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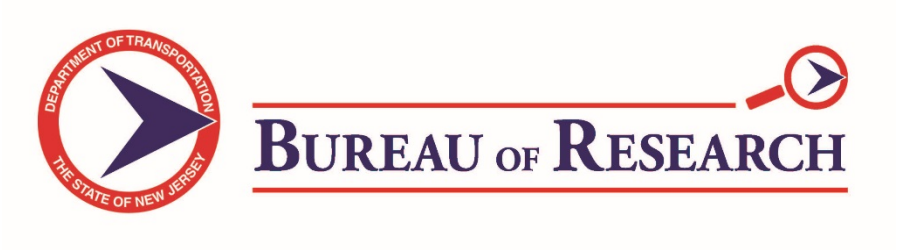

NJDOT UAS/Drone Procedures Manual and Best Practices for Use in New Jersey

FINAL REPORT

January 2021

Submitted by

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In cooperation with

New Jersey Department of Transportation
Bureau of Research
And
U. S. Department of Transportation
Federal Highway Administration

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NJDOT Customer: Glenn Stott, UAS Program Manager, Bureau of Aeronautics, Division of Multimodal Services, NJDOT

16. Abstract

Recent advances in Unmanned Aircraft Systems (UAS) technologies have tremendous potential of improving the reliability and efficiency of inspections of transportation infrastructures, such as bridges, highways, railroads, construction projects, high mast light poles, etc. Two major challenges in the adoption of UAS operations for NJDOT transportation infrastructures are: (i) regulatory compliance with the FAA regulated airspaces, and (ii) the absence of comprehensive operational procedures and guidelines for performing the UAS missions. Therefore, the main objectives of this research were to investigate the local laws, statues and conditions affecting the NJDOT's UAS operations, and to develop comprehensive procedures for the use of UAS by a public agency, such as NJDOT for their inspection, operation, and management activities. These UAS procedures comply with current Federal regulations and include appropriate forms to maintain documentation and ensure FAA compliance. The outcomes of this research are presented as two separate sections in this report. The first section addresses the existing laws and practices for UAS operations in the State of New Jersey. The second section discusses NJDOT's unique safety and risk management concerns and fully integrates them with established best UAS procedures for use by NJDOT. These procedures cover all aspects of UAS operations conducted on behalf of NJDOT, whether it is by public employees, a consulting firm, or a contract with a commercial UAS vendor.

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PREFACE

This report includes two sections. Section 1 is a summary of five subtasks, which reviewed the local conditions (such as UAS operations classification, applicable state and local laws, operation near NJ public airports, etc.) related to the operation of UAS in the State of New Jersey. Section 2 is focused on Flight Operations Manual (FOM), which has been developed specifically for NJDOT's UAS operations.

SECTION 1:

LOCAL CONDITIONS AFFECTING UAS OPERATIONS IN STATE OF NEW JERSEY

CHAPTER 1. INTRODUCTION

1.1 Background

Recent advances in Unmanned Aircraft Systems (UAS) have tremendous potential of improving the reliability and speed of inspections of numerous transportation infrastructures, such as bridges, high mast light poles, railroad tracks, construction projects, etc. The New Jersey Department of Transportation (NJDOT) has identified 38 transportation related operations, where UAS could increase efficiency. Examples of these areas include infrastructure inspections, traffic and project management. One of the major challenges in the adoption of UAS operations for NJDOT is the regulatory compliance with airspace. The Federal Aviation Administration (FAA) has the authority over the operation of all aircrafts, including UAS, and has the mandate to ensure public aviation safety. Management of the National Air Space (NAS) with respect to UAS is governed by the FAA through Title 14 of the Code of Federal Regulations (14 CFR) Part 107. On June 21, 2016, the FAA issued an Advisory Circular 107-2 (AC 107-2). Through this circular, the FAA amended its regulations to adopt specific rules for the operation of small Unmanned Aircraft Systems (sUAS) in the NAS through a final rule. This advisory document does not provide, nor is intended to provide, a legal interpretation of the regulations. Rather, AC 107-2 provides the best practice methods for developing operational programs.

1.2 Purpose

The NJDOT Bureau of Aeronautics needs a comprehensive set of UAS (or drone) procedures. The main objective of this research is to develop procedures for the NJDOT UAS Program for their inspection, operation, and management activities. These new UAS procedures must comply with existing State and Federal regulations, such as 14 CFR Part 107 UAS regulations and FAA Advisory Circular 107-2. These new procedures must incorporate NJDOT's unique safety and risk management concerns and fully integrate them with established UAS best practices.

They must cover all aspects of UAS operations conducted on behalf of NJDOT, whether it is by department employees, consultant firms, or a contract with a commercial UAS vendor. This includes the necessary procedures, forms, and internal processes.

1.3 UAS Operations

UAS operations have various levels of functional categorization. At the topmost level, UAS operations can be categorized as recreational and non-recreational. NJDOT — either as a drone operator or as a transportation management agency — participates in non-recreational usage of UAS. Non-recreational operations also can be divided in three types: public agency, law enforcement, and commercial operations.

NJDOT UAS operations as public agency can be divided into two general categories: emergency and non-emergency operations, as illustrated in Figure 1. Emergency operations are defined as time-critical operations that fit pre-determined criteria for rapid response. These operations may have to be carried out at short notice and may require coordination with appropriate Federal and State agencies outside of normal working hours during a disaster or emergency. Some of these emergency operations can be classified as:

Pre-hazard monitoring:

- Prewinter storm brine spreading
- Drainage issues pre-storm, etc.

Post-hazard monitoring:

- Bridge scour monitoring
- Damage inspection
- Searching operations, etc.

Emergency management:

- Highway incidents
- Railway
- Flooding
- Bridge failure, etc.

Non-emergency applications are categorized into eight groups:

1. Physical infrastructure inspection (e.g., bridges, tunnels, railways, roadways, drainage systems, trenches, high mast light poles, traffic signs, and barriers);
2. Environmental surveys (e.g., vegetation inspection, wildlife management);
3. Construction inspection (e.g., aerial site surveys, real time construction monitoring, etc.);
4. Traffic management (traffic data collection, traffic flow monitoring, qualitative assessment of congested interchanges, etc.);
5. Aeronautics (e.g., 5010 obstacle mapping);
6. Planning survey (e.g., conceptual design, transportation corridor design);
7. Maritime (e.g., channel dredging); and
8. Others (e.g., event photography).

The focus of this research has been on the development of procedures for non-emergency operations, since emergency operations will be carried out under a Certificate of Authorization (COA) by the FAA to emergency response agencies such as police, fire departments, etc. For all categories of non-emergency operations listed above, the procedure for UAS operations, e.g., planning, launching, flight operation and landing of UAS, will be similar.

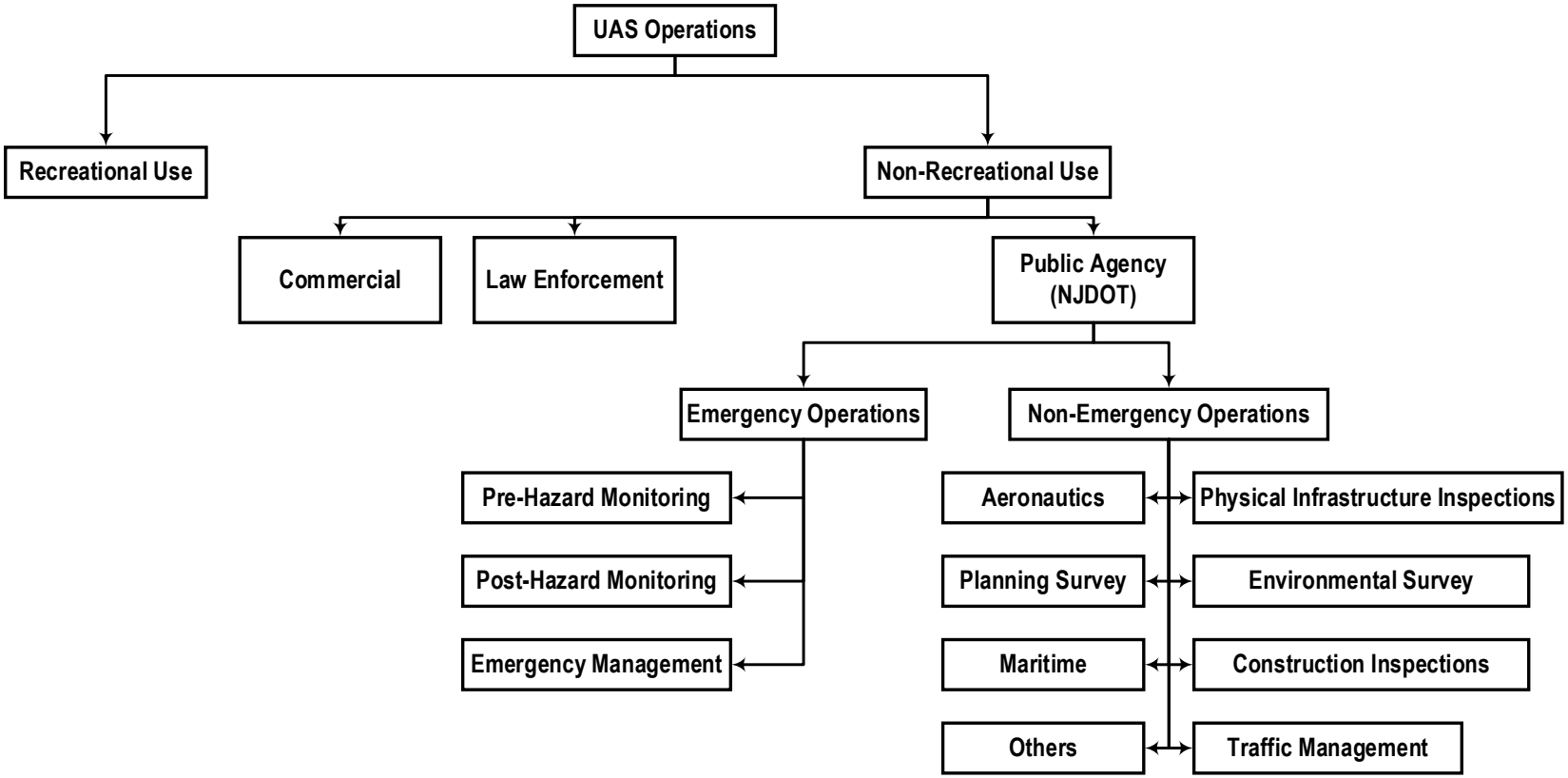

Figure 1. UAS operational categories.

CHAPTER 2. APPLICABLE NEW JERSEY STATE / LOCAL LAWS

2.1 Introduction

The goal of this chapter is to review all pertinent local and state laws, codes, regulations, and statutes for UAS operations in New Jersey. Overall, UAS operations in New Jersey are impacted by the following four types of laws:

- motor vehicle laws
- privacy laws
- insurance laws
- public records laws

The *Constitution of New Jersey* is the foremost source of the state law. The legislation is enacted by the New Jersey Legislature, is published in the *Laws of New Jersey*, and is codified in the *New Jersey Statutes* (NJS). State agency regulations (sometimes called administrative law) are published in the New Jersey Register and are codified in the *New Jersey Administrative Code*.

2.2 New Jersey Statutes (NJS)

Following titles of NJS directly or indirectly affect the UAS operations in New Jersey (besides the fact that UAS is considered as “aircraft” as per Title 6 of NJS):

- Title 2C - Criminal justice
- Title 17 - Corporations and Institutions for Finance and Insurance
- Title 47 - Public records
- Title 6 - Aviation

2.2.1 Title 2C - Criminal Justice

Section 2C:40-27 of NJS, which was passed in 2017, defines terms related to operation of unmanned aircraft systems as follows:

> “1. a. As used in this act:
>
> "Operate" means to fly, control, direct, or program the flight of an unmanned aircraft system.
> "Unmanned aircraft" means an aircraft that is operated without the possibility of direct human intervention from within or on the aircraft.
> "Unmanned aircraft system" means an unmanned aircraft and associated elements, including communication links and the components that control the unmanned aircraft, that are required for the pilot in command to operate safely and efficiently.
>
> b. Except as otherwise prohibited by P.L.2017, c.315 (C.2C:40-27 et al.), a person who is authorized by federal law to operate an unmanned aircraft system may operate an unmanned aircraft system in this State for any purpose, provided that the person operates the unmanned aircraft system in a manner consistent with applicable federal law and regulations. Nothing in this section shall be construed to affect federal preemption of State law regarding aviation.
>
> For purposes of this subsection, "person" means an individual, partnership, corporation, association, governmental entity, or other legal or commercial entity.
>
> c. An owner or operator of a critical infrastructure, including a political subdivision, may apply to the Administrator of the Federal Aviation Administration, pursuant to section 2209 of the "FAA Extension, Safety, and Security Act of 2016," Pub.L.114-190, in order to

prohibit or restrict the operation of unmanned aircraft systems in close proximity to the critical infrastructure.

Prior to applying to the Administrator of the Federal Aviation Administration to prohibit or restrict the operation of unmanned aircraft systems in close proximity to a critical infrastructure, a political subdivision shall hold a minimum of one public hearing, with adequate notice to the public, concerning the proposed application."

Section 2C:40-28 defines violations, degree of offense, crime related to UAS operations and considers the following cases:

"2. a. A person commits a disorderly persons offense if he knowingly or intentionally operates as defined in section 1 of P.L.2017, c.315 (C.2C:40-27) an unmanned aircraft system as defined in section 1 of P.L.2017, c.315 (C.2C:40-27) in a manner that endangers the life or property of another. In making this determination, the court shall consider the standards for safe operation of small unmanned aircraft systems prescribed by federal law or regulation.

b.(1) A person commits a crime of the fourth degree if he knowingly or intentionally creates or maintains a condition which endangers the safety or security of a correctional facility by operating an unmanned aircraft system on the premises of or in close proximity to that facility without license or privilege to do so.

(2) A person commits a crime of the third degree if he knowingly operates an unmanned aircraft system to conduct surveillance of, or gather information about, a correctional facility without license or privilege to do so.

For purposes of this subsection, "correctional facility" means a jail, prison, lockup, penitentiary, reformatory, training school, or other similar facility within the State of New Jersey.

c. A person commits a crime of the fourth degree if he knowingly or intentionally operates an unmanned aircraft system in a manner that interferes with a first responder who is actively engaged in response or actively engaged in air, water, vehicular, ground, or specialized transport.

For purposes of this subsection "first responder" means a law enforcement officer, paid or volunteer firefighter, paid or volunteer member of a duly incorporated first aid, emergency, ambulance, or rescue squad association, or any other individual who, in the course of his employment, is dispatched to the scene of a motor vehicle accident or other emergency situation for the purpose of providing medical care or other assistance.

d. A person commits a disorderly persons offense if he knowingly operates an unmanned aircraft system or uses an unmanned aircraft system to take or assist in the taking of wildlife.

e. A person commits a disorderly persons offense if he operates an unmanned aircraft system while under the influence of intoxicating liquor, a narcotic, hallucinogenic, or habit-producing drug or with a blood alcohol concentration of 0.08% or more by weight of alcohol in the defendant's blood.

f. It shall be a violation of any restraining order issued by the court pursuant to section 2 of P.L.1999, c.47 (C.2C:12-10.2), section 3 or 4 of P.L.2015, c.147 (C.2C:14-15 or C.2C:14-16), section 12 of P.L.1991, c.261 (C.2C:25-28), section 4 of P.L.1999, c.334 (C.2C:35-5.7), or any other court order restraining contact with a person or location, for a person subject to that order to knowingly operate an unmanned aircraft system to fly within a distance of a person or location that would violate that restraining order.

g. Notwithstanding the provisions of N.J.S.2C:1-8 or any other law to the contrary, a conviction under this section shall not merge with a conviction of harassment pursuant to N.J.S.2C:33-4, stalking pursuant to section 1 of P.L.1992, c.209 (C.2C:12-10), invasion of privacy pursuant to section 1 of P.L.2003, c.206 (C.2C:14-9), obstructing administration of law or other governmental function pursuant to N.J.S.2C:29-1, introducing contraband pursuant to N.J.S.2C:29-6, contempt of a domestic violence order pursuant to subsection b. of N.J.S.2C:29-9 which constitutes a crime or disorderly persons offense, or any other criminal offense, even if any other conviction involves the use of an unmanned aircraft system, nor shall the other conviction merge with a conviction under this section."

2C:40-29 Provisions preempt existing laws

5.The provisions of P.L.2017, c.315 (C.2C:40-27 et al.) shall preempt any law, ordinance, resolution, or regulation adopted by the governing body of a county or municipality concerning the private use of an unmanned aircraft system that is inconsistent with the provisions of this act.

2C:40-30 Authorized use permitted

6. Nothing in P.L.2017, c.315 (C.2C:40-27 et al.) shall prohibit the authorized use, in compliance with applicable federal rules and regulations, of an unmanned aircraft system by a public employee or a public entity, or by a first responder in the performance of official duties.

For purposes of this section "first responder" means a law enforcement officer, paid or volunteer firefighter, paid or volunteer member of a duly incorporated first aid, emergency, ambulance, or rescue squad association, or any other individual who, in the course of his employment, is dispatched to the scene of a motor vehicle accident or other emergency situation for the purpose of providing medical care or other assistance.

In addition to this, following sections of Subtitle 2C:14-9 "Invasion of privacy, degree of crime; defenses, privileges" maybe applicable when performing UAS operations.

"1. a. An actor commits a crime of the fourth degree if, knowing that he is not licensed or privileged to do so, and under circumstances in which a reasonable person would know that another may expose intimate parts or may engage in sexual penetration or sexual contact, he observes another person without that person's consent and under circumstances in which a reasonable person would not expect to be observed.

b.(1) An actor commits a crime of the third degree if, knowing that he is not licensed or privileged to do so, he photographs, films, videotapes, records, or otherwise reproduces in any manner, the image of another person whose intimate parts are exposed or who is engaged in an act of sexual penetration or sexual contact, without that person's consent and under circumstances in which a reasonable person would not expect to be observed.

b. (2) An actor commits a crime of the fourth degree if, knowing that he is not licensed or privileged to do so, he photographs, films, videotapes, records, or otherwise reproduces in any manner, the image of the undergarment-clad intimate parts of another person, without that person's consent and under circumstances in which a reasonable person would not expect to have his undergarment-clad intimate parts observed."

Also, section (c) of this subtitle, defines the crimes of disclosing the recorded data in three situations:

"An actor commits a crime of the third degree if, knowing that he is not licensed or privileged to do so, he discloses any photograph, film, videotape, recording or any other reproduction of the image, taken in violation of subsection b. of this section, of: (1) another person who is engaged

in an act of sexual penetration or sexual contact; (2) another person whose intimate parts are exposed; or (3) another person's undergarment-clad intimate parts, unless that person has consented to such disclosure."

Section c of 2C:18-3 "Unlicensed entry of structures; defiant trespasser; peering into dwelling places; defenses" is allocated to peering into windows or other openings of dwelling places. It states that "A person commits a crime of the fourth degree if, knowing that he is not licensed or privileged to do so, he peers into a window or other opening of a dwelling or other structure adapted for overnight accommodation for the purpose of invading the privacy of another person and under circumstances in which a reasonable person in the dwelling or other structure would not expect to be observed."

2.2.2 Application of Title 2C - Criminal Justice to Protect the Privacy of Residents During UAS Operations

There are tremendous benefits of commercial and non-commercial uses of UAS, also known as Unmanned Aerial Vehicles (UAV) or drones, in New Jersey. However, any use of UAS must comply with NJ 2C (Criminal Justice) and NJAC 7:25-5.22 (Wild animals; possession, killing). In addition, both commercial and non-commercial use of UAS in New Jersey should include the following best practice principles to facilitate the integration of the technology, while respecting concerns of the people of the state of New Jersey.

- **Consent**: As much as practicable, UAS operators should seek advance consent if their operation may require flying over other people's private property, except in case of emergency situations. However, consent may not be needed if the UAS is transiting in compliance with Federal Aviation Administration regulations, authorizations, or exemptions.
- **Data Collection**: Any data collected during such operations should not have an "identifiable feature" of a person's personal, private, or family activities or features of the property that are not publicly available. Collected data should be specific to drone operation and should be necessary enough to achieve objectives of the operation. Any data having "identifiable feature" discussed above should be deleted immediately and a new set of data without "identifiable features" should be collected.
- **Data Management**: All collected data shall be compliant with the Open Public Records Act (OPRA), pursuant to N.J.S.A. 47:1A-1 et seq., as amended and supplemented and the current Acceptable Use of Data policy of New Jersey. Any data not necessary for the objectives of the operation should be deleted in accordance with the Destruction of Public Records Act, N.J.S.A. 47:3-15 et seq. and the records retention schedule pursuant to N.J.S.A. 47:3-20.
- **Critical Infrastructures**: Critical infrastructures are defined as per 2339D of Title 18, United States Code, as "systems and assets vital to national defense, national security, economic security, public health, or safety including both regional and national infrastructure and may be publicly or privately owned". Examples of critical infrastructure include:
    - Gas and oil production, storage, or delivery systems
    - Water supply systems
    - Telecommunications networks
    - Electrical power generation or delivery systems
    - Financing and banking systems

- Emergency services (including medical, police, fire, and rescue services)
- Transportation systems and services (including highways, mass transit, airlines, and airports)

Operations of UAS over these critical infrastructures may be carried out on case by case basis by the infrastructure owners in coordination with FAA and state entities, such as NJDOT.

2.2.3 Title 17. Corporations and Institutions for Finance and Insurance

NJS. Subtitle 17:17-1 of Title 17: "Corporations and Institutions for Finance and Insurance" defines insurance requirements for collision with moving or stationary objects in New Jersey. Although Title 17 does not mention UAS specifically, NJS Title 6 (Aviation 6 § 2-1) defines an aircraft as a:

- Balloon
- Airplane
- Seaplane
- Every other vehicle used for navigation through the air

A seaplane, while at rest on water and while being operated on or immediately above water, shall be governed by rules regarding water navigation; while being operated through the air otherwise than immediately above water, it shall be treated as aircraft."

In the context of above definition, a UAS will automatically be considered an aircraft and will be subjected to insurance requirements of NJS Title 17. These provisions also include state agencies such as NJDOT. NJS. Subtitle 17:17-1 of Title 17 requires both liability and property insurance for a UAS and operations by a UAS, as described in the following paragraphs.

Liability Insurance: Against bodily injury or death by accident, and upon the health of persons, including a funeral benefit to an amount not exceeding $100 or against loss or damage to automobiles or motor vehicles, or to wagons or vehicles propelled by a horse or team of any description, resulting from collision with moving or stationary objects, against perils to property arising from the use of elevators, aircraft, automobiles or other motor vehicles, or against loss by legal liability for damage to persons or property (including, if the insured is a state or a political subdivision of a state or a municipal corporate instrumentality of one or more states, loss by voluntary payments made by the insured under circumstances where the insured would have legal liability if it were a private corporation) resulting from collision of automobiles, aircraft, or motor vehicles, or of wagons or vehicles propelled by a horse or team with moving or stationary objects.

Property Insurance: Against loss or damage by burglary, theft, larceny, robbery, forgery, fraud, vandalism or malicious mischief, or anyone or more of such hazards; and against any and all kinds of loss or destruction of or damage to moneys, securities, currencies, scrip, coins, bullion, bonds, notes, drafts, acceptances of drafts, bills of exchange and other valuable papers or documents, except while in the custody or possession of and being transported by a carrier for hire or in the mail; and against loss or damage to automobiles and aircraft by burglary, larceny, or theft, vandalism or malicious mischief, confiscation or wrongful conversion, disposal or concealment, whether held under conditional sale contract or subject to chattel mortgages, or otherwise, or anyone or more of such hazards.

Hence, although insurance for a UAV (including the liability because of a UAV) may be a relatively new concept, NJS Title 17 already mandates insurance requirements for UAS, which is similar to an aircraft. The insurance company will be required to cover damages and liability costs to a

certain extent in case of loss or accident of a UAS. Similar to automobiles, insurance companies may require information for both the operator (e.g., proof of training) and vehicle (e.g., operating manuals, maintenance logs, and a record of parts or add-ons).

Current aviation insurance types include:

- Public liability insurance: This coverage, often referred to as third party liability covers aircraft owners for damage that their aircraft does to third party property, such as houses, cars, crops, airport facilities and other aircraft struck in a collision.
- Passenger liability insurance: This will not be applicable to UAS.
- Combined Single Limit (CSL)
- Ground risk hull insurance not in motion: This may not be applicable to UAS.
- Ground risk hull insurance in motion: This may not be applicable to UAS.
- In-flight insurance: Liability for collision with other aircrafts, UAS or property.

Following insurance coverage has also been noted from the review of 2015 insurance summary of Academy of Model Aeronautics (2014)[1]: "In lieu of relying on homeowners insurance to provide liability protections, membership in the Academy of Model Aeronautics provides up to $2,500,000 of liability coverage for bodily injury and property damage incurred from UAS operations that occur within the confines of the AMA National Safety Codes[2]. This coverage has specific limitations and expressly excludes injury to household family members and UAS operations used for business purposes. Despite these restrictions, the coverage does include theft, fire, and vandalism protection."

2.2.4 Title 47 - Public records

UAS data collected by NJDOT or its contractors may be subjected to NJS Title 47-Public Records provisions. It is possible that some of the photogrammetry data collected during a UAS operations may contain material that may be an evidence to a crime bring committed or may have legal implications. Hence, explicit procedures on data to be collected for a particular UAS operation and handling of such data by NJDOT employees / contractors should be developed prior to an operation planned to be conducted. Data collection and handling procedures should be consistent with NJDOT organizational policy on data collection, handling, and destruction.

2.2.5 Title 6 - Aviation

This title of NJS regulates aircraft for civil purposes in NJ State. All UAS flying over ground will be qualified as "aircraft" as per definition of an "aircraft" as per NJS Title 6. Based on the review by the research team, the following provisions of Title 6 may be directly applicable to the operation of UAS in NJ:

6:1-12. Pilots to have federal license; certificate to be carried and shown on demand: No person shall operate or navigate any aircraft within the state unless he shall have a proper and effective pilot's license or permit issued by the department of commerce of the United States for the type of flying operation in which he is engaged. A certificate of the license shall be kept in the personal possession of the licensee while he is operating aircraft within this state, and must be presented for inspection upon demand of any passenger, police officer of this state, or member or representative of the state aviation commission, or any official, manager or person in charge

[1] https://www.modelaircraft.org/membership/programs-benefits
[2] https://www.modelaircraft.org/sites/default/files/105.pdf

of any airport or landing field in this state upon which he shall land.

6:1-13. Aircraft to be licensed and registered by department of commerce: No person shall operate or navigate any aircraft within the state unless such aircraft has an appropriate effective license issued by the department of commerce of the United States, and is registered by the department of commerce of the United States.

6:1-17. Exhibitions to be licensed: No air meet, air race or aerial exhibition shall be conducted or operated in this state without a license first obtained from the commission. This section shall not apply to the aircraft of the armed forces of the United States or the civil aircraft of the United States or any state or territory thereof.

6:1-18. Flying aircraft while under influence of liquors or drugs; passengers: No person shall fly any aircraft in this state while under the influence of or using intoxicating liquors, cocaine or other habit-forming drugs, nor shall such person carry passengers who are obviously under the influence of intoxicating liquors, cocaine or other habit-forming drugs.

6:1-19. Violations; penalty: Any person who shall violate any provision of this article shall be guilty of a misdemeanor.

6:1-20. Purpose: The purpose of this act is to provide in the interest of public safety and of aeronautic progress for the regulation of aeronautics in and over this State; to require that aircraft, airports, airport managements, landing fields, landing strips, and other navigational facilities, airmen, ground personnel and all persons engaged in aeronautics within or over this State, shall conform to standards of safety and sound practice as prescribed by the laws of this State and any rules or regulations thereunder, and for uniformity in certain regards with the laws, rules and regulations of the United States Government.

6:1-34. Licenses: aircraft; requirement for: It shall be unlawful, except as hereinafter provided, to operate, pilot or navigate, or cause to be operated, piloted or navigated, any aircraft on or over the land or waters or through the air space of this State unless it shall be licensed as provided in this chapter.

6:1-35. Licenses: aircraft; provisions for: The commissioner may provide for the licensing of civil aircraft by reasonable rules, regulations, and orders adequate to protect the public safety and the safety of those participating in aeronautics and to ensure the satisfactory and safe performance of aircraft in accordance with their design or contemplated use. Any class of aircraft shall be deemed to be licensed under the provisions of section 16 of this article; provided such aircraft shall be validly and effectively licensed and registered under the provisions of laws, rules and regulations of the United States Government.

6:1-37. Identification of aircraft: It shall be unlawful to operate, pilot or navigate any aircraft on or over the land or waters or through the air space of this State unless such aircraft shall display its license number.

6:1-38. Licenses: pilots, requirement for: It shall be unlawful, except as hereinafter provided, for any person to operate, pilot or navigate any aircraft on or over the land or waters or through the air space of this State unless he shall be licensed as provided in this chapter.

6:1-40. Licenses: possession; inspection: Any pilot licensed under this chapter shall at all times have his license and the license of the aircraft operated by him or under his control available for inspection by any officer charged with the enforcement of this chapter.

6:1-45. Licenses: modification; suspension; revocation: Any license issued pursuant to the provisions of this chapter may be modified, suspended or revoked when in the interest of public safety or the safety of those participating in aeronautical activities, the commission shall deem such action advisable, after violation of any provision of this chapter or any rule, regulation or

order promulgated thereunder.

In the event the commission shall exercise the powers granted by sections sixteen, twenty, twenty-two and twenty-five of this article, it shall by rule, regulation or order provide for the modification, suspension or revocation of the privilege granted thereunder, as the public safety or the safety of those participating in aeronautical activities shall require.

6:1-48. Periodical inspection: aircraft, airports, avigation facilities, et cetera: The commission may adopt rules, regulations and orders providing for the periodical inspection and examination of aircraft, airports, landing fields, landing strips, fixed base operators or other avigation facilities, aircraft power plants, accessories and other equipment, which rules, regulations or orders may require full particulars concerning the design and calculations upon which the design is based and of the materials and methods used in the construction and operation of such aircraft, airports, landing fields, landing strips, fixed base operators or other avigation facilities, aircraft power plants, accessories, and other equipment.

6:1-50.1 Verification of identity of pilots renting aircraft: Any person who provides aircraft for rent in New Jersey shall verify the identity of the pilot seeking to rent the aircraft by requesting and examining a government-issued form of photo identification and comparing it with the information on the individual's pilot certificate. The aircraft provider shall record or copy the information on the government-issued photo identification and retain it for five years. No aircraft rental shall be permitted absent verification in accordance with this act.

6:1-59.1 Violations or failure to have license; penalties and costs. Any person violating any provisions of this act or any rule, regulation or order authorized hereby and any person who operates, conducts, uses or permits others to operate, conduct, use or employ any aeronautical facility, operation or activity which is required to be licensed, without said license being previously issued or renewed as required, shall be liable to a penalty of up to $1,000, which may be collected and enforced in an action by the Division of Aeronautics in the name of the State in any municipal court or in any other court of competent jurisdiction in a summary manner, without a jury, in accordance with the procedure prescribed in the "Penalty Enforcement Law of 1999," P.L.1999, c.274 (C.2A:58-10 et seq.). All penalties and costs collected in such actions shall be accounted for by the judge and forwarded to the Division of Aeronautics, which shall transmit the same to the State Treasurer, who shall credit such moneys to the Airport Safety Fund established by section 4 of the "New Jersey Airport Safety, Security and Improvement Act," P.L.1983, c.264 (C.6:1-92).

6:1-61. Evidence regarding safety of methods of operation of aircraft and airports, duty to furnish; notice:
association or corporation who causes to be operated, piloted or navigated, any aircraft on or over the land or water or through the air space of this State or on or upon any airport within this State thereby submits himself to the power and authority of the State to investigate the safety of the methods of operation of aircraft and airports within the State and agrees to appear and testify in person or by such copartner or copartners, officer or officers, as the Commissioner of Conservation and Economic Development shall designate, at any investigation or hearing to be held before said commissioner or a member of the Department of Conservation and Economic Development designated by the commissioner in connection with the safety of the operation of any aircraft or airport within this State and further agrees to produce any books and records, which may be relevant to the subject matter of the investigation, after reasonable notice given to him or to any one of the copartners or to any of its officers, in person or by registered mail, which notice shall designate the person or persons required to appear and testify and the books and records required to be produced.

6:1-97. Aircraft exempt from taxation: All aircraft, whether or not the same are required to be

registered under State or federal law, shall be exempt from taxation under chapters 4 and 11A of Title 54 of the Revised Statutes or any other law of this State which may impose a personal property tax.

6:1-100. Definitions relative to airport employment restrictions, criminal history record checks: Currently, there is no requirement on checking background / criminal history of remote pilot applicants.

6:2-4. Right of sovereignty in air: Sovereignty in space above the lands and waters of this state is declared to rest in the state, except where granted to and assumed by the United States pursuant to a constitutional grant from the people of this state.

6:2-5. Ownership of space: The ownership of space above the lands and waters of this state is declared to be vested in the several owners of the surface beneath, subject to the right of flight described in section 6:2-6 of this title.

6:2-6. Flight over lands permitted; liability for forced landing: Flight in aircraft over the lands and waters of this state is lawful, unless at such a low altitude as to interfere with the then existing use to which the land or water, or the space over the land or water, is put by the owner, or unless so conducted as to be imminently dangerous to persons or property lawfully on the land or the water beneath. The landing of an aircraft on the lands or waters of another, without his consent, is unlawful, except in the case of a forced landing. For the damages caused by a forced landing, however, the owner or lessee of the aircraft or the airman shall be liable as provided in section 6:2-7 of this title.

6:2-7. Liability for injuries to person or property; lien on aircraft; mortgagees, vendors and trustees not deemed owners: The owner of every aircraft which is operated over the land or waters of this State is absolutely liable for injuries to persons or property on the land or water beneath, caused by ascent, descent, or flight of the aircraft, or the dropping or falling of any object therefrom, whether such owner was negligent or not, unless the injury is caused in whole or in part by the negligence of the person injured, or of the owner or bailee of the property injured. If the aircraft is leased at the time of the injury to person or property, both owner and lessee shall be liable, and they may be sued jointly, or either or both of them may be sued separately. An airman who is not the owner or lessee shall be liable only for the consequences of his own negligence. The injured person, or owner or bailee of the injured property, shall have a lien on the aircraft causing the injury to the extent of the damage caused by the aircraft or object falling from it.

A chattel mortgagee, conditional vendor, or trustee under an equipment trust, of any aircraft, not in possession of such aircraft, shall not be deemed an owner within the provisions of this section.

6:2-8. Liability for collision: The liability of the owner of one aircraft, to the owner of another aircraft, or to aviators or passengers on either aircraft, for damages caused by collision on land or in the air, shall be determined by the rules of law applicable to torts on land.

6:2-11. Acrobatic stunts; low flying over public gatherings prohibited; penalty: Any airman or passenger who, while in flight over a thickly inhabited area or over a public gathering within this state, shall engage in trick or acrobatic flying, or in any acrobatic feat, or shall, except while in landing or taking off, fly at such a low level as to endanger the persons on the surface beneath, or drop any object except loose sand or water ballast, shall be guilty of a misdemeanor and shall be punished by a fine of not more than one thousand dollars or imprisonment for not more than one year, or both.

6:2-12. Killing of birds and animals from planes; penalty: Any airman or passenger who, while in flight within this state, shall intentionally kill or attempt to kill any birds or animals shall be guilty

of a misdemeanor and shall be punished with a fine of not more than one hundred dollars or imprisonment for not more than three months, or both.

2.3 New Jersey Administrative Code (NJAC)

The New Jersey Administrative Code (N.J.A.C.) is a compilation of all rules adopted by state agencies. Title 7 by Environmental Protection is directly applicable to the use of UAS in NJ.

2.3.1 Title 7. Environmental protection

Title 7 is the only title which has an explicit article about UAS. Subchapter 5 of chapter 25 of this title is about hunting of wild animals.

Section 2 of § 7:25-5.22 states:

No person shall hunt from or shoot at any wild animal or bird from any airborne conveyance, including an unmanned aircraft or drone. Except when authorized through a permit issued pursuant to N.J.A.C. 7:25-5.32, no person shall disturb wildlife utilizing any unmanned aircraft or drone for the purpose of:

i. Hunting, concentrating, driving, rallying, or stirring up any migratory game bird to put them in the range of hunters; or

ii. Herding any wild animal or bird for the purpose of scouting, hunting, or trapping.

CHAPTER 3. SURVEY OF PUBLIC AIRPORTS

3.1 Introduction

Because of increasing interest in both recreational and non-recreational UAS operations, there is an increased likelihood of conflict of UAS operations near airports with routine airport activities. The level of required coordination of UAS operations near airports depends on the traffic and the type of airport. The complexity of coordination between UAS and manned aircraft at airports may impact security control, airport inspections, airport perimeter control, data collection, and airport airspace analysis. These activities may require various agencies, organizations, users, and public entities to establish standardized guidelines and practices for use and integration of UAS near airports. The association of Unmanned Vehicle Systems International (AUVSI) and the Academy of Model Aeronautics (AMA) have developed safety guidance and regulations for non-recreational sUAS operations in collaboration with FAA (http://knowbeforeyoufly.org). This guidance suggests that the pilot-in-command (PIC) contact the airport or control tower before flying a UAS in the vicinity of an airport.

3.2 Survey on sUAS Operations near NJ Public Airports

New Jersey has 43 public airports whose operations may be impacted by drones flying in their vicinity. An online survey was conducted to understand the impact of recent increased use of recreational and commercial sUAS near New Jersey State public airports on regular airport activities. The survey questions are provided in the Appendix A of this report. A detailed analysis of responses from airport operators is provided in this chapter.

The survey was distributed to 43 NJ State public airports via email and an online questionnaire. After following up with these airport owners through phone calls and emails, thirty-one (31) out of forty-three (43) (approximately 72%) public airports responded to this survey. Information on airports responding to the survey is shown in Table 1 and Figure 2. A detailed analysis of responses of airport operators to survey questions is presented in the following by the question number.

Table 1. List of New Jersey public airports participating in the survey.

Row	Name	Response	Row	Name	Response
1	Blairstown	No	23	Greenwood Lake	Yes
2	Bucks	No	24	Lakewood	Yes
3	Cross Keys	No	25	Linden	Yes
4	Hackettstown	No	26	Little Ferry	Yes
5	Hammonton Muni	No	27	Morristown Muni	Yes
6	Lincoln Park	No	28	Newark Liberty Intl	Yes
7	Millville Muni	No	29	Ocean City Muni	Yes
8	Monmouth Executive	No	30	Ocean County	Yes
9	Old Bridge	No	31	Princeton	Yes
10	Redwing	No	32	Sky Manor	Yes
11	Kroelinger	No	33	Solberg-Hunterdon	Yes
12	Red Lion	No	34	Somerset	Yes
13	Spitfire Aerodrome	Yes	35	South Jersey Rgnl	Yes
14	Aeroflex-Andover	Yes	36	Southern Cross	Yes
15	Alexandria	Yes	37	Sussex (KFWN)	Yes
16	Atlantic City Intl	Yes	38	Teterboro	Yes
17	Camden County	Yes	39	Trenton Mercer	Yes
18	Cape May County	Yes	40	Trenton-Robbinsville	Yes
19	Central Jersey Rgnl	Yes	41	Trinca	Yes
20	Eagles Nest	Yes	42	Vineland-Downstown	Yes
21	Essex County	Yes	43	Woodbine Muni	Yes
22	Flying W	Yes			

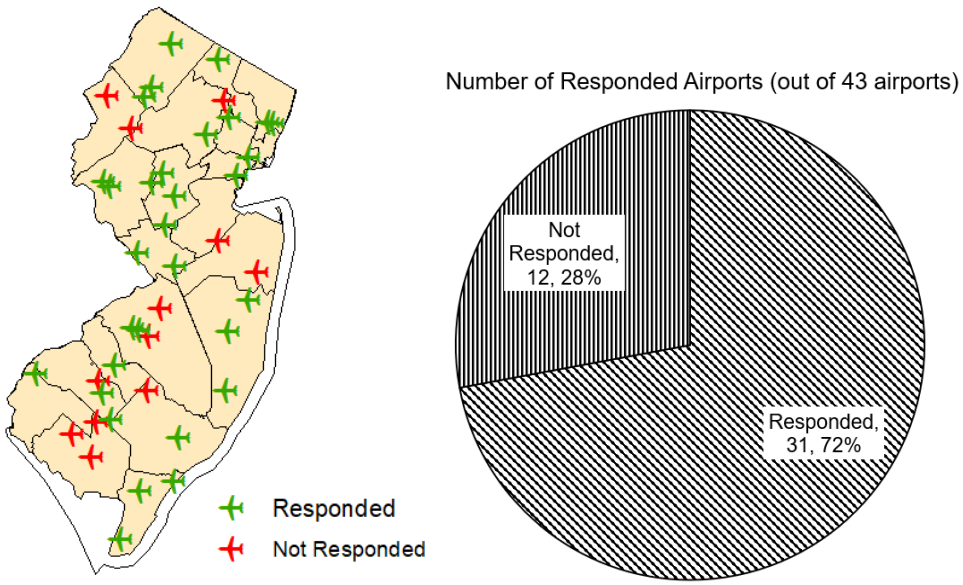

Figure 2. Respondents to the survey.

Questions 1-2

The first survey question was on the familiarity of the airport manager / operator with a UAS. Twenty-eight (28) out of 31 respondents (90%) were found to be familiar with UAS / drones (See Figure 3). The second question asked if the airport operators or anybody else had flown a UAS at their airports for any purpose. Approximately 39% of respondents (12 out of 31) experienced a UAS flying at their airport (see Figure 3).

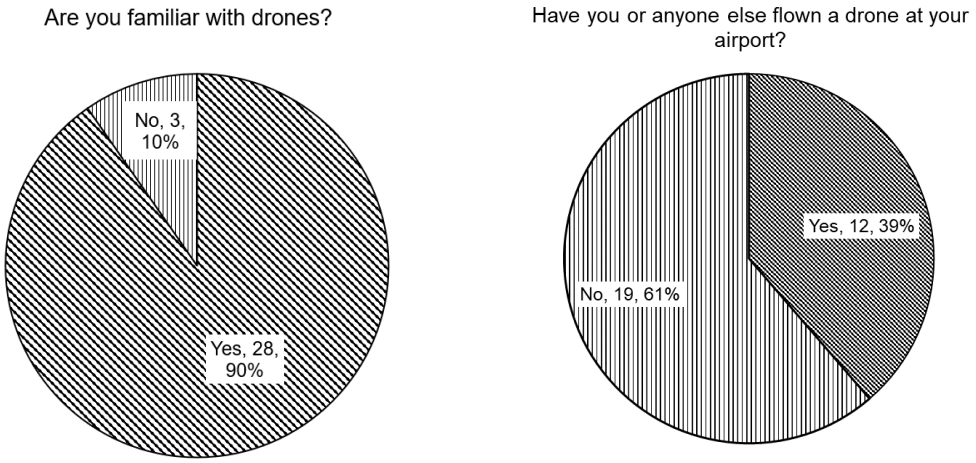

Figure 3. Responses of airport managers to the first and second question.

These twelve (12) respondents were asked to select the purpose of their UAS operations. Responses from these airport operators are shown in Figure 4. It is noted that 25% (3 out of 12) of the responding airport operators identified airport inspection as the most common purpose for the UAS operation at their airport. Approximately 33% of the respondents did not identify any purpose. Other respondents identified crowd analysis, project management and airport perimeter control as the purpose.

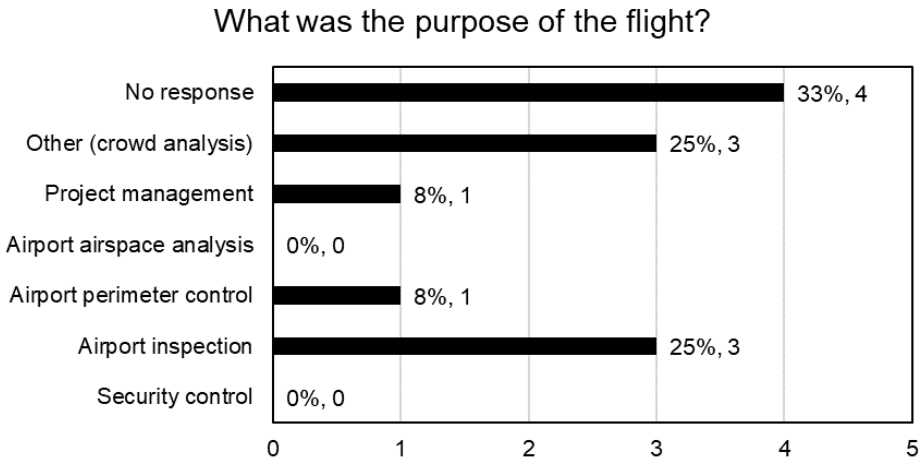

Figure 4. The purpose of UAS Operations at NJ Airports.

In response to the follow-up information on under Question 2 on any existing policy or guideline regarding the operation of drones from their airport, six out of 31 (19%) airport operators stated

that their airport has policies, guidelines or procedures for the operation of drones from their airports (see Figure 5).

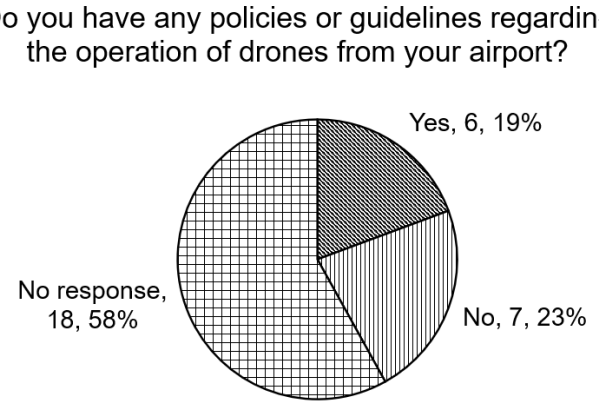

Figure 5. Airports with policies on drone operations.

Questions 3-4

Question 3 was about receiving any requests from UAS operators to fly near their airport. Nine respondents (29%) mentioned that they received such request, as depicted in Figure 6.

In question 4, airport operators were asked if they ever prohibited a UAS from flying near their airport. Figure 7 shows their response to this question. As observed from this figure, 9 out of the 31 airport operators (29%) responded that they prohibited a UAS from flying near their airport.

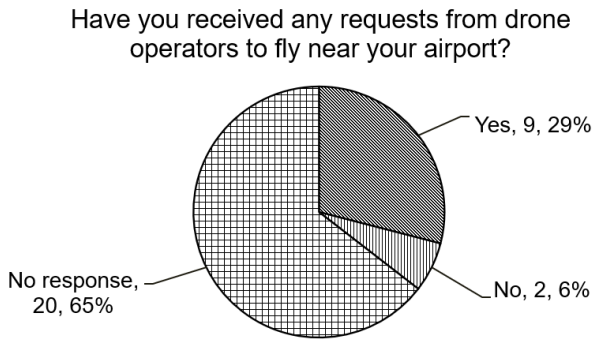

Figure 6. Request from drone operators to fly near airports.

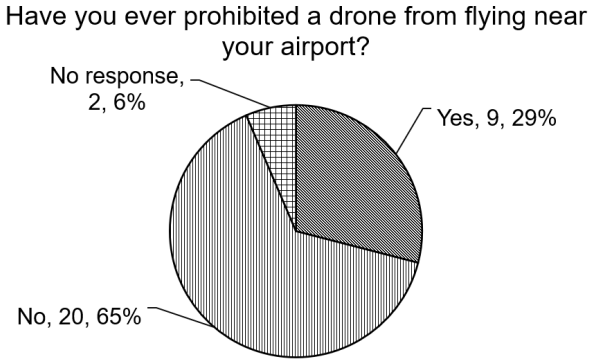

Figure 7. Prohibition of a drone flying near an airport.

Questions 5-6

In response to question 5 regarding the conflict between a UAS and manned aircraft near airports, three of the airport operators (10%) stated that they witnessed conflict because of a UAS with their airport operations (see Figure 8).

In the sixth question, airport operators were asked about any accidents involving UAS. Only one airport responded as witnessing an accident involving UAS (see Figure 9).

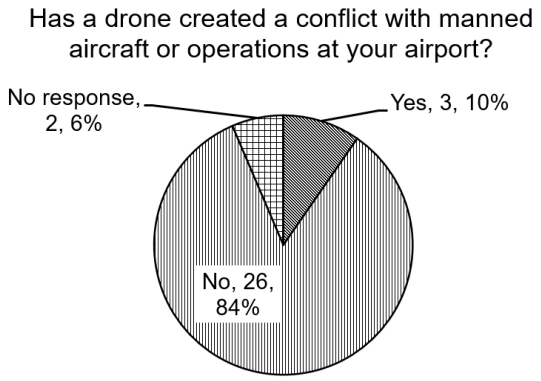

Figure 8. Conflicts between manned and unmanned airport operations.

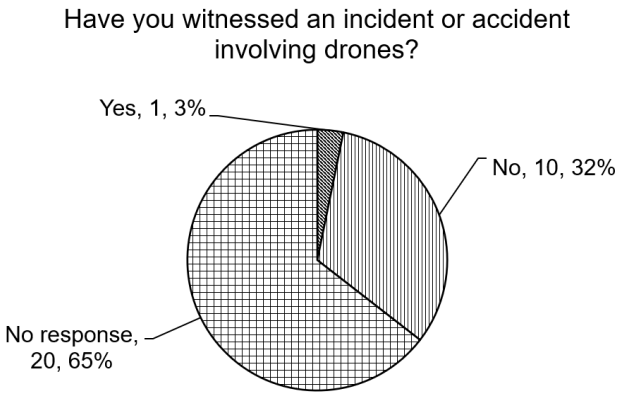

Figure 9. Witnessing drone incident or accident.

Question 7

In question 7, airport operators were asked about their willingness to allow drone operations based from their airport. Three airport operators expressed their interest in allowing UAS operations from their airport, as depicted in Figure 10

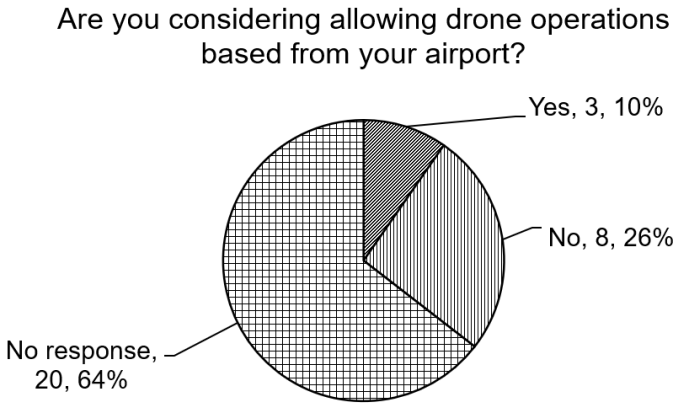

Figure 10. Allowing drone operation at airports.

Questions 8 and 9

Question 8 solicited airport operator's opinions regarding privacy. Out of 31 airport operators, 10 expressed their opinion regarding privacy issues. In general, these 10 operators considered that privacy issues should be addressed.

Question 9 of the survey addressed liability and insurance issues. This question was responded by 10 airport operators. In general, airport operators were not certain about the insurance requirements for non-recreational operators and felt that either FAA or manufacturers should address their insurance requirements. However, all airport operators agreed that commercial operators should carry liability insurance.

Question 10

This question involved the compatibility of current airport operation manuals with drone

operations. Among 31 respondents, 3 (10%) stated that their current manual is compatible with drone operations, while 21 (68%) indicated no such compatibility with their current operation manual (see Figure 11).

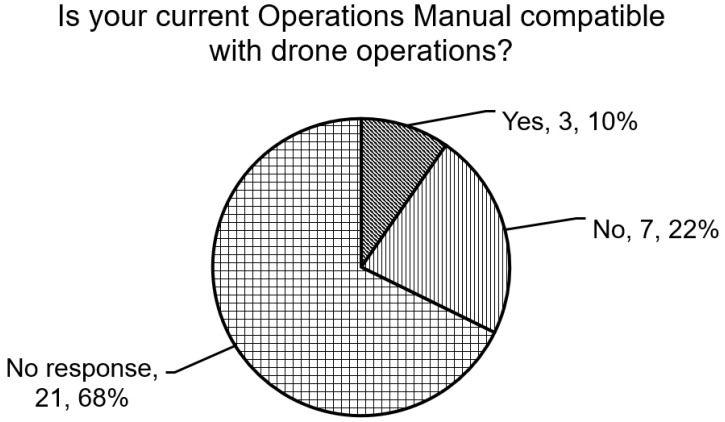

Figure 11. Compatibility of operational manual with drone operation

Question 11

In this question, airport operators were asked about accommodation in their operations manual regarding mixed mode operations. This question was answered by 10 airport managers. Almost all respondents mentioned not considering mixed mode operations in their operations manual.

Question 12

Finally, airport operators were asked to provide additional feedback related to drone operations near airports. Their feedback was mostly related to their concerns with non-commercial operators interfering with airport operations, especially when not notified regarding UAS operator's location, start time and end time, as per 14 CFR Part 107, when operating within five miles of their facility.

SECTION 2: FLIGHT OPERATIONS MANUAL (FOM)

CHAPTER 4. INTRODUCTION

4.1 Background

Unmanned Aircraft Systems (UAS), also commonly known as drones or Unmanned Aerial Vehicles (UAVs), operate under remote control without any pilot onboard. As per NJ Statute § 2C:40-27, an unmanned aircraft means an aircraft that is operated without the possibility of direct human intervention from within or on the aircraft. A UAS consists of an unmanned aircraft and associated elements, including communication links and the components that control the unmanned aircraft that are required for the pilot in command to operate safely and efficiently. Part 107 of 14 CFR defines a small UAS (sometimes referred to as sUAS and referred to as UAS hereafter) as a UAS weighing less than 55 pounds on takeoff, including everything that is on board or otherwise attached to the aircraft.

The New Jersey Department of Transportation (NJDOT) has identified more than 38 such areas where UASs could improve the efficiency of the agency significantly in carrying out infrastructure inspection, management, and operations. This NJDOT UAS Flight Operations Manual (UASFOM) provides necessary operational guidance for various UAS activities carried out by or on behalf of NJDOT.

This UASFOM includes five chapters. In Chapter 4, the framework and purpose are discussed. This chapter outlines procedures to address the privacy concerns of citizens and documents state laws and regulations relevant to New Jersey UAS operations. Chapter 5 discusses the NJDOT safety management system (SMS) and risk assessment approach. Chapter 6 discusses the customized three-phase NJDOT UAS training program. Chapter 7 discusses all pre-, during, and post-flight operational issues. Finally, Appendices B and C include all the required forms, checklists, and flight supporting documents referenced in Chapters 4 to 7.

The UASFOM is compliant with current FAA regulations and New Jersey statues relevant for the operation of UAS. Following FAA and other aviation agencies documents and regulations have been reviewed and considered in the preparation of this manual:

- 14 CFR Part 107
- FAA Advisory Circular (AC) 107-2
- NJDOT Aircraft Accident Procedures Manual
- NJDOT UAS Training Program
- NJDOT UAS Policy and Procedure
- NTIA Voluntary Best Practices for UAS Privacy, Transparency, and Accountability
- FAA FORM 7711-1 UAS COA Attachment
- NJ Statutes
- NJ Administrative Code

4.2 Purpose and Scope of the Manual

This UASFOM provides guidance for NJDOT personnel, employees, consultants and contractors in the performance of UAS Operations. This manual has been developed with a strong emphasis on continuously demonstrating a high level of safety standards in daily flight operations while meeting performance targets.

This manual standardizes all aspects of UAS operations by or on behalf of NJDOT. Other interested New Jersey agencies or commercial organizations use this manual at their own risk. While this manual provides the best possible information on operational aspects under most conditions, it is not a substitute for sound judgment. Emergencies, adverse weather, terrain

factors, or other extenuating circumstances may require modification of any flight operational procedure presented herein. When any part contained in this manual is found to be in conflict with NJ regulations, FAA Regulations, or policies, it shall be superseded by the more senior authority.

4.3 Manual Amendment Requests

This manual is a living document. It is not now, nor in the future in its "final form." Suggestions to improve this manual are encouraged and shall be submitted to the NJDOT Bureau of Aeronautics.

4.4 NJDOT UAS Program Organizational Structure

The Bureau of Aeronautics is the lead agency for Unmanned Aircraft Systems (UAS)/Drones operations at NJDOT under the direction of the UAS Program Manager (UASPM). The UASPM is responsible for overseeing all aspects of the UAS program. The UASPM leads a team of UAS specialists, who assist on all operational and administrative aspects of the program. The responsibilities of NJDOT UAS Program personnel can be found in NJDOT UAS Policies and Procedures.

4.5 UASFOM Waiver Procedure

NJDOT UAS Program may deviate from the specific requirements in the UASFOM to address emergent situations that may require rapid deployment in response to an emergency or emergent situation. A waiver allows a specific operation to be conducted that may not meet all requirements in the UASFOM and may be issued when the waiver does not create undue risk, hazard or constitute a change of general operating procedures.

In emergent situations, a flight mission may be authorized verbally or via e-mail as opposed to the written authorizations required in the UASFOM. Safety is the primary consideration in the decision to approve or disapprove the waiver request. When approved, a request for waiver is issued for a specific period and may be renewed as necessary. In all waiver requests, the UASPM will notify the Manager, Bureau of Aeronautics, and Director, Multimodal Services. Additionally, the UASPM will follow up with written explanation for the necessity immediately upon completion of the mission.

4.6 Remote Pilot in Command (RPIC)

In accordance with 14 CFR 91.3, Remote Pilot in Command has the final authority and responsibility for all aspects of flight operations. RPIC must hold the appropriate FAA certifications and have completed the NJDOT UAS training program. The RPIC may deviate from any procedure to the extent necessary to ensure the safety of the flight during an emergency. A RPIC can operate only one UAS at any given time.

4.7 Visual Observer (VO)

The Visual Observer for a UAS operation is a responsible person tasked to identify and notify the RPIC of issues that could potentially impact the safety of flight. The VO must constantly assess potential conflicts and promptly alert the Remote Pilot. NJDOT requires one RPIC and at least one VO per operation. A VO must not perform crew duties for more than one UAS at a time. A VO is not allowed to perform concurrent duties both as a RPIC and as a VO. The VO must maintain situational awareness through direct visual observation regarding:

- The UAS location, attitude, altitude, and direction of flight.
- Proximity of other aircraft
- Potential hazards in the airspace such as trees, wires, structures, etc.

- The potential of the UAS to endanger the life or property of another.
- Potential traffic congestion issues due to the UAS operation.

4.8 Recommended NJDOT Privacy Practice on UAS

There are tremendous benefits of commercial and non-commercial use for UAS. However, any use of UAS must comply with:

1. NJ Stat § 2C:18-3 (Trespassing),
2. NJ Stat § 2C:14-9 (Invasion of Privacy),
3. NJ Stat § 2C:40-27(Definitions relative to operation of unmanned aircraft systems),
4. NJ Stat § 2C:40-28 (Violations, degree of offense, crime),
5. NJ Stat § 2C:40-29 (Provisions preempt existing laws),
6. NJ Stat § 2C:40-30 (Authorized use permitted), and
7. NJAC 7:25-5.22 (Wild animals; possession, killing).

In addition, both commercial and non-commercial use of UAS in New Jersey shall follow the following best practice principles to facilitate the integration of the technology, while respecting concerns of the people of the state of New Jersey.

- **Data Collection**: RPIC shall be sensitive to people's privacy concerns. Any data collected during a UAS operation shall not have "identifiable feature" of a person's face, personal, private, or family activities or features of the property that are not publicly available. Collected data shall be specific to the transportation mission. Any data having "identifiable feature" discussed above shall be deleted immediately and a new set of data without "identifiable features" shall be collected.
- **Data Management**: All collected data shall be compliant with the "Acceptable Use of Data" policy of the New Jersey Department of Transportation. Any data not necessary for the objectives of the operation shall be deleted following data disposal policy of NJDOT.

4.9 NJ State Legislation

Operations of UAS in New Jersey is impacted by various New Jersey Statutes and Administrative codes discussed in Chapter 2. Some of these statutes and administrative codes that need to be considered while conducting a UAS operation are listed below.

4.9.1 Criminal Justice

NJ Title 2C defines specific terms and crimes related to UAS operations in New Jersey (See 2.2.1 for detailed information).

1) NJ Rev Stat § 2C:40-27 (2017) (Definitions relative to operation of unmanned aircraft systems): Provides definitions for various terms related to UAS operations in New Jersey.
2) NJ Rev Stat § 2C:40-28 (2017) (Violations, degree of offense, crime): Crimes related to using UAS to (i) endanger the life or property of another, (ii) endanger the safety or security of a correctional facility, (iii) conduct unauthorized surveillance of a correctional facility, (iv) interfere with an actively engaged first responder, (v) take or assist in the taking of wildlife, (vi) operate an unmanned aircraft system while under the influence of intoxicating liquor, a narcotic, hallucinogenic, or habit-producing drug and (vii) fly within a distance of a person or location that would violate a court restraining order.
3) NJ Rev Stat § 2C:40-29 (2017) (Provisions preempt existing laws): Preempts any local (county / municipality) law on private use of an unmanned aircraft system that is inconsistent with the provisions of this act.
4) NJ Rev Stat § 2C:40-30 (2017) (Authorized use permitted).

4.9.2 Unwarranted Surveillance

NJ Title 2C does not specify a specific violation for UAS relative to Trespassing or Invasion of Privacy. Application of the laws given below shall be considered when NJDOT conducts UAS flight operations (see 2.2.2 for detailed information).

1) NJ Rev Stat § 2C:18-3 (2013) (Unlicensed entry of structures; defiant trespasser; peering into dwelling places; defenses): Subsections a, b, and c of this statute may apply to UAS operations carried out by NJDOT. Trespassing applies when a UAS enters the physical boundaries of another individual without the expressed permission of said individual.
2) NJ Rev Stat § 2C:14-9 (2013): (Invasion of Privacy, degree of crime; defenses and privileges): Subsections a, b, and c of this statute may apply to UAS operations carried out by NJDOT. In these statutes, the word "actor" may refer to crewmembers of the UAS operations. These statutes apply to invasion of privacy by video recordings of individuals in their home and include peering into windows, "Peeping Tom".

4.9.3 Environmental Protection

1) Current policy of NJ Department of Environmental Protection (NJDEP), Division of Parks and Forestry prohibits the operation of UAS in NJ State Parks[1].
2) In accordance with NJ Administrative Code Title 7 Chapter 25 Subchapter 5 regarding environmental protection, all NJDOT personnel shall operate NJDOT UAS in compliance with current or future laws protecting both New Jersey's wildlife and the environment. Therefore, no person shall hunt from or shoot at any wild animal or bird from any airborne conveyance, including an unmanned aircraft or drone. Except when authorized through a permit issued pursuant to N.J.A.C. 7:25-5.32, no person shall disturb wildlife utilizing any unmanned aircraft or drone for the purpose of:
   - Hunting, concentrating, driving, rallying, or stirring up any migratory game bird to put them in the range of hunters; or
   - Herding any wild animal or bird for the purpose of scouting, hunting, or trapping.

[1] https://www.state.nj.us/dep/parksandforests/parks/docs/policy_2.38_unmanned_aerial_vehicles-drones.pdf

CHAPTER 5. SAFETY MANAGEMENT SYSTEM AND RISK ASSESSMENT

5.1 Introduction to Safety Management System

Safety Management Systems (SMS) is an approach to enhance the safety of all aspects of a UAS operation by identifying the risks, and ensuring that they are not repeated, or are mitigated to a tolerable level. Miscommunication among crewmembers, automation errors, and environmental and weather issues can potentially endanger the safety of UAS operations. The NJDOT SMS achieves these goals through three components: (i) Risk Identification, (ii) Risk Assessment, and (iii) Risk Mitigation. A safety assurance audit should be carried out over a regular interval to continually improve the NJDOT SMS.

The flowchart in Figure 12 shows the procedure for implementing NJDOT SMS during UAS operations. The SMS process starts with the RPIC identifying risks as described in Section 5.2. Following this, the RPIC estimates the risk using the NJDOT Risk Assessment Worksheet in Section 5.3. If the estimated mission risk is not acceptable, it needs to be mitigated through the appropriate risk mitigation measures. Some typical risk mitigation measures are listed in Section 5.4. The mission can then proceed to execution phase if the estimated risk with mitigation measures in place is acceptable. Missions of slight to moderate risk categories are considered to be acceptable, as discussed in Section 5.3.

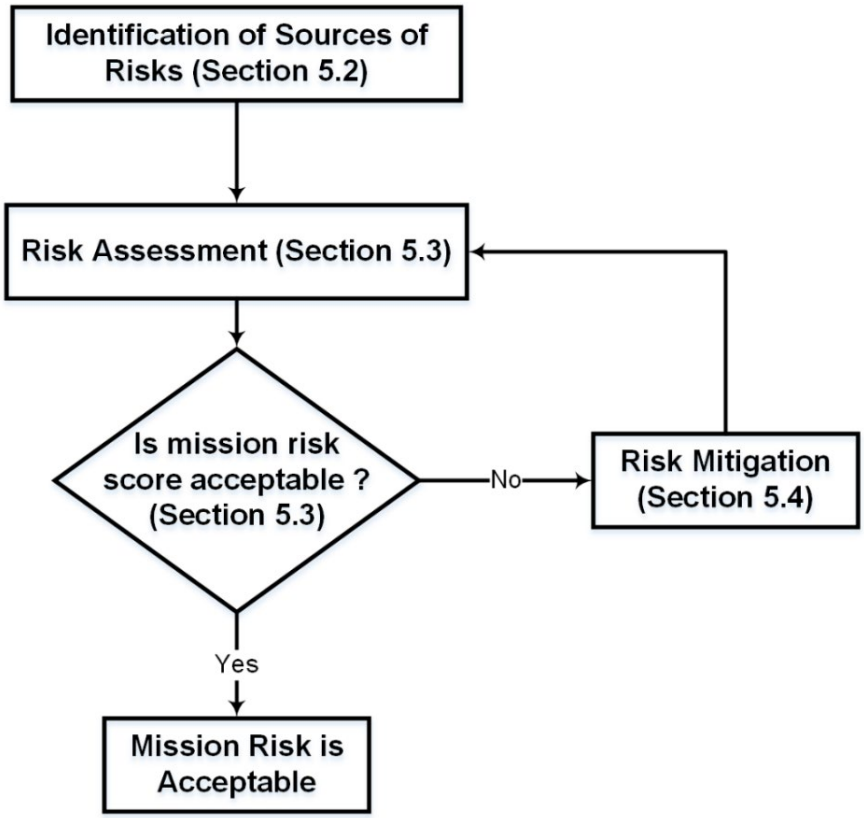

Figure 12. NJDOT Safety Management System (SMS) Flowchart.

5.2 Risk Identification

During a UAS operation, potential sources of risks could include, but not limited to, the following:

Equipment-Based:

- Loss of datalink communications and/or GPS
- Autopilot Software error/failure
- Loss of engine power or engine failure
- Ground control system failure
- Failure of parts/components

Human-Based:

- UAS crew fatigue / stress
- Excessive mission complexity
- Lack of crew proficiency
- Interference by non-crewmember
- Incorrect flight control commands
- Moving parts impacting personnel
- Unintentional movement of UAS on ground
- UAS impacting ground or other structure
- UAS conflicting with manned aircraft

Environment Based:

- Limited visibility
- Excessive precipitation
- Extreme temperature
- Densely populated area
- Complexity of airspace
- Time of operation (daylight or nighttime)
- Excessive wind conditions
- Adverse launch / landing site conditions (water / steep terrain / wires)
- Hazardous materials exposure during UAS Operations
- Potential privacy concerns
- Potential wildlife / birds interference

During the planning of any UAS operation, other potential sources of risks should be identified through detailed flight planning and site surveys. Impact of these risks on the flight mission must be considered along with mitigation measures.

5.3 Risk Assessment

Risks are cumulative. Each individual identified risk factor may not be critical to the mission. However, all identified risk factors compounded together could seriously influence the safety of a mission.

Evaluation of the risk level of a factor starts from estimating the likelihood of its occurrence and severity of its consequence. Based on combinations of likelihood and severity scales, five risk levels are defined as: Slight, Low, Moderate, Elevated and High. These risk levels are assigned

scores of 1, 2, 3, 4 and 5, respectively. Table 2 shows scales of likelihood varying from frequent to improbable, and scales of severity varying from catastrophic to negligible. Figure 13 shows the plot of likelihood versus severity scales. The use of the chart in Figure 13 is illustrated for an example of low visibility (weather). The likelihood of visibility less than 3 miles is occasional. However, the consequences of flying a mission during low visibility could be catastrophic. Plotting this case on the chart in Figure 13 (indicated by an asterisk *) shows that the risk level for low visibility is Elevated, which will have a score of 4.

Table 2. Likelihood and severity scale definition.

Likelihood Scale Definitions	
Frequent (A)	Likely to occur often. Continuously experienced.
Probable (B)	Occur several times. Occur often.
Occasional (C)	Likely to occur sometime. Occur several times
Remote (D)	Unlikely to occur, but possible. Unlikely but can reasonably be expected to occur.
Improbable (E)	So unlikely, it can be assumed it does not occur. Unlikely to occur, but possible.
Severity Scale Definitions	
Catastrophic (I)	Results in fatalities and/or loss of the system.
Critical (II)	Severe injury and/or major system damage.
Marginal (III)	Minor injury and/or minor system damage.
Negligible (IV)	Less than minor injury and/or less than minor system damage.

Likelihood	**Severity**			
	Negligible (IV)	**Marginal (III)**	**Critical (II)**	**Catastrophic (I)**
Frequent (A)				High
Probable (B)			Elevated	
Occasional (C)				* (Low Visibility Example)
Remote (D)	Slight	Low	Moderate	
Improbable (E)				

Figure 13. Likelihood versus severity chart.

In order to evaluate the impact of several risk factors, the NJDOT risk assessment worksheet was developed. This worksheet tool provides a weighted risk score called "*Mission Risk Score*" for the mission based on the cumulative contribution of scores for each of the potential equipment, human and environmental risk factors. These scores have been determined from the chart in Figure 13 by repeating the process similar to low visibility example.

Table 3 shows the ranges of the mission risk score in Column 1 for different mission risk levels in Column 2. Column 3 shows the acceptability of mission risk levels. For example, a mission risk score in the range of 28-48 will imply a moderate risk for the UAS flight mission and will be acceptable. A mission with at least one risk factor with a score of 5 or at least two risk factors

with scores of 4 are categorized as a high-risk mission. *Mission Risk Score* of more than 73 will automatically have at least one 5 or two fours and will be categorized as a high-risk mission. Missions of slight to moderate risk categories are considered to be *acceptable*. Approval from the NJDOT UAS Program Manager is needed to carry out a mission of elevated or high-risk categories. When risk based on this *Mission Risk Score* is unacceptable, some risk control or mitigation measures may be needed to bring the overall risk associated with the mission to an acceptable level.

An image of the NJDOT risk assessment worksheet, which was created in Microsoft Excel format, is included in Appendix B. Figure 16 shows an example of the use of this risk assessment worksheet. The factors contributing to risks to a UAS mission have been divided into 6 categories in this worksheet, including Weather, Crew Experience, Mission, Operations Area, Crew Rest / Duty Day, and Equipment / Aircraft. In selecting scores for some of these factors, e.g., wind, the manufacturer's manual should be consulted for any limitations. In addition to these factors, there may be additional risks to a UAS mission because of in-flight emergency issues such as the loss of data link communication, loss of GPS or loss of engine power, etc. These are addressed through several checklists (discussed in Chapter 7 and included in Appendix B) and risk mitigation measures discussed in section 5.4.

As shown in Figure 16, the risk assessment sheet consists of three steps marked as Box1, Box 2, and Box 3. A RPIC can calculate mission risk score by using the following steps:

- **Step 1**: Enter the general information on the mission, such as mission number, flight date, and purpose, requesting division, names of RPIC and VO, etc. in Box 1.
- **Step 2**: Select the range for each of the risk factors in the worksheet from the dropdown menu. Associated risk score corresponding to the selected range will be automatically populated (predetermined for different possible scenarios of risk factors in the worksheet based on the chart in Figure 13).
- **Step 3**: Click "Evaluate" button in Box 3. *Mission risk score* and corresponding risk category will appear in Box 3.

Table 3. Mission risk assessment.

Mission Risk Score	Mission Risk Level	Mission Risk Acceptance
1-12	Slight Risk	Acceptable
13-27	Low Risk	
28-48	Moderate Risk	
49-72	Elevated Risk	Risk Mitigation / NJDOT UAS Program Manager Approval Needed
Any 5 or two 4	High Risk	

Calculation of *Mission Risk Score* using the NJDOT risk assessment worksheet is shown through the following example mission details:

Example:

A mission with the following properties is needed to be performed. Estimate the mission risk score using The NJDOT Risk Assessment Worksheet.

- *Weather*
  - Celling: 2700 ft
  - Visibility: 3.7 miles
  - Winds (KTS) + 1/2 Gust: 8G15
  - Rain/Snow: Occasional light showers
  - Thunderstorms: Scattered (21%-40%)
  - Low-level wind shear within 10 miles: No
  - Temperature: 30 ˚F
  - Density altitude: 4500 ft.
- *Crew Experience*
  - RPIC experience: RPIC has flown more than 20 hrs.
  - Crew currency: Flew a mission 24 days ago.
  - Crew mission: The crew is proficient.
- Crew Rest/Duty
  - Hours of rest: 12 hrs
  - Length of duty day: 7 hrs
- Mission
  - Time of mission: *Mission is performed in daylight.*
  - Operating over water: *Mission is over land.*
  - Operating from a boat: *Operation is performed from land*
  - Operating overland: *Mission area is not GPS denied (None).*
  - Flights planned: *Mission will be completed in 6 flights.*
  - Mission complexity: *Mission is routine*.
  - Electrical interference: No.
  - Operating near traffic: Operation is near a local road.

- Operation Area:
  - Launch/Recovery site: Familiar
  - Terrain: Wooded
  - Population: Urban
  - Complex high-density airspace: D
  - Obstructions: No obstruction within a radius of 20 ft from RPIC

Step 1

This part is not filled for this example.

Step 2

The value of each risk factor is selected from a dropdown menu. For example, as it is shown in Figure 14 since the visibility is 3.7 miles, the “3-5” option is selected from the menu. The similar approach can be used for all other risk factors.

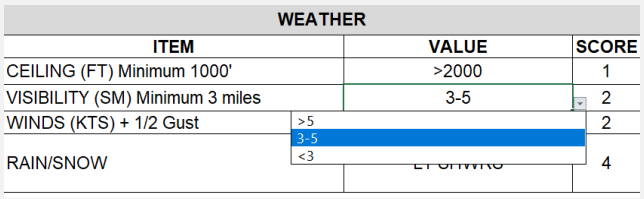

Figure 14. An example of the drop-down menu for Visibility.

Step 3

Click “Evaluate” button in Box 3. Based on the chosen severity of each risk factor, the Mission Risk Score is calculated, and the corresponding risk description is shown next to it.

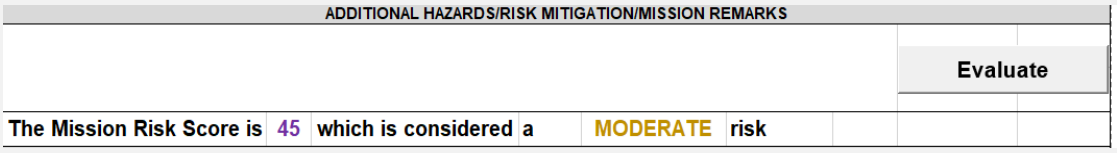

Figure 15. Final step in risk evaluation (Box 3).

As it is seen in Figure 15, this mission is considered a moderate-level mission.

NJDOT UAS OPERATION RISK ASSESSMENT WORKSHEET

DATE	MISSION/FLIGHT PURPOSE	N-NUMBER	UAS TYPE	NJDOT DIVISION

REMOTE PILOT-IN-COMMAND	VISUAL OBSERVER	COA/PT 107

Mission #	FREQUENCY	AIRSPACE CLASS

BOX 1

Weather briefings will be obtained and provided for inspection before flight operations.(*)

Select an applicable risk from drop-down list, and read the totaled score below.

WEATHER			OPERATIONS AREA		
ITEM	VALUE	SCORE	ITEM	VALUE	SCORE
CEILING (FT) Minimum 1000'	>2000	1	LAUNCH/RECOVERY SITE	UNFAMILIAR	2
VISIBILITY (SM) Minimum 3 miles	<3	4	TERRAIN	WOODED	2
WINDS (KTS) + 1/2 Gust (**)	6-10G15	2	POPULATION	URBAN	3
RAIN/SNOW	LT SHWRS	4	COMPLEX HIGH DENSITY AIRSPACE (TRAFFIC, PATTERNS, ETC)	C,D	3
THUNDERSTORMS (FORECAST/REPORTED)	ISOL (10%-20%)	1	OBSTRUCTIONS (WITHIN RADIUS OF R FROM RPIC)	15' < R < 25 '	2
LOW LEVEL WIND SHEAR WITHIN 10MI	NONE	0			
TEMPERATURE (Degrees F°)	20-35	3			
DENSITY ALTITUDE (FT)	>4000	3			

*Flights are not authorized when t-storms and/or lightning are observed within 5 mi of operations area.
**The manufacturer's manual should be consulted for any limitations

CREW EXPERIENCE			CREW REST/DUTY DAY		
ITEM	VALUE	SCORE	ITEM	VALUE	SCORE
RPIC EXPERIENCE	MODERATE 15-30	2	HOURS OF REST (CREW FATIGUE)	>7	0
CREW CURRENCY (DAYS)	<90	1	LENGTH OF DUTY DAY	<12	1
CREW MISSION	REQUALIFYING	2			

MISSION			EQUIPMENT/AIRCRAFT		
ITEM	VALUE	SCORE	ITEM	VALUE	SCORE
TIME OF MISSION	TWILIGHT	2	AIRCRAFT	NONE	0
OPERATING OVER WATER	YES	3			
OPERATING FROM A BOAT	NO	0			
OPERATING OVER LAND	NONE	0			
FLIGHTS PLANNED	5-8	3			
MISSION COMPLEXITY	ROUTINE	1			
ELECTRICAL INTERFERENCE	NONE	0			
OPERATING NEAR TRAFFIC	LOCAL ROAD	2			

BOX 2

ANY FACTOR RATING '4 OR HIGHER, ADEQUATE CONTROL MEASURES MUST BE DOCUMENTED AND PROVIDED TO SUPERVISOR.

ADDITIONAL HAZARDS/RISK MITIGATION/MISSION REMARKS

BOX 3

Evaluate

The Mission Risk Score is 47 which is considered a HIGH risk

BRIEFING APPROVAL

RPIC NAME/SIGNATURE	SUPERVISOR NAME/SIGNATURE	RISK ASSESSMENT TOTAL
		47

MISSION APPROVAL AUTHORITY

MISSION COMMANDER(LOW):	DATE:	TIME:
PROGRAM MANAGER (MODERATE):	DATE:	TIME:
PROGRAM DIRECTOR OR VP (HIGH OR ANY 5 VALUE):	DATE:	TIME:

MISSION BRIEF BACK

MISSION STATUS (Choose one):	COMPLETED

REMARKS

Please refer to Table 3, Mission Risk Assessment. Mission Risk Level is High because of having two items with a score of 4.

SEPARATE DRIVER, RPIC, AND VO. NO AIRBORNE CHASE OPERATIONS AS PER 14 CFR PART 107

Figure 16. Example of Risk Assessment Worksheet for a High-Risk Mission.

5.4 Risk Mitigation

If the mission risk score is elevated or high, mitigation measures are required to reduce the risk. Risk mitigation begins with identifying both risk and potential threats. For example, any individual item with a score of 4 or higher (for example, an obstacle within 15 ft. of RPIC) in the risk assessment worksheet can be recognized as a potential hazard with an adverse effect on the safety of the mission. This risk can be mitigated by, for example, by choosing a launch / landing zone with no obstacles within 15 ft. of the RPIC. Table 4 presents different potential hazards and possible mitigation measures. The information in Table 4 also includes UAS hazards based on actual accidents from New York State UAS accident database[1]. Both UAS hazards and mitigation measures in this table should be reviewed for changes to the NJDOT risk assessment worksheet, as necessary. An accident investigation report can also be used to update risk assessment worksheet to mitigate the likelihood and severity of future hazards.

[1] http://rochester.nydatabases.com/map/domestic-drone-accidents

Table 4. Hazards and associated risks before mitigation.

Row	Hazard	Associated Risks	Pre-Mitigation			Mitigation	Post-Mitigation		
			Likelihood	Severity	Risk Level		Likelihood	Severity	Risk Level
WEATHER									
1	Low ceiling	•May interfere with visual line of sight	Occasional	Catastrophic	Elevated	•Semi-annual training •WX mitigation policies in FOM •Use weather apps	Remote	Catastrophic	Moderate
2	Low visibility	•May interfere with visual line of sight	Occasional	Catastrophic	Elevated		Remote	Catastrophic	Moderate
3	Thunderstorm	•Loss of control •Damage to UAS	Probable	Catastrophic	High		Probable	Catastrophic	High
4	High-density altitude	•Adverse UAS performance	Remote	Catastrophic	Moderate		Remote	Catastrophic	Moderate
5	Extreme (high/low) temperatures	•Adverse UAS performance •Potential equipment failure •Temporary incapacitation	Probable	Catastrophic	High	•Reschedule mission Time •Heat/cold stress training •Use appropriate clothing	Occasional	Catastrophic	Elevated
6	Wind	•Loss of control	Probable	Critical	Elevated	•Better takeoff and landing zones •Reschedule mission time •WX mitigation policies in FOM •Use weather apps	Probable	Critical	Elevated
OPERATIONS AREA									
7	Launch /Recovery Site	•Unfamiliar site conditions	Occasional	Marginal	Low	•Visiting the site before mission day •Asking other RPIC •Viewing Google Earth maps	Remote	Marginal	Low
8	Terrain / Obstacles	•Obstacles: Buildings, Power lines, Trees, antennas	Occasional	Critical	Elevated	•Site Survey •Obstacle Map / Drawing •RPIC maintains a safe distance of 15’	Occasional	Marginal	Low

Row	Hazard	Associated Risks	Pre-Mitigation			Mitigation	Post-Mitigation		
			Likelihood	Severity	Risk Level		Likelihood	Severity	Risk Level
9	Complex high-density airspace	• Mid-air collision • Airspace violation due to altitude or airspace	Remote	Catastrophic	Moderate	• VFR / UAS Geo-fencing • FOM / Training • Collision avoidance feature in UAS	Improbable	Catastrophic	Low
CREW EXPERIENCE									
10	Lack of crew currency	• Reduced proficiency	Probable	catastrophic	High	• FOM retraining	Remote	Marginal	Low
11	Crew Fatigue	• Damage to UAS and property • Loss of time • Risk of Injury	Probable	Catastrophic	High	• Fatigue management program • Time off requirements • Maximum duty day policy • Mandatory rest period for duty day extension	Remote	Marginal	Low
MISSION									
12	Time of mission (nighttime)	• Limited range of visual sight	Probable	Catastrophic	High	• Using more than one VO • Waypoint planning and altitudes to avoid hitting structures • Using anti-collision lighting • Nighttime training	Occasional	Catastrophic	Elevated
13	Operation over water	• Increased severity of crash • Limited landing options • Light reflection impairs VPS[1]	Probable	Marginal	Moderate	• Disable VPS • Enable maximum flight distance • Chase vehicle (boat)	Occasional	Marginal	Low
14	Operation from boat	• Adverse landing and recovery sites • Risk of sudden extreme weather • Non-stationary RTH point	Occasional	Critical	Elevated	• Hand launching/ catching • Configure dynamic RTH point • Start landing with higher remaining percentage of battery	Occasional	Critical	Elevated

[1] Aircrafts are usually equipped with the Vision Positioning System (VPS) that maps the surface below to help position the drone.

Row	Hazard	Associated Risks	Pre-Mitigation			Mitigation	Post-Mitigation		
			Likelihood	Severity	Risk Level		Likelihood	Severity	Risk Level
		• Vertical structures on the boat							
15	Operation in GPS denied areas	• Loss of control	Probable	Catastrophic	High	• Checking GPS signal on the controller • Avoiding high-potential zones • UAS with GPS-denied environment capacity (RTK)	Occasional	Catastrophic	Elevated
16	Flight planned (ad-hoc missions)	• Reduced planning time	Occasional	Negligible	Slight	• UAS dispatch procedures • Safety management system (SMS) • Safety assessment worksheet	Occasional	Negligible	Slight
17	Disaster operations	• Perceived pressure to launch • Adverse conditions	Probable	Catastrophic	High	• FOM • Emergency procedures • Nighttime operation Procedures	Occasional	Catastrophic	Elevated
18	Electrical Interference	• Impaired compass, GPS • Lost link event	Probable	Critical	Elevated	• Keep a safe distance from the source • Watch for lines of static interference during video streaming on the controller	Improbable	Critical	Low
19	Operations near traffic	• Distraction to the drivers • Causing congestion • Distraction to RPIC	Occasional	Catastrophic	Elevated	• Concealed landing and take-off zones • Actively monitoring traffic congestion • RPIC training for operations near traffic	Probable	Negligible	Low
EMERGENCY									
20	UAS Engine Failure	• Damage to UAS and/or property • Lost mission time • Risk of Injury	Remote	Catastrophic	Moderate	• Routine Maintenance • Daily equipment inspections • Emergency procedures briefing	Improbable	Catastrophic	Low
21	Lost Link Event	• Uncommanded UAS action	Remote	Catastrophic	Moderate	• Preprogramed lost link logic for auto home return • Emergency procedures briefing	Improbable	Negligible	Slight

Row	Hazard	Associated Risks	Pre-Mitigation			Mitigation	Post-Mitigation		
			Likelihood	Severity	Risk Level		Likelihood	Severity	Risk Level
22	Fly Away	• Uncommanded UAS action	Remote	Catastrophic	Moderate	• Visual observer • Emergency procedures briefing • Configuring emergency modes on the controller • Calling 911	Remote	Marginal	Low
23	Multiple UAS operations	• Collision or interference with other UAS or aircraft	Occasional	Catastrophic	Elevated	• Marked UAS operation sectors • Altitude buffer between aircrafts • Use of visual observers for separating UAS from other aircraft	Improbable	Catastrophic	Low

5.5 UAS Safety Assurance

UAS Safety assurance is an ongoing process to ensure the overall safety of the NJDOT UAS Program. It should be carried out on regular basis to review of NJDOT UAS operations, pre- and post-mission briefings and other available data on UAS accidents/incidents. This can be done on randomly selected samples of mission reports (lesser of 5 or 10% of all missions during the prior year) to check compliance with procedures established for NJDOT UAS Program. This process could include evaluation of compliance of NJDOT flight crewmembers with:

- FAA compliance through UAS DA-56.
- NJDOT three-phase training requirement.
- NJDOT UASFOM.
- NJDOT accident reporting requirement.
- Safety management system (SMS). This can be done by reviewing any correlation between the risk found in the initial site survey/mission safety report and assessed mission risk by the risk assessment worksheet. For example, when the result of risk assessment worksheet shows a low level of the risk on a considerable number of missions, but an accident/incident occurs, the risk assessment worksheet may need further revisions to address this inconsistency between predicted and actual risk.

The form DA-59 included in Appendix B of this manual can be used to carry out safety assurance and evaluation of NJDOT's UAS program.

5.6 Accident Reporting and Documentation

All accidents shall be made known to the FAA in accordance with FAA Part 107.9. When an accident occurs:

a) All involved flight crew members shall be grounded until the accident investigation is complete.
b) All participants shall document what was said, seen, and done both prior to and after the accident in a witness statement.
c) Photographs of the accident site, ground station configuration at the time of the accident and any other person or property that was damaged in the accident shall be taken.

Form DA-58, included in Appendix B, shall be used to report any incident/accident to NJDOT UAS Program Manager. RPIC must also report accidents in accordance with the Part 107 rule through "DroneZone" website1. Accident reports may also be made by contacting the nearest FAA Flight Standards District Office (FSDO). The list of FSDOs can be found on the FAA website[2].

Accidents/incidents during operations under public agency sUAS COA granted to NJDOT must be reported separately through the COA Application Processing System (CAPS[3]) by the NJDOT UAS Program Manager, who must provide initial notification to the FAA via email at 9-AJV-115-UASOrganization@faa.gov and via the CAPS forms (Incident/Accident) within 24 hours of an incident or accident that meets the criteria in Appendix C.

Initial reports must contain the information identified in the CAPS Accident/Incident Report. Follow-on reports describing the accident/incident/mishap(s) must be submitted by providing copies of aviation accident/incident reports upon completion of safety investigations by the

[1] https://faadronezone.faa.gov
[2] https://www.faa.gov/about/office_org/field_offices/fsdo/?state=NJ
[3] https://caps.faa.gov/

NJDOT Bureau of Aeronautics. The above procedures are not a substitute for separate accident/incident reporting that may be required by the National Transportation Safety Board under 49 CFR §830.5.

5.7 Liability and Insurance

According to the FAA, federal laws do not require UAS insurance. NJDOT staff carrying out UAS operations may be covered by the State of New Jersey self-insurance in the case of an accident. NJDOT consultants or contractors flying UAS operations should be sufficiently insured during all operations as per insurance requirements determined by the NJDOT Project Manager.

CHAPTER 6. TRAINING PROGRAM

6.1 General FAA Requirements

Current FAA requirements under the FAA's small UAS (14 CFR Part 107) require the understanding of the regulations, operating requirements, and procedures to receive a remote pilot certificate from the FAA. The basic requirements for this certification are:

- Be at least 16 years old
- Be able to read, speak, write, and understand English
- Be in a physical and mental condition to safely fly a drone
- Pass the initial aeronautical knowledge exam

A Visual Observer (VO) must complete the requirements as outlined later in this chapter (there are no specific VO requirements from the FAA).

6.2 Customized NJDOT Training Program Requirements

NJDOT has developed a 3-phase customized training program that includes the FAA RPIC general requirements. The NJDOT 3-phase customized training includes the following phases:

- Phase 1- FAA Certification
- Phase 2- Best Practices & Practical Training
- Phase 3- Skill Building & Mission Specific Training

6.2.1 Phase 1 – FAA Legal Certification:

The first component of training is to be competent in pertinent FAA UAS regulations and then successfully pass the 14CFR Part 107 written test for FAA certification. This test may include the following contents:

1. FAA Part Regulations: Applicable regulations relating to small unmanned aircraft system rating privileges, limitations, and flight operation
2. National Airspace System and Sectional Charts: Airspace classification and operating requirements, and flight restrictions affecting small unmanned aircraft operation
3. Aviation weather sources and effects of weather on small unmanned aircraft performance
4. Small unmanned aircraft loading and performance
5. Emergency procedures
6. Crew resource management
7. Radio communication procedures
8. Determining the performance of small unmanned aircraft
9. Physiological effects of drugs and alcohol
10. Aeronautical decision-making (ADM) and judgment
11. Airport operations
12. Maintenance and preflight inspection procedures

This test can be taken at any knowledge testing center. A government-issued ID is required to take the test. After successfully passing the test, a permanent remote pilot certificate can be obtained by completing FAA Form 8710-13 at the FAA website. A copy of the certificate must be

submitted to the NJDOT UAS Program Manager for compliance tracking.

6.2.2 Phase 2- Practical Training

This practical training phase is designed to supplement the trainee's academic knowledge with skills and hands on flight experience such that the trainee can safely fly without the supervision of the flight instructor. These skills shall include, but are not limited to:

1. Pre-mission planning
2. Site survey and risk assessment
3. Pre-flight equipment checks
4. Personnel mission briefing
5. Take off/Landing and basic flight maneuvers
6. Camera controls and software
7. Recordkeeping
8. Data management
9. Pre-mission and flight planning
10. On-site survey and mission briefings
11. Battery technology and charging
12. Operations and maintenance
13. Photo and video production
14. Waivers and authorizations

6.2.3 Phase 3A- Skill Building

The newly certified UAS RPIC will be assigned a mentor and will be authorized to practice his/her UAS flying skills without the supervision of an instructor. The presence of a visual observer is still mandatory. The skill building exercise should include the following activities:

1. Using a UAS simulator, trainees practice quadcopter flying in a controlled indoor environment
2. Performing a preflight and configuration checks
3. Presenting a mission briefing
4. Flying and performing depth-perception exercises
5. Using the drone camera to capture photos and video
6. Planning and flying an autonomous flight

6.2.4 Phase 3B- Mission Specific

This phase is mission specific to the Division's objectives. The skill and proficiency required to fly over marshland at high altitude are distinctly different than the skills required for an under-deck bridge inspection. This training shall be developed and conducted within NJDOT for the following activities:

- Traffic Incident Management
- Structural Inspections
- Aerial 3D Corridor Mapping
- Emergency Response Assessment
- Real-time Construction Project Monitoring
- 3D Reality Modeling
- Landfill Volume Calculations

Additional activities may also be considered for this phase by the NJDOT UAS Program Manager, depending on the division's requirements.

6.3 Recurrency in Training

Regular flying is required to maintain proficiency. Phase 3A-Skill Building Training is the required for a RPIC after a 90-day gap of flying experience. Both phase 2 and phase 3 training are required after a year-gap of mission flying experience.

6.4 RPIC Initial and Recurrent Ground Briefing

All RPICs will undergo initial and recurrent ground training in the following subjects:

- NJDOT UAS Policy
- NJDOT UASFOM
- FAA Part 107
- State and Federal UAS related regulations

6.5 Visual Observer Training

A visual observer will be trained by a RPIC with roles and responsibilities listed on NJDOT Form DA-54 included in Appendix B.

6.6 Training for Night Operations

NJDOT Public Agency sUAS certificate of waiver (COA) authorizes NJDOT for night UAS operation. NJDOT crewmembers must be trained prior to conducting night operations to recognize and overcome visual illusions caused by darkness and understand physiological conditions that may degrade night vision. This training must be documented and must be presented for inspection upon request from the Administrator or an authorized FAA representative. NJDOT will issue and record a certification of night operation training following the completion of such training (Form DA-55).

6.7 Emergency Procedures Training

Emergency procedures training is required for all UAS operators. During initial training and every year thereafter, UAS RPICs shall perform the function, action, or obtain a suitable demonstration by other means, e.g. audio-visual, for the following:

1) Fly away
2) Flight controller malfunction
3) Emergency landing/ditching
4) Crewmember incapacitation
5) First-aid and health emergencies

6.8 Crew Resource Management

Crew resource management (CRM) training is using all available resources, such as human resources, hardware, and information supporting aeronautical decision-making (ADM), to improve crew cooperation and decision-making. CRM training and knowledge should highlight the need to improve communication between crewmembers by eliminating social barriers such as seniority and experience. CRM encourages all crewmembers to help in decision-making processes and provide better crew coordination to prevent accidents from occurring. CRM includes the concept of *sterile cockpit procedures* which mean that crewmember engage only in activities related to the

safe completion of the mission. For NJDOT UAS operations, CRM training should consist of the following 5 components:

6.8.1 Decision Making

Flaws in the decision-making process are responsible for a large majority of accidents. Poor judgement, poor perceptual skills, and biases can all impede the ability to think rationally. NJDOT UAS crew members must be trained in making objective and concise decision making based on "Go/No-Go" criteria. Decision-making case studies based on available accident databases and potential accident scenarios could be used to train crew members. Some of the key components of the decision-making process that must be emphasized during all phases of a UAS operation:

- Effective communication between the RPIC and VO
- Channelized attention: do not get overly focused on any one issue.
- Clear responsibilities and roles
- Standardized language for communications
- Checklists with standard callouts during operations
- Avoiding behavioral biases
- Stress Management for crew members

6.8.2 Training and Regulatory Compliance

Training of crewmembers in communication skills to maximize coordination and minimize the chance for errors is critical to any UAS mission. Crew members should also be trained at regular intervals on:

- NJDOT UAS Policy
- NJDOT UASFOM
- FAA Part 107
- State and Federal UAS regulations

6.8.3 Coordination

All crewmembers need to be coordinated and communicate effectively and synchronously. This could be achieved by:

- Pre-mission meetings between crew members
- Respecting each crew member to encourage honesty and openness
- Attitude of initiating action rather than stagnating or being indecisive
- Monitoring results

6.8.4 CRM regarding Ground Operations

During ground operations, casual conversations should be limited while checklist items are completed.

6.8.5 CRM regarding Flight Operations

During flight operations, both RPIC and VO need to follow sterile cockpit procedure. CRM training can be done through training or continuing education seminars when needed.

CHAPTER 7. OPERATIONS

7.1 Introduction

All UAS operations performed by or on behalf of NJDOT must comply with 14 CFR Part 107 or 14 CFR Part 49 for public operators. Additionally, all NJDOT UAS flights must follow the operational procedures described in this chapter. A typical UAS operation consists of three phases: Mission Planning, Mission Execution, and Mission Debriefing, as illustrated in Figure 17 below. Detailed procedures for each of these phases are described in the following.

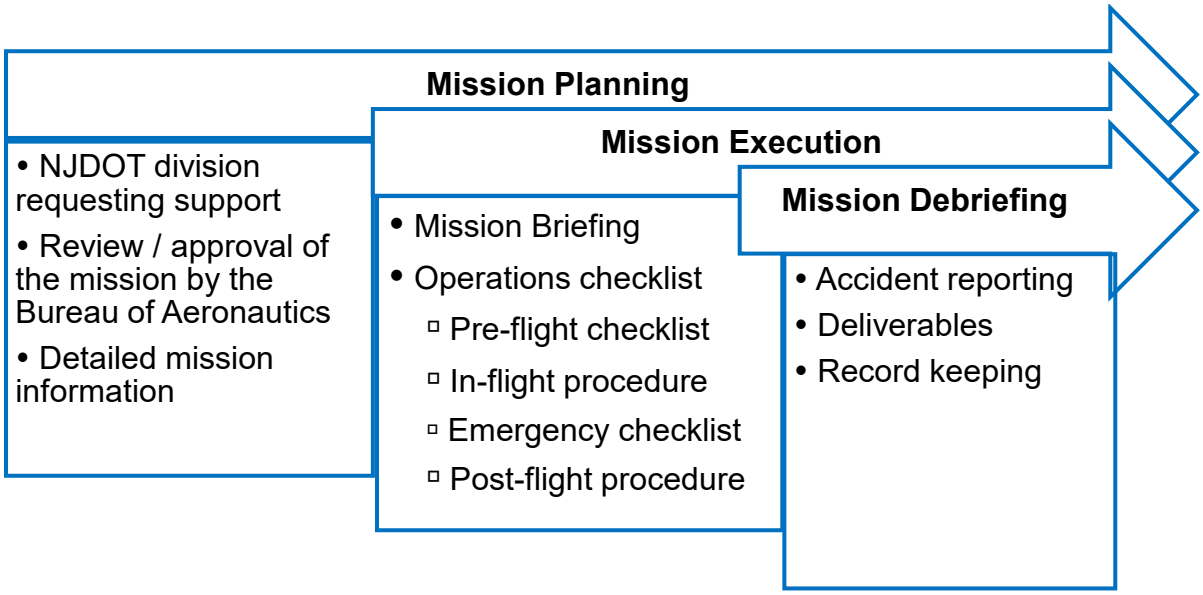

Figure 17.Three Phases of a Typical UAS operation.

7.2 Mission Planning

Planning any NJDOT UAS mission must have the potential to meet one or more of the four criteria:

(i) Increased Safety,

(ii) Increased Efficiency,

(iii) Saving Time, and

(iv) Saving Money.

NJDOT divisions interested in using UAS for their projects must start the process to request UAS support from the Bureau of Aeronautics by completing appropriate forms. Submission of completed DA-50 is required when a NJDOT employee is requested to fly the UAS. Form DA-51 is required when a NJDOT division requires a consultant to fly the UAS. Both these forms must be initiated by an NJDOT project engineer or higher. This form requires the following information from the requesting division/consultant:

- Contact details of the division/consultant requesting support
- Flight location map
- Permission for taking off and landing using private properties (if applicable)
- Objectives/goals of the mission
- Brief Overview of the Mission

- Expected Outcome of the mission (Type of data to be collected)

Following the approval of a UAS support request, the RPIC will complete the following additional information regarding the proposed mission:

- Estimated Flight Time / Duration
- Estimated Flight Altitude
- Estimated Maximum Distance from Take-Off Location
- FAA Waiver or Certificate of Authorization (COA), if required
- Airspace Classification
- Identification of obstacles
- UAS Make, Model and registration details
- RPIC FAA certificate and contact details
- RPIC training and compliance with FAA and NJDOT requirements
- VO name and contact details
- Site condition concerns
- Over-water areas (see section 7.8.3.2)

In addition to the above information, the RPIC also needs to perform the following during the mission-planning phase:

- A survey of the site where the mission is to be performed (For operations under a COA, NJDOT Public Agency sUAS COA states that a site safety evaluation/visit may be required to ensure COA compliance, assess any adverse impact on ATC or airspace, and ensure this COA is not burdensome or ineffective).
- Launch and recovery site selection (See Section 7.8.3.8 under “Detailed Information on Some Operational Issues” For detailed guidance)
- An airspace analysis for the mission site
- Safety risk assessment using NJDOT risk assessment worksheet.
- Review of state and local laws applicable to the mission
- Coordination with Regional Operations Intelligence Center (ROIC) (https://www.njsp.org/)
- For night operations under public agency sUAS COA issued to NJDOT, please refer to section 6.6 for night operation training of crewmembers and section 7.8.3.3 for lighting requirements on UAS.

A mission planning checklist in Form DA-61, included in Appendix B, can be used to ensure that all aspects of mission planning have been covered. A proposed mission can be considered ready for field execution if there are no concerns during the collection of the above information. Prior to the execution of any mission for the NJDOT, the flight crew should ensure that the documentation listed in Table 5 is available.

Table 5. Required documents during the pre-mission phase.

Item	Documents
	Should be Available at the operation site
1	Photo ID's of RPIC and VO
2	Remote Pilot UAS Certifications, including NJDOT training compliance
3	Copy of FAA UAS Registration Certificate.
4	Copy of COA, if applicable
5	Copy of Risk Assessment Worksheet and Mitigation Plans
6	UAS Operations Checklist (See Section 7.4)
7	Copy of NJDOT FOM
	Should be Available During Mission Planning
8	Approved Flight Authorization from the NJDOT UAS Program Manager
9	RPIC Logbook.
10	Copy of UAS Maintenance Log.
11	Land Use Agreement (if required).
12	Copy of RPIC Logbook (if applicable)
13	Emergency Procedures
14	Copy of Insurance Coverage (Liability and Hull), if applicable.

7.3 Mission Execution

The timeframe for mission execution should begin 72 hours prior to flight operations if (D) NOTAM is required. When conducting operations under a public agency sUAS COA, the RPIC must follow the (D) NOTAM filing and coordination requirements listed in section 7.8.3.6.

The RPIC shall conduct a mission briefing prior to each flight. For missions that require more than one flight in a day, mission briefings after the first flight may be shortened to include only items that have changed since the first flight. If there is a change of crewmembers after any flight of the day, a detailed mission briefing is required.

The RPIC should discuss the following topics during a mission briefing:

- Roles and responsibilities
- Flight location
- Safety concerns (obstacles)
- Weather
- Current airspace (including flying under a COA)
- Standard callouts
- Sterile cockpit
- UAS settings
- Emergency procedure
- Answering questions

A sample mission briefing for the inspection of a high-mast tower near a major highway can be in the following:

Hi everybody, this is the briefing of UAS Mission number 19-140. I am Glenn, the RPIC, and I am responsible for the safe operation of this flight with the assistance of John as my visual observer (VO). The VO is the person responsible for keeping the UAS in sight at all times and notifying me of potential hazards to the flight. We will be flying this mission in Hamilton on Route 130. The goal of this mission is to inspect four high mast light poles near the highway. We will be conducting four flights today gathering high definition photos. There are two high-tension power lines in the west and east of the mission area. The temperature is 75 degrees, the sky is clear, and wind is 220 degrees at 10 knots. We will be flying in Class G airspace. I am going to review the standard verbal callouts. The VO will acknowledge each command by repeating it during the mission.

- *"Power on Aircraft": The VO will turn on the aircraft and I will load the mission commands.*
- *"Clear Airspace": The VO will ensure the takeoff area is clear of any potential threats during the takeoff.*
- *"Taking off": After hearing the response to "take off" from VO, I will take off.*
- *"Controllability check": I will check to ensure the aircraft is properly executing the maneuvering commands from the remote control.*
- *"Landing gear up": I will raise the landing gear, if applicable.*
- *"Climbing 50, 100, …" (every 50 ft.): I will say the UAS altitude every 50 ft. until the mission altitude.*
- *"Proceeding to the mission": I will start flying the aircraft to the mission location.*
- *Battery Callout (every 10%): I will read the remaining battery percentage every 10%. The aircraft must be on the ground with no less than 20% battery remaining.*
- *"Returning home": Either when the mission is complete or the battery percentage reaches 30%, I will command the aircraft to start proceeding home. I will stabilize the aircraft in a hover approximately 15 ft. above the landing site.*
- *"Gear down": I will activate "gear down".*
- *"Gimbal up": I will raise the camera gimbal.*
- *"Landing": I will commence a descent to touchdown. The VO will monitor potential hazards to ensure a safe landing.*
- *"Going around": If anyone observes a hazard during landing, he/she will call "Go around" and I will repeat "going around". I will immediately initiate a climb to a safe altitude. Once at a safe altitude, we will discuss the hazard and attempt another landing.*
- *"Power off aircraft": The VO turns off the UAS.*

The "Sterile Cockpit" procedure is mandatory once the "clear airspace" command is given. This means that only conversation essential to safely complete the mission is permitted.

Emergency Procedures: I have set the "return to Home" maximum altitude to 300 ft. in the event of a lost link. I have set the controller to a maximum altitude of 125 ft. and a maximum distance of 1000 ft. The compass is calibrated, and the SD card is formatted.

In case of an emergency, we will follow the following emergency procedure:

- *I will announce the emergency.*
- *We all remain calm.*
- *In case of Loss of Power, I will try to regain control of the UAS. Everybody should maintain visual contact with the UAS.*
- *In case of an airspace intrusion, I will suspend the operation and land the UAS.*

- *In case of a flyaway or loss of control, I will try to put the aircraft in "return-to-home" mode. If the aircraft is going to enter controlled airspace, I will contact ATC immediately.*
- *In case of any impending impact causing injuries, the VO will call 911 and I will notify the NJDOT Bureau of Aeronautics.*

Briefing complete. Any questions?

Flight operations should commence as soon as possible after the mission briefing is complete. NJDOT standard operating procedures require the RPIC to perform a pre-flight check on the UAS prior to flight. The RPIC is required to operate the UAS in compliance with all FAA regulations, and NJDOT operational procedures. The RPIC may not deviate from standard operating procedures unless he/she declares an in-flight emergency. When an emergency is declared, the RPIC must follow the manufacturer's recommended emergency procedure.

7.4 Operations Checklist

The objective of the operations checklist is to ensure that all safety and operational procedures are addressed, and nothing gets missed. Operations checklists shall include the following:

Pre-flight checklist: The detailed pre-flight checklist in the form DA-62 in Appendix B should be used to ensure safety of the mission. This checklist consists of in-office checklist on the details of the mission and in-field checklist on various safety issues (such as assembly, connections of components, datalink, power on, etc.).

In-Flight Procedures:

Flight procedures will somewhat depend on the aircraft being used. However, certain procedures are required for every flight including,

- The RPIC will announce to the flight crew and observers present that the flight operation has begun.
- A mission briefing: The RPIC should deliver the mission briefing using the sample mission briefing as a guide. This briefing will also include any site-specific safety issues for the mission and will provide the opportunity for questions.
- The RPIC will begin scanning the project area for hazards or concerns and will inform the crew if potential hazards are detected. The VO will scan the surrounding airspace for other aircraft and will continue to scan the airspace for the remainder of the flight operation. It is important that the VO does not become fixated on the aircraft. The VO is responsible for remaining alert to the conditions over the entire operational area, including ground personnel and traffic. The RPIC and VO will remain in constant contact for the duration of the flight mission. Prior to aircraft take off, both RPIC and VO will take their positions and will be at least 12 ft. from the drone. All other personnel will stay behind RPIC and VO during takeoff and landing. There shall be no other person between the UAS and RPIC / VO.
- When notified by an ATC, the RPIC must be able to terminate the operation within 2 minutes of notification, whether flying under 107 Part 2 or a COA.
- The RPIC will follow the standard callout procedure in the table below to commence the flight mission.

Table 6. Standard Callout Procedure.

	RPIC	VO	Action
Normal	"Power on aircraft"	"Power on aircraft"	RPIC turns on the aircraft and loads the mission commands.
	"Clear Airspace"		RPIC looks around the takeoff zone and mission area for any obstacle (birds or other UASs)
		"Clear airspace"	The VO verifies and affirms that the area is clear and safe for launch
	"Taking off"	"Take off"	VO has verified that conditions are safe. He / she then responds "take off". The RPIC then starts taking off.
Failure	"Take-off aborted"	"Take-off aborted"	Take off ceases.
Normal	"Controllability check" (about 15 ft.)		The RPIC checks if the aircraft is executing the maneuvering commands of remote control.
	"Landing gear up"	"Landing gear up"	If the aircraft has controllable gear, the RPIC activates "landing gear up" and VO will confirm that landing gear is up.
	Climbing 50, 100, … (every 50 ft.)	Repeats the altitude information	The RPIC will say the UAS altitude every 50 ft. till the mission altitude.
	Proceeding to the mission	"Proceeding to the mission"	VO will keep the UAS within visual line of sight and will monitor for hazards.
	Battery callout (every 10%)	Battery callout at every 10%	The RPIC reads the remained battery percentage every 10%. Aircraft must be on the ground with no less than 20% battery remaining.
	"Returning home"	"Returning home"	Either when the mission is complete or at battery percentage of 30%, RPIC shall start proceeding home.
	Putting the drone in hover	"Drone in hover"	At about 15 ft. above the landing site, the RPIC puts the aircraft in hover mode to stabilize the landing process.
	"Gear down"	"Gear down"	If the aircraft has controllable gear, the RPIC activates "gear down" and VO will confirm that gear is down.
	"Gimbal up"	"Gimbal up"	RPIC will put gimbal up and VO will confirm it.
	"Landing"	"Landing"	VO will monitor any hazard to ensure safe landing of the UAS.
Aborted Landing	"Going Around"	"Going around"	Crewmember have observed a hazard and have initiated "abort landing sequence". The RPIC manually takes over and initiates a climb away from the ground. Once at a safe altitude, RPIC will discuss "go around" and attempt another landing / recovery.
Normal	"Power off aircraft"	"Power off aircraft"	VO turns off the UAS.

In-flight Emergency Procedures: Possible in-flight emergencies listed in form DA-64 should be reviewed during the pre-flight checklist. The form DA-64 lists possible in-flight emergencies and recommended actions. Both the RPIC and VO should review this table before commencing the flight. A copy of this table should be accessible during the flight. Form DA-64 is not meant to override emergency procedure recommendations of the manufacturer.

7.5 Post-Flight Procedures

- At the conclusion of the flight, the RPIC will announce the impending landing of the aircraft to the flight crew and observers. Callouts for flight landing will follow the standard callout procedure in Table 6.
- The aircraft, control, and communications equipment will be powered down, removed from the landing area, inspected for cleanliness and condition prior to being stowed. The goal of cleanliness is to ensure the prevention of any dust/debris contaminating the UAS. UAS components are very sensitive to contamination by fine dust particles.
- Traffic control signs will be picked up.
- Once the project site is secured, the RPIC is responsible for a post-flight briefing. The post-flight briefing will review the events of the flight and will include a critique of the operation to include any lessons learned.

7.6 Mission Debriefing

The objective of the mission debriefing is to discuss any problem areas and methods to prevent their reoccurrence. The RPIC is required to perform a mission debriefing. All crewmembers should participate in mission debriefing and offer suggestions. If there are any in-flight emergencies, the RPIC is required to report to the NJDOT UASPM or the Manager, Bureau of Aeronautics if UASPM is unavailable. Any suggestions arising from the debriefing should also be reported by the RPIC to the Bureau of Aeronautics.

7.6.1 Flight Log

The RPIC should also complete the flight log with details of the flight so that it can be used when the UAS is used in future missions. A typical flight log should include at least:

- Mission number
- Mission objective
- Location(s)
- Date
- Names of RPIC and VO
- Flight Duration
- UAS make and model
- Comments / Feedback

Comments and feedback in the flight log should address the following items:

- Opportunities for Improvement: How could the operation be improved during future flights?
- Safety: Were margins of safety eroded at any time during the flight?
- Standards: Were any standards, policies, or procedures compromised? (Identify any areas that could cause a future flight evaluation, downgrade or FAA action).

7.6.2 Deliverables

The data collected during the mission shall be submitted to the Bureau of Aeronautics and will be

processed in the following manner.

- Photographs

The size and resolutions of photos should be as per customer specifications. All photographs should be watermarked with "©NJDOT Aeronautics UAS Photo". The photos should be named according to the following protocol.

PROJECTNAME YYYYMMDD.ext

The photograph should be saved with the extension (format) requested by the customer (JPG, BMP, TIF, PNG, PSD, PBM, etc.). For example, a photo taken for a project named OMR-Gull Island on 07/20/17 in JPG format is named "OMR-Gull Island 20170720.jpg".

- Videos

The size and format of videos should be as per customer specifications (4k resolution, Apple iPad format, WMV file for presentation). All videos recorded during the missions should be watermarked with " © NJDOT Aeronautics UAS Program". The naming procedure should be similar to that for photos.

All other data not being reported should be destroyed following the acceptance of the mission report by the division requesting UAS support.

- Flight Report

Depending on the project requirement, a flight report detailing all aspects of the mission may be prepared by the project engineer. The RPIC will provide all documentation necessary to prepare this report to the project engineer.

7.6.3 Accident / Incident Reporting

As a part of mission debriefing, accidents or incident during all NJDOT UAS operations shall be reported to relevant authorities following requirements in section 5.6.

7.6.4 Reporting COA Missions to FAA

The FAA requires NJDOT to report the documentation of all UAS operations under a COA, regardless of the airspace in which the UAS operates. This report should be submitted monthly, even when no (zero) mission has been conducted. NJDOT UASPM must submit the following information on a monthly basis through the COA Application Processing System (CAPS[1]). The RPIC must provide the following information to the UASPM as a part of mission debrief for any mission under COA:

1. Name of Proponent (NJDOT), and aircraft registration number
2. UAS type and model
3. All operating locations, to include city name and latitude/longitude
4. Number of flights (per location, per aircraft)
5. Total aircraft operation hours
6. Takeoff or landing damage
7. Equipment malfunction. Required reports include, but are not limited to, failures or malfunctions to the:
    i. Control station
    ii. Electrical system

[1] https://caps.faa.gov/

iii. Fuel system
iv. Navigation system
v. On-board flight control system
vi. Power plant

8. The number and duration of lost link events (control, performance and health monitoring, or communications) per UAS, per flight.

7.7 UAS Maintenance Checklist

Maintenance of a UAS should follow the recommended manufacturer's maintenance procedure. However, a generic maintenance checklist is included in the Form DA-60 in Appendix B for the UAS owned by the NJDOT.

7.8 Detailed Information on Some Operational Issues

7.8.1 Crew Related Operational Issues

7.8.1.1 Number of Required Crew Members

Any NJDOT UAS operation shall involve at least two crew members: Remote Pilot in Command (RPIC) and Visual Observer (VO). However, in cases where a tethered drone is used, an additional crew member to operate the tethering mechanism may be required. For more complex UAS operations, such as operation over water, additional crewmembers may be required. Roles and responsibilities of these additional crewmembers shall be defined for that particular UAS operation.

7.8.1.2 Operator Physical Condition

Any RPIC must not act as a UAS operator with a known medical deficiency that would render him unable to perform his/her duties. Any physical deficiency that renders a UAS operator unable to meet his/her flight duties shall be reported to the NJDOT UAS Program Manager immediately. Both RPIC and VO should follow FAA guidance on "Physiological Factors (Including Drugs and Alcohol) Affecting Pilot Performance" in FAA-G-8082-22 (Remote Pilot – Small Unmanned Aircraft Systems Study Guide) for medical issues that may be hazardous during UAS operation.

7.8.1.3 Duty Day and Fatigue

Fatigue is a recognized hazard and is discussed in detail in the chapter on "Physiological Factors (Including Drugs and Alcohol) Affecting Pilot Performance" in FAA-G-8082-22 (Remote Pilot – Small Unmanned Aircraft Systems Study Guide). All personnel are expected to manage their personal time to be well rested when reporting for work. The NJDOT risk assessment worksheet requires flight crew to rest at least 7 hours. Flight crews with rest less than 6 hours are considered high risk to the safety of the mission. A duty day of less than 12 hours is considered low risk whereas a duty day of longer than 14 hours is considered high risk. These limitations on crew rest and duty day are the mitigations designed to manage the associated risks to an acceptable level. These limitations and any extensions of duty time should be regularly evaluated as part of the SMS evaluation using NJDOT's Risk Assessment Worksheet.

7.8.1.4 Personal Electronic Devices

When operating UAS, small personal electronic devices are often used to display both the aircraft status information and flight plan data. NJDOT authorizes the use of these devices as required items for daily operations. Examples of these devices include but are not limited to cell phones,

tablets, and computers when required for flight operations.

Portable electronic devices may become a distraction to the flight crew and are prohibited from personal use during NJDOT UAS operations.

7.8.1.5 Crew Members Effective Communication

The primary communication between a RPIC and VO should be direct. However, the crew may use a hands-free communications system to convey flight commands, traffic alerts and information. Handheld radios may be used to maintain constant communication between the RPIC and the VO as a backup communications link, if needed. The RPIC and VO must follow "sterile cockpit procedures" (which prohibit crewmembers performing non-essential duties or activities) while in critical phases of flight. All crewmembers should follow *"See something – Say something"* principle. During UAS operations at or near airports, crewmembers may also use situational awareness tool/app such as B4UFLY, Kitty Hawk, AirMap, Hover, etc.

7.8.1.6 RPIC Communication with ATC

For the operations under COA in Class D airspace, the RPIC must monitor the appropriate ATC frequency as assigned for situational awareness. However, ATC may require two-way frequency communications on a case-by-case basis. The RPIC shall at all times have a telephone available as backup for communications with ATC.

7.8.2 Aircraft Related Issues

7.8.2.1 Battery Safety Issues

Battery and lubrication requirements for a UAS can be found in manufacturers manual and should be followed. Battery fires can be caused by overcharging, a faulty battery, or damage resulting from neglect. Fires which occur in the air shall be extinguished once the UAS has touched down in a safe area away from other people or equipment. Any fire shall be contained immediately in accordance with local and national laws.

The RPIC shall evaluate the selected battery voltage to determine both flight time and approximate Return-to-Home voltages prior to takeoff. The Return-to-Home function brings the aircraft back to the last recorded Home Point. There are three events that trigger this procedure:

- Smart Return-to-Home: Use the Return-to-Home button on the remote controller or the RTH button when available GPS enables Smart Return-to-Home.
- Low Battery Return-to-Home: Low Battery Return-to-Home triggers when the Intelligent Flight Battery depletes to a point which may affect the safe return of the aircraft. Users are advised to fly back or land the aircraft immediately when presented with these warnings.
- Fail Safe Return-to-Home: Fail Safe Return-to-Home is activated automatically when the remote controller signal (including video relay signal) is lost for more than 3 seconds, provided that the Home Point has been successfully recorded and the compass works normally. The operator can interrupt the Return-to-Home procedure and regain control over the aircraft when the remote controller signal is recovered.

7.8.2.2 UAS Critical Surface Contamination

The RPIC shall not commence a flight unless the inspected UAS is cleaned of any frost, ice, snow, mud or debris.

7.8.2.3 Airworthiness

In accordance with Title 14 Code of Federal Regulations (CFR) Parts 47 and 48, each aircraft

must be registered through the FAA's web-based registration portal or through the traditional request to the FAA's Aircraft Registration Branch in Oklahoma City, Oklahoma. Once registered, the aircraft shall be considered airworthy for operations as per AC 107 Part 2. For any operation beyond AC 107, part 2, a Certificate of Waiver or Authorization (COA) for said operation is required from the FAA.

7.8.2.4 Tethered Operations

Tethered Operations must adhere to the Obstruction Marking and Lighting Requirements of AC No:70/7460-1L[1].

7.8.3 Site Condition Related

7.8.3.1 Operation from Moving Vehicle

Operations from a moving vehicle or watercraft shall be conducted only over a sparsely populated area and only when RPIC and VO are co-located. The operation shall be conducted with no less than a Driver, RPIC and VO. The Driver shall not be distracted while the vehicle is in motion. However, the RPIC or VO may notify the driver of an object that could interrupt the path of the vehicle.

7.8.3.2 Over Water Considerations

All UAS operated on extended flights over water (more than 30 minutes at normal cruising speed, away from land suitable for making an emergency landing) shall have a chase vehicle. The chase vehicle, such as a watercraft, shall have all required equipment on board for each person, as recommended by the U.S. Coast Guard. Prior to any UAS being operated on an extended flight over water, the risk to survival of the watercraft occupants in the event of an emergency shall be assessed.

7.8.3.3 Night Operations

The UAS night operation is only allowed under a COA. For NJDOT UAS operations under public agency sUAS COA, the UAS must be equipped with anti-collision lighting visible from a distance of no less than 3 statute miles. The intensity of the anti-collision lighting may be reduced if, because of operating conditions, it would be in the interest of safety to do so. Additionally, in order to comply with 14 CFR § 91.209 - Aircraft lights, the aircraft must have position lighting that enables determination of location altitude, attitude, and direction of flight.

7.8.3.4 Operation near Active Roadways

Standard NJDOT safety procedures shall be followed for UAS crews operating near active roadways. Safety protocols such as minimum personal protective equipment (PPE), positioning of vehicles from active roadways, staging of personnel can be found in NJDOT Work Zone Safety Setup Guide[2].

7.8.3.5 Operations near Aeronautical Facilities

The RPIC or assigned crewmember shall maintain continued situational awareness with incoming or outgoing air traffic from the airport runways' approach and departure routes. For airports with

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[1] https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.current/documentNumber/70_7460-1.

[2] https://www.state.nj.us/transportation/about/publicat/pdf/WorkZoneSafetySetupGuide.pdf

an air traffic control tower, the tower frequency shall be monitored to avoid conflicts with manned aircrafts. For airports without an ATC, published Common Traffic Advisory Frequency (CTAF) should be monitored.

A Chart Supplement, formerly known as the Airport/Facility Directory, available for download from FAA website[1], has general information a pilot needs to know about a certain airport. Specific airport information, such as the airport identifier, the class of airspace, runway information, communication radio frequencies, weather data sources, and other airport remarks can be found within the Chart Supplement.

7.8.3.6 NOTAM Requirements

For NJDOT UAS operations under public agency sUAS COA under Class D, a Distant (D) NOTAM must be issued prior to conducting UAS operations not more than 72 hours in advance, but not less than 24 hours prior to the operation for routine operations. This requirement may be accomplished through the (D) NOTAM issuing authority, such as the NOTAM Flight Service Station at 1-877-4-US-NTMS (1-877-487- 6867). The issuing agency will require:

- Name and contact information of the pilot filing the (D) NOTAM request,
- Location, altitude, and operating area
- Time, duration, and nature of the activity.

The area of operation defined in the (D) NOTAM must only be for the actual area to be flown for each day defined by a point and the minimum radius required to conduct the operation. The RPIC must cancel (D) NOTAMs if UAS operations will not be conducted or are suspended.

For operations near airports under a public agency sUAS COA, the RPIC must be accessible for direct real-time coordination purposes with airport ATC for the duration of operations. Direct real-time coordination information, to include primary and backup contact methods, as well as the name of the point of contact must be provided in the (D) NOTAM when filed. ATC may delay, limit, prohibit or terminate UAS operations when the safety of manned aircraft operations is a concern. Before starting an operation requiring a COA, the RPIC must strictly follow the NOTAM requirements outlined in the COA. If a review of NOTAMs during preflight actions reveals other UAS operating in the intended operating area, the NJDOT RPIC must contact the operator(s) of the other UAS to avoid conflict.

7.8.3.7 Temporary Flight Restrictions

A Temporary Flight Restriction (TFR) is a type of NOTAM which defines an area restricted to air travel due to a hazardous condition, a special event, or a general warning for the entire FAA airspace. An example of TFR would be during a large sporting event, for example during football games at the Meadowlands.

NOTAMs inform pilots about any unique activities conducted within a desired airspace. NOTAMs provide essential information for pilots such as temporary hazards, military exercises, airport constructions, and other UAS activities.

There are two primary means by which a RPIC becomes aware of applicable Notices to Airmen (NOTAMs), Temporary Flight Restrictions (TFRs), or other airspace restrictions.

- The FAA's Pilot Web online database link (https://pilotweb.nas.faa.gov/PilotWeb/) provides pilots current NOTAMs, ARTCC (Air Route Traffic Control Center) notices, TFRs

[1] https://www.faa.gov/air_traffic/flight_info/aeronav/digital_products/dafd/

and other special notices within flight path or operating area.

- The RPIC may call 1-800-WXBRIEF and ask to talk to a briefer. The briefer can provide standard weather briefing and the RPIC should request information regarding current NOTAMs, TFRs, or airspace restrictions.

The RPIC may also access the online FAA databases:

- https://pilotweb.nas.faa.gov/PilotWeb/ for NOTAMs
- http://tfr.faa.gov/tfr_map_ims/html/cc/scale4/tile_8_4.html for TFRs
- https://www.faa.gov/uas/where_to_fly/airspace_restrictions/ for airspace restrictions.

A RPIC can also use available commercial applications for TFRs, such as:

- http://knowbeforeyoufly.org/air-space-map/
- Kitty hawk
- Airmap
- https://maththinking.com/tfrvisualizer/
- https://skyvector.com/
- https://droidefb.com/
- Google Earth Pro with the Aviation Chart Bundles

RPIC should also check sporting Websites for game schedules:

- Major League Baseball games based on published schedules from www.mlb.com.
- National Football League games, (including pre-season) based on published schedules from www.nfl.com.
- NASCAR Sprint Series, based on published schedules from www.nascar.com and MySportsCal.com. (Champ racing was merged with Indy in 2008.)
- IndyCar Series, based on the published schedule from www.indycar.com and MySportsCal.com
- NCAA Division I Football Schools are obtained from NCAA IA (Bowl Subdivision).

The Visual Flight Rules (VFR) Raster charts or Sectional Aeronautical Charts are the primary navigational reference medium used by the VFR pilot community. These charts display all public and private airports and different types of airspace such as controlled airspace and special use airspace. The FAA provides these charts free of charge on their website (https://www.faa.gov/air_traffic/flight_info/aeronav/digital_products/vfr/), though this link may be subject to change. Online resources, such as SkyVector, providing pilots with a nationwide view of these Sectional Aeronautical Charts, are also available. SkyVector recently added a UAS NOTAM layer system called DROTAMs, which provides General Aviation pilots the situational awareness of UAS activity through their flight path.

7.8.3.8 Launch and Recovery Sites Selection

For any flight operation being conducted in New Jersey, it is necessary to review the following items to select a suitable launch and recovery site:

1. Airspace analysis
2. COAs or Part 107 Waivers
3. NJDOT Risk Assessment Worksheet for site safety analysis
4. Establish land use agreements on private property when required
5. Right of way, and additional interagency agreements, if needed.
6. Emergency vs. non-emergency landing areas

Executing a site survey, the day before the flight is vital to a safe UAS operation. Land surveys using satellite imagery provide an initial environmental analysis but should not be the sole means of evaluating a potential launch and recovery site. Identifying potential flight risks is best accomplished by walking through the launch and recovery sites to verify following items:

1. Vertical obstructions such as trees, tall buildings and towers, high tension wires, etc.
2. Steep terrains
3. Potential sources of radio frequency interference (RFI)
4. Icy, slippery surfaces
5. Proximity to live traffic
6. Proximity to water bodies
7. Proximity to domesticated animals or wildlife impacted by flight operations
8. Location of non-participating persons and private property

7.8.3.9 Local Situational Awareness

The RPIC must focus on the controls and position of the UAS. This may cause RPIC to become less aware of immediate surroundings. Hence, it becomes the responsibility of the VO to ensure that the RPIC maintains situational awareness by providing warnings regarding any potential danger such as high wires, trees, terrain, wildlife, etc.

CHAPTER 8. APPENDIXES

Appendix A: Online Survey Questions

We are working with the New Jersey Department of Transportation on developing regulatory policies for operating Unmanned Aircraft Systems (or UAS, also known as drones) in New Jersey.

Understanding the interactions of drones with regular air traffic operated by or near your airport is a necessary part of this process. Generally, UAS are allowed to operate near airports under two acts of law:

- Title 14 of the Code of Federal Regulations (14 CFR) Part 107 for FAA certified UAS Pilots,
- 14 CFR Part 101 for recreational users or hobbyists

We appreciate it if you could kindly complete this survey. The results of this survey will be analyzed by the Bureau of Aeronautics at NJDOT. The results may be shared with you by NJDOT once the analysis is complete.

Participant's name:

Name of the airport:

Position at the airport:

Tel. No.

Email:

1. Are you familiar with drones? (Y/N)
2. Have you or anyone else flown a drone at your airport? (Y/N)

   If the answer is yes, answer the next 2 questions.

   a. What was the purpose of the flight?

      i) Security control ii) Airport inspection iii) Airport perimeter control iv) Airport airspace analysis, v) Project management vi) Other (please specify)

   b. Do you have any policies or guidelines regarding the operation of drones from your airport? (Y/N) If yes, please provide details and a copy of the policy.
3. Have you received any requests from drone operators to fly near your airport? If yes, approximately how many, and please provide details below.
4. Have you ever prohibited a drone from flying near your airport? (Y/N) If yes, please provide details below.
5. Has a drone created a conflict with manned aircraft or operations at your airport? (Y/N) If yes, please provide details below.
6. Have you witnessed an incident or accident involving drones? (Y/N) If yes, please provide details below.
7. Are you considering allowing drone operations based from your airport? (Y/N) If yes, please provide details below.
8. Privacy is a major consideration during drone operations. What is your opinion on privacy during drone operations?

9. Liability is a major consideration during drone operations. What kind of liability insurance should a drone operator carry?
10. An updated Operations Manual may be necessary to ensure the safe integration of drones with other air traffic. Is your current Operations Manual compatible with drone operations?
11. What accommodations does your Ops Manual have for the inclusion of mixed (manned and unmanned) operations?
12. Do you have any other information or suggestions regarding potential drone policy? Please write in the box below.

Appendix B: NJDOT Bureau of Aeronautics Forms

This appendix provides images of fillable NJDOT forms for inclusion in this report.

Form DA-50-Request UAS/Drone Support from Aeronautics

Form DA-50 (09/19)

UAS/Drone Support Request from Aeronautics

Mission Number:

To be Completed by Requesting NJDOT Unit	
Requesting Unit:	**Proposed Flight Date(s):**
Contact Person:	**Phone Number:**
Contact Title:	**E-mail address:**
Flight Location *(Please write the physical address):* *Please click below to attach a map of the location. The map should be in JPG format with maximum size of 2 MB and minimum dimension of 1920×1080 pixels (The sample map with required details is shown on the last page).*	
Please input the Google Map® link of flight location here:	
Do you expect to take off or land using private property? ☒ **Yes** ☐ **No** Upload Permission Please provide details below and attach landowner owner's permission with this form.	
Objective / Goal of the Mission (Maximum 100 words): Why are you requesting UAS support instead of traditional methods to perform this mission?	

Clear the form

Page 1 of 4

Form DA-50 (09/19)

UAS/Drone Support Request from Aeronautics

To be Completed by Requesting NJDOT Unit
Brief Overview of the Mission (maximum 300 words): Include brief operational details, including any risk factors involved during the operation.
Expected deliverables(video, 3D map, still map, livestream) of the mission (maximum 100 words):

Requestor's Name/Title:

Requestor's Signature:

Date:

Clear the form

Form DA-50 (09/19)

UAS/Drone Support Request from Aeronautics

To Be Completed by the NJDOT's RPIC	
Estimated Flight Time/Duration:	
Estimated Flight Altitude:	
Estimated Max Distance from Take Off Location:	
FAA Waiver or Authorization Number: *(Attach a copy of the FAA Authorization with this form for record)*	Attach FAA Authorization
Airspace Classification:	
UAS Make and Model:	
FAA UAS Certificate of Registration Number:	Attach FAA Registration No.
Remote Pilot (RPIC) Name:	
Remote Pilot's Phone Number:	
Remote Pilot's Email Address:	
Remote Pilot FAA Certificate Number *Attach a copy of the Remote Pilot's FAA certificate.*	Attach RPIC FAA Certificate
Date of Remote Pilot's Last Training:	
Is Remote Pilot Compliant with FAA Requirements?	☒ Yes ☐ No
Visual Observer's (VO) name(s): *Please attach a "DA-54 Visual Observer Briefing Form" for each visual observer.*	Attach a DA-54 for each VO
Visual Observer's Phone Number:	
Visual Observer's Email Address:	
Site Condition Concerns? *Potential site concerns that could affect safety?* (Cranes, High Voltage lines, etc.?)	
Comments:	
Approved by:	

Clear the form

Map of Flight Location Requirements and Sample

The attached map should contain an approximate polygon of the flight location similar to what shown below. You can use either Google Earth® or Google Maps® images and add the polygon in any image editing software (e.g., MS Paint®).

Form DA-51-UAS/Drone Support Request by a NJDOT Consultant

Form DA-51 (09/19)

UAS/Drone Support Request by a NJDOT Consultant

Mission number:

To be Completed by NJDOT Division Requesting Consultant Support	
Requesting Unit:	**Proposed Flight Date(s):**
NJDOT Contact Person:	**Phone Number:**
NJDOT Contact Title:	**E-mail address:**
Flight Location *(Please write the physical address):* *Please click below to attach a map of the location. The map should be in JPG format with maximum size of 2 MB and minimum dimension of 1920×1080 pixels (The sample map with required details is shown on the last page).*	
Please input the Google Map® link of flight location here:	
Click to upload the map	
Brief Overview of the Mission (Maximum 100 words):	

NJDOT Requestor Name/Title:

Requestor Signature:

Date:

Clear the form

Form DA-51 (09/19)

UAS/Drone Support Request by a NJDOT Consultant

To be Completed by the Consultant's Remote Pilot in Command	
Remote Pilot (Remote PIC) Name:	
Remote Pilot's phone number:	
Remote Pilot's email address:	
Remote Pilot FAA Certificate Number: *Attach a copy of the Remote Pilot's FAA certificate.*	Attach RPIC FAA Certificate
Visual Observer's name(s)? (VO): *Please attach a "DA-54 Visual Observer Briefing Form" for each visual observer.*	Attach Form DA-54 for each VO
Visual Observer's phone number:	
UAS Make and Model:	
FAA UAS Certificate of Registration Number:	Attach UAS Registration
Landowner Approval: *Required for proposed operations taking off or landing on a private property.*	Attach Landlord Approval
Mission Airspace? *Which type of airspace will you be flying in (B, C, D, E or G)?*	
FAA Waiver or Authorization Number (if required)? *Attach a copy of the FAA Authorization.*	Attach FAA Waiver or Authorization
Equipment Status? *(Is the equipment in proper working condition for the flight?)*	
Ground Safety Equipment (PPE) to be used? *(Hard Hats, vests, boots, safety glasses, etc.)*	
Site conditions? *What site condition potentially present a risk to mission safety? (For example:* Cranes, Construction equipment, High voltage lines?)	
Adjacent Property Specific Limitations? *Are there any special limitations by adjacent properties that could potentially restrict mission operations?*	
Deployment/Landing Zones? *Has an alternative landing zone been identified?*	
Pedestrian/Vehicular Traffic/Congestion? *Will there be pedestrian or vehicular traffic in the area? If so, what is your mitigation plan for avoiding congestion and direct flight over pedestrians or vehicles?*	
Privacy Concerns? *How will the privacy of the general public be protected?*	
Emergency Contacts? *In the event of an emergency, who can we contact on your behalf (personal and supervisor)?*	
Client Contact? *Will there be an onsite supervisor for this flight location? If so, please provide the name, agency, and telephone number?*	

Clear the form

Form DA-51 (09/19)

UAS/Drone Support Request by a NJDOT Consultant

Acknowledgement by the Consultant's Remote Pilot in Command
For NJDOT UAS operations, all Remote Pilots are responsible to ensure that: • The flight mission is compliant with all Federal and New Jersey state regulations. • The flight(s) will be flown in a manner to minimize driver distraction and roadway congestion. • The UAS will not be flown over an active roadway (please provide details on FAA waiver or authorization on Page 1 in case of waiver for flying over people or active roadway). • The flight will be conducted with a Visual Observer. • All participants will receive a thorough mission briefing immediately prior to the flight to include environmental and airspace concerns, site conditions, safe areas, roles and responsibilities, privacy considerations, and emergency/contingency plans. • The overall safety of the UAS flight operation will be maintained at all times during the mission.

Remote PIC's Name:	
Remote PIC's Signature:	
Date:	

NJDOT Bureau of Aeronautics Only	
Reviewed By:	
Approved by:	
Date:	
Comments:	

Clear the form

Map of Flight Location Requirements and Sample

The attached map should contain an approximate polygon of the flight location similar to what shown below. You can use either Google Earth® or Google Maps® images and add the polygon in any image editing software (e.g., MS Paint®).

Enclosed Documents Checklist:

- Landlord approval
- RPIC FAA certification
- FAA authorization
- VO briefing form

Form DA-53-Request Change to an Approved Mission

Form DA-53 (07/20)

Request Change to an Approved Mission

General Information			
Mission No:		Date:	
Requestor:			
RPIC Name:			

Description	Reason

NJDOT Bureau of Aeronautics Only

Request is ☐ Approved ☒ Denied

Comments:

Name: _____ Title: _____

Signature _____ Date _____

Page 1 of 1

Form DA-54-NJDOT Visual Observer (VO) Role and Responsibilities

Form DA-54 (09/19)

NJDOT Visual Observer Responsibility Certification

The Visual Observer for an Unmanned Aircraft System (UAS) operation is a responsible person tasked to identify and notify the Remote Pilot in Command (RPIC) of issues that could potentially impact the safety of flight. The RPIC and the VO must maintain effective communication with each other at all times. The VO must constantly assess potential conflicts and promptly alert the Remote Pilot. The VO must maintain situational awareness through direct visual observation regarding:

- The UAS location, attitude, altitude, and direction of flight.
- The position of other aircraft and potential hazards in the airspace.
- The potential of the UAS to endanger the life or property of another.
- Potential traffic congestion issues due to the UAS operation.

To prepare for this duty it is important to understand the following guidelines to performing the duties of a Visual Observer.

- Be familiar with Federal Aviation Administration (FAA) regulations pertaining to UAS operations, specifically 14 Code of Federal Regulation (CFR) Part 107 requirements, UAS waivers, and NJDOT COA's in particular.
- Be familiar with official FAA weather forecasting and reporting language and be able to read and understand aviation METAR's and TAF's.
- Be familiar with the classifications of New Jersey airspace as depicted on aviation sectional charts.
- Be familiar with the operation of portable communication devices potentially used by UAS crews to enhance communication with the RPIC.
- The communication method between RPIC and VO must be determined prior to operation.
- Be familiar with the capabilities and limitations of UAS equipment
- Be familiar with UAS Emergency, Return to Home, and contingency procedures.
- Obtain regular recurrent annual training from an FAA certified RPIC regarding communication of remaining clear of conflicting traffic, terrain, and obstructions, maintaining proper cloud clearances, and providing navigational awareness.
- Be familiar with UAS night operation procedures and training.
- Understand how to read and interpret Temporary Flight Restrictions (TFR) and Notices to Airmen (NOTAM).
- Understand that nearby predator birds can potentially threaten a UAS operation.
- Be in a physical and mental condition as to not interfere with the safe operation of the UAS.
- Have vision corrected to at least 20/20.

Name of the RPIC who conducted this briefing: _____

By signing below, I certify that I understand and am ready to accept the role and responsibilities of a NJDOT Visual Observer.

Print Name: _____

Signature: _____ Date: _____

Form DA-55-NJDOT Certificate of Attendance Night Operations

Division of Multi-Modal
Bureau of Aeronautics

No.

CERTIFICATE OF ATTENDANCE

This certifies that

with FAA RPIC Certificate Number of DA5168A45 *has attended a 1-hour training on*

Unmanned Aircraft Systems (UAS) Night Operations

on *at New Jersey Department of Transportation*

Glenn G. Stott, ATP
NJDOT UAS Program Manager

Date of issue

NJDOT Bureau of Aeronautics
1035 Parkway Avenue, PO Box 600
Trenton, NJ 08625-0600

Form DA-56-NJDOT Internal Form to Track and Record FAA Compliance

Form DA-56 (07/20)

NJDOT Internal Form to Track and Record FAA Compliance, Training and Qualifications

RPIC General Information:		
First Name:		Last Name:
E-mail:		Phone Number:
Address:		
City:	State:	Zip code:
Emergency Contact:		Emergency Phone:
NJDOT Division/Unit:		

UAS/Drone Related Information:	
UAS Operation Role: ☐ RPIC ☐ VO ☒ Both	Attach RPIC Certificate
RPIC's FAA Certificate Number:	Date of FAA Exam:
Date of Last UAS Training:	Date of Last UAS Flight:

Remote Pilot's Training / Qualification Information:			
Please provide dates completed for the following training:			
Phase 1 Training:	Attach Certificate	Recurrent Training:	Attach Certificate
Phase 2 Training:	Attach Certificate	Nighttime Training:	Attach Certificate
Phase 3 Training:	Attach Certificate		

Current Authorization Status:	
Is the RPIC and/or VO authorized? ☐ Yes ☐ No	
Comments:	
Name: _____	Title: _____
Signature: _____	Date: _____

Page 1 of 1

Form DA-57-NJDOT UAS Accident Report Form

Form DA-57 (07/20)

NJDOT UAS Accident Report Form (Part 107 and COA)

Mission Number:

Accident Information	
Date of Incident:	Time of Incident:
System Information	
Aircraft Model: General Location (near an airport, highways, busy streets, bridges, etc.): Latitude : Longitude: Altitude: ☐MSL ☐AGL Ground Control Station Type: Ground Control Station Location during Accident:	
General Flight/Mission Description	
Flight Number on the Day of Accident: Flight Duration (total number of minutes in numeric): Total Time/Number of Flights on Aircraft at Time of Accident: Flight Crew Information (Crew positions involved):	
RPIC: VO: Class of Airspace: Phase of Flight: Landing LRE[1] / MCE[2] Control (Line-of-Sight / Beyond Line-of-Sight): ATC Communication (Line-of-Sight):	
Purpose of Flight:	
Weather:	
Attach a copy of the weather conditions for the mission (METAR, TAF, or FAA area forecast)	Attach Weather Condition

NJDOT UAS Accident Report Form (Part 107 and COA)

Additional Info / Comments:
Description of Accident (injury, crash, damage to a property, type of injury, name(s) of injured person(s)):
Damage and Fix Action
Damages and Injuries:
Immediate Fix Action(s):
Investigation Plan:

[1] Launch and recovery element: conducts takeoffs and landings
[2] Mission control element: responsible for executing the mission

Form DA-58-NJDOT UAS Accident Investigation Form

Form DA-58 (07/20)

NJDOT UAS ACCIDENT INVESTIGATION FORM

1. ACCIDENT CASE INFORMATION	b. Date (*YYYY/MM/DD*)	c. Time	d. UAS FAA Certi. of Reg. #	e. UAS MAKE/MODEL
2. ACCIDENT CATEGORY ☒ Flight ☐ Aircraft Ground	**3. PERIOD OF DAY** ☒ Dawn ☐ Day ☐ Dusk ☐ Night			
4. AIRCRAFT INVOLVED	a. Number of Aircraft Involved	b. Inflight/Mid-Air Collision ☒ Yes ☐ No ☐ Unknown		
5. ACCIDENT LOCATION	a. Street	b. City	c. State	d. Latitude and Longitude of Accident
6. ACCIDENT COST DATA	a. UA Total Loss (over 60% total UAS cost) ☐ Yes ☒ No	b. UA damage or replacement cost (Excluding man-hours) $	c. Number of Man-Hours	d. Man-hour Cost $
e. Other UAS Sub-System Cost $	f. Other Damage Cost-Property $	g. Injury/Occupational Illness $	h. Total Cost (This UAS) $	i. Total Cost (All aircraft, property, personnel) $
7. MISSION PREPAREDNESS: (Mark the following that were completed) ☐ Weather Brief ☐ ATC Coordination ☐ Mission Brief ☐ Flight Plan ☐ Risk Assessment	a. Estimated Risk Level ☒ Slight ☐ Low ☐ Moderated ☐ Elevated ☐ High			
8. TELEMETRY DATA				
a. Telemetry saved for accident? ☐ Yes ☒ No	b. Telemetry file name for this accident	c. Telemetry saved location	d. Telemetry size	
9. RPIC Statement (history of the flight, sequence of actions proceeding the accident, immediate actions following the accident. Attach additional sheet(s) as needed).				

Form DA-58 (09/19)

NJDOT UAS ACCIDENT INVESTIGATION FORM

10. FLIGHT DATA	Flight Duration	Altitude MSL	Altitude AGL	Airspeed (m/s)	UA Weight (lbs)	UA Over gross weight for conditions
a. At Emergency/Onset	Hours: Mins:					☒ Yes ☐ No
b. At Impact/Accident or Termination	Hours Mins:					☒ Yes ☐ No
c. Flight Control Malfunction	Check all that apply: ☐Human ☐Environmental ☐Material ☐Hardware ☐Software ☐Component/Part ☐N/A					

11. ACCIDENT CAUSE FACTORS (For blocks 11a-c, D=definite, S=Suspected, U=Undetermined and N=No/None)

a(1). Human Factors: ☐D ☐S ☐U ☐N

a(2). Organizational Influences	a(3). Supervision	a(4). Preconditions	a(5). Acts

b. Material Factors	b(1). Type (Check all that apply.)
☐ D ☐ S ☐ U ☐ N	☐ Component/Part ☐ Hardware ☐ Software

b(2). Component and Part (Part that initiated failure/malfunction)

Item	UAS Subsystem (UA, GCS, GSE, etc.)	Major Component	Part
Nomenclature			
Type, Design, and Series			
Part Number			
NSN/Manufacturers Number			
Serial Number			
Cause of Failure/Malfunction		☐Material ☐Maintenance ☐Design ☐Manufacturer	

c. Environmental Factors	c(1). General (Check all that apply.)	c(2). Environmental Signal Factors
☐ D ☐ S ☐ U ☐ N	☐ VMC [1] ☐ IMC [2] ☐ Icing ☐Turbulence ☐ High wind speed	☐ Uplink ☐Downlink ☐ Interference ☐N/A ☐ Other(specify) _____

12. LOSS OF LINK	a. Type of Lost Link	b. UA distance from the GCS at time of lost link
☐ D ☐ S ☐ U ☐ N	☐ Uplink ☐ Downlink ☐ Unknown	

c. Loss of Link Factors

☐Human ☐Environmental ☐Material ☐Hardware ☐Software ☐Component/Part ☐N/A

13. TYPE OF STRIKE

☐Wire ☐Bird ☐Tree ☐Lightning ☐Antenna ☐Terrain ☐N/A ☐Other (specify):_____

[1] VMC: Visual meteorological conditions
[2] IMC: Instrument meteorological conditions

Form DA-58 (09/19)

NJDOT UAS ACCIDENT INVESTIGATION FORM

14. PERSONNEL DATA (Complete for each crew member with access to flight controls, personnel injured/occupational illness, personnel having a contributing role in the accident; use additional forms if needed.)

a) Remote Pilot in Command (PIC)		**Organization:**			
(1) Name (Last, First, MI)	(3) Contributing Role	(4) Activity in last 24 hours:			(5) UA Flt Hours
		(a) Hrs Slept	(b) Hrs Worked	(c) Hrs Flown	
(2) Contact number:	☐D ☐S ☐U ☐N				(6) Total Flt Hrs

b) Visual Observer (VO)		**Organization:**			
(1) Name (Last, First, MI)	(3) Contributing Role	(4) Activity in last 24 hours:			(5) UA Flt Hours
		(a) Hrs Slept	(b) Hrs Worked	(c) Hrs Flown	
(2) Contact number:	☐D ☐S ☐U ☐N				(6) Total Flt Hrs

c) Additional Crew Member		**Organization:**			
(1) Name (Last, First, MI)	(3) Contributing Role	(4) Activity in last 24 hours:			(5) UA Flt Hours
		(a) Hrs Slept	(b) Hrs Worked	(c) Hrs Flown	
(2) Contact number:	☐D ☐S ☐U ☐N				(6) Total Flt Hrs

15. FINDINGS AND RECOMMENDATIONS (Use continuation sheet if more space needed)

16. LIST OF ATTACHMENTS (Certifications, Images, Witness Statements, etc.)

17. LEADERSHIP REVIEW

Reviewer	Organization	Name (Last, First, MI)	Comments	Signature
a. Investigator				
b. UAS Program Manager			☒ Concur ☐ Non-Concur	
c. Bureau Manager			☐ Concur ☐ Non-Concur	

NJDOT UAS ACCIDENT INVESTIGATION FORM

CONTINUATION SHEET

Form DA-58 (09/19)

NJDOT UAS ACCIDENT INVESTIGATION FORM

Name (Last, First, MI):	Organization:	Date:	Crew Position:
WITNESS STATEMENT			
Signature		Phone Number:	Email:

Form DA-59 (07/20)

NJDOT Safety Assurance Form of UAS Missions

Please select a lesser of 5 or 10% of the NJDOT mission reports during the last one year.

Reviewer's Name:	Date:
Number of mission reports reviewed:	
Did all crewmembers comply with FAA Licensing requirements? ☐ Yes ☒ No If no, please describe in the box below:	
Did all crewmembers comply with NJDOT training requirements? ☐ Yes ☒ No If no, please describe in the box below:	
Did all missions follow NJDOT flight operations requirements in FOM? If no, please describe below. ☐ Yes ☒ No	
Were any accidents/incidents reported during any of the missions? ☒ Yes ☐ No If yes, please answer the following questions: 1. What was the mission risk score from the risk assessment worksheet? 2. Which risk factor was the major contributor to the event? 3. What were the recommended corrective actions? Please describe the accident/incident and corrective action(s) taken:	

Form DA-59 (07/20)

NJDOT Safety Assurance Form of UAS Missions

Please provide any recommendations for changes to the risk assessment worksheet:		
Reviewed Mission Information		
Mission Number	Mission Title	Mission Date

Form DA-60 (07/20)

NJDOT UAS Maintenance Checklist

Regular maintenance of UAS equipment is necessary not only for successful UAS missions, but also for reducing safety risks during UAS operations. Some UAS manufacturers recommend comprehensive maintenance of a UAS after 200 flights or 50 flight hours. Based on this information, all NJDOT UAS shall undergo a regular maintenance inspection after 200 flights or 50 flight hours.

A generic maintenance checklist is included in this form for completion of each of the UAS owned by NJDOT. If detailed technical guidance is available from the manufacturer, it will be conducted in lieu of the generic checklist. A maintenance checklist for the DJI Inspire 2 is attached with this form as an example.

Form DA-60 (07/20)

NJDOT UAS Maintenance Checklist

Record Basic Details	
Technician name:	Date of maintenance:
Aircraft model name:	Aircraft serial number:
Aircraft model number:	Aircraft weight (lbs):

Checking the Battery System

☐ Read the Intelligent Flight Battery Safety Guidelines
☐ Ensure the batteries have the latest firmware
☐ Inspect charger for visible damage
☐ Take voltage reading
☐ Ensure the batteries are paired
☐ Inspect battery packs for bulges or leakage
☐ Check the status of the battery in drone controller app after powering on the aircraft.
☐ Store the battery in a specified transportation box/bag before the transit
☐ Follow the stated temperature for battery use as follows:

Temperature for Battery Use	Products
-20° to 40°C (-4 ° to 104°F)	Inspire 2
-10° to 40°C (14 ° -104°F)	Mavic Pro, Inspire 1 Series, Phantom 3 Series
0° to 40°C (32° to 104° F)	Spark, Phantom 4 Series

Checking the Airframe

☐ Make sure all battery packs are disconnected and the drone is fully powered down.
☐ Clean the whole aircraft using the following tools:

- Anti-static cloth
- Small cleaning brush (for tight crevices)
- Compressed air canister (air duster)
- Anti-static wristband
- Isopropyl alcohol

☐ Inspect chassis for cracks (comments on chassis damage):
☐ Check all screws for tightness and security
☐ Check landing gear condition
—Make sure the legs and feet of the unit are not bent or cracked.

Inspect antenna
☐ Antenna are in good condition
☐ Antenna are properly screwed into the unit

Checking the Motors

☐ Motors are free from debris
☐ Motors are in good condition
☐ Check state of wiring and solder joints
☐ Detach the propellers and start the motors.
☐ Check for any abnormal or excessive vibration.

NJDOT UAS Maintenance Checklist

Checking the Propellers
☐ Check propellers for cracks and damage to the leading edges ☐ Replace broken parts ☐ Check propellers mounts for blade wobble
Checking the Control and Video Transmission System
—Visually inspect each component for damage and complete the sub-checklist below as you go. ☐ Remote controller antenna ☐ Remote controller chassis ☐ Extended range transmitter/receiver (if applicable) ☐ Control station smart phone ☐ Control station laptop computer
Checking the Gimbal and Camera
☐ Check unit camera is clean —Wipe the lens of the camera clean, and remove dirt and debris on the body and frame ☐ Inspect the gimbal for damage
Checking the Vision Systems
☐ Check for and remove objects that might block the sensors

Software/Firmware
☐ Check the drone firmware version ☐ Check the controller station software version

NJDOT UAS Maintenance Checklist

DJI Inspire 2 Maintenance Checklist (from manufacture's website)

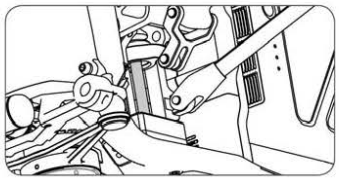
I. Checking the Battery System

1. Check the Intelligent Flight Batteries for damage and deformities. If there are any signs of damage to an Intelligent Flight Battery, stop using it and discharge it fully for disposal. Do not disassemble an Intelligent Flight Battery for any reason.
2. Check the Intelligent Flight Battery pins and rub them clean with an eraser if any residue is observed. This will help to ensure reliable connections.
3. On the Intelligent Flight Battery Charging Hub, check the metal pins on the charging ports. Remove any corrosion or residue to ensure reliable connections.
4. Run the DJI GO 4 app to confirm that each Intelligent Flight Battery's cells are at similar voltage levels and stay at the same level when the Intelligent Flight Battery is fully charged. If all cells maintain voltage levels above 3.7 V but any cell is 0.2 V higher or lower than the others, contact DJI Support for analysis. You can also check the battery cell warning history. If any warnings are reported, contact DJI Support.
5. Check that the plastic components of the battery compartments are in good condition and that all screws are secure. This prevents the Intelligent Flight Batteries from becoming loose during flight.
6. Insert an Intelligent Flight Battery into each battery compartment, check that they mount securely with the Battery Release Button raised, then press the Battery Release Button to make sure the Intelligent Flight Batteries can be released. If not, change an Intelligent Flight Battery or contact DJI Support.
7. For Intelligent Flight Batteries in long term storage, refer to the Intelligent Flight Battery Safety Guidelines and check the Intelligent Flight Batteries once a month to prevent the battery cells from being damaged.
8. Check the power cables between the aircraft's arms and body. If the cables are worn, contact DJI Support to arrange repair.

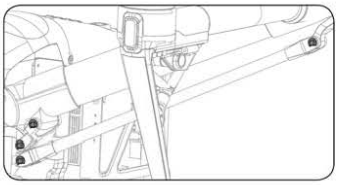
II. Checking the Transformation System

Before checking the Transformation System, remove the gimbal and camera, and enable the Disable Landing Gear Auto Lock setting in the DJI GO 4 app so that you can raise the landing gear using the remote controller while the aircraft is not airborne. When the checks are complete disable this feature.

1. Power off the aircraft and insert an SL3.0 screwdriver into the small hole on the bottom of the aircraft directly below the center of the linear actuator. Use the screwdriver to slowly and evenly rotate the gears in the servo gearbox to check that the mechanism moves smoothly.
2. Raise the landing gear using the remote controller. During the transformation, observe the lead screw (the threaded rod inside the linear actuator, highlighted in the figure below), as it becomes exposed. If the lead screw bends during the transformation, or if it is scratched, bent or otherwise damaged, contact DJI Support to arrange repai.



3. Listen to the servomotor during the transformation. If there is any abnormal noise it may indicate that the servomotor components are worn, which can be caused by the presence of corrosion, grit, or dust on the lead screw. If any abnormal noise is heard, contact DJI Support.
4. With the landing gear fully raised, check the lead screw and its lower bearing. If any corrosion, grit, dust, or other dirt is found, clean with WD-40 spay, then apply grease. (Use grease and do not use oily lubricants. Use grease that is compatible with metal and plastic components and that can perform adequately in the temperature range -4° to 248° F (-20° to 120° C)). If small plastic shards are found, contact DJI Support.
5. Check the bolts at either end of the aircraft arm support rods and the bolts in the circlips, which are highlighted in the figure below (four pairs of bolts on each side of the aircraft). If any of the bolts are deformed or loose, contact DJI Support.

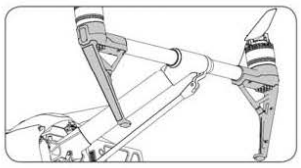


III. Checking the Airframe

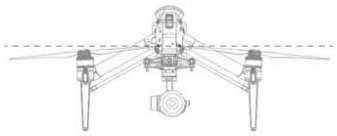
1. Confirm that all the screws are still adequately tightened.
2. Check the aircraft for breaks and damage. If there is any reason to believe that detectable damage might affect flight safety, consult with DJI Support.
3. Check the carbon fiber arm tubes for damage and looseness. Grasp and twist the two landing gear feet on one side to ensure they are not loose, then repeat on the other side.
4. Ensure that the screws used to secure the landing gear to the carbon fiber arm tubes are tight and the plastic components around the motors are in good condition. If any plastic components are damaged or broken, contact DJI Support to arrange repair.

Form DA-60 (07/20)

NJDOT UAS Maintenance Checklist



5. Check that the right and left landing gear rest at the same tilt angle.



IV. Checking the Motors

1. Detach the propellers and start the motors. Carefully examine the edges of each rotor and confirm that it is perfectly centered on its motor. Check for any abnormal or excessive vibration. Listen carefully for any abnormal noise, which may be a sign that the bearings are worn. If any problems are detected, contact DJI Support to order replacement motors.

V. Checking the Propellers

1. Check the propellers. If there is any bending, breakage or cracking on a propeller, do not use it. Replace worn-out propellers and propeller bases promptly.
2. Check that when you attach each propeller, the propeller locks (clicks) into place correctly. For each propeller, use one hand to prevent the motor rotor from rotating and use your other hand to try to rotate the propeller. If the propeller rotates, the propeller base is loose and needs replacing.
3. Attach the propellers to the motors, place the aircraft on the ground and power it on. Stand 3.3 ft (1 m) away from the aircraft and observe the rotating propellers. If you can see two distinct propeller outline layers, when looking at a spinning propeller from the side, that propeller is damaged and should not be used.

VI. Checking the Flight Control System

1. In the DJI GO 4 app, review the IMU bias and compass interference readings. Even if the IMU biases are below the warning thresholds, an IMU calibration can be performed to remove small biases and improve Flight Control System performance. The IMU calibration procedure involves holding the aircraft in five different positions. In each position, the aircraft must be held very stably, otherwise the calibration may be inaccurate. The Carrying Case can be used to support the aircraft in positions that require support. Perform a compass calibration if necessary.
2. The flight control module fan is located at the bottom of the flight control module, just above the Gimbal Connector. Power on the aircraft and listen for any abnormal noise or vibration from the fan. If any irregularity is detected, contact DJI Support.
3. Ensure that there are no obstacles on or around the GPS module. Remove any obstacles (such as tape with conductive material) that might affect or block the signal.

VII. Checking the Control and Video Transmission System

1. Make sure the aircraft antennas located on the outside of the four landing gear feet are not covered with stickers or tape.
2. Check the remote controller antennas for damage.
3. Check the remote controller neck strap for damage or wear and replace if necessary.

VIII. Checking the Gimbal and Camera

1. The Gimbal Connector is a particularly vulnerable component. If the gimbal fails to initialize when turned on, fails to work after initialization, or fails to transmit video to the app (while OSD data is displayed), check the metal contacts on the two halves of the gimbal connector. If there is any dirt, rub the contacts clean with an eraser. If any contact is scratched or oxidized, contact DJI Support to arrange repair/replacement of the Gimbal Connector.
2. If the gimbal is performing stably during normal operation, there is no need to check it. If its performance has deteriorated, contact DJI Support to arrange repair.
3. Check the camera, especially the lens. If moisture ingress has occurred, use desiccant or a moisture-absorbing dry box to remove the moisture.
4. The Gimbal Connector's rubber damping balls are consumable items. It is recommended that they are replaced after 120 flights or 40 flight hours and they also need to be replaced in the following circumstances:
   - A ball has been pierced and the white damping grease has leaked out.
   - A ball does not return to a spherical shape when uninstalled.
   - The rubber has aged and a ball has lost elasticity.
   - A ball was subjected to excessive forces during a crash or other incident.

IX. Checking the Vision System

1. Check the camera lens. If any dirt or residue is detected, gently clean the lens.
2. Check for and remove objects that might block the sensors.
3. Ensure that the Upward Infrared Sensors are securely installed on the aircraft and are not blocked by stickers or tape.
4. Detach the propellers and turn on the aircraft. Hold the aircraft 1 to 2 m above a surface with rich patterns, under good lighting conditions. Change the Flight Mode switch to P-mode on the controller and check the DJI GO 4 app. If the app displays an altitude value and indicates that P-OPTI mode is active, the Vision System should function normally.
5. If a Vision System abnormality is displayed in the app, connect to DJI Assistant 2 and recalibrate the Vision System.

After-Sales Information

Visit the following pages to learn more about after-sales service policies, repair services and support:

- After-sales Service Policies: http://www.dji.com/service/policy
- Paid Repair Service: http://www.dji.com/service/repair
- DJI Support: http://www.dji.com/support

Form DA-61-NJDOT Mission Planning Checklist

Form DA-61 (07/20)

NJDOT UAS Mission Planning Checklist

	Items
Regulation	☐ Getting the required COA or FAA authority ☐ Getting the required UAS waivers ☐ Reviewing the state and local laws ☐ Reviewing industry standards ☐ Reviewing agency policies (e.g., data collection policy) ☐ Getting land use agreement of private properties (if applicable)
Pre-mission	☐ Mission/flight purposes and objectives definition ☐ Identifying mission area (including obstacles) ☐ Identifying take-off/landing locations on the map ☐ Estimated max distance from take-off location ☐ Flight planning ☐ Safety risk assessment using NJDOT risk assessment worksheet ☐ Coordination with Stakeholders ☐ An airspace analysis for the mission site ☐ UAS Make, Model and registration details ☐ Over-water areas planning ☐ Operating from moving vehicle planning ☐ Confirm mission approval on Form DA-50 or DA-51

Form DA-62-NJDOT Preflight Checklist

Form DA-62 (07/20)

NJDOT UAS Pre-Flight Checklist

Pre-Flight Checklist	
In Office	*Mission overview* ☐ Review flight logs to ensure airworthiness of UAS ☐ Review the programmed flight path to ensure its compliance with the mission objectives ☐ Review operational limitations of Part 107 applicable to the mission ☐ Review local regulations and permissions ☐ Reassess the flight risk using NJDOT SMS ☐ Assign crew duties and responsibilities
	Equipment ☐ First aid kits ☐ Safety Cones / flags ☐ Formatted SD Card ☐ USB Cable ☐ Charged Batteries ☐ PPE (hard hats, safety vests, etc.) ☐ Take-off and landing pad ☐ VHF Radios, hand-held charged ☐ Fire Extinguisher ☐ Overall airframe condition ☐ Charged Tablet ☐ Water and Cooling ☐ Extra Props
	UAS Assembly and Inspection ☐ Check components for any loose connections / screws ☐ Check the propeller/rotor blades for chips, cracks, and any deformation ☐ Check the aircraft according to the manufacturer's manual ☐ Ensure FAA aircraft registration certificate is available FAA # is clearly visible
	Check the following components for condition and security: *Component* — *Operation Condition* Motor frame ☐ Propellers ☐ Camera / Gimbal ☐ Storage card ☐ Other payload (if applicable) ☐

Form DA-62 (07/20)

NJDOT UAS Pre-Flight Checklist

	Pre-Flight Checklist
On-site	*Environmental items* ☐ Recheck the weather / wind ☐ Check for site-specific hazards (including traffic, obstacles, power lines, electrical interference) ☐ On-location risk assessment and any deviations to the flight plan ☐ Verify launching areas for safety ☐ Identify alternate / emergency landing areas ☐ Placement of traffic control signs
	Communications ☐ Working aviation radio, if required by the COA or working near airport ☐ Check for cell phone connectivity ☐ Check for cell phone battery
	Aircraft items ☐ Set up the control and communication equipment ☐ Remove gimbal lock ☐ Install battery / check it is secured ☐ Check hull / landing gear for defects ☐ Check props – cracks, secure, free rotation ☐ Check motor housings for debris ☐ Ensure display device is connected ☐ Turn on the controller ☐ Power on the UAS ☐ Verify datalink (handshaking connection between GCS and the UAS) ☐ Check warmup notifications (approx. 4 min) ☐ Check battery voltage / signal strength ☐ Check camera settings ☐ Check emergency settings (maximum altitude, maximum distance and return-to-home (RTH)) ☐ Position the aircraft on an NJDOT take-off and landing pad in the take-off area.

Form DA-63-NJDOT Pre-take off Checklist (Mission Briefing)

Form DA-63 (06/20)

NJDOT Pre-take off Checklist (Mission Briefing)

Mission Information	
Date:	Mission No:
Total Estimated Time:	Estimated Mission Risk Level:
Preflight Start Time:	Proposed Launch Time:
Launch Site:	
Recovery Site:	
Flight Objectives:	Special Operation Consideration:

UAS Information	
UAS Model:	Payload:

Airspace Information	
Airspace Class:	Operational Altitude:
Operational COA:	Flight Limitations:

Weather Information			
TEMP:	Sky:	Visibility:	Wind:
Special Weather Considerations/Forecasts:			

Crew Member	
RPIC:	VO:
Payload Operator:	Subject Matter Experts:
Boat Captain:	Vehicle Driver:

Communication	
Primary:	Secondary:
Pertinent Phone Numbers:	
Emergency Contact List:	NOTAM Filed:

Form DA-63 (06/20)

NJDOT Pre-take off Checklist (Mission Briefing)

Emergency Items (Refer to Form DA-64)
☐ Lost Link
☐ Total Loss of Power
☐ Airspace Intrusion
☐ Fly away
☐ Bird Strike
☐ Loss of Line of Sight
☐ Loss of RPIC/VO Communication

A typical mission should cover the following items:

- Roles and responsibilities
- Location and why
- Safety concerns (obstacles)
- Weather
- Current airspace (including flying under a COA)
- Call outs
- Sterile cockpit
- UAS settings
- Emergency procedure
- Questions

Sample mission briefing for the inspection of a high-mast tower

Hi everybody, this is the briefing of UAS Mission number 19-140. I am Glenn, the RPIC, and I am responsible for the safe operation of this flight with the assistance of John as my visual observer (VO). The VO is a responsible person for keeping the UAS in sight at all times and notifying me of potential hazards to the flight. We will be flying this mission in Hamilton on Route 130. The goal of this mission is to inspect four high mast light poles near the highway. We will be conducting four flights today gathering high definition photos. There are two high-tension power lines in the west and east of the mission area. The temperature is 75 degrees, the sky is clear, and wind is 220 degrees at 10 knots. We will be flying in Class G airspace. I am going to review the standard verbal callouts. The VO will acknowledge each command by repeating it during the mission.

- *"Power on Aircraft": The VO will turn on the aircraft and I will load the mission commands.*
- *"Clear Airspace": The VO will ensure the takeoff area is clear of any potential threats during the takeoff.*
- *"Taking off": After hearing the response to "take off" from VO, I will take off.*
- *"Controllability check": I will check to ensure the aircraft is properly executing the*

maneuvering commands from the remote control.

- *"Landing gear up": I will raise the landing gear, if applicable.*
- *"Climbing 50, 100, …" (every 50 ft.): I will say the UAS altitude every 50 ft. until the mission altitude.*
- *"Proceeding to the mission": I will start flying the aircraft to the mission location.*
- *Battery Call out (every 10%): I will read the remaining battery percentage every 10%. The aircraft must be on the ground with no less than 20% battery remaining.*
- *"Returning home": Either when the mission is complete or the battery percentage reaches 30%, I will command the aircraft to start proceeding home. I will stabilize the aircraft in a hover approximately 15 ft. above the landing site.*
- *"Gear down": I will activate "gear down".*
- *"Gimbal up": I will raise the camera gimbal.*
- *"Landing": I will commence a descent to touchdown. The VO will monitor potential hazards to ensure a safe landing.*
- *"Going around": If anyone observes a hazard during landing, he/she will call "Go around" and I will repeat "going around". I will immediately initiate a climb to a safe altitude. Once at a safe altitude, we will discuss the hazard and attempt another landing.*
- *"Power off aircraft": The VO turns off the UAS.*

The "Sterile Cockpit" procedure is mandatory once the "clear airspace" command is given. This means that only conversation essential to safely complete the mission is permitted.

Emergency Procedures: I have set the "return to Home" maximum altitude to 300 ft. in the event of a lost link. I have set the controller to a maximum altitude of 125 ft. and a maximum distance of 1000 ft. The compass is calibrated, and the SD card is formatted.

In case of an emergency, we will follow the following emergency procedure:

- *I will announce the emergency.*
- *We all remain calm.*
- *In case of Loss of Power, I will try to regain control of the UAS. Everybody should maintain visual contact with the UAS.*
- *In case of an airspace intrusion, I will suspend the operation and land the UAS.*
- *In case of a flyaway or loss of control, I will try to put the aircraft in "return-to-home" mode. If the aircraft is going to enter controlled airspace, I will contact ATC immediately.*
- *In case of any impending impact causing injuries, the VO will call 911 and I will notify the NJDOT Bureau of Aeronautics.*

Briefing complete. Any questions?

Form DA-64 (07/20)

NJDOT UAS In-Flight Emergency Checklist

Lost Link [1]	• Put the UAS in "Return-to-Home" mode • Try to regain the UAS control through the remote controller (for example the ATTI-mode switch on DJI Controller). If the control regained, land immediately *If the aircraft is away from the project site* • Follow the procedure for "Fly-away Emergency" *If the aircraft remains within the project site* • Warn nearby people of an emergency landing • Continue to issue the "Return-to-Home" command • Wait until the battery is discharged and the aircraft auto lands or crashes. • Notify the NJDOT Bureau of Aeronautics.
Total Loss of Power [2]	*Before Impact* • Identify emergency landing or ditch area • Try to restore power and regain control of the aircraft • Warn nearby people of crash landing by shouting a warning • Immediately land or ditch the aircraft, if full or partial power regained • Maintain visual contact with the aircraft • Prepare to take post-crash action *After Impact* • Contact 911 if the landing location endangers life or property • Send the command to power off the aircraft • Power off the control and communication systems • If the aircraft is in hazardous location, wait for emergency responders • Check the aircraft for fire • Notify the NJDOT Bureau of Aeronautics
Airspace Intrusion	• VO to alert the RPIC of the position and heading of the encroaching aircraft. • Continuously call out the position and heading of the encroaching aircraft. • RPIC to take evasive actions if a collision imminent. • if there is any risk of collision, temporary suspend the operation. Do not resume flight operation until the encroachment has ended.

NJDOT UAS In-Flight Emergency Checklist

Fly away [2]	• Put the aircraft in "Return-to-home" mode • Contact ATC immediately, if the aircraft may enter the controlled airspace • Contact 911 immediately, if aircraft may cause potential injury or property damage. • Try to regain the aircraft control through the remote controller • Note time, battery percentage, heading, and remaining flight time • Keep the aircraft in visual line of sight, if possible • If control is regained, land immediately • Follow the procedure for after impact for "Total Loss of Power" case.
Bird Strike	*If the aircraft can be controlled* • Put the aircraft in "Return-to-home" mode or land it immediately. • Notify the NJDOT Bureau of Aeronautics. *If the aircraft can be partially controlled* • Follow the procedure for "Loss of Control" case. *If the aircraft cannot be controlled* • Follow the procedure for "Total Loss of Power" case.
Loss of Line of Sight	• VO must notify the RPIC immediately. If the UA is visually reacquired promptly, continue the mission. • If not, terminate the operation. • For flights under COA, notify the appropriate ATC facility within 15 minutes of the end of the flight.
Loss of RPIC/VO Communication	• Follow the procedure for "Lost Link" case. Resume the mission if communication is reestablished. • If not, terminate the operation. • For flights under COA, notify the appropriate ATC facility within 15 minutes of the end of the flight.

NJDOT UAS In-Flight Emergency Checklist

Notes:

1. Lost Link Procedures: ATC does not need to be notified provided the RPIC complies with the following provisions:
    a. In the event that the data link is lost for at least three (3) seconds: The aircraft will execute the flight controller fail safe mode and climb to an altitude not exceeding the upper limits of the approved COA to attempt to re-establish Link.
    b. If link cannot be established for a period of 30 seconds:
        i. The RPIC must notify any ground assets that could be affected.
        ii. The VO must be instructed to note bearing and approximate distance to commence recovery operations.
        iii. The aircraft will fly back to the home point and land.
    c. The UA will remain within the defined incident perimeter.
    d. The UA will not interfere with the traffic pattern nor arrival/departure procedure of airports within the defined incident perimeter.
    e. The RPIC will notify the appropriate ATC facility within 15 minutes of the end of the flight.

2. Fly Away/Loss of Control: In the event of a fly-away, the RPIC will immediately notify the ATC facility with jurisdiction over the operations area. The RPIC will provide the following information:
    a. Altitude.
    b. Last known location.
    c. Direction of flight/heading.
    d. Fuel on board/Battery Time.
    e. RPIC intentions.
    f. Termination of flight or emergency condition.

NJDOT UAS OPERATION RISK ASSESSMENT WORKSHEET

DATE	MISSION/FLIGHT PURPOSE	N-NUMBER	UAS TYPE	NJDOT DIVISION

REMOTE PILOT-IN-COMMAND	VISUAL OBSERVER	COA/PT 107

Mission #	FREQUENCY	AIRSPACE CLASS

Weather briefings will be obtained and provided for inspection before flight operations.(*)

Select an applicable risk from drop-down list, and read the totaled score below.

WEATHER			OPERATIONS AREA		
ITEM	VALUE	SCORE	ITEM	VALUE	SCORE
CEILING (FT) Minimum 1000'	>2000	1	LAUNCH/RECOVERY SITE	UNFAMILIAR	2
VISIBILITY (SM) Minimum 3 miles	<3	4	TERRAIN	WOODED	2
WINDS (KTS) + 1/2 Gust (**)	6-10G15	2	POPULATION	URBAN	3
RAIN/SNOW	LT SHWRS	4	COMPLEX HIGH DENSITY AIRSPACE (TRAFFIC, PATTERNS, ETC)	C,D	3
THUNDERSTORMS (FORECAST/REPORTED)	ISOL (10%-20%)	1	OBSTRUCTIONS (WITHIN RADIUS OF R FROM RPIC)	15' < R < 25 '	2
LOW LEVEL WIND SHEAR WITHIN 10MI	NONE	0			
TEMPERATURE (Degrees F°)	20-35	3			
DENSITY ALTITUDE (FT)	>4000	3			

*Flights are not authorized when t-storms and/or lightning are observed within 5 mi of operations area.
**The manufacturer's manual should be consulted for any limitations

CREW EXPERIENCE			CREW REST/DUTY DAY		
ITEM	VALUE	SCORE	ITEM	VALUE	SCORE
RPIC EXPERIENCE	MODERATE 15-30	2	HOURS OF REST (CREW FATIGUE)	>7	0
CREW CURRENCY (DAYS)	<90	1	LENGTH OF DUTY DAY	<12	1
CREW MISSION	REQUALIFYING	2			

MISSION			EQUIPMENT/AIRCRAFT		
ITEM	VALUE	SCORE	ITEM	VALUE	SCORE
TIME OF MISSION	TWILIGHT	2	AIRCRAFT	NONE	0
OPERATING OVER WATER	YES	3			
OPERATING FROM A BOAT	NO	0			
OPERATING OVER LAND	NONE	0			
FLIGHTS PLANNED	5-8	3			
MISSION COMPLEXITY	ROUTINE	1			
ELECTRICAL INTERFERENCE	NONE	0			
OPERATING NEAR TRAFFIC	LOCAL ROAD	2			

ANY FACTOR RATING '4 OR HIGHER, ADEQUATE CONTROL MEASURES MUST BE DOCUMENTED AND PROVIDED TO SUPERVISOR.

ADDITIONAL HAZARDS/RISK MITIGATION/MISSION REMARKS

Evaluate

The Mission Risk Score is 47 which is considered a HIGH risk

BRIEFING APPROVAL

RPIC NAME/SIGNATURE	SUPERVISOR NAME/SIGNATURE	RISK ASSESSMENT TOTAL
		47

MISSION APPROVAL AUTHORITY

MISSION COMMANDER(LOW):	DATE:	TIME:
PROGRAM MANAGER (MODERATE):	DATE:	TIME:
PROGRAM DIRECTOR OR VP (HIGH OR ANY 5 VALUE):	DATE:	TIME:

MISSION BRIEF BACK

MISSION STATUS (Choose one):	COMPLETED

REMARKS

Please refer to Table 2.2 of the NJDOT Flight Operation Manual. Mission Risk Level is High because of having two items with a score of 4.

SEPARATE DRIVER, RPIC, AND VO. NO AIRBORNE CHASE OPERATIONS AS PER 14 CFR PART 107

Appendix C: Accidents/Incidents Reporting

All accidents/incidents during operations under NJDOT COA meeting the following criteria must be reported according to section 5.6.

1) All accidents/mishaps involving UAS operations where any of the following occurs:
   (a) Fatal injury, where the operation of a UAS results in a death occurring within 30 days of the accident/mishap
   (b) Serious injury, where the operation of a UAS results in:
      i. Hospitalization for more than 48 hours, commencing within 7 days from the date of the injury was received;
      ii. A fracture of any bone (except simple fractures of fingers, toes, or nose);
      iii. Severe hemorrhages, nerve, muscle, or tendon damage;
      iv. Involving any internal organ; or
      v. Involves second- or third-degree burns, or any burns affecting more than 5 percent of the body surface.
   (c) Total unmanned aircraft loss
   (d) Substantial damage to the unmanned aircraft system where there is damage to the airframe, power plant, or onboard systems that must be repaired prior to further flight
   (e) Damage to property, other than the unmanned aircraft.

2) Any incident/mishap that results in an unsafe/abnormal operation including but not limited to
   (a) A malfunction or failure of the unmanned aircraft's on-board flight control system (including navigation)
   (b) A malfunction or failure of ground control station (GCS) flight control hardware or software (other than loss of control link)
   (c) A power plant failure or malfunction
   (d) An in-flight fire
   (e) An aircraft collision involving another aircraft.
   (f) Any in-flight failure of the unmanned aircraft's electrical system requiring use of alternate or emergency power to complete the flight
   (g) A deviation from any provision contained in the COA
   (h) A deviation from an ATC clearance and/or Letter(s) of Agreement/Procedures
   (i) A lost control link event resulting in
      i. Flyaway, or
      ii. Execution of a pre-planned/unplanned lost link procedure.