



System Operations, Airspace & Aeronautical Information Management

U.S Assessment of Amendment 33

To

ICAO Annex 15, Chapter 10,

Electronic Terrain and Obstacle Data

Focus on Electronic Terrain With Emphasis on Area 2

Problem Statement:

How do we meet the requirements of
amendment 33 in a cost efficient
manner?

Area 1 Entire Territory of a State

Post Spacing – 3 arc seconds (approx 90 meters)

Vertical Accuracy – 30 meters

Vertical Resolution – 1 meter

Horizontal Accuracy – 50 meters

Confidence Level – 90%

Data Classification-routine

Integrity Level – 1×10^{-3}

Maintenance Period – as required

Requirement met by: Seamless Shuttle Radar Topography Mission

- Flown aboard the NASA Space Shuttle Endeavour February 11-22, 2000, SRTM successfully collected data over 80% of the Earth's land surface, for all area between 60 degrees N and 56 degrees S latitude.
- SRTM data is being used to generate a digital topographic map of the Earth's land surface with data points spaced every 1 arc second for the United States of latitude and longitude (approximately 30 meters). The SRTM "finished" data meet the absolute horizontal and vertical accuracies of 20 meters (circular error at 90% confidence) and 16 meters (linear error at 90% confidence), respectively, as specified for the mission. The vertical accuracy is actually significantly better than the 16 meters. It is closer to +/- 10 meters.

SRTM Generated Image



Area 2 Terminal Control Area

Post Spacing – 1 arc second (approx 30 meters)

Vertical Accuracy – 3 meters

Vertical Resolution – 0.1 meter

Horizontal Accuracy – 5 meters

Confidence Level – 90%

Data Classification-essential

Integrity Level – 1×10^{-5}

Maintenance Period – as required

Terminal Control Area?

The Smaller of TCA or 45 km radius
No TCA with IFR Ops, 45 km radius

- Class B Airspace (> 250,000 enplanements)
- Class C Airspace (25,000 – 250,000)
- Class D Airspace (control tower)
- Class E Surface Airspace (non-tower IFR)
- Class E 700' Floor Airspace (non-tower IFR)
- Class E Other Than 700' Floor (non-tower IFR)
- Combination of all Class Airspace

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Class B Airspace



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Class C Airspace



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Class D Airspace



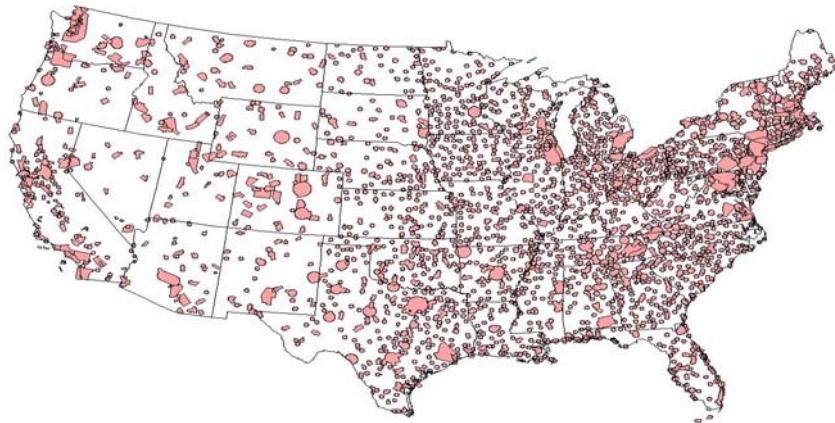
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Class E Surface Airspace



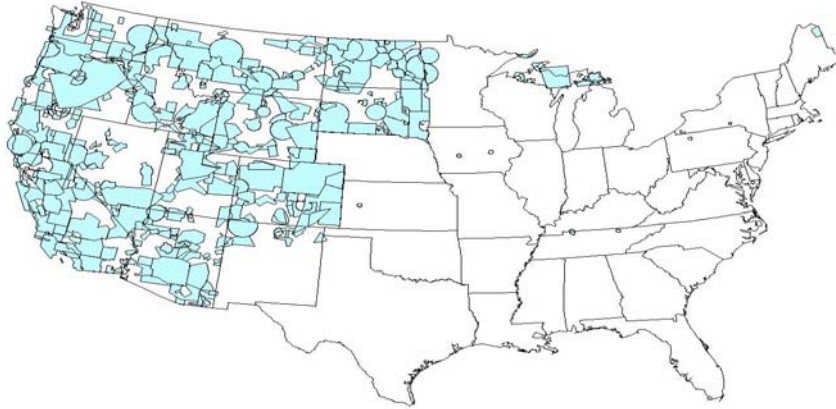
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Class E 700' Floor Airspace



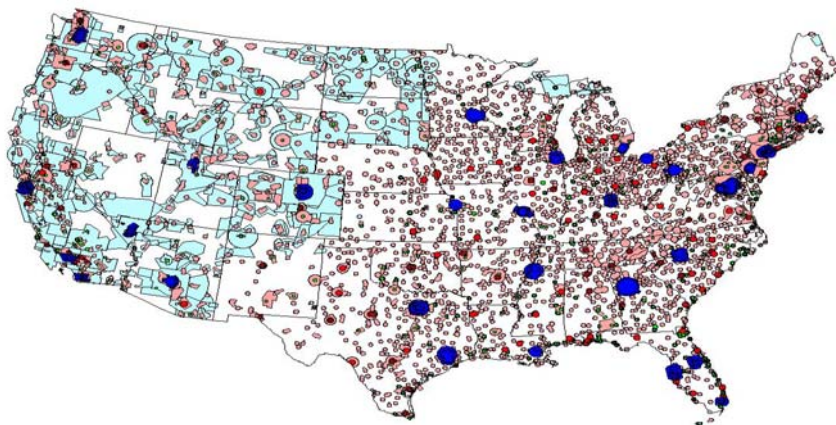
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Class E Other Than 700' Floor



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Combined Airspace



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U.S. Airspace Situation

There are very few areas requiring Area 1 accuracies. The entire United States would have to be surveyed to at least Area 2 requirements.

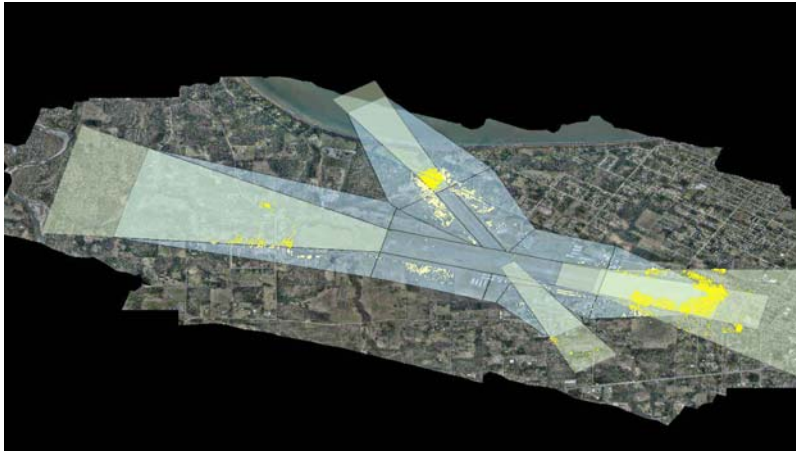
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How to meet Area 2 Requirement?

- Airborne Laser Terrain Mapping utilizing Light Detector and Ranging Data (LiDAR)
- Interferometric Synthetic Aperture Radar (IFSAR)
- Commercial Satellite Imagery

LiDAR

Port Angeles, Washington LiDAR Survey, CFR Part 77
Approach, Transitional, and Departure Surfaces
composite image



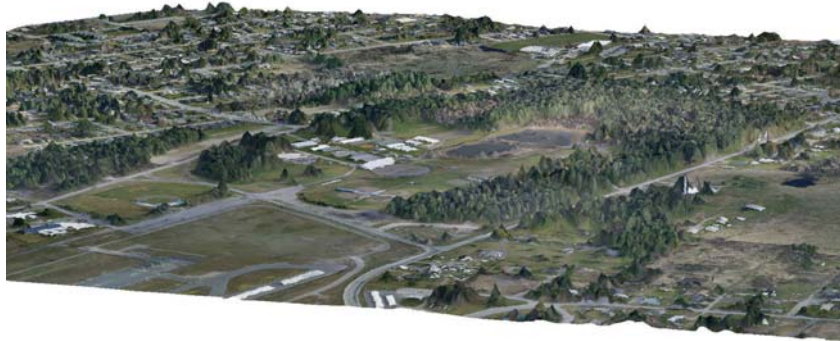
LiDAR Continued

Orthorectified Image Rwy 26 Approach



LiDAR Continued

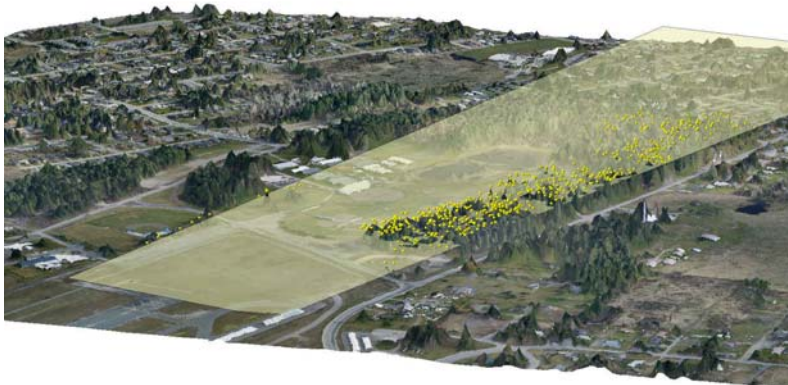
LiDAR Generated 3D View of Runway 26,
Port Angeles, Washington



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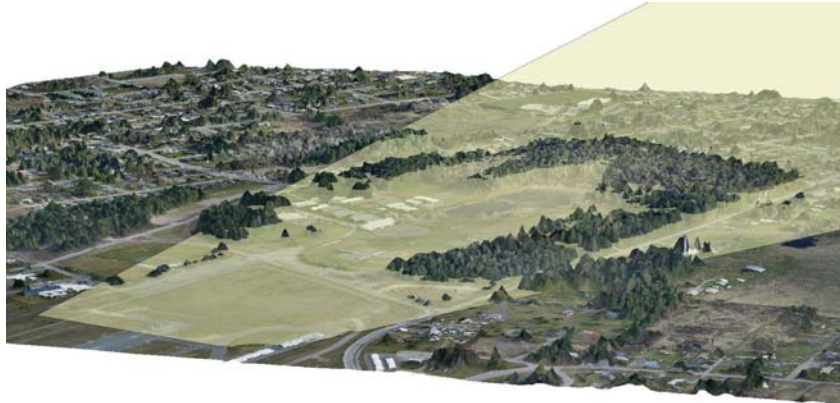
LiDAR Continued

LiDAR 20:1 Approach Surface, Runway 26
Port Angeles, Washington



LiDAR Continued

LiDAR 40:1 Departure Surface, Runway 26,
Port Angeles, Washington



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LiDAR?

- Meets or exceeds accuracy requirements for Area 2 data
- Collection process for terrain is nearly fully automated with higher resolutions than some photogrammetric methods
- Data collected easily imported into commercially available GIS packages
- Data changes easy to detect from re-survey

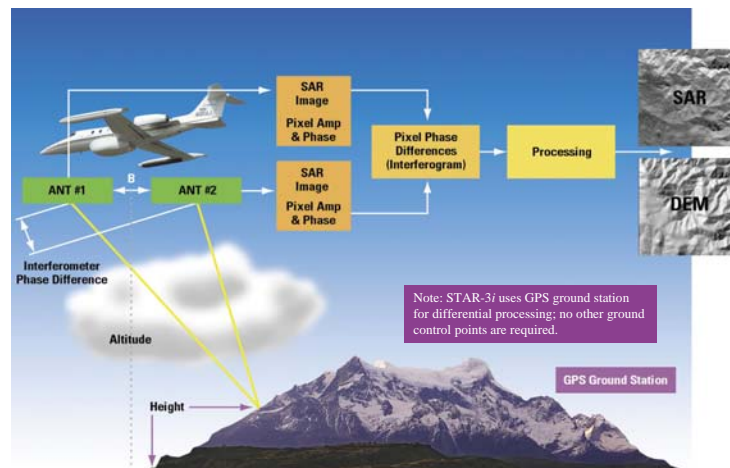
LiDAR?

- Can not observe very thin objects (antennae) requiring ground survey verification
- Excessive cost: \$60,000 to conduct the survey and \$26,000 for data processing = \$86,000 for delivered product
- \$86,000 x 5,300 public use airports in the United States = \$455,800,000
- \$455,800,000 does not include entire Terminal Control Area as required in the amendment
- LiDAR not currently a cost effective solution for Area 2 electronic terrain/obstacle collection
- Could be cost effective as the technology advances

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IFSAR

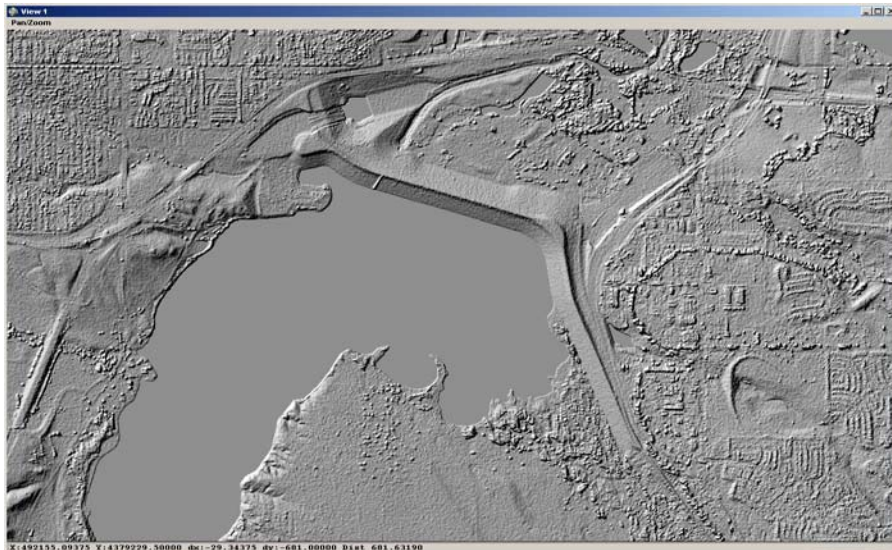
IFSAR Collection Process



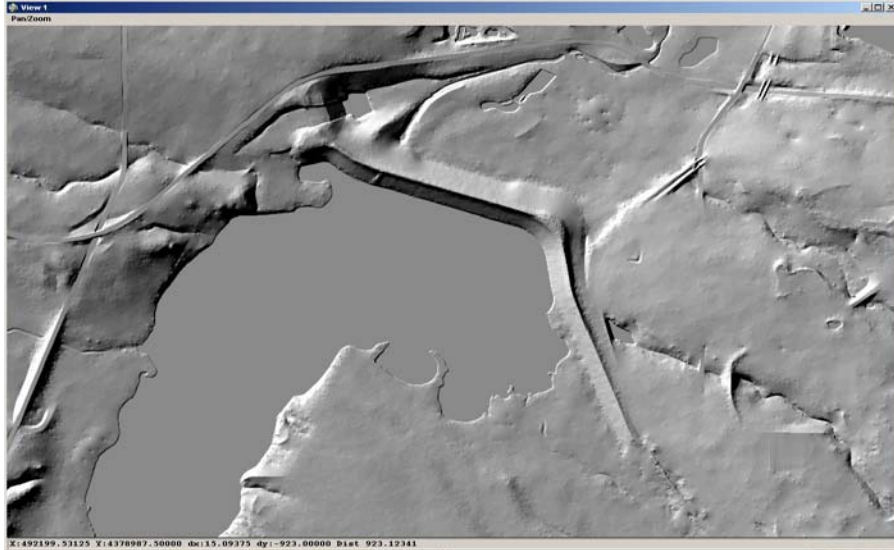
IF SAR Products

- Digital Surface Model (DSM)
 - A first surface measurement (reflected radar pulse)
- Digital Terrain Model (DTM)
 - Bare earth measurement (Process & Edit)
- Ortho-rectified Radar Image (ORI)
 - Black & White
- National Color Image Layer (NCIL)
 - ORI fused with colour Landsat
 - Selected urban areas (optical imagery)
- Selected vector products
 - Contours
 - 3D Roads

IF SAR DSM



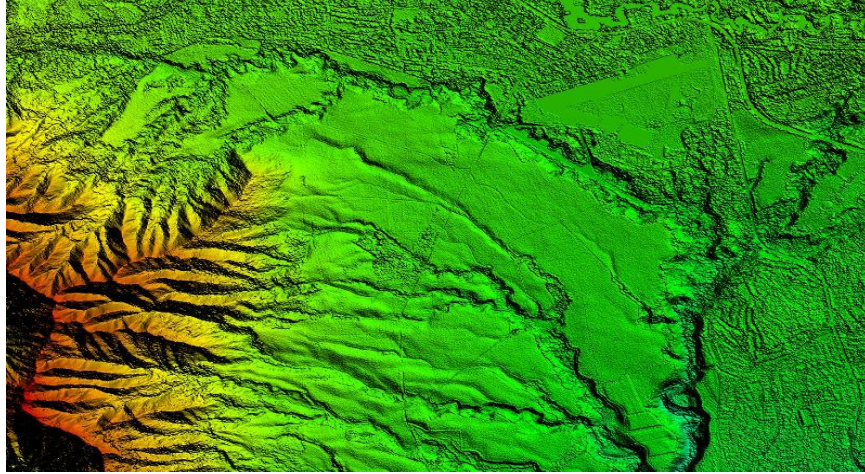
IFSAR DTM



IFSAR ORI

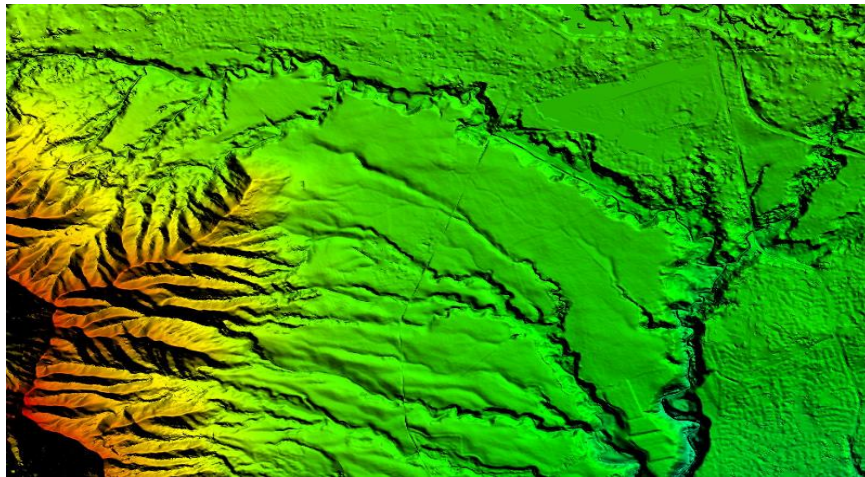


IF SAR COLOR DSM



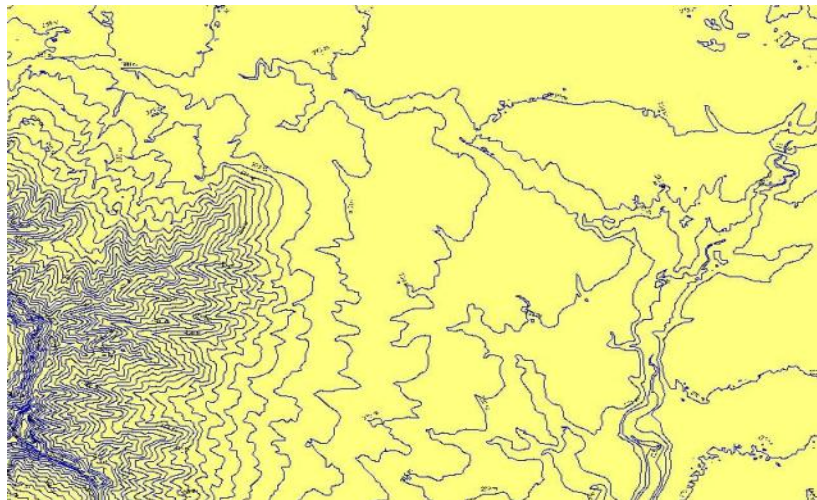
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IF SAR COLOR DTM

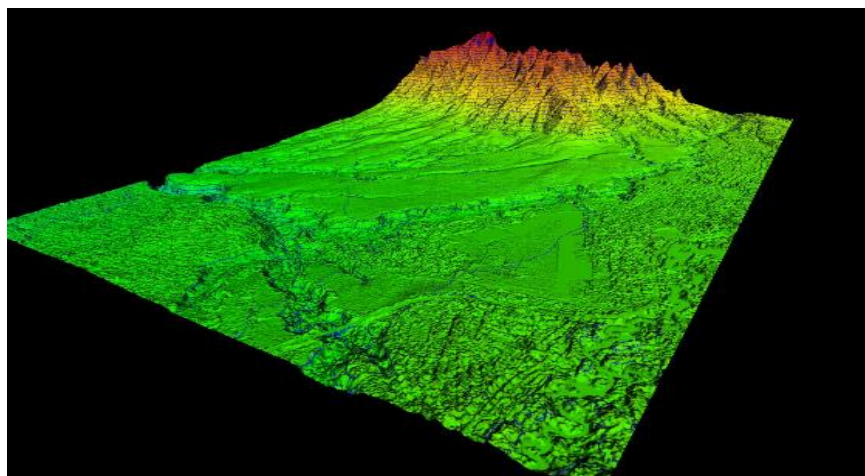


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IFSAR Vector Contours



IFSAR 3D



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IFSAR?

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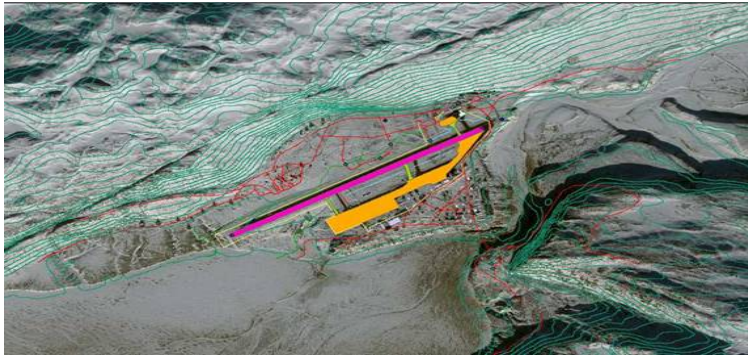
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IFSAR?

- Vendor claims vertical accuracy of 1 meter, horizontal accuracy of 1.8 meters, and post spacing every 5 meters which exceeds Area 2 requirements
- Vendor claims 100% collection of the continental United States, Hawaii, & Puerto Rico (excluding Alaska and possessions) by 2008, data processing and final output by 2009
- Vendor claims price for core product set of the continental United States, Hawaii, & Puerto Rico (excluding Alaska and possessions) approximately \$25,000,000
- IFSAR possible Area 2 solution for electronic terrain

Commercial Satellite Imagery

Leading commercial satellite imagery vendor, current airport mapping product



Next generation product

- Vendor claims next generation system will provide ground resolution of 0.41 meter stereo panchromatic and 1.65 meter multispectral or color imagery
- Vendor has constructed and is awaiting launch of its next generation commercial satellite imaging system mid to late 2007
- Next generation commercial satellite imagery possible Area 2 solution for electronic terrain

Area 3 (Aerodrome/Heliport Area) &
Area 4 (Category II or III
Operations Area)

- Requirements will be met by FAA Advisory Circulars (AC) , AC150/5300-16, 17, & 18.
- AC 150/5300-18 specifically addresses areas 3 & 4 and is currently under revision to include these requirements.

Thank You