Safety뀀□ηand뀀□ηMishap뀀□ηPlan뀀□η
DJI뀀□ηMatrice뀀□η600뀀□ηMultirotor뀀□ηUAVs뀀□η
Characterization 뀀□ηof 뀀□ηAir 뀀□ηEmissions 뀀□ηfrom 뀀□ηOpen 뀀□ηBurning 뀀□ηat
September, 뀀□η26 뀀□η-□ 뀀□ηOctober 뀀□η7, 뀀□η2016. 뀀□ηRadfo

Version□□□1.4,□□□Presented:□□□Wednesday,□□□September□□□21□□□2016□□□
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RC□□□Pilot□□□and□□□Safety□□□Pilot,□□□Dr.□□□Ved□□□Chirayath□□□

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I. Overview & Objectives

This document contains a detailed report on safety and mishap procedures for a series of low altitude sampling Nlights over open air burn pans at Radford's Army Am located in Radford, VA. The purpose of this mission is to quantify e dry propellants (MKP90 rocket motor propellants) contain process wastes from or ammunition production operations. Successful quantification of these burns is dependent on whether the amount of each interrogated compound present in the source compared to the amount detected by the sensors at predeNined Nlight

This is a collaborative mission between the following federal agencies: the Environmental Protection Agency's OfNice of Research and Development (EPA/ORD), the Uni NASA Ames Research Center's Earth Science Division. A single unmanned eight-rotor DJI Matrice 600 multi-rotor UAV equipped with one of two ORD *Kolibri* gas sampling system. The two *KNight* systems differ in pump and can be attached and detached from the Matrice 600 depending on analysis.

The following small unmanned aerial system (sUAS) will be Nlown on Matrice 600. This aircraft will house one of two gas sensor payloads, Protection Agency (EPA). All Nlights will take place within a two week period between *Monday, September 26, 2016 and Friday, October 7, 2016*, excluding weekends.

UAS operations will be reviewed and approved under the authority of the NASA Ames Research Center Airworthiness and Flight Safety Review Board (AFSRB), and Flight (FRRB). All Nlight planning an operations will be coordinated with and Mission Manager and Range Safety OfNicer.

There is a risk of possible damage or loss of a NASA-owned UAS mitigated and minimized wherever possible, which is outlined in this mission's corresponding Flight Test Plan. However, the risk of damage or loss of these vehi hard copy of this plan will be retained at the aircraft staging area and the safety elements of this plan shall be briefed to all participa of Nlight operations.

II. Vehicle Details

Radford, VA Army Ammunition Plant

All of the Nlights conducted during this mission will occur over burn region of RFAAP, bordered on the northern side by a ridge line of south. This area is a secured military operations area, with limited acc coordinates of the burn pans, located within RFAAP's premises are 37º11' at an elevation of 1701 ft. An annotated aerial view of the Nlight prospective launch and landing location are shown in Figure 1.

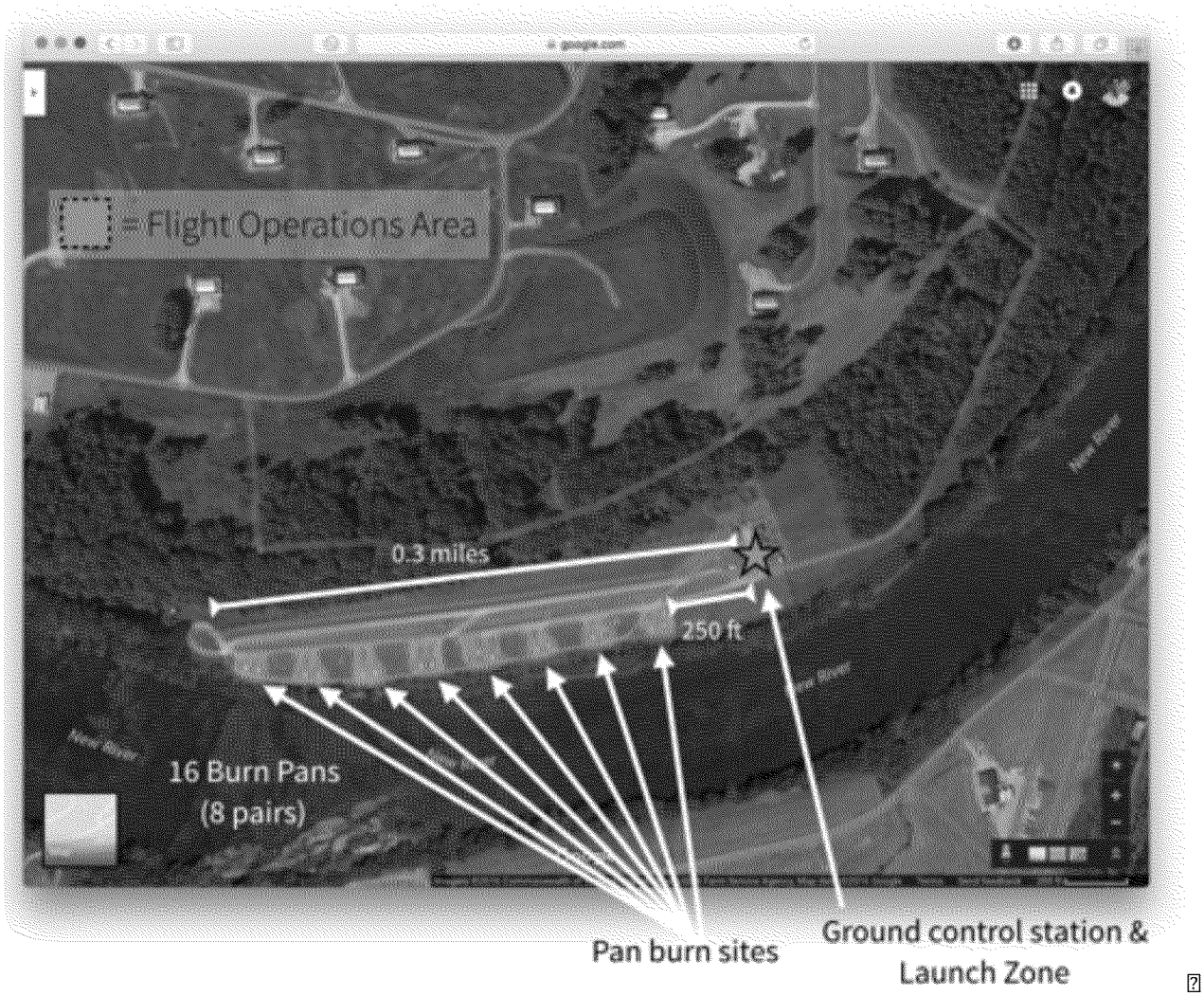

Figure 2-1. Flight Operations Area, Radford Army Ammunition Plant An aerial image of the northwest region of RFAAP, with the Nlight operations area highlighted in and farthest burn pan from the location of the ground control station, design included for reference.

All Nlights during this mission will be conducted under established Military Operations Area (MOA). The two closest airports to the RFAAP, New River Valley Airport and Montgomery Executive Airport (BCB) are both over 3 nautical miles away zone. PSK is approximately 7.5 nautical miles away, and BCB is 5.1 Nlight operations region. This information is illustrated in the Figure 3.2. chart of Radford and surrounding regions is shown in Figure 3.3.

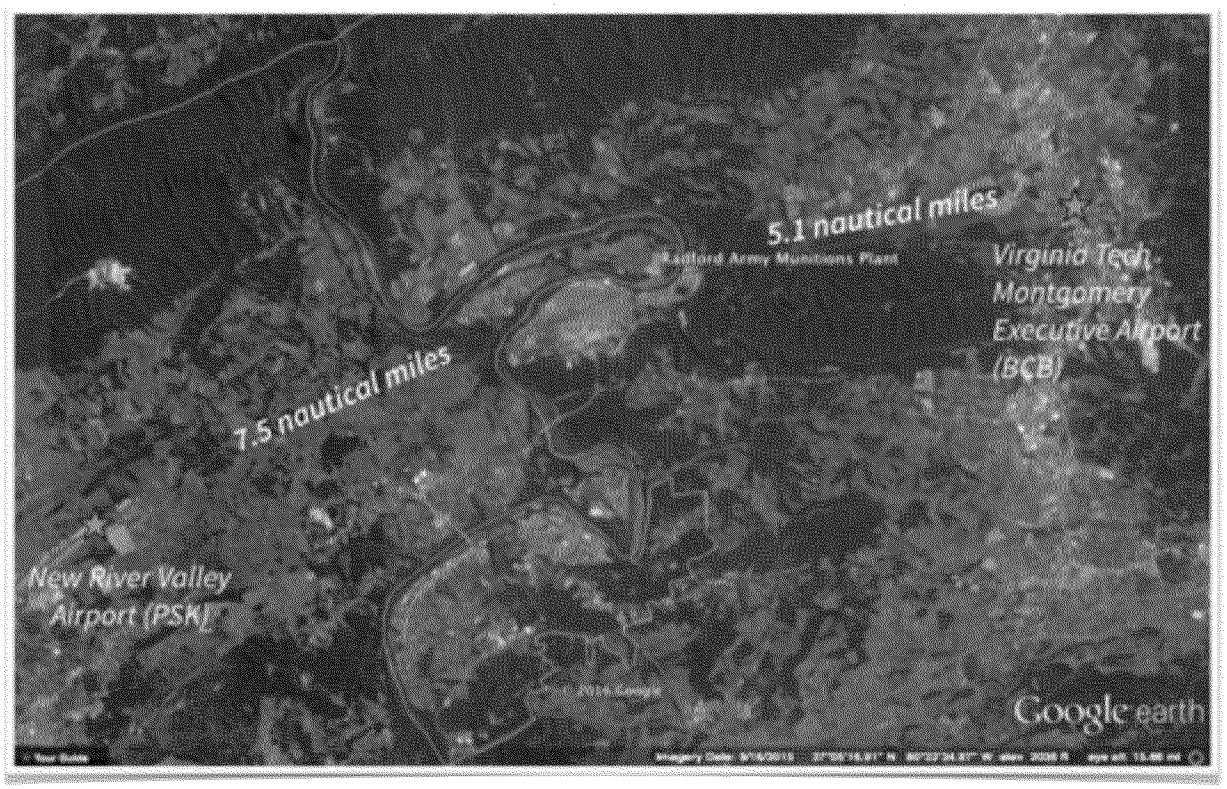

Figure 2-2. Distances to Closest Airports. Radford, VA.

[illegible]

The designated Safety Observer will be responsible for monitoring the airc
whenever power is drawn from the batteries. All safety observers are responsible for all
avoidance and Nlight safety for the duration of this mission. In the event any ground or airspace
incursions are identiNied, safety observers will direct the pilot in comman
avoidance maneuvers.

Any additional safety observers will attend all preNlight meetings to ensur
the predeNined mission Nlight lines, altitudes and emergency plans. Safety
positions will be deNined based on Nlight requirements. Safety observers will also have a direct
means of communication with the Mission Manager and Ground Control S
duration of this mission, the Nlight crew and accompanying personnel are
to all safety protocols instructed by either the Ames Range Safety Officer, or Radford's on site
Range Safety Officer.

[illegible]

Safety hazards pertaining to the planned mission are deNined and addressed below, and are
separated into the following categories: (1) UAS SpeciNic Hazards, (2) Env
Ground Incursions, and (4) Medical and Fire Emergencies.

(1) UAS-speciJic hazards

- The preNlight briening by the [illegible], include a review of sa
procedures and potential hazards speciNic to the Nlights to be conduct

- All listed personnel must attend any preNlight brieNings on the day
- The UAS uses electric motors that may start at any time the aircraft is drawing power. The aircraft shall be restrained whenever a battery pack is installed.
- All mission personnel except the designated RC Pilot and Ground Control Station Operators (GSO) shall remain clear of the approach and landing area.

(2) Environmental Hazards

- Lightning warnings or inclement weather will trigger a stand-down of as directed by Pilot and NASA Principal Investigator, Ved Chirayath
- All mission personnel are advised to dress appropriately for outdoor e 6 hours.
- Personnel are required to wipe down all aircraft equipment wearing p as any auxiliary equipment used on the test range, before leaving t
- NASA personnel will follow Army Range Operator guidance on base at
- Propellants used include, according to the EPA provided QAPP:
- Nitrocellulose 48-58 %
  Nitroglycerin 35-40 %
  Copper, beta-resorcylate salicylate lead complexes 2-6% Benzenamine, 2-nitro-
  Hexanedioic acid, dipropyl ester 1-3%
  Glycerol triacetate 1-3 %
  Candelilla was 1%

(3) Ground Incursions

- Personnel are advised to exercise caution near the approach and landing of bystanders, oncoming vehicles and other low Nlying unmanned aircraft.
- Personnel are advised to exercise extreme caution near possibly volatile compounds. All personnel are required to use an appropriate level of personal protective equipment (PPE), which includes protective gloves, when handling aircraft that have been within close range of open burn compounds, as advised by the onsi Army Ammunition Plant.

(4) Medical and Fire Emergencies

- A class D Nire extinguisher will be available on site for the du circumstances will Nlights be conducted without a Nire extinguisher on
- A Nirst aid kit provided by the UAS operator must be present crew and accompanying personnel.

The designated project **Ron Sagunsteella** shall be the on-site POC for Nire, emergencies requiring an immediate response.

The plan recognizes the need to document the events leading up to this mission, as well as the need to fully cooperate with the NASA

[illegible]

The following members of NASA Ames Laboratory of Advanced Sensing (LA
Ames Earth Science Division, will be present for the duration of the

Table 2-1. Mission Personnel, NASA Ames Research Center

Name	Title	Affiliation	Phone	Email
Dr. Ved Chirayath	LAS Lab Director & ARC Pilot Pilot	NASA Earth Science	(650) 604 6278 (work) (949) 413 8928 (mobile)	ved.chirayath@nasa.gov
Mr. Ron Instrella	Ground Control Station Operator (GSO)	BATRI & NASA Earth Science	(650) 604 0939 (work) (516) 850 6465 (mobile)	ron.instrella@nasa.gov

Personnel from participating collaborators, both within federal agencies and from partnering contractors, will also be present for the duration of this mission. These names, affiliations and contact information of these members are summarized in **Table 2-2**.

Table 2-2. Site and Project Personnel, Collaborators

Name	Affiliation	Role	Phone	Email
Dr. Brian Gullett	EPA/ORD	Project Coordinator, EPA Air Sampling Team	(919) 541 1534 (work) (919) 699 3074 (mobile)	gullett.brian@epa.gov
Mr. Paul Groff	EPA/ORD	EPA Quality Assurance Manager	(919) 541 0979 (work)	groff.paul@epa.gov
Dr. Johanna Aurell	TDRI	Lead Field Sampler	(919) 541 5355 (work)	aurell.johanna@epa.gov
Mr. Dennis Tabor	EPA/ORD	Chemist, sample transmittal	(919) 541 2686 (work)	tabor.dennis@epa.gov
Mr. Bill Mitchell	EPA/ORD	Electronics Operations	(919) 541 2515 (work)	mitchell.bill@epa.gov
Mr. Robert Davie III	US Army	Radford Army Ammunition Plant Representative	(540) 731 5776 (work)	robert.davie4.civ@mail.mil
Mr. R. Brian Jennings	US Army	Radford Army Ammunition Plant Representative	(540) 731 5781 (work)	rbrian.jennings.civ@mail.mil
Mr. Jay Stewart	BAE, Inc.	Radford One Site Environmental Operations	(540) 639 7785 (work) (540) 200 9536 (mobile)	jay.stewart@baesystems.com
Ms. Kim Meier	BAE, Inc.	Radford Area Manager	(540) 395 4927 (work)	kim.meier@baesystems.com

Each NASA afNiliated member of the proposed project is expected to a responsibilities for the duration of the mission.

1. **NASA Mission Manager, RC Pilot, and safety observer pilot,** and direct all ground and air operations. The Project Manager will also serve as point of contact for all major decisions and interactions with the public and collaborating science personnel. As RC pilot, this person is responsible for executing operations. The pilot is expected to switch from radio control (RC) to autopilot mode to execute all mid-Pair preprogrammed Nlight paths. In the event of lost signal or inclement weather, the RC pilot will take full control of aircraft back to the designated landing zone.
2. **Ground Control Station Operator (GSO),** *Ron Anstella* will set all Nlight parameters, preprogrammed Nlight paths and waypoints using the A3 autopilot user also monitor the aircraft's Nlight path and telemetry via video downlink. The GSO issues recurring updates on Nlight conditions to personnel. In the event of an Nlight emergency with strong GPS signal, such as unexpected behavior from the aircraft GSO will command the aircraft to land using the Nlight controller's

Detailed information regarding the roles and responsibilities of all major can be found in this mission's NRMRL[1] Quality Assurance Project Plan, which has bee and Niled with both the EPA and Ames Safety Review Board.

Mission Statement.

As noted in the procedural requirements for mishap reporting set forth in NPR 8621.1B, this document deNines the plan for responding to and reporting mishaps.

The mission personnel *mishap* Nlight as follows:

- Any action of the UAS that results in personnel or public injury.
- Any action of the UAS that results in property damage, excluding the UAS itself, which is considered fully expendable.
- An instance in which the UAS leaves any of the predeNined Nlight

The designated safety observer will initiate the NASA chain of command contacting each of the following from the nearest available land or mo Ammunition Plant.

- Chief of the Ames Aviation Management OfNice, Roy Williams, 650 279
- Aviation Safety OfNicer and Chairman of the Flight Readiness Review E Dearing, 650 314 3223.
- Director of Safety and Mission Assurance, Mike Liu 650 793 562 (c
- Company Personnel (N/A).

If needed, additional numbers relevant to mission operations are listed bel

- **Holiday Inn Express Front Desk** burg, VA. 540 381 8100 (front de both the NASA Nlight crew as well as EPA collaborators will be duration of the mission.

[1] National Risk Management Research Laboratory (NRMRL)

- **Mr.** **Jay** **Stewart,** of Radford Army Ammunition's Plant on site Environmental Operations
- **Carillon** **New** **River** **Valley** **Medical** **Center,** (540) 731 2000.

If a mishap requires EMS, Nire or police response, all mission personnel will cooperate with local authorities and ofNicers and follow ofNicial instructions. If damage is severe enough to pose any danger to the personnel or public, such as a [illegible] are to remain upwind of and a safe distance from the aircraft until Safety OfNicer deem is safe to approach the crash site.

In the event of a serious crash, the RSO will be responsible for securing the crash site and performing the following actions:

- Removing the fuse from any LiPo battery packs.
- Capturing photos of the crash site and debris Nield, including any [illegible]
- Completing the UAS Mishap Report contained in this Safety and Mishap [illegible]
- Assuring the collection of documentation and electronic Niles, including bu[illegible] GCS and aircraft logs, (2) memory cards, and (4) Nlight test plan.
- Obtaining witness reports within 48 hours of the incident.

The Ames AMO and Code Q shall determine the level of reporting [illegible] reviewing the documentation.

All mishap reporting shall conform to NPR 8621.1B Chapter 3 (NASA [illegible] Mishap and Close Call Reporting, Investigating, and Record keeping w/Change [illegible] chapter 4.

UAS Mishap Report

1. UAS Designation: _____
2. Vehicle serial number: _____
3. Log number: _____
4. Software tag: _____

5. Date of Mishap: _____
6. Time: _____
7. Location: _____
8. Test Coordinator: _____
9. Pilot: _____
10. Range Safety Officer: _____
11. Launch Time: _____
12. Duration of Flight: _____

13. Weather:
    a. Temperature: _____
    b. Wind Speed: _____
    c. Wind Direction: _____

14. Mission:
    a. Launch location: _____
    b. Mission proNile: _____

15. Summary of mishap and damage:

    _____
    _____
    _____
    _____
    _____
    _____

16. Property damage (if any):

_____
_____
_____
_____
_____

17. Personnel information and injuries (if any):

_____
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_____
_____

18. Witnesses:

_____
_____
_____
_____
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