NEVADA FAA UAS TEST SITE
QUARTERLY REPORT

December 30, 2016

4th Quarter, CY16

Submitted in accordance with
Other Transactional Agreement
DTFACT-14A-00003

Prepared by:

Nevada Institute for Autonomous Systems

for

The Nevada Governor's Office of Economic Development

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EXECUTIVE SUMMARY, 4th QUARTER, 2016

Per the Other Transaction Agreement (OTA) between the Federal Aviation Administration (FAA) and the State of Nevada, DTFACT14A-00003, the State of Nevada FAA Unmanned Aircraft Systems (UAS) Test Site submits the following 4th Quarter, 2016 report to the FAA. The content in this report is an outline summary of the Nevada UAS Test Site activities over the past 90 days through 31 December 2016.

The Nevada Governor's Office of Economic Development ("GOED") is the lead Nevada state entity for interface and coordinating with the FAA UAS Department for developing and integrating the FAA's UAS Systems under the OTA. In turn, GOED has contracted with the non-profit corporation, the Nevada Institute for Autonomous Systems (NIAS) to operate, oversee, and perform profit and loss (P&L) budget responsibilities over designated Nevada UAS Test Site ranges and unmanned aviation activities as well as provide expert leadership to the Nevada UAS Industry. The NIAS manages unmanned aviation operations and logistic resources, develops expanded airspace opportunities, and generates UAS business leads that benefit UAS public and commercial companies. The NIAS is staffed with permanent senior leaders (management) with the unique responsibility to grow the Nevada UAS Industry on behalf of GOED. No other Nevada entity has this overarching and critical responsibility. The GOED and NIAS personnel are hereinafter referred to collectively as ("Nevada personnel") in this report.

During the 4th Quarter, CY 16, the FAA online reporting system recorded 225 Certificate of Authorization (COA) flights for the Nevada UAS Test Site representing a 42.7% increase in COA flights from the 3rd Quarter COA flights. The aggregate COA flight total for CY 2016 is reported at 873 total COA flights. This exponential increase in Nevada UAS Test Site COA missions from the 2015 calendar reporting year and the explosion of UAS across Nevada will continue for the foreseeable future. As the demand for UAS increases, concerns regarding how UAS will impact existing manned aviation grow stronger, especially in terms of safety, privacy, frequency crowding, and airspace congestion. To meet this demand, the Nevada UAS Industry has evolved to include a wide variety of fixed wing and rotary UAS of various sizes, weights, and speeds, operating across the Nevada desert and outside and inside populated complex metropolitan areas. With the release of the FAA's Part 107 regulations the summer of 2016 and the range of airspace, from low-altitude to higher altitudes has increased significantly. Some UAS are dependent on thermals and wind, such as gliders while others fly faster with every technological innovation – some UAS fly as fast as manned aviation systems. As UAS technology advances, so do the challenges associated with maintaining a safe and integrated Nevada airspace and the task to grow the Nevada UAS Industry. Additionally, while the expanded use of UAS presents great opportunities, it also presents significant challenges in Nevada as unmanned aircraft systems are inherently different from manned aircraft. Addressing the Nevada UAS challenges in a complex, multi-layered system has never been more critical. Some of the UAS challenges can be addressed through new Nevada legislation; therefore, Nevada legislation should be developed, updated, and geared toward growing the Nevada UAS Industry to keep pace with FAA regulatory and global UAS industry demand and to better integrate and enhance the Nevada UAS Test Site as a highly effective and resilient outlet for airworthiness, safety, and standardization across the commercial and public Nevada UAS Industry.

The continued safe integration of Nevada UAS in the NAS and ensuring the growth of the Nevada UAS Industry will be driven by advances or authorizations in: (1) UAS capital investments in Nevada to facilitate the Nevada UAS Strategic goals, objectives, research and development (R&D—including long-distance test ranges associated with R&D); (2) development of new and innovative UAS policy and procedure recommendations to the FAA (including operational approval and airworthiness standards across the Nevada UAS Industry); (3) development of Nevada UAS-related new technologies; and (4) the strategic and operational freedom given to NIAS to grow the Nevada UAS Industry with required resources. The exponential industry growth will continue to raise the bar for safe integration of UAS into the NAS and continue to drive changes to the Nevada UAS Strategic goals over the next four years.

Nevada Aligned FAA Focus and Integration Areas

Critical Infrastructure

FAA's Drone Detection at Airports and Critical Infrastructure
Nevada UAS Test Site and Eye in the Sky UAS Team

FAA Drone Detection Pathfinder at the Denver International Airport (14-18 November 2016)

Discussion. The UAS Detection at Airports Ground and Flight Testing Operations at Denver International Airport was a success from a UAS flight operations perspective. When two or more UAS Test Sites are involved, designating one Air Boss proved to be very beneficial in orchestrating all air operations. The collaboration and flexibility between the Nevada UAS Test Site and the North Dakota UAS Test Site team was seamless and this led to operational excellence under challenging flight and environment (high wind and severe cold weather) conditions. Another key element that proved successful was the daily flight operations, safety, and air mission briefs conducted by NIAS and the FAA project manager. These briefings were critical to the success of the project because it reiterated flight safety and the importance of standardized flight and safety processes and procedures were in place to ensure overall situational awareness during the NOTAM flight operation active times.

The Nevada UAS Test Site selected the very top performing flight teams and this high level of professionalism was critical to executing all 35 Certification of Authorization missions flown in support of the various FAA Test Card scenarios. There were several historic UAS operations that took place during this project and this was made possible due to the detailed planning and preparation of the flight teams. These UAS Industry first include: (a) first UAS flights in Class B Airspace, (b) first fixed-wing flights in Class B Airspace, (c) first multi-aircraft (simultaneous) operations in Class B Airspace, (d) first night and multi-aircraft (simultaneous) operations in Class B Airspace, and (e) first UAS flights, night operations, and multi-aircraft operations in severe cold weather conditions in Class B Airspace.

Lessons Learned. The Nevada UAS Test Site had gleaned several positive lessons learned. All conditions were set in the FAA Nevada UAS Certificate of Authorization and Letter of Agreement to ensure all flight crews adhered to FAA and Denver International Airport ATC policy and procedures. The Nevada UAS Test Site ensured UAS were seamlessly integrated with manned aviation operations. There were zero accidents or incidents during the flight performance period for both UAS Test Sites under the operational control of the Nevada UAS Test Site. Communication methods with VOs (Visual Observers) were highly practiced, consistent, and very effective during the multiple test scenarios.

Operational Challenges. Safety precautions were taken to accommodate both UAS fixed-wing aircraft and rotary-wing aircraft flight characteristics (e.g., launch and recovery zones were designated by cones and caution tape). Nevada flight crews were extremely professional and resilient in their pre-flight checklists which allowed for multiple changes in the flight operations when the North Dakota flight crew had technical setbacks or aborted their flights when weather conditions did not allow for flying their UAS. Adverse weather called for aircraft modifications to keep the flight control unit and the UAS heated and able to fly. Due to the extreme cold temperatures, battery power was closely monitored and the flight crews observed that battery life decreased. To achieve FAA night operations Test Cards, the flight crews decided to land the aircraft with 40% battery life remaining as opposed to the standard 20% reserve power. Airborne and landing procedures were modified to allow for landing in 12 inches of snow.

Agricultural and Soil Irrigation Architecture
DRI and Above NV

Agricultural Survey Mission

Discussion. The Desert Research Institute continues to pursue UAS applications research, development and collaborations. The goals of this project are to acquire and analyze UAS visible (RGB), near infrared and thermal infrared image data to assess variances in field and crop conditions due to pests, disease, environmental conditions (e.g., saline soils) and irrigation inefficiencies. The project was initiated at the beginning of April with several flights occurring during the 2nd and 3rd Quarters. Although the focus of this project is the development of image products that are of value to the farm manager, DRI also examined efficiencies in UAS operations and image acquisition. Since the last quarterly report, DRI has conducted flight operations on 8 November 2016. A fixed wing UAS were deployed to acquire RGB and near infrared imagery of agricultural fields under bare soil conditions.

Lessons Learned and Operational Challenges. The project focus was on data processing and developing the best methodology to create digital elevation models from the UAS photographs. The operational lessons learned from the data analysis is that significantly more ground area beyond the study area must be flown to ensure that the data processing edge effects do not coincide with the study area.

Expanded Operations (includes EVLOS and BVLOS)

NASA UTM TCL 2 –Nevada UAS Test Site, RTAA, UNR/NAASIC, & GC2IT/FRA

3-25 October 2016 at Reno-Stead Airport UAS Range

Discussion. The mission was to execute the milestone NASA Unmanned Traffic Management (UTM) Technical Capability Level (TCL) 2. The UTM TCL-2 Shakedown #2 took place on 3-7 October 2016 and the TCL-2 Demonstration took place on 17-25 October 2016 at Reno-Stead Airport. The NASA event involved up to 12 NASA partner entities with the Nevada UAS Test Site involved in NASA airworthiness and running range flight operations for each NASA event. For the first time, NASA allowed an outside entity (NIAS) to jointly participate in their detailed aviation flight readiness review board for each participating UTM UAS vehicle.

Lessons Learned. This was the largest Nevada UAS Test Site flight operations to date and the lessons learned in the areas of complex airworthiness procedures, extended communications, extended visual lines of

sight operations, multiple aircraft operations, air traffic congestion (both unmanned and manned), altitude stratification, and local visual line of sight operations will all be applied in the Nevada UAS Test Site's way forward to develop beyond line of sight operations. Three things were noted during the exercise that were valuable to the overall success: (a) the UTM clients were more stable; (b) better collaboration across the UAS Range with the *Slack Chat* for "next up" mission control; and (c) the positive radio contact across the UAS Range that helped keep the Range in a hot mission state for the NASA Mission Manager's situational control for meeting his Test Plan goals and objectives. In addition, using one radio "Range Net" for Stead Range, NASA Safety, NIAS Range Control and the Observer Controllers (OCs) proved very beneficial. This combined with using a second discrete net at each ground control station (GCS) between OCs and Visual Observers (VOs) worked well for line of site operations. NASA authorized the Nevada UAS Test Site to install and integrate their LSTAR-2 radar into the Nevada Unmanned Autonomous and NextGen Collaborative Environment (NUANCE) lab. The radar was tested for two days during Shakedown #2 flight operations with no issues. LSTAR-2 ran simultaneously with LSTAR-1 at a different location. Both radar feeds were successfully merged into a single display effectively increasing the UAS detection range. Both LSTARs operating together covered the other's dead zones and the common operating picture and traffic avoidance among UAS crews were dramatically enhanced. One point the Nevada-NASA team observed is that you can't run both LSTAR radars simultaneously on the same frequency within 1.5 miles of each other. This dual operation in close proximity to each other resulted in interference. Testing was completed during Shakedown#2 and the LSTAR-2 was not used during the main TCL demonstration.

Operational Challenges. There were two operational challenges noted during this event. The first challenge was line of sight challenges. Maintaining visual contact was challenging during the EVLOS missions primarily with small drones, like the DJI Phantom because it is small and lacking in either bright lights or bright colors. The ground station for the DJI Phantom was 1.0 mile from the first VO and 1.3 miles from the second VO. A third VO was stationed 0.8 miles from the ground station to try and close the gap. Unless the VOs knew exactly where to look in the sky and the Phantom was less than 0.5 miles away, the UAS was not detectable. Another challenge to maintaining visual contact during the NASA flights was due to depth perception of UAVs as they crossed back and forth from above to below the mountainous skyline. This was mostly an issue for the fixed wing since they can be difficult to track while they are banking. The presence of shadows from clouds on sunny days made this more difficult than when there was considerable cloud cover. The second challenge relates to UAS altitude. The VOs and OCs were especially alert to the potential for collision during the vertically stratified missions and they had to be ready to recommend a course of action for de-confliction. One challenge involved depth perception when the two aircraft were of different size and were approaching the area of overlap from different directions. Depending on the positions of the VOs relative to the flight paths of the vertically segregated UAVS as they approached the crossover, the UAVs can appear to be at the similar altitudes. Another challenge with the non-segregated operations resulted from the strong wind updrafts on the range that could change the altitude of a UAV quite quickly and dramatically. The fixed wing UAVs were typically more susceptible to the updrafts, so the recommended course of action was to assign the multi-rotor to an altitude below the fixed wing during vertically stratified operations.

The specific mission successes for the NASA UTM air operation at Reno-Stead Airport for October 2016 included the following:

- Participated in every NASA AFSRB—first in NASA history for ext. entity
- Executed all NASA test cards on time—127 COA flights were conducted during the project
- Ran all UAS Range Operations
- Multi-aircraft operations in BVLOS virtual UTM environment
- Provided the full range of logistical and support operations for the entire NASA Ames team
- Deployed a new Observer Controller scheme to set the conditions for sustaining prior operational experience
- Exercised EVLOS and long-range communications
- Effectively mitigated and managed risk minimizing impact to operations

SUMMARY

The use of UAS is expected to increase exponentially in Nevada and across the National Air Space (NAS); therefore, developing a safe and efficient Nevada UAS strategy is the critical path and optimal approach to position Nevada as an incredibly strong FAA UAS R&D and Testing Center Partner and global UAS thought leader. The need for new capabilities, mitigations, and verification and validation methods to enable safe UAS operations will require the development, integration, and implementation of emerging and new technologies. The overarching approach contained in the Nevada UAS Strategy is for goals to enhance public UAS integration, which includes civil integration, and grow the Nevada UAS Industry at a pace commensurate with the exponential growth of the global UAS Industry. The scope and magnitude of growing the Nevada UAS Industry dictates that R&D activities must be well understood within an integrated framework in terms of relevance, timeliness, and relationships among related research activities and their interactions with NIAS. For sure, advancing Nevada Strategic UAS plans is integral toward growing the Nevada UAS Industry, UAS businesses, and job creation.