### Overview of Small UAS Notice of Proposed Rulemaking

**Summary of Major Provisions of Proposed Part 107**

The following provisions are being proposed in the FAA’s Small UAS NPRM.

| Operational Limitations | • Unmanned aircraft must weigh less than 55 lbs. (25 kg).  
|                         | • Visual line-of-sight (VLOS) only; the unmanned aircraft must remain within VLOS of the operator or visual observer.  
|                         | • At all times the small unmanned aircraft must remain close enough to the operator for the operator to be capable of seeing the aircraft with vision unaided by any device other than corrective lenses.  
|                         | • Small unmanned aircraft may not operate over any persons not directly involved in the operation.  
|                         | • Daylight-only operations (official sunrise to official sunset, local time).  
|                         | • Must yield right-of-way to other aircraft, manned or unmanned.  
|                         | • May use visual observer (VO) but not required.  
|                         | • First-person view camera cannot satisfy “see-and-avoid” requirement but can be used as long as requirement is satisfied in other ways.  
|                         | • Maximum airspeed of 100 mph (87 knots).  
|                         | • Maximum altitude of 500 feet above ground level.  
|                         | • Minimum weather visibility of 3 miles from control station.  
|                         | • No operations are allowed in Class A (18,000 feet & above) airspace.  
|                         | • Operations in Class B, C, D and E airspace are allowed with the required ATC permission.  
|                         | • Operations in Class G airspace are allowed without ATC permission.  
|                         | • No person may act as an operator or VO for more than one unmanned aircraft operation at one time.  
|                         | • No careless or reckless operations.  
|                         | • Requires preflight inspection by the operator.  
|                         | • A person may not operate a small unmanned aircraft if he or she knows or has reason to know of any physical or mental condition that would interfere with the safe operation of a small UAS.  
|                         | • Proposes a microUAS option that would allow operations in Class G airspace, over people not involved in the operation, provided the operator certifies he or she has the requisite aeronautical knowledge to perform the operation.  

| Operator Certification and Responsibilities | • Pilots of a small UAS would be considered “operators”.  
|                                            | • Operators would be required to:  
|                                            |   ▪ Pass an initial aeronautical knowledge test at an FAA-approved knowledge testing center.  
|                                            |   ▪ Be vetted by the Transportation Security Administration.  

- Obtain an unmanned aircraft operator certificate with a small UAS rating (like existing pilot airman certificates, never expires).
- Pass a recurrent aeronautical knowledge test every 24 months.
- Be at least 17 years old.
- Make available to the FAA, upon request, the small UAS for inspection or testing, and any associated documents/records required to be kept under the proposed rule.
- Report an accident to the FAA within 10 days of any operation that results in injury or property damage.
- Conduct a preflight inspection, to include specific aircraft and control station systems checks, to ensure the small UAS is safe for operation.

### Aircraft Requirements

- FAA airworthiness certification not required. However, operator must maintain a small UAS in condition for safe operation and prior to flight must inspect the UAS to ensure that it is in a condition for safe operation. Aircraft Registration required (same requirements that apply to all other aircraft).
- Aircraft markings required (same requirements that apply to all other aircraft). If aircraft is too small to display markings in standard size, then the aircraft simply needs to display markings in the largest practicable manner.

### Model Aircraft

- Proposed rule would not apply to model aircraft that satisfy all of the criteria specified in Section 336 of Public Law 112-95.
- The proposed rule would codify the FAA’s enforcement authority in part 101 by prohibiting model aircraft operators from endangering the safety of the NAS.
Unmanned Aerial Systems (UAS): Present & Future

Sreekala Bajwa
Professor & Chair, Agricultural & Biosystems Engineering

&

John Nowatzki
Extension Ag Machine Systems Specialist
North Dakota State University

UAS for Agriculture

• NDSU UAS Activities
• UAS Regulations
• Important Issues
• Future UAS Applications in Ag & Natural Resources
UAS at NDSU

- Teaching – minor in precision agriculture
  - Precision agriculture – includes UAS & remote sensing
  - Data Management and Processing
- Research
  - UAS Applications in Crop, Livestock, Rangeland, and Energy at 7 Research & Extension Centers
  - Sensor Evaluation
  - Industry Collaboration
- Extension
  - Education Programs for Consultants, Producers
  - Data Management and Analyses

NDSU UAS Ag Resources

Agricultural and Biosystems Engineering Department
- Mr. John Nowatzki, Extension Ag Machinery, Precision Ag
- Dr. Sreekala Bajwa, Chair, Precision Ag Research
- Dr. Ganesh Bora, Assistant Professor – Precision Ag Courses

NDSU Ag Experiment Station – VP Dr. Ken Grafton
- Research Extension Centers
NDSU UAS Activities

Livestock Production

Crop Production

Collaborative UAS Projects
Field Crop and Livestock Production

- Research North Dakota – 3 projects
  - 2014 – CREC
  - 2015 – All NDSU REC’s
- Partners
  - LW Survey
  - Sentera
  - Elbit Systems of America
  - AeroVironment
  - ND Soybean Council
  - ND Corn Council
  - NDSU Ozbun Fund
  - NPUAS Test Site
NDSU UAS Projects - 2015

NDSU Ag UAS Research in 2015

- NDSU 7 Research Extension Centers (RECs)
  - Estimate Plant Stand
  - Nitrogen Deficiencies in Corn
  - Canola Diseases
  - Weed Mapping & Herbicide Resistant Weeds
  - Impact of Oil Drilling on Crop & Livestock
  - Irrigation Water Stress
  - Iron deficiency in Soybean
  - Livestock Management
  - Identifying Weed Infestations
  - Sugarbeet Diseases
1. Effectiveness UAS-mounted Sensors Field Crop and Livestock Production: Evaluate UAS with Color, Thermal and Infrared Sensors
   - Crop Management & Livestock Management
   - UAS Business Development in ND
   - NDSU Extension Education Program
2. UAS Imagery to identify specific weed infestation in cropland – identify weeds & develop business model
3. Large-scale UAS data collection, processing and management for field crop management
4. Detect and map Rizocotonia in sugarbeet

UAS Research Projects

Cameras
- Sony NEX-5R Camera and Voigtländer Lens RGB and IR
- ICI 9640 S Thermal Camera
- Large area scanning EO/IR/NIR camera
- Tetracam ADS
- Hyperspectral camera - 2016
- LIDAR - 2016
Fixed-Wing UAV – Autonomous-2014-15

Single Image from Sony Camera on Draganflyer

Image of Wheat in June 2014
Convert images from Sony Raw format to .tiff

Mosaic from Sony Camera on Draganflyer

Full Color Image in June
Image Management Software

- Agisoft
- AgPixel
- Trimble Business Center
- Autopano Giga
- Micro D Player
- Microsoft Ice
- Able RAWer
- ArcGIS

Annual Grass Control in Wheat

Full Color – Wheat

“NDVI” – Wheat
Soybean-Fall Kochia Removal - Mosaic

Plant Population and Hybrid Maturity on Corn
MATLAB Software

Stand Count - Corn

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Trimble UX5 Images in September - 2014

Infrared Mosaic Image
UAS in Agriculture: Tech Issues

- Data Transfer
- Data Management
  - Time Required
  - Software
  - Image Degradation
  - Image Geo-referencing
- Data Analyses
- Autopilot on UAS
- Sensors and Cameras
sUAS Regulations

- Hobbyist
  - Under 400 ft, line of sight, away from airports
- COA
  - Typically up to 400 ft (could be higher)
  - Line of sight
  - Universities and government agencies can apply
  - Need one for each aircraft for specific area
- Commercial Exemption
  - Over 1300 commercial exemption were issued
  - Up to 200 ft, stay away from airports
  - Line of sight

Proposed sUAS Rulemaking (handout)

- Operational limitations
  - Line of sight, not operate over any persons not involved in flying, daylight operation only, max airspeed 100 mph (87 knots), 500 ft max altitude, preflight inspection by operator
- Operator Certification and responsibilities
  - Operators are required to pass an FAA-approved test, be certified on sUAS, etc
- Aircraft requirements
  - Airworthiness certification not required
  - Aircraft marking required
- Model aircraft
  - Rule would not apply to model aircraft
Future of UAS Application in Ag

- **Individual Farmers**
  - Eye in the Sky
  - Scouting for plant stand, disease, pests, weeds, fertility issues, soil problems, water problems, weather damage, etc
  - Prediction of yield & yield quality
  - In-season fertilization, pesticide application, replanting, etc

- **Crop and Livestock Consultants**
  - Increase business efficiency
  - Increase confidence

Future of UAS

- **New technology**
  - New sensors with better resolution, data quality and bands
  - New UAV platform, navigation systems & applications
  - Data storage, transfer and processing tools

- **Beyond line of sight**
  - Line of sight: 0.5-1 mile
  - Multi-aircraft sUAS system to cover large farms

- **Combination of large and small UAS**
  - Broad area assessment by large UAS followed by spot inspection by small UAS
  - Hermes 450 covers 25,000 acres at 1” ground resolution in 1 hour, compared to Trimble UX5 that covers ~500 acres at 1” resolution in 1 hour
Future of UAS

- **A lot of new application**
  - Crop health, yield and acreage
  - Livestock monitoring – activity, behavior, health
  - Weather monitoring: $6 M NSF grant to UK
  - Plant breeding - phenotyping
  - Building/construction site inspection
  - Oil field applications – pipeline monitoring, surveying
  - Utility monitoring – line sagging, tree overlap, damage
  - Plant identification & mapping – invasive plants, weeds
  - Disaster monitoring – flood, hale, fire, etc
  - Wildlife & ecosystem monitoring
  - Security application, and many more

NDSU Research Plans

- Broad area UAS application in field crop, beyond line of sight, with LARGE UAS (Hermes 450, Elbit Systems of Am.) at multiple heights & comparison with sUAS
- Crop phenotyping with sUAS
- Weed and invasive species identification & mapping
- Crop fertility problems & fertilizer requirement mapping
- Crop diseases – Rizoctonia, club root, fusarium, etc
- Cropping system study
- Irrigation requirement and water stress in crops
- Any other issues & weather impact on selected fields