- USB compatible external medium, such as an external hard drive (DVD may be used for data sets 40GB or less)
- Establish the directory structure so each sub-directory contains pertinent information about each item
- Name the root directory using the assigned FAA airport location identifier (eg., BOS AP Acquisition Report)
- Develop and include a table of contents for each submission and store it in the root directory. The use of this standardized format assists in NGS verification

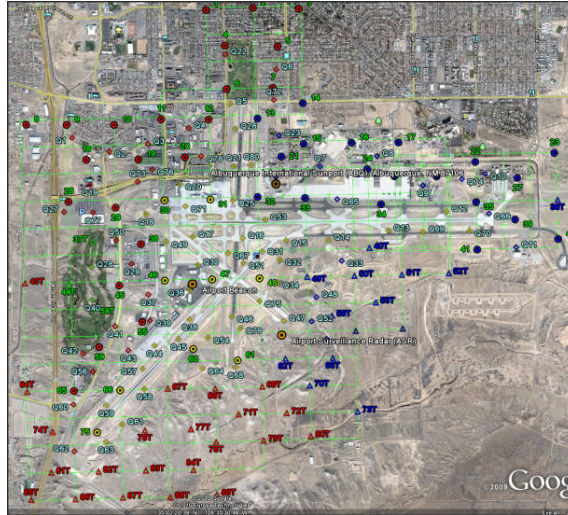


Imagery Final Report

- A formal final report is not required, however, the contractor should provide any supplemental information they consider useful or explanatory for use by NGS in reviewing the usability of the imagery
- Comments are required when the project is completed differently than identified in the imagery plan due to unusual circumstances or problems, equipment malfunctions, changes to proposed methodologies, equipment, or any types of deviations from these specifications



High Flight Mission Example (Google Earth: ABQ)

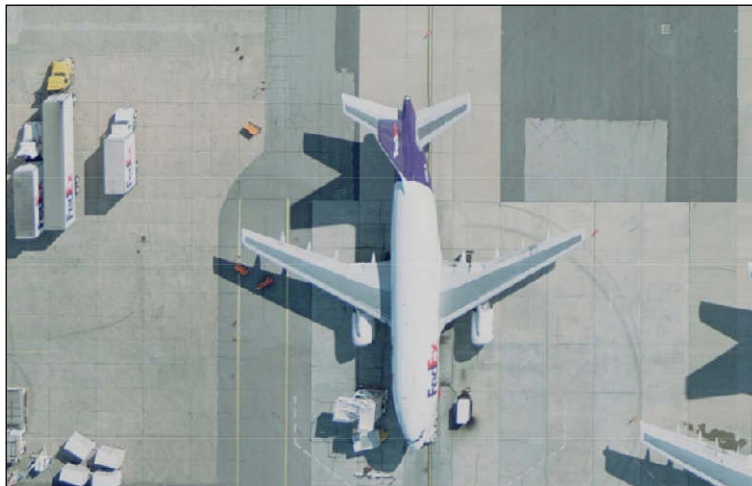


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Orthoimagery Example (Valley International)



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Light Detection and Ranging (LiDAR)

- Airborne LiDAR is not acceptable for obstacle analysis
- Airborne LiDAR may be used to develop a Digital Terrain Model (DTM) after coordination with AAS-100 to cost effectively develop ground contours
- Ground based (stationary or mobile) is being evaluated to capture runway surface and other terrain data (Coordinate with AAS-100)
- LiDAR is usually used to augment photogrammetry (Collected concurrently)
- Must show as cost effective

**Note: Advisory Circular 150/5300-17C
Issued: September 30, 2011
Includes LiDAR Specifications**



Are Imagery Waivers Allowed?

- **FAA AC's: FAA Approve Waivers**
 - Coordinate all waivers with AAS-100
- **Have waived Full Foliage with Airport provided documentation**
- **Possible waiver for sun angle, visibility, etc.**
 - What mitigation is incorporated to meet the intent?
- **Included Airport documentation in SOW (to archive and allow NGS to access)**



Imagery Considerations

- Imagery is not required for general construction projects
- Specified accuracy effects flying height and associated costs
- Ground Contours are valuable but materially increase costs
- Recommend flying entire airport property at lower flight level even if the project is to develop an approach procedure for a single runway. Then the imagery can be used to leverage robust feature extraction without re-flying
- Imagery “collection” is relatively inexpensive – processing/analysis can add considerable costs that increase significantly with lower flight levels.
- Recommend Airport keep copy of Stereo and Orthoimagery
- May Need to fly without foliage to develop Ground Contours
- Evaluate Map/Photo Scale required for project
- May wish to include imagery “patch” to orthoimagery as a task in major development projects (e.g. new runways, extensions, terminals, etc.)

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