NYC Buildings

USING DRONES TO CONDUCT FAÇADE INSPECTIONS

LOCAL LAW 102 OF 2020

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TABLE OF CONTENTS

INTRODUCTION & EXECUTIVE SUMMARY

> *This is a step forward in a longer process of updating our laws to reflect technology we have available today. Drones can play a positive role in building management, from façade and roof inspections to energy efficiency analysis. Drones can offer cost-effective opportunities to detect problems early and prevent tragic injuries and deaths.*
>
> NYC Council Member
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>
> New York City Council
> Housing & Buildings Committee

In 2020, the New York City Council passed **Local Law 102 of 2020 (Local Law 102)**. Local Law 102 requires the New York City Department of Buildings (DOB) to study the use of unmanned aircraft systems, which are commonly referred to as drones, to conduct façade inspections in conjunction with hands-on inspections.

This report will:

- provide a **Façade Inspection Safety Program (FISP)** overview, which requires the façades of buildings greater than six stories in height to be inspected periodically
- provide an overview of existing drone technology and use
- provide an overview of existing regulations pertaining to drones
- explore the obstacles in using drones to conduct façade inspections, that include regulatory barriers and privacy concerns
- explore various aspects pertaining to using drones to conduct façade inspections, including whether drone use can improve safety, whether drone use could have an impact on the use of sidewalk sheds and scaffolding, and whether drone use could result in any economic benefits.

Key takeaways from this report include:

- Drones are a useful tool for collecting visual data. Drones are useful tools for collecting significant amounts of visual data such as photographs, videos, thermal images, and similar outputs. Drones can also access angles that are more difficult to achieve using other methods of visual inspection, which is particularly helpful for the inspection of larger buildings.

- Façade inspections require more than just visual images. For façade inspections, visual data collected by drones could include photographs and location information to easily pinpoint where a defect is located on a building. However, visual data, whether collected by drones or other tools, cannot replace the current requirement for physical examinations. Physical examinations by qualified professionals include sounding and probes that are necessary to accurately identify façade defects. Physical examinations also allow qualified professionals to immediately mitigate hazards.
- Façade inspections require more than just data collection to inform building maintenance and repairs. Drones can collect data efficiently, but the data needs to be reviewed and analyzed to inform decisions regarding building maintenance and repairs. In the case of required façade inspections, a qualified professional must review available data and determine how to address deficiencies. Data by itself, whether collected by drones or using other tools, does not translate into actionable façade repairs.
- Current regulations limit drone use in New York City. Current regulations limit drone use in New York City and are outside of DOB's purview. Such regulations have resulted in limited experience with drone operations in the City, including to conduct façade inspections.
- There is a lack of data and experience with using drones to conduct façade inspections. There is limited experience with the use of drones to conduct façade inspections in New York City and in other jurisdictions, which makes it difficult to determine precisely how drone use might support the existing façade inspection requirement and to assess related issues that may arise, including privacy concerns, whether drones could have an impact on the use of sidewalk sheds and scaffolding, and whether drone use could result in any economic benefits.

DOB recognizes drones may support the existing requirement to conduct façade inspections in a beneficial way and would invite further study on how drone use, and its accompanying technologies, can be employed. Specifically, the following areas may benefit from further study:

- **Time and costs.** Whether drone operations reduce the time spent on collecting and reviewing façade conditions, and whether this lowers the cost of façade inspections for building owners. Also, whether repairs and remediation occur in a more expedited fashion if the use of drones allows for deficiencies to be more easily identified during required inspections.

- **Types of deficiencies.** What types of façade deficiencies are more easily identified using drone data. For example, cracks in masonry may be easier to determine than displacement or bulges from photographs or videos captured by drones.
- **Additional or more targeted hands-on inspections.** Whether additional hands-on inspections would be required because more areas of concerns can be identified by drones. Similarly, whether an inspector can better target which areas require hands-on inspections for more accurate examination of façade conditions.
- **Frequency of drone inspections.** Whether periodic use of drones can help to identify if movement or degradation has occurred as compared to previous inspections.
- **Types of buildings.** What type of building or building material would drone inspections be most beneficial for. For example, a building with a glass and steel façade may have readily identifiable deficiencies that can be captured by a drone, whereas a building with an ornate masonry façade would require close-up inspection to ensure that defects are not hidden in images. Also, whether drone use would be better for taller high-rise buildings, which may not have alternate means of access such as permanent window washing rigs, or smaller ones, which may not benefit from drone use due to scale.
- **Other applications.** Whether drones can be used in other applications:
  - Drones are sometimes deployed in emergency response and expanded use would be useful in more localized incidents such as building fires or explosions.
  - Drones could identify open roofs in a structurally compromised building without endangering DOB responders.
  - Drones equipped with thermal imaging cameras may be beneficial in improving the energy efficiency of façades and assist in retro-commissioning efforts.

SECTION I: WHERE WE ARE TODAY

1. FAÇADE INSPECTION SAFETY PROGRAM (FISP)

A. Background and Evolution of FISP

The purpose of this section is to provide background information on FISP and the FISP Unit at DOB, including how façade inspection requirements in New York City have evolved over time. Further, this section explains the current inspection requirements in detail and begins to explore how new technology could support such inspection requirement.

Owners of all buildings in the City are required by law to maintain their buildings in a safe condition, including their components, such as façades, boilers, elevators, and structural systems. FISP provides DOB with important information about the condition of façades on buildings that are greater than six stories in height. Specifically, FISP requires that owners of buildings greater than six stories in height file a periodic report prepared by a licensed design professional, attesting to the condition of their building's façade and appurtenances. This report is subject to review and acceptance by the FISP Unit at DOB, which includes a review by licensed design professionals.

i. Local Law 10 of 1980

Following a fatal incident in Manhattan caused by a hazardous façade condition, the City adopted Local Law 10 of 1980 (Local Law 10) on February 21, 1980. Local Law 10 required the periodic inspection of exterior walls and appurtenances of buildings greater than six stories in height once every five years. The law required a report of the inspection to be prepared, signed, and sealed by a licensed design professional and submitted to DOB.

To comply with Local Law 10, owners of subject buildings were required to hire a licensed design professional to examine the street-fronting façade of their building and submit a report to DOB by February 21, 1982, and continue to do so on a five year cycle (Cycle 1 started in 1980, Cycle 2 in 1985, and so on). Exceptions were made for façades that were located 25 feet or more from a street or paved pedestrian walkway. DOB promulgated requirements related to Local Law 10 by rule (1 RCNY §32-03). Such rule detailed the requirements of the inspections and report filing related to the law. The first version of the rule that accompanied this law indicates that "use of a scaffold or other observation platform is *preferred* but the Architect or Engineer may use other methods of inspection as he deems appropriate. These may include the use of photographic magnification techniques or the use of remote observation equipment." The licensed design professional was to indicate in a report whether the façade "conformed to Code requirements and applicable Rules, Regulations, and Directives," required precautionary work, or had unsafe conditions. Of note, as of Cycle 3, per Operational Policy and Procedure Notice 9/90, 10% of such reports filed as **precautionary** were audited by DOB.

Local Law 10 established what would become the longest continually running façade inspection program in the country. Over the next 41 years, both the law and the associated rule would undergo multiple revisions to strengthen the program and address additional safety concerns. These revisions changed the requirements to which building owners and licensed design professionals would have to adhere, including the minimum requirements for visual inspections and physical examinations. DOB's staffing, administration, and oversight of this population of buildings would also evolve in that time, to appropriately support the program.

ii. Local Law 11 of 1998

The requirements of the façade inspection program remained static for almost 20 years until December 1997, when a large swath of bricks peeled off of the non-street facing cavity wall façade of a building in Midtown Manhattan. This non-street facing façade was not subject to Local Law 10 because it was more than 25 feet from the street line. This incident resulted in Local Law 11 of 1998 (Local Law 11), which went into effect in March 1998 and removed the exception in Local Law 10 for walls 25 feet beyond public facing areas. Additionally, Local Law 11 changed the previous façade classification system to **Safe**, **Unsafe**, and **Safe With a Repair and Maintenance Program**, which would come to be known as **SWARMP**. These classifications remain in use today.

Concurrent with Local Law 11, the eighth version of 1 RCNY 32-03 went into effect in January of 1999. This is the first version of the rule that includes the phrase "physical examination" and states that such examination from a scaffold or other observation platform is required for a representative sample of the exterior wall. Previously, these physical examinations were to be performed at the licensed design professional's discretion. The new rule specifically stated: "A physical examination from a scaffold or other observation platform is required for a representative sample of the exterior wall. The professional shall determine what constitutes a representative sample. The representative sample must include at least one physical examination along a path from grade to top of an exterior wall on a street front using at least one scaffold drop or other observation platform configuration."

iii. Expansion of the FISP Unit and Introduction of the 2008 Construction Codes

Local Law 11 and its accompanying rule went into effect towards the end of Cycle 4 of the City's ongoing façade inspection program. After the passage of Local Law 11, DOB required owners to either submit a supplemental statement to amend their Cycle 4 reports addressing the newly subject walls by March 1, 2000, or they could file their Cycle 5 report, which would have to comply with Local Law 11.

When Cycle 5 began, the Local Law Enforcement Unit, which would come to be known as the FISP Unit in Cycle 7, was expanded to include a technical component, which was comprised of licensed architects and engineers employed by the City. Starting in Cycle 6, which began in 2005, the FISP Unit stopped being strictly administrative, and the Unit's dedicated plan examination staff took on the responsibility of reviewing every submitted façade inspection report. An inspectorial component was also added to the Unit at this time, with one supervising inspector and two to three inspectors. The administrative staff provided support to the plan examiners and the inspectors of the FISP Unit.

Local Law 11 would remain in effect until the first major overhaul of the New York City Construction Codes in 40 years, the 2008 Construction Codes. 1 RCNY 32-03 was subsequently repealed and replaced with 1 RCNY 103-04, though the content of the rule had not significantly changed since its revision in 1999. The final version of 1 RCNY 32-03 included the clarification that a physical examination is a ***close-up inspection***. This clarification remains in the current version of 1 RCNY 103-04. This is the phrase we will use in the remainder of this report as it is more descriptive and more clearly distinguishes these types of inspections from visual inspections.

iv. 2015 Fatality & Department of Investigation (DOI) Analysis of the FISP Unit

In May 2015 a child was fatally struck by a piece of terra cotta windowsill that fell from the 8th floor of an apartment building in Manhattan. DOI, along with DOB's cooperation, reviewed the case and determined that the building owners had not been consistent with their façade inspection compliance filings, and there was some duplicity with the licensed design professionals with whom they contracted. DOB, for its part, brought a criminal case against the building's owners who pleaded guilty to two misdemeanor counts for criminal violations of the City's Administrative Code in 2019.

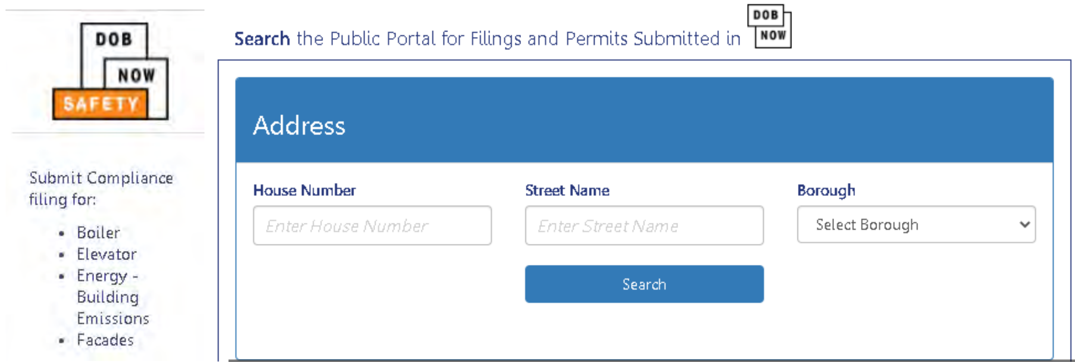
DOI also analyzed the FISP Unit's policies and procedures and determined that some of the Unit's practices needed to be formalized and performed on a more routine basis to be able to better address such nefarious behaviors on the part of building owners and professionals. DOI, working together with DOB, made ten policy and procedure recommendations for the Unit. These included recommendations for an automated database to track the compliance history of each building more accurately, minimum requirements for inspections performed by DOB staff, as well as newly required attestations and certifications on the part of owners and licensed design professionals. These recommendations would inform the continued evolution of the façade inspection requirement and the FISP Unit, both from an operational and staffing perspective. Several of the recommendations also prompted a major revision to 1 RCNY 103-04, including an increase in the required number of close-up inspections.

v. *DOB NOW: Safety*

Through the end of Cycle 7, the compliance filings related to the City's façade inspection program were submitted as voluminous amounts of paper, which included the required forms in addition to individually prepared reports, which were then marked up in red pen by a plan examiner. By this time, per the last version of 1 RCNY 32-03, the contracted licensed design professionals performing these façade inspections were referred to as **Qualified Exterior Wall Inspectors (QEWIs)**, a term that will be used in the remainder of this report.

When Cycle 8 of the City's façade inspection program began in 2015, the direction to QEWIs was to submit their reports as PDFs on CDs or DVDs, which were then reviewed and marked up by the plan examiners on their computers, using PDF editing software. Despite the switch to a paperless review, the process was still a manual one, with no way to monitor the status of a building's compliance without going into a database to look for it.

By this time, the FISP Unit was comprised of four plan examiners, a technical director, a compliance officer, and an inspection staff of ten. Also, due to the volume of subject buildings by this time, 14,500 in Cycle 7, the cycle deadline was broken down into three sub-cycles, based on the last number of the block on which the building is located, each with deadlines one year apart.



DOB NOW Public Portal

Also at the same time, DOB was in the process of developing a system to replace its legacy mainframe system, the Buildings Information System (BIS), which was established in 1989. The new online system created to replace BIS is known as DOB NOW. Façade inspection reports were the first required compliance filings to be filed completely online through the DOB NOW: *Safety* module. The system made it easier for the FISP Unit to monitor compliance with FISP, including to take appropriate enforcement action.

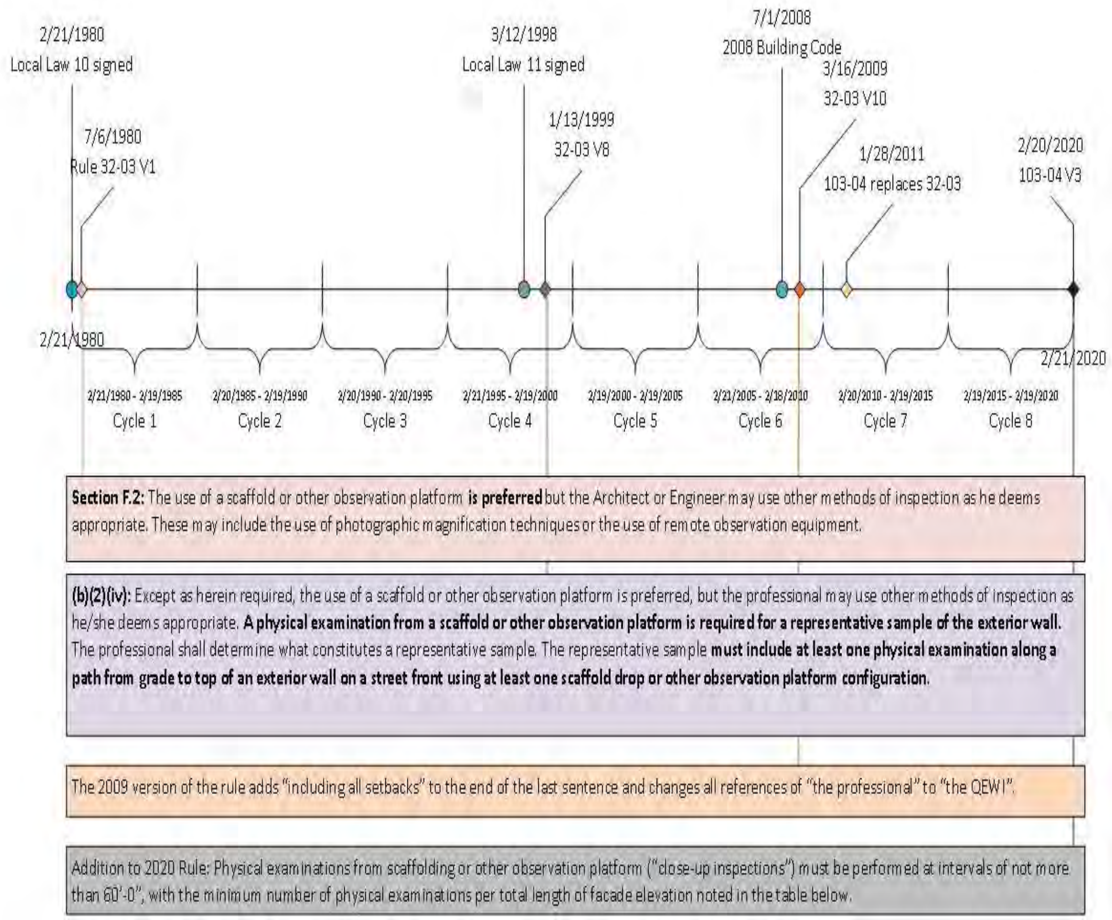
vi. Strengthening the FISP Rule

On February 20, 2020, the last day of Cycle 8, the latest version of 1 RCNY 103-04 went into effect. With this rule revision, DOB significantly enhanced QEWI qualifications, façade inspection requirements, and increased civil penalties for non-compliant owners, all in the interest of improving public safety. This revision also made the first significant change to the close-up inspection requirements since Local Law 11 went into effect in 1998. It added a new requirement for close-up inspections to be performed at intervals of not more than 60'-0" fronting each public right-of-way, to allow for more thorough inspections of the exterior walls of larger buildings.

It also added a new requirement that the QEWI perform probes, which are openings of the exterior wall to expose the underlying support condition, to determine whether ties are present and in good condition at cavity wall buildings in every odd filing cycle, starting with Cycle 9. This new probing requirement was included in response to multiple recent incidents in the City of failures of cavity walls due to missing or deficient ties. These probes must occur at every location where a close-up inspection is performed. However, there are exceptions to the requirements for a probe, one of which is the allowance for alternate methods of determining the condition and spacing of wall ties.

This section of the rule also explicitly states that "the use of drones, high resolution photography, non-destructive testing, or other similar methods does not eliminate the requirements for close-up inspections." This is the first-time emerging technologies as they pertain to façade inspections are mentioned in the rule.

Timeline of Development of FISP Physical Examination Requirement



B. Description of Current FISP Inspection Procedures by QEWIs

This section will describe standard inspection methods that QEWIs currently employ in connection with façade inspections, both for visual and close-up inspections.

i. Overview of Building Types

Any building greater than 6 stories in height is required to comply with FISP. The diversity of building types subject to the inspection requirement is great and includes: 7-story 19th century masonry clad load bearing wall buildings; early 20th century 15-to-30 story steel framed, masonry, and terra cotta clad buildings; 1950s and 1960s cavity wall buildings; and modern high rises with glass curtain walls. With this broad panoply of subject buildings, there are various ways a QEWI could conduct both the visual and close-up inspection to meet the requirements of the rule.

ii. Critical Examinations (Visual Inspections)

Critical examinations, commonly referred to as visual inspections, are performed by a QEWI hired by the building owner. These inspections are typically conducted from the streets and sidewalks with the use of binoculars and cameras with zoom lenses. For shorter buildings, say up to 10 stories, this can be an effective method of inspection. As the buildings become taller, other vantage points are often sought after, such as finding roofs, setbacks, terraces, and balconies of neighboring buildings that are of similar heights or taller. This can become a challenge as access to the neighboring buildings and to appropriate vantage points is required.

For clusters of high rises, such as those found in Midtown Manhattan, Long Island City, or Downtown Brooklyn, sometimes the façade is visually inspected from the windows of neighboring buildings of similar height. However, there are instances where there may not be buildings of a comparable height nearby, which means that a visual inspection with binoculars from the ground is the only option.

iii. Physical Examination (Close-Up Inspections)

Physical examinations, also known as close-up or hands-on inspections, are required every 60'-0" length of façade which fronts a public right of way and must be along a path from grade to the top of the exterior wall. A close-up inspection can be executed in several different ways, but they often take the form of a scaffold drop (often referred to as a *drop*) performed from a swing stage with two riggers and the QEWI. Other forms of close-up inspection techniques are industrial rope access (IRA), where the professional rappels off the side of the building using ropes and climbing equipment. QEWIs also regularly use available fire escapes to access areas of the façade, provided that the fire escape provides the professional continual access to the façade being inspected from the top of the parapet down to grade, as required by the rule.

During the close-up inspection, a qualified inspector is able to sound various materials to determine their actual condition rather than just relying on a visual image that may erroneously indicate that the façade is in a safe condition. Damaged or deteriorated materials are also remedied with immediate removal during these hands-on inspections.

Examples of Different Types of FISP Buildings

Pre-War Residential

Modern Glass Clad Office/Residential

Post-War Cavity Wall Residential

Early 20th Century Office

C. Importance of Required Close-Up Inspections

The close-up inspection, also often referred to as the *hands-on* inspection, affords the QEWI several opportunities to enhance their knowledge of the condition of the building's façade to make a more accurate assessment. First, by examining the façade up close, the QEWI is able to identify any damage or imperfections that may be missed when the façade is viewed from the ground through binoculars. When visual observations using binoculars are performed from the street level, deficiencies on horizontal façade elements at upper floors may be hidden. For example, a common unsafe façade condition that could potentially be missed from a street level observation is cracked windowsills, which could be seen from above but not below.

Professionals also often use the opportunity of the close-up inspection to *sound* building façades that are comprised of masonry, concrete and/or stone. This often takes the form of tapping the façade gently with a rubber mallet. If there are corroded supports behind the outer layer of façade, the tapping sound will change in tone, alerting the professional that the back-up structure of the façade may be compromised, indicating that this area might be one where a probe should be conducted. Close-up inspections are also valuable in allowing the professional to make an unsafe condition safe by removing it. For example, if there is a loose piece of stone that presents a danger to the public, the professional has the opportunity to remove if during a close-up inspection if it is safe to do so.

D. FISP Report

The goal of FISP, which is consistent with the overall mission of DOB, is to have well maintained and safe buildings. Owners of buildings subject to FISP are required to hire DOB-approved qualified professionals to inspect a building's façades and prepare a report identifying the condition of the façade and to provide a photograph of every defect found that would be classified as either unsafe or SWARMP. If an owner does not correct their unsafe or SWARMP conditions within the designated timeframe, they will be subject to violations and penalties. To correct the unsafe or SWARMP conditions, owners are required to hire a licensed professional, not necessarily a QEWI, to prepare construction documents and file for permits as required by Code.

2. DRONES AS TOOLS

Unmanned aerial vehicles, more commonly known as drones, are a type of aircraft that can be controlled by a pilot remotely. In recent years, drone use has grown, fueled by hobbyists and commercial businesses as the technological capabilities of drones have advanced and commercially available drones have become less expensive.

A. History of Drones

Drones have a long history, originating from military use as far back as 1849, when Austrian forces launched pilotless balloons with explosives over Venice, Italy. Most scholarly resources note that drones, as we currently understand them, were first used as tools of war during World War I. The de Havilland DH82B Queen Bee (Queen Bee) is frequently cited as the first successful example of a drone being used as a tool of war. The Queen Bee was first flown in Britain in 1935, and was devised as a low-cost radio-controlled target aircraft, for realistic anti-aircraft gunnery training. While the aircraft could be flown from the front seat, the enclosed rear cockpit was equipped with radio-control gear to maneuver the aircraft. The Queen Bee also seems to be the inspiration for calling such pilotless aircraft *drones*, named after stingless male bees.

Since that time, drone technology has steadily improved. Outside of military use, consumer drones have in recent years benefited greatly from growth in smartphone computing as well as advances in microchip and sensor technology over the last two decades. This has changed the overall shape of commercially available drones from miniature airplanes (fixed wing) to quadcopter (multirotor), which allow for more stable and agile movement. Drones that are commercially available today are lighter, fly longer, and have greater capabilities.

As drone technology has continued to improve, commercial businesses have found countless ways to incorporate them into their workflows. Drones are already quite common in photography and video production, where spectacular images are captured without great expense or danger to the photographer. Various industries have also found drones useful in accessing difficult locations, including in agriculture to monitor field conditions, in construction to monitor sites, and in mining to monitor stockpiles. Accessory technologies, such as thermal imaging and orthomosaics, which will be discussed in further detail later in this report, are also translating the data and images collected by drones into easily understood and actionable information.

B. Availability & Design of Drones

Drones are available in various sizes and configurations for different applications. Available designs for commercial drones primarily include fixed wing drones, rotary wing drones, and hybrid models.

Fixed wing drones are like airplanes with rigid, aerodynamic wings and require a runway to take off and land. These types of drones are best suited for flying over large areas as they have faster speeds and longer flight times. They are also able to carry heavier payloads than other types of drones due to their size. While fixed wing drones can fly at higher altitudes and are relatively stable in high winds, they cannot hover in place and generally have less maneuverability. Fixed wing drones are also more expensive and difficult to transport and set-up on sites.

This image was released by the United States Navy (ID 140606-N-IQ177-002). This tag does not indicate the copyright status. A normal copyright tag is still required.

SOURCE: Lt. Jessica Crownover, US Navy - https://commons.wikimedia.org/w/index.php?curid=33354689

Rotary wing, or multicopter drones, use rotor blades to lift the aircraft into the air, with four rotors for a quadcopter formation being the most common. Rotary wing drones can take off and land vertically, and similar to helicopters, both are vertical take-off and landing (VTOL) aircraft. These types of drones have the ability to hover, as well as a greater range of maneuverability to access tighter areas. These capabilities can be combined with automated flight plans to enable more precise, repetitive data collection for consistent monitoring over time.

Rotary wing drones do require more power than fixed wing drones, and as a result have a shorter flight time. Interruptions to change batteries impact the flight operation and data collection, which may slow a project's overall timeline.

One type of rotary wing drone, which addresses the need to change batteries, is a tethered drone, which has a thin cord that provides the drone with power allowing it to hover for an extended period of time. While limited in the area the drone can visually cover, they can be useful to incident responders who may only require a fixed view of an unfolding situation, such as a large fire. These drones typically do not require special piloting skills, which can also prove advantageous in an emergency situation requiring quick response.

SOURCE: https://www.dji.com/phantom-4-pro

A third option of drone design is the hybrid VTOL aircraft, which combines the vertical take-off and landing of rotary drones with the flight capability of a fixed wing drone. While this option combines the best features available, there is a price premium to procure these hybrid drones.

C. Accessory Technologies

The increased utility of drones for commercial purposes has been in part due to the development of accessory technologies, including high-resolution cameras and sensors.

i. Thermal Imaging

Thermal imaging, or infrared thermography, captures radiation emitted from the surfaces of objects and creates an image to graphically display temperature differentials. Because thermal imaging does not require visible light to capture images, thermal cameras are typically used for surveillance or other military uses. Law enforcement notably uses thermal cameras to track individuals at night from helicopters, and security systems are commonly outfitted with infrared motion sensors to more accurately detect live movement at night. Additionally, thermal imaging does not require destructive physical testing to find potential defects and is particularly useful in disciplines such as medicine and archaeology, where information cannot be gained without disrupting other bodily conditions or irreversibly altering artifacts.

With increased interest in energy efficiency and non-destructive diagnostic capabilities, thermal cameras are frequently found along with standard visual cameras on drones. Utility and oil companies operate drones with both types of cameras to pinpoint exact locations of potential defects, allowing inspectors to discover issues from a safe distance. Building managers in other municipalities have also used drones equipped with thermal cameras to quickly cover large roof areas to help locate potential water penetration and damaged materials, rather than having staff walk roof surfaces to determine potential problem locations.

When applied to façade inspections, thermal imagining can use temperature data to help identify potential façade defects similar to roof inspections. Further, thermal imaging could help make a building more energy efficient by locating areas where heat or cooled air are escaping from a building's envelope. Building owners can use the information to decide where to add insulation or weather seals to keep heating or cooling within the building. While reflective materials may pose a challenge for thermal imaging, experienced thermographers are able to calibrate a thermal camera in order to obtain more consistent temperatures for analysis.

ii. Photogrammetry and Orthomosaics

Photogrammetry uses photographs and other digital images to extract and obtain measurable three-dimensional information. The process involves taking overlapping photographs of an object, structure, or space from different vantage points, and then converting that information into digital models. The photogrammetric process also produces orthomosaic maps and GIS layers that can be used to analyze data and measure elements collected from images. While photogrammetry was initially used by surveyors to produce topographic maps, architects, engineers, and contractors have recently begun to use it to create maps, point clouds, or drawings based on real-world objects or environments.

There are two general types of photogrammetry, aerial photogrammetry and close-range photogrammetry. Close-range photogrammetry often uses images captured from a handheld camera or with a camera mounted to a tripod, and results in three-dimensional models of smaller objects rather than large-scale maps. Aerial photogrammetry uses aircrafts to collect aerial images from multiple perspectives and processes those images to produce larger models or maps that can be used to measure and quantify site conditions. In both types of photogrammetry, the number of photographs and images needed to accurately create a three-dimensional model will depend on the size of the site or object, as well as the desired accuracy of the final product. An orthomosaic is a photogrammetrically corrected image resulting from the image collection, where the geometric distortion between the sensor and the object or terrain has been corrected and the imagery has been color balanced to produce a seamless mosaic dataset. While orthomosaics are one of the more common outputs from photogrammetry, other three-dimensional models and maps can be created for more precise measurements and analysis.

Recent advances in hardware capabilities and photogrammetry software have shortened the time between the image collection process to final data products. With the use of commercial drones, thousands of images can be quickly captured for processing, allowing for regular monitoring and documentation of large-scale sites. At the same time, photogrammetry software is relatively accessible with numerous providers to support various applications ranging from detailed mapping to marketing images. Archaeology in particular, has benefited from the use of drone-based photogrammetry, where drones can record data over a large area faster than land-based surveys that focus on single structures. Using drones with photogrammetric imaging, archaeologists can develop a wholistic understanding of ancient communities and map out where to target their excavations.

iii. Light Detection and Ranging (LiDAR)

LiDAR is a remote sensing method that uses pulses of light, typically a laser, to measure distances from the light instrument to an object or surface. When taken with other data recorded, such as GPS location and orientation, these light pulses can generate precise, three-dimensional information about surface characteristics. LiDAR products often result in a set of data points that can serve as the basis for other types of three-dimensional models and allow for different types of analyses. A LiDAR instrument principally consists of a laser, a scanner, and a specialized GPS receiver. This equipment can be fixed to aircraft, satellites, or drones to acquire data over broad areas below.

There are two types of LiDAR data produced, topographic and bathymetric. Topographic LiDAR typically uses a near-infrared laser to map the land, including natural and physical features. Bathymetric LiDAR uses water-penetrating green light to also measure seafloor and riverbed elevations.

Similar to thermal imaging, topographic LiDAR does not require visible light to capture data since the light instrument uses near infrared sensors and can be readily used at night. Bathymetric LiDAR benefits from use in daylight, since there would also be visual photographs combined with the LiDAR data. Both data types allow scientists and mapping professionals to examine natural and artificial environments with accuracy, precision, and flexibility.

LiDAR technology was used in New York City when a federal Disaster Recovery Community Development Block Grant (CDBG-DR) from the Federal Emergency Management Agency (FEMA) was awarded to New York City after Superstorm Sandy for disaster recovery and resiliency initiatives. Part of that funding was used to capture data from an airplane flying in pre-planned paths over the City and to process and verify high-resolution tidally-coordinated topographic and bathymetric LiDAR data and LiDAR-derived datasets. The City can now use the data captured during those flights to analyze changes in the shoreline and elevations in order to support policy making and future resiliency planning efforts.

When combined with drones, LiDAR technology allows for quick deployment in situations where three-dimensional mapping and geospatial data capturing are needed. In lieu of flying airplanes or waiting for satellite availability, drones equipped with LiDAR instruments can make surveying and management of vast terrain more efficient. LiDAR on drones have been useful for forestry management, agriculture, and archaeology, where detailed measurements over large areas and accurate descriptions of surface characteristics are traditionally time intensive to acquire.

D. Drone Applications

Once considered a military tool, drone use in commercial applications has expanded greatly over recent years as the technological capacity increased and overall costs decreased. Drones are already employed in various industries and are particularly useful where operations require managing assets spread over large areas and regular data collection is needed.

i. Agriculture

Farmers have incorporated different types of drones into their normal operations. Data collected by drones allow for faster and more consistent monitoring of growing conditions. Access to information sooner can help farmers manage their resources as well as make decisions on how to improve the quantity and quality of their crops. Drones equipped with spraying capabilities can also help farmers directly in the field by spraying fertilizer or pesticides as needed.

ii. Mining

Large scale mining operations require significant data to ensure that the work can proceed safely, and with drones, information can not only be collected quickly but also frequently. Drones can capture precise visual data for site surveys and measurements of stockpiles. Also, instead of sending personnel with traditional survey equipment, drones can provide safe access into difficult to reach parts of mines or quarries without endangering personnel.

iii. Oil & Gas

Energy companies spend significant time monitoring their infrastructure to ensure safe, continued production and distribution. Drones are able to provide better views for assessing conditions of piping and wires while letting personnel review from a safe distance. Also, drones equipped with thermal imaging cameras can help capture issues in different types of systems, such as flare ups in electrical lines or gas leaks in piping.

iv. Emergency Response

One area that drones have been particularly useful for is in emergency response efforts after disasters such as hurricanes, high wind events, and floods. Due to the immediate need for damage assessments in the aftermath of a disaster, drones allow first responders to quickly survey large areas and locate specific areas of need.

In the immediate aftermaths of Hurricanes Harvey and Irma in 2017, the Federal Aviation Administration (FAA) authorized drones to help with the mapping and surveying of damaged areas. In Houston, Texas, which was impacted by Hurricane Harvey, the FAA issued 137 authorizations to allow drone operators to perform search and rescue missions as well as damage assessments of roads, bridges and other infrastructure. In Florida, which was impacted by Hurricane Irma, both public and private entities were able to use drones for aerial surveys, identifying areas in need, and to collect data on various infrastructure and critical facilities. Drones also helped utility companies safely inspect their power grid and allowed for faster restoration of power to residents.

v. Building & Construction Uses

Typical drone services for construction combine drones with high-resolution cameras to capture site conditions. Drone services for construction allow for faster documentation, access to difficult to reach locations, and the ability to monitor large sites. Specifically, drones can be used for construction to conduct aerial site surveys and to aid in project planning and progress tracking.

E. Where Drone Use May be Incorporated in Façade Inspections

The goal of FISP is to ensure that the façades of buildings greater than six stories in height are maintained in a safe condition. This goal is accomplished by requiring the owners of such buildings to have their façades inspected periodically, which includes a visual inspection and a close-up inspection.

Drones and accompanying technologies can offer a QEWI an enhanced visual inspection. As mentioned previously, the visual inspection is traditionally conducted with binoculars and cameras from the street level and any other accessible vantage points, such as the roofs of neighboring buildings. If a QEWI had access to a rotary wing drone, the maneuverability alone would provide them with enhanced vantage points, which would allow them to easily view windowsills from above and to navigate around cantilevered appurtenances that may obstruct their views, such as balconies or mechanical equipment. It is with these types of scenarios where drones may be the most beneficial in terms of time savings and ability to observe defects.

If coupled with photogrammetry or orthomosaics, any images collected can be stitched together and further examined. With traditional photography, the QEWI may be able to more closely examine an area of potential concern not noted in the field, but the condition may be hard to locate in a sea of similar images. Location information intrinsic to the software used by drones would allow the QEWI to pinpoint with certainty any areas of concern that may have been missed while in the field.

SECTION II: CURRENT LANDSCAPE FOR DRONE USE & LEARNING FROM OTHER JURISDICTIONS

1. LAWS & REGULATIONS ON DRONE USE

A. Overview of Drone Regulations

While drones and drone use has quickly expanded over the last two decades, legislative changes and applicable regulations to ensure the safe and reasonable use of drones have taken a much slower path to develop. It wasn't until the early 1980s that guidance from the federal government on drone use was developed. In the decades that followed, rapid growth in drone use compelled the Federal Aviation Administration (FAA) to develop more detailed and specific regulations for drone use in 2016.

During the early 2000s, governments and regulatory bodies across the world began establishing specific regulations to address drone use, and legislation for commercial drone use started to take shape in local jurisdictions once the FAA published its regulations in 2016. Since the initial set of drone regulations were developed, the FAA has continued to develop and refine those rules to allow for the safe use of drones for commercial and recreational users.

B. Federal Aviation Administration Background

As the federal regulators of the National Airspace System, which includes the air space over New York City, the FAA is the primary agency responsible for implementing regulations related to drones.

Modern aviation started in the early 1900s when the Wright brothers completed the first powered flight in North Carolina, leading to the development of airplanes as we know them today. Along with this technological development, commercial interests in air transport soon led to the Air Commerce Act of 1926. This national legislation became the framework for air commerce as well as establishing rules on managing air traffic, licensing pilots and certifying aircraft throughout the country. To further support the development of aviation, the Civil Aeronautics Act of 1938 codified the federal government's role in managing the navigable air space and its responsibility in ensuring safety along with efficient commerce and national defense.

As air traffic grew post-World War II, aeronautical safety remained a critical issue in the United States requiring additional federal oversight. The Federal

Aviation Act of 1958 created an independent agency responsible for civil aviation safety named the Federal Aviation Agency. In 1967, the Department of Transportation was established to provide comprehensive policies and programs regarding all modes of transportation and to combine federal transportation responsibilities. This new federal department would house the Federal Aviation Agency, which was subsequently renamed to what is now known as the FAA.

The FAA's role quickly expanded from providing air traffic control to environmental controls and safety certifications of not only airplanes and pilots but of airlines, and airports. As part of its work in air traffic, FAA has had to research and develop rules and regulations to address how the national airspace is used and the types of aircraft permitted. Although safe air travel and efficient commerce were fundamental responsibilities, the FAA also had to address recreational use as well as commercial and public use of the national air space.

i. Model Aircraft and Recreational Use

One of the earliest sets of guidance for recreational unmanned aircraft came from the FAA in 1981 through its Advisory Circular, AC No. 91-57. This FAA document outlined the "voluntary compliance with safety standards for model aircraft operators" that would help reduce potential hazards to piloted aircrafts and maintain a safe airspace. The operating standards requested that operators use sound judgement and suggested sufficient distance from populated areas, limited the height for flights or operations to 400 feet, and required yielding to full scale aircraft.

As drone use expanded into more areas of the country, the guidelines from AC No. 91-57 were no longer sufficient to address the increasing number of drones instead of model aircraft and the rise in commercial applications over just hobby use. By 2007, the FAA published a new policy statement outlining its view of drones and determining that operating "a UAS [drone] in the National Airspace System without specific authority" would not be permitted. While AC No. 91-57 would essentially remain in place for recreational use, the FAA differentiated commercial use from recreational use of the same types of aircraft. As a result, drone use, outside of use by hobbyists, was effectively limited in the United States until further protocols were established.

ii. FAA & Part 107

With commercial interest growing, the FAA continued to work on finalizing requirements for legal drone use. In June 2016, the FAA issued its official rules on the use of unmanned aircraft systems under the Code of Federal Regulations, Title 14 Part 107. 'Part 107,' as it is known, restricts drone weight to 55 pounds, while outlining the operational limitations and pilot responsibilities for drones. These rules limit flights to daylight hours only, include no fly zones directly over persons or moving vehicles, restrict payload capacities for drones, and limit drone flight to a maximum altitude of 400 feet. Most importantly, Part 107 requires a visual line of sight (VLOS) to the drone by the remote pilot or by a visual observer for the duration of the flight, as well as requiring close proximity between the drone and remote pilot.

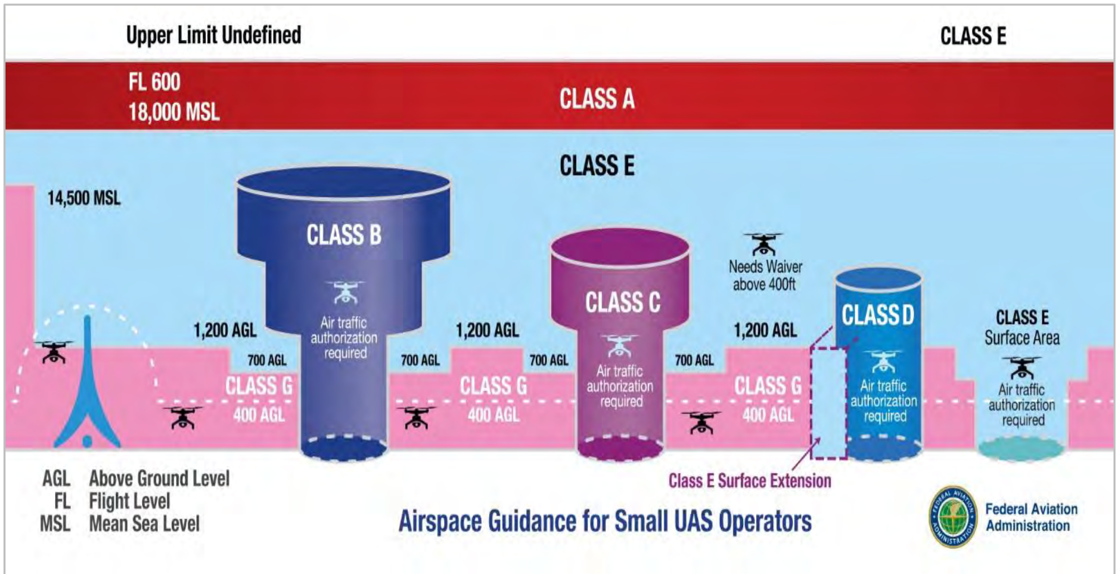
Part 107 also established a separate certification process for commercial drone use, creating a remote pilot in command position, where the operator must be certified by the FAA. The certification involves registering for and passing a test on aeronautical knowledge of drones and requires that the operator be at least 16 years old. The remote pilot must register their drone with the FAA and conduct a preflight check to ensure that it is in a condition for safe operation each flight. There is also a requirement for the remote pilot to report any drone operation that results in serious injury, loss of consciousness, or property damage of at least $500 to the FAA.

Many of the restrictions put in place by the FAA in Part 107 can be waived provided the applicant demonstrates that planned drone operations can safely be conducted under the terms of a certificate of waiver. The waiver application process allows 90 days for the FAA to review and respond to a specific request. Each request must describe the proposed operations in detail to the FAA and identify the possible operational risks and methods to mitigate those risks.

iii. Updates to Part 107

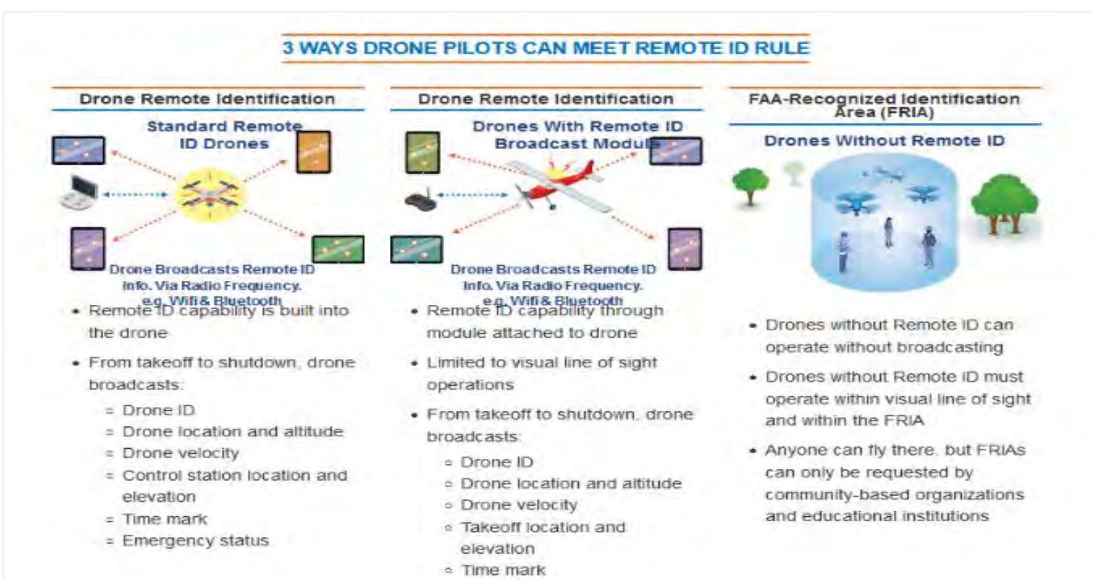
In January 2021, the FAA updated Part 107 to further integrate use of drones into the National Airspace System. The final rules are interconnected and changed two fundamental aspects of drone flights.

First, the updated Part 107 regulations require remote identification (Remote ID) for most unmanned aircraft to operate in the National Air Space in the coming years. Identification of unmanned aircraft is a step toward enabling further operational capabilities as well as addressing safety and law enforcement concerns. Remote ID will provide the FAA with information on drone flights, such as the identity, location, and altitude of the drone, as well as the control station or take-off location of a particular drone. The rule will also allow authorized public safety organizations to request the identity of a drone's owner from the FAA.



Airspace Guidance for Small Drone Operators

Remote ID can either be found as a built-in capability of a drone, or as an attached broadcast module on a retrofitted drone. The requirement for Remote ID will go into effect on September 16, 2023. Once the Remote ID regulations go into effect, both the built-in and attached module will broadcast the required drone information through radio frequency (e.g., WiFi or Bluetooth technology). Retrofitted drones will be limited to visual line of sight requirements. Drones without Remote ID will be permitted only in what are known as FAA-recognized identification areas. Currently only community-based or educational institutions can request such area designation from the FAA.

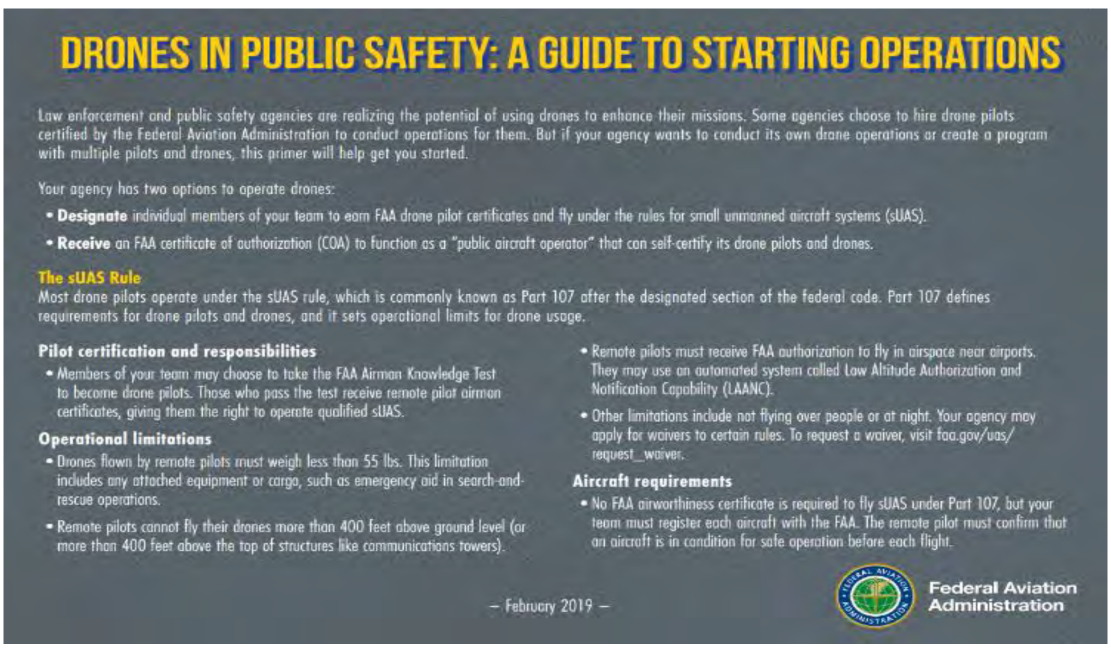


Remote ID Rule

Another change made by the FAA to Part 107 would allow drones outfitted with Remote ID to perform routine operations over people, moving vehicles, and nighttime flights under certain circumstances. The change eliminates the need for individual Part 107 waivers from the FAA for those specific operations. The FAA will also require pilots to complete a recurrent aeronautical knowledge test with the requirement to complete online recurrent training. Drones without Remote ID will not be permitted to operate over people.

iv. Certificate of Waiver or Authorization

In addition to Part 107, an option currently available to government agencies, law enforcement, and public safety entities who wish to pilot drones for official purposes are to obtain a Certificate of Waiver or Authorization (COA) from the FAA for these specific drone operations. A COA allows approved agencies or entities to operate as Public Aircraft Operators, who can then self-certify its drones and drone pilots. Types of public operators that have been granted COAs include federal and state agencies, higher education institutions, and various public safety agencies such as police or fire departments.



DRONES IN PUBLIC SAFETY: A GUIDE TO STARTING OPERATIONS

Law enforcement and public safety agencies are realizing the potential of using drones to enhance their missions. Some agencies choose to hire drone pilots certified by the Federal Aviation Administration to conduct operations for them. But if your agency wants to conduct its own drone operations or create a program with multiple pilots and drones, this primer will help get you started.

Your agency has two options to operate drones:

- **Designate** individual members of your team to earn FAA drone pilot certificates and fly under the rules for small unmanned aircraft systems (sUAS).
- **Receive** an FAA certificate of authorization (COA) to function as a "public aircraft operator" that can self-certify its drone pilots and drones.

The sUAS Rule

Most drone pilots operate under the sUAS rule, which is commonly known as Part 107 after the designated section of the federal code. Part 107 defines requirements for drone pilots and drones, and it sets operational limits for drone usage.

Pilot certification and responsibilities

- Members of your team may choose to take the FAA Airman Knowledge Test to become drone pilots. Those who pass the test receive remote pilot airman certificates, giving them the right to operate qualified sUAS.

Operational limitations

- Drones flown by remote pilots must weigh less than 55 lbs. This limitation includes any attached equipment or cargo, such as emergency aid in search-and-rescue operations.
- Remote pilots cannot fly their drones more than 400 feet above ground level (or more than 400 feet above the top of structures like communications towers).
- Remote pilots must receive FAA authorization to fly in airspace near airports. They may use an automated system called Low Altitude Authorization and Notification Capability (LAANC).
- Other limitations include not flying over people or at night. Your agency may apply for waivers to certain rules. To request a waiver, visit faa.gov/uas/request_waiver.

Aircraft requirements

- No FAA airworthiness certificate is required to fly sUAS under Part 107, but your team must register each aircraft with the FAA. The remote pilot must confirm that an aircraft is in condition for safe operation before each flight.

– February 2019 –

Federal Aviation Administration

Drone operations under a COA are restricted to specific public safety or governmental functions that are reviewed as part of the application to the FAA. While a COA provides an alternative to Part 107 waivers for approved agencies, the FAA conducts a more technical and comprehensive review of these applications prior to granting allowances for the requested drone operations. The review also includes an evaluation of the training and certification process for drones and pilots to ensure safety in the airspace. As a result, operating under a COA requires planning, training, and compliance requirements that do not exist under normal Part 107 operations.

v. *Emergency Response Authorization*

While the FAA regulations related to UAVs have grown stricter in recent years, there has been a specific carve out specifically related to emergency situations, allowing for greater flexibility in existing regulations in select cases. In the event of natural disasters or other emergency situations, first responders and other similar emergency response organizations may be eligible for expedited approval through the FAA's Special Governmental Interest (SGI) process. This allows pilots certified under Part 107 or entities with a COA to be granted approval on specific drone operations to respond to emergencies as needed. Operations that may be considered include firefighting, search and rescue, and utility or infrastructure restoration. Emergency response authorizations are reviewed with nearby air traffic control to ensure that use of the air space is coordinated.

vi. *FAA Partnerships and Research*

The FAA's publicly stated long-term vision for drones and other unmanned aerial systems is to fully integrate drone use in the National Airspace System. Instead of the current segregated operations, drones and other small, unmanned aircraft would share the same airspace and use the same air traffic management systems and procedures as manned aircraft. The FAA is currently collaborating with industry, government, and academia to develop protocols and tools that support this long-term goal. These partnerships and initiatives have already developed useful tools to help both the FAA and drone operators to safely fly drones.

One example is the mobile app B4UFLY, which improves upon the FAA's original interface to provide interactive maps indicating where drones can and cannot fly safely. The app provides "situational awareness" to both recreational flyers and other drone users by allowing operators to verify if any active airspace advisories are in effect in the surrounding airspace prior to launching a drone. The app also recently added a feature to allow crowdsourced data on local advisories and airspace restrictions to further help operators understand specific airspace conditions before flying. While B4UFLY is useful in preplanning drone flights, the app does not authorize users to enter controlled airspace.

Another partnership that further helps integrate drone use is FAA UAS Data Exchange, which supports the Low Altitude Authorization and Notification Capability (LAANC) system. LAANC works to provide drone pilots with access to controlled airspace up to 400 feet while simultaneously providing air traffic professionals at airports with information on where and when drones are operating nearby. LAANC includes an automated application and approval process for airspace authorizations through applications developed by approved UAS Service Suppliers. These applications greatly improve the time in which drone operators receive FAA approval for flights in controlled airspace. Pilots can receive their authorization in near-real time once approved. Requests for access are vetted through multiple airspace data sources in the FAA UAS Data Exchange. LAANC is already available at 726 airports nationwide, including John F. Kennedy International Airport, LaGuardia Airport, and Newark Liberty International Airport, and represents a major step in developing air traffic management for drones.

Parallel to these partnerships, the FAA is also researching and developing protocols in preparation for further expansion of commercial drone use, including data exchange requirements and a framework to allow multiple visual line of sight drone operations, in situations where FAA air traffic services are not available. Currently, the FAA, along with NASA, other federal agencies, and industry, are working on the Unmanned Aircraft System Traffic Management (UTM), which is a "traffic management" ecosystem for uncontrolled operations that is separate from, but complementary to, the FAA's Air Traffic Management (ATM) system. Instead of scaling the existing ATM system up to meet air service demands for drones, a UTM would provide an alternate system that relies on a network of separate service providers.

Under a UTM, operators of drones will not communicate with a single entity, such as the air traffic controller, to understand the surrounding airspace, but rather, will connect with service providers to determine the appropriate course of action for their planned flight. These service providers will be able to coordinate with the rest of the network to make efficient decisions based on specific flight objectives and will be held to relevant safety, security and performance standards. While the FAA's work to create a UTM is ongoing, UTM development will ultimately identify services, roles and responsibilities, information architecture, data exchange protocols, software functions, infrastructure, and performance requirements that facilitate the management of low-altitude uncontrolled drone operations.

As drone use continues to expand, more localized management of the airspace will be needed to ensure safe operations. The FAA has already taken the first steps into developing the necessary systems through UTM, and individual states and cities will have to continue this work for their regional environments.

C. Regulations Pertaining to Drone Use Throughout the United States

While drone operation in the United States is primarily overseen by the FAA, and drone usage across the country must comply with these national regulations, as discussed in the previous section, most states have also enacted legislation specific to when, where, and by who drones can be operated. There are some examples of specific laws that remain unique to a single state. However, there are also broader topics that have been addressed in a similar fashion by several states through similar pieces of legislation. The following presents several examples of state-wide drone regulations that have been enacted, and that impact drone use for façade inspections in those states.

Multiple states across the country currently have regulations prohibiting drones from flying over institutional facilities such as correctional facilities and have related regulations prohibiting the use of drones to assist in criminal activity, such as delivering contraband. Violation of these regulations are considered misdemeanors in multiple states. Many states, including Florida, allow drone use by law enforcement where “swift action” is required, but only after that law enforcement entity first obtains a warrant. Florida has also proposed legislation that would further expand the situations in which a drone could be authorized for use by law enforcement and other public officials. These types of state laws clearly limit where drones would be able to fly and who can fly them.

Privacy laws in multiple states across the country have been modified in recent years to address issues concerning the use of drones. For example, a 2015 Texas law allows for “individuals in certain professions” to use images captured by drones, as long as anyone in those images is unidentifiable. Such professions allowed to use images captured by drones include licensed real estate brokers, owners of gas pipelines and licensed engineers using the drone “in connection with the practice of engineering.” While laws protecting personal images in commercial drone use exist, there does not seem to be as many laws that specifically deal with how images and information from drones are captured and retained. One such law comes from Illinois. The Illinois law states that a law enforcement agency must destroy all information gathered by a drone within 30 days, unless a supervisor at that agency determines there is a reasonable suspicion the information contains evidence of criminal activity or may be part of an ongoing investigation.

D. New York State and New York City

Similar to other states, New York State has specific rules and regulations for drone use. Notably, while legislation has been proposed to address privacy concerns when using drones, there are no laws that would outright prohibit drone use. New York State regulations also build upon the federal requirements for drone operations previously described and are within the purview of specific state agencies.

i. New York State

Currently, regulations specific to drone use in New York State are limited, targeting only drone use in state parks, over historic sites, or on state managed lands. Since 2015, New York State Office of Parks, Recreation and Historic Preservation (OPRHP) has regulated the recreational, commercial and administrative uses of drones in OPRHP facilities, such as state parks and historic sites. Because drones operating within OPRHP facilities may impact staff, visitors, buildings, and natural resources, including wildlife, a permit is required to operate the drone. This permitting requirement allows OPRHP to monitor and control drone activities on these specific properties across the state. The OPRHP regulations specifically apply to drones launched and operated within OPRHP properties and relies on existing FAA regulations when drones are launched outside of such sites.

The New York State Department of Environmental Conservation (DEC) also has rules regarding the use of drones on lands it manages. The DEC rules for drone use vary depending on the area within the DEC managed land and the proposed activity. While DEC generally allows both commercial and hobbyist drones to operate in state forests, contact with the local DEC office prior to a flight is recommended to determine whether drones are permitted to operate in specific areas. A temporary revocable permit approval may also be required by DEC for activities such as research, gatherings of more than 20 people, competitive events or tournaments, or filmmaking. In March 2021, DEC published its drone policy for public comment, which includes details on how the agency itself would use drones to further its mission, as well as outline the rules for the public to operate drones within state lands. For example, any identifying information collected by a DEC drone, that is not part of DEC's work will be removed within 180 days.

Recently, new policies and legislation have been proposed as drone use continues to expand across New York State, particularly with the topic of privacy in mind. In January 2021, the New York State Legislature introduced a new bill, the "Protect Our Privacy (POP) Act," which would impose limitations on the use of drones for law enforcement purposes. In response to growing concerns over government surveillance, the bill prohibits the use of drones by law enforcement at concerts, protests, demonstrations, or other actions protected by the First Amendment. The proposed POP act would also require a search warrant to be obtained prior to a law enforcement entity using a drone.

ii. New York City

In addition to existing federal and state regulations, New York City has specific limitations set forth in the New York City Administrative Code that prohibit aircrafts from taking off or landing from areas outside of designated airports and heliports. Specifically, New York City Administrative Code Section 10-126(c) states:

"Take offs and landings. It shall be unlawful for any person navigating an aircraft to take off or land, except in an emergency, at any place within the limits of the city other than places of landing designated by the department of transportation or the port of New York authority."

Although this specific statute from 1948 was intended to target other types of aircrafts, it also applies to drones, and presents a barrier for drone operations to be expanded throughout the City. Section 10-126(h) of the New York City Administrative Code allows the Police Commissioner to develop rules and regulations to enforce the provisions of the section, and Section 10-126(i) deems any violation of the section a misdemeanor.

While Section 10-126(c) is often cited as the general prohibition on drone operations in the City, there are additional rules in place at the city level that regulate drone use. The New York City Department of Parks and Recreation (DPR) has specific regulations to limit where drones may be operated on park properties. DPR Rule 1-05(r)(2) states:

"No person shall engage in any toy or model aviation, model boating, model automobile, or activity involving other similar devices except at such times and at such places designated or maintained for such purposes. Violation of this paragraph constitutes a misdemeanor."

Designated areas for model aircraft fields are limited to the following five parks in the City:

- Brooklyn – Calvert Vaux Park and Marine Park
- Queens – Flushing Meadows Corona Park and Forest Park
- Staten Island – La Tourette Park

Because New York City Administrative Code Section 10-126(c) limits take-offs and landings to areas near airports and heliports, drone operations are then also limited to these areas. This will impede the potential use of drones in façade inspections in several ways. First, drone batteries are part of the aircraft payload and energy must be expended to fly drones from designated areas to subject buildings. Battery capacities may not be sufficient to cover substantial distances to and from a site and then to continue to operate during façade inspections. Second, areas near designated airports and heliports may not be located in close proximity to buildings that require façade inspections since many adjacent neighborhoods in these areas consist of low-rise buildings. Even where subject buildings are near an airport or heliport, a visual line of sight must be maintained by the drone pilot, which means that the pilot may have to walk the drone from designated take-off and landing spaces to the subject building. Take-off and landing of a drone cannot occur at the building, which would increase the flight time, and walking the drone from designated areas may endanger the remote pilot.

The New York City Council has introduced bills to clarify the provisions of Administrative Code Section 10-126 or to directly address drone use in New York City. Notably, Intro 0403-2018 sought to amend the Administrative Code with regard to regulating the use of drones in the City's airspace. Among the proposed provisions, this bill expressly defined drones in Section 10-126 and created the allowance for drones to take off or land where a drone may be operated legally, provided there was no threat of harm or risk to people or property. Intro 0403-2018 also exempted city agencies from the provisions of Section 10-126, which would allow the City to use drones for public safety and other public work. Another proposal, Intro 0235-2018, sought to regulate drones through registration and insurance mandates. The requirement for liability insurance is proposed to insure the drone owner, lessee, operator, and the City, and would cover personal injury and property damage.

E. FISP Rule and Drone Use

If legislation was enacted to allow for drone flights in New York City, and the use of drones to conduct façade inspections is determined to be appropriate, 1 RCNY 103-04 would need to be revisited and revised. Elements of the rule that would need to be revised include the qualifications for QEWIs, ensuring the burden of responsibility for the inspection remains with the QEWI, and addressing which elements of the façade inspection could be performed with the use of a drone.

The first section of the rule to consider is section (c) regarding critical examinations. Currently, subsection (2)(iii) states "the QEWI must design an inspection program for the specific building to be inspected, which must include, but not be limited to, the methods to be employed in the examination…" It should be considered that a QEWI would have the ability to incorporate a drone survey as a component of the inspection program they are designing. This requirement would have to be applied in a unique fashion to drone use, as drones are required to be flown by licensed pilots. The rule further states that "architects, engineers, individuals with a bachelor's degree in architecture or engineering and three (3) years of relevant FISP inspection experience, or individuals with five (5) years of relevant FISP inspection experience working under the QEWI's direct supervision, may be delegated to perform selected inspection tasks." The population of people with these credentials who also have their FAA Part 107 pilots license may be small. As drone flight teams usually consist of a minimum of the *pilot in command*, who is required to have their pilots license, and the "visual observer," who is not required to be licensed, consideration should be given to requiring that the visual observer be the QEWI to meet the requirements of the rule.

The next subsection (2)(iv) addresses the methods by which the QEWI must perform the façade inspection. This section states that drones and other technologies do not eliminate the requirements for close-up inspections. However, prior to that statement, several different aspects of the inspection program are addressed. The following are those points in the subsection, along with the potential applicability of drone use.

- "Except as herein required, the use of a scaffold or other observation platform is preferred, but the QEWI may use other methods of inspection as they deem appropriate." This requirement could be met by a drone, but the limitations of drone use would need to be addressed in the rule.
- "Physical examinations from scaffolding or other observation platform *(close-up inspections)* must be performed at intervals of not more than 60'-0", with the minimum number of physical examinations per total length of façade elevation noted in the table below." As stated throughout this report, the rule is explicit in prohibiting the use of drones to replace the close-up inspection, but they could potentially be used to assist in the selection of the location of close-up inspections.
- "The QEWI shall determine the most deleterious locations and perform physical examinations at those locations." Again, a drone could be used to augment the QEWI's critical examination to choose optimal locations for the close-up inspection.

The following subsection, (2)(v), addresses the extent of the critical examination, recognizing that all buildings are different and would need "special or additional inspections and/or tests" depending on the history of the building and the nature of materials used. One of the requirements in the subsection is that the QEWI "must ascertain the cause of these and such other conditions detected." While a drone could help detect a defect, it is not capable of assigning potential cause of the condition. This would require the QEWI to observe the condition up close. Another requirement is that "probes must be performed on all cavity wall construction" and these probes "must be completed along each required close-up inspection interval." A drone does not have the capability to conduct required probes, and as a result, this requirement could not be met with the assistance of a drone.

2. COMPARISON WITH SIMILAR JURISDICTIONS

A. Comparison of Façade Requirements in Other Cities in the United States

The first façade inspection ordinance in the country was proposed in Chicago in 1976, although it wasn't enacted at that time. New York City started requirements for façade inspections with Local Law 10 of 1980 which, though modified over the years, has continued making us the first location in the country to enact a façade ordinance. Since that time, 11 other cities in the United States now have requirements for routine inspections of building façades.

The ordinances throughout the United States follow similar requirements, though they vary in the following aspects:

- which buildings are subject to the requirements
- which walls of those buildings are subject to:
  - overall inspection requirements; and
  - close-up inspection requirements
- when the first inspection report is due; and
- how often an inspection would have to be conducted and a report filed after the initial filing.

In all but one case, the inspection has to be performed by a licensed architect or engineer (Detroit is the only exception, allowing for a "competent person"). When the first report is due has the greatest variation ranging from within the first year of adoption of the Code (Pittsburgh adopted its Code in 2003) to 30 years after building completion (San Francisco and Cleveland). Almost all of the cities specify a frequency of five years for when reports are to be filed, though some specify different frequencies depending on whether a building is occupied (in Boston a report must be filed every year if the building is unoccupied) or depending on construction type (Cincinnati requires reports every 5, 8, or 12 years depending on whether the walls are in contact with corrodible, corrosion resistant, or non-corroding metal, respectively).

Most cities cite five stories as the minimum height for buildings subject to façade inspection requirements and state that all walls are subject to inspection. Though Chicago specifies that subject buildings are to be 80 feet or greater, and inspection requirements cover only 50% of walls, 100% of corners and all terra cotta. Only five cities besides New York City specify minimum standards for required close-up inspections. In Columbus, close-up inspections are required only in a designated geographic area. St. Louis and Pittsburgh don't mention any close-up inspection requirements and three other cities (Detroit, Philadelphia, and Cleveland) leave it open to the determination of the person performing the inspection (keeping in mind Detroit is the one city that does not require a licensed professional to perform the façade inspection).

In comparing FISP to the inspection requirements of other cities with façade ordinances, it is apparent that New York City has regulations that are generally aligned with such other cities. Five other cities across the country have specified requirements for close-up inspections. Four of these city façade ordinances require that one scaffold drop per façade be conducted at a minimum, which is similar to the requirements of the previous version of 1 RCNY 103-04 but is less comprehensive than current requirements under FISP. Pittsburgh specifies that 25% of each subject façade is to have a close-up inspection, which puts it more in line with the latest version of the FISP rule, which requires a minimum of one close-up inspection for every 60 feet fronting a public right-way.

B. Review of Drone Use for Façade Inspections in Other Jurisdictions

DOB contacted the governments of other major cities with comparable building stock, including Chicago, Philadelphia and Miami, to better understand how drones may be incorporated into façade inspections.

i. Chicago

As noted previously, Chicago has a façade ordinance in place with similar height thresholds as New York City, but there are notable differences in the filing and reporting requirements in each city. In Chicago, buildings over 80 feet in height are required to be inspected on a biennial basis with a report filed with the Chicago Department of Buildings. The report consists of a short form checklist and a letter enumerating the façade conditions that require ongoing monitoring based on a visual inspection. Since a 2012 rule change in Chicago, the **hands-on** requirement for façade inspections has been optional. A hands-on inspection is only mandatory if a building owner is more than ten months late with their required façade inspection filing, or where the inspecting professional finds areas of concern from the visual inspection.

In 2019, local restrictions on drone use in Chicago were lifted. In DOB's discussions with officials in the Chicago Department of Buildings, it was noted that there have not been many documented instances of drone use for façade inspections. Officials noted one case where a building had missed its filing deadline, and the ten-month grace period, triggering the requirement for hands-on inspections. The subject building was built in 2000 and was described as a plain rectangular building. Typically, a hands-on inspection from a hanging scaffold would be required on each face of the exterior walls, but the applicant proposed to use a drone to accomplish the work. Ultimately, the use of drones was allowed on two elevations because there were hands-on inspections performed from the balconies to supplement the drone data captured.

ii. Philadelphia

The threshold for façade inspections in Philadelphia is slightly lower than New York's, where buildings over 60 feet or 6-stories in height, including appurtenances, are required to be inspected every 5 years. The inaugural inspection for new buildings is 10 years after construction and then every 5 years. Recently, Philadelphia opened an online portal for filing a one-page summary documenting the façade inspection. Previously, applicants emailed their findings with attachments to the Philadelphia Department of Licenses and Inspections, which included the full façade inspection report and additional information.

Hands-on inspections are required and at least one physical inspection must be performed from a scaffold or observation platform. Any additional hands-on inspections, including the number and interval, are determined by the registered design professional to provide a representative sample of a building's conditions. The façade inspector must certify that all details of the building façade (e.g., windows and sills) have been inspected.

In the past, a few reports have included references to photographs that were captured by drones. The images were to supplement the visual inspection and did not supplant the hands-on inspection requirement. Philadelphia has also considered in the past to use drones in emergency response or to identify unsafe buildings that would require action from the City. Unfortunately, there were not sufficient resources to move forward with these proposals.

iii. Miami & Miami-Dade County

DOB also spoke with officials from Miami-Dade County and the City of Miami. Miami and Miami-Dade County require all buildings 40 years and older to be recertified for continued safe use. All buildings, except single family homes, duplexes, or structures less than 2,000 square feet, are required to file a recertification report with the Department of Buildings. The report is prepared by a design professional (engineer or architect) registered in Florida and certifies that the building is structurally and electrically safe for continued occupancy. The recertification requirements focus on the overall structure and are not specific to façades. After the initial 40-year recertification, inspections are then required every 10 years after.

One façade component required for regular inspection in these jurisdictions is structural glazing systems (fixed glass) installed on a threshold building, on buildings greater than three stories or 50 feet in height, or which has an assembly occupancy with a large number of occupants. The structural glazing system must be inspected and recertified every 5 years to determine the structural condition and adhesive capacity of the silicone sealant used for structural glazing. The condition of the structural glazing is documented in a report certified by a registered design professional. Other types of façades do not have mandatory inspection requirements.

Given the nature of Miami and Miami-Dade's requirements, drones have not played a large role in building inspections. While drones are prominently used for aerial photography during construction to monitor sites and progress, neither building official recalls any instances where drones were used for building inspections. Additionally, neither municipality has used drones due to privacy concerns.

C. Setting the Standard of Care for Drone Use for Façade Inspections

This section described the regulatory framework that restricts or otherwise controls the use of drones in the United States and locally. With the growth of drone use, current regulations are the result of distinct interests in drone operations and require compliance with multiple levels of government. Despite clear rules and laws on drone operations, there is a lack of specific regulations regarding the use of drones to conduct façade inspections.

After DOB's discussions with other major cities, DOB found that the use of drones explicitly for façade inspections has been minimal, even in cities where drone operations are permitted. Furthermore, DOB learned that proposing drone use for façade inspections touches on various issues and concerns that are not related to façade inspections and building safety. These issues range from universal concerns, such as privacy, to operational tasks, such as data management.

With the longest running, and arguably one of the most robust, façade inspection programs in the United States, New York City has the opportunity to set the standard of care for drone use for façade inspections. In that regard, New York City has an opportunity to lead the way in using drones and other new technologies to enhance its already formidable façade inspection program.

City	Enacted	Subject Buildings	Reporting Frequency	Subject Walls	Close-up Inspections
New York, NY	1980	H > 6.5 stories	5yrs	All Walls (except w/in 12" of adjacent walls)	1 per 60' along ROW
Boston, MA	1995	H > 70 feet or high rise excluding residential three family or less	5 years (1yr if unoccupied)	All walls	high-rise or >125', one drop per façade
Chicago, IL	1996	H => 80 feet	2 years (critical exam every 4, 8, or 12 years)	50% of walls, 100% corners, all terra cotta	1 drop per public way spanning no less than 24'
Columbus, OH	1985	Age => 20 years w/in 10 feet of right of way excluding residential three family or less	5 years	All walls	downtown special critical observation areas only
Detroit, MI	2003	H => 5 stories	5 years	All walls, projections, and roof mounted structures	as required by BSEED
Milwaukee, WI	2001	H => 5 stories and age => 15 years	5, 8 or 12 years (based on age)	All walls	one scaffold drop per façade
Philadelphia, PA	2010	H => 6 stories or =>60' w/ appurtenances, and >2 story buildings in areas TBD	5 years	All walls and appurtenances	Representative area (no required minimums)
Pittsburgh, PA	2004	All buildings	5 years	All walls (except buildings in Use Group R-3)	N/A
St. Louis, MO	2009	H > 6 stories	5 or 3 years for balconies, stairs, and fire escapes	All walls	N/A
San Francisco, CA	2016	H=> 5 stories	5 years	All walls	25% of each subject façade
Cincinnati, OH	2016	H=> 5 stories	5, 8, or 12 years (based on type of wall construction)	All walls	one scaffold drop per façade, and any additional areas requiring investigation
Cleveland, OH	2016	H=> 5 stories or 75'	5yrs	All walls	areas found to be deficient

SECTION III: WHAT COULD WE EXPECT?

1. DRONES IN SOCIETY

Drone use for façade inspections might impact New Yorkers in different ways, including property owners of FISP buildings, QEWIs, emergency responders, and pedestrians walking down the street. While drones are in limited use by New York City's emergency response agencies today, expanding the use of drones to façade inspections could have economic impacts and raise broader data collection and privacy concerns.

A. Current Drone Use by New York City Emergency Response Agencies

The Fire Department of New York (FDNY) and the City's Emergency Management Agency (NYCEM) have established drone programs within recent years and shared their knowledge on the subject as part of interviews for this report. Before discussing FDNY and NYCEM's programs, note that this report does not include an interview with the New York Police Department (NYPD), which also has its own drone program. Although NYPD's drone program would be beneficial in understanding citywide drone use, the use of drones in law enforcement differs from emergency response and façade inspections.

i. FDNY

FDNY's drone program officially began in February 2017 after several years of planning and is now part of their Robotics Unit, which is the group within the agency dedicated to all robotic technology. They initially focused on the use of tethered drones as they were initially thought to be safer to operate. However, soon after, they found that untethered drones proved to be a safer alternative, compared to the tethered model. The presence of magnetic interference, primarily in Manhattan, causes problems with a drone's Inertial Measurement Unit (IMU), which controls headings and station keeping, and was especially problematic for the tethered drone models that were initially being used. While the tethered model is still available, FDNY currently only owns and regularly uses untethered quadcopter drones. The Agency is also currently researching into whether to incorporate hybrid drones with propellers and fixed wing for vertical takeoff and landing (VTOL) into their existing drone program, which allows for take-off and landings anywhere with the added capability of long endurance flights.

Currently, drone operations are part of the Command Tactical Unit (CTU), which is located within the agency's larger Rescue Operations group. The entire CTU has, or is in the process of getting, their pilots license. Each operation of a drone conducted by FDNY in the field consists of the following three- to four-person team:

- **Pilot in Control** – The individual who operates the drone and makes required notifications to the FAA.
- **Visual Observer** – The individual, required per FAA requirements, to scan the airspace and activity below and who may drive the FDNY vehicle to the location of operations.
- **Data Specialist** – The individual responsible for the safe set up and uploading of streaming video, which gets transported to the incident commander on emergency sites and any other relevant parties.
- **Air Boss** *(Large Scale Events Only)* – Where needed, this individual's role is to reduce the risk of collision between drones and manned aviation (i.e., helicopters or planes), by looking at parts of the situation that the above members are not.

As part of the drone program, FDNY had previously trained with the New York State agency responsible for security and emergency services at their dedicated training center upstate. This training program offers several different courses to help public safety agencies develop their own drone programs and train drone operators. Recently, FDNY decided to open their own drone training facility, and are looking for accreditation for their training program. This training program would include a 40-hour course, which includes break out modules on various topics related to drones. In addition to the pilot's license required by the FAA regulations, this course would teach additional techniques and skills needed for planning and piloting drone operations in an urban environment.

ii. NYCEM

Similar to FDNY, NYCEM recently developed its own drone program to capture and map data during and after emergency events. Many of those involved with FDNY's drone program were tapped to help NYCEM create their program, and drones now play a role in NYCEM's field response unit to support their emergency response work. This agency combines drones with geographic information system (GIS) software to build a visual understanding of an emergency incident. The result creates a greater situational awareness for team members responding to an incident, that allows members of the team across different units to quickly identify areas of concern and respond more efficiently.

When deployed in the field, the typical drone team currently consists of two individuals, including a pilot and a visual observer. While the drone pilot is

FAA certified, the visual observer is usually someone who is interested in working with drones but who has not necessarily been certified yet. NYCEM's drone program regularly coordinates with FDNY's drone program, with teams working closely together when responding to incidents, to ensure the safety of anyone near the in-flight drones. The two agencies currently also coordinate on shared drone training programs.

NYCEM primarily uses quadcopter type drones with built-in cameras, which include both visual cameras as well as infrared (IR) capabilities. These types of drones allow for easy deployment, although local conditions, such as increased magnetic interference found in Manhattan, may make for more difficult operations. Based on technological limitations, images and data collected by these NYCEM drone-mounted cameras are not immediately accessible to the agency and need to be processed at the back end to translate the information into a more usable format. This process takes an additional two to three hours after images are downloaded, which makes this drone program more suitable for longer term planning operations. As data from drones become more readily available, software to manage all this information will play a larger role in NYCEM's program. Storage capacity is also a concern where there may not be sufficient capacity to process the raw data in a timely manner for use in responding to an event.

B. Potential Data Collection and Security Obstacles Related to Drones

In the case of façade inspections, drones and other technologies could be used to capture and process photographs. Additionally, location data associated with the photographs may also be another datapoint that is collected should drones be used to conduct façade inspections, although this information may not be submitted to DOB. Two of the important aspects of the use of drones for image capture are privacy concerns and the integrity of data collection and data transfer. Drones can collect and transmit data in new and more efficient ways, but essentially the data they would collect for a FISP inspection would not be that different from data that is currently collected and submitted to DOB following a traditional inspection.

i. Data Collection & Management

There are multiple software programs through which a drone's flight plan is programmed and the data is collected, with different companies having different specialties (i.e., one type of program may be more suited to agricultural uses, whereas others are more appropriate to public safety operations). Whereas previously a drone being used with one software could not *see* a drone flying with a different software, the new FAA requirement of Remote ID addresses this issue by requiring drones to provide their identity and location as well as other information.

As it relates to FISP, DOB is not aware of any software specifically related to façade inspections, however, it would seem that on the scale of drone use, this type of inspection would mostly be straightforward, collecting images only and their associated locations. Most software can also collect infrared, thermal and moisture data as well, although this type of information is not needed for a FISP report.

There are concerns that data collected by drones can end up in the wrong hands and be used for other than their intended purpose. However, with regards to FISP inspections, the process of image collection and handling would not deviate significantly from current practice. Collecting the data with a drone, which in the case of a façade inspection would consist of capturing photographs and the accompanying location data, is the first step in turning that information into part of a usable and acceptable FISP report. This data would need to be transmitted to the company's servers, via an SD card or potentially a cloud-based program. It would be reasonable to assume that any security threats that are normally associated with cloud computing would still apply in this case. The data is then stored on the company's servers. In most cases, the data retention protocol at this point is the same for any other file. In many cases, the data becomes the property of the client, the building owner.

The personnel handling this information would be the pilot, QEWI, QEWI's designees and the building owner and/or their representatives. Apart from the pilot, this is the same personnel that currently has access to the images captured in conjunction with a FISP report. Having said that, one company DOB spoke with, which provides drone services, told us that in some cases they are not privy to why they are collecting images. As is discussed elsewhere in this report, if a drone inspection is accepted as part of an overall FISP report, a third-party drone service provider would be required to be directed by a QEWI. Thus, who is collecting what data would be clear.

ii. Façade Inspections with Drones & Privacy Concerns

The unexpected presence of a small, unmanned aircraft in one's vicinity can be unnerving, typically because the operator or purpose is often unclear. However, a drone inspection related to FISP can easily be a known entity because, while more subtle, a drone inspection is just as, if not less, invasive than a close-up inspection. Currently the required close-up inspections of façades require a certain level of potential intrusion in and of themselves, with QEWIs, scaffold riggers, and other contractors gliding past windows on multiple floors in a continuous fashion from grade to the top of the wall as they complete the required physical, close-up examination. One firm informed us that they can review the images with the client to see if anything needs to be adjusted for privacy's sake (i.e., blurring of faces or other identifying characteristics). If the use of drones were to be allowed in New York City, adding language to any rule that owners are taking all necessary precautions to protect the privacy of individuals, and that the drone won't be used for any other purpose, could be considered.

In most cases of occupied buildings, the inspection is coordinated with building management whose responsibility it is to alert their tenants. When DOB discussed this topic with private companies who use drones for similar inspections, they indicated that they leave the responsibility for notification with the property owner or building management. The method of alert is determined by the building management, whether it's a note slipped under doors, an email or text blast, or drawing the curtains as may be the case in a hospital.

However, in these cases, it is very apparent to people inside and outside of the building who is looking at what because they are on notice. A professional taking pictures will limit the photographs to the façade and the associated deficiencies found, while it may appear to an outside observer that a drone is taking videos or photographs of everything in sight. One agency DOB spoke with pointed out that the data taken from most drone software programs include the direction of the camera to address such issues. Should a challenge arise as to what the drone was inspecting, such information could be shared to clarify intentions.

One drone operator, based in upstate New York, informed DOB that their pilots wear high visibility vests when flying their drones. While that may be an effective way to communicate their activities to observers in a campus-type environment of a suburban hospital or learning complex, that may not be so effective when the pilot is on 5th Avenue in Manhattan and the drone is hovering outside of a penthouse apartment on the 43rd Floor. So potentially, where in a traditional FISP inspection, the subject building's staff and occupants are notified, should notification to surrounding buildings be required as well? Might a sign, similar to the people working sign in the street and surrounding streets be sufficient? Notification to adjoining properties should be considered if drone use will be allowed as part of the FISP inspection process.

A comprehensive evaluation and discussion of the security of data collection methods and any associated privacy concerns is outside of the purview of this report. Such issues would need to be studied by those with more expertise in either or both of those areas of concern as the use of drones for façade inspections is further evaluated. However, as it relates to façade inspections and the specific type and volume of data that would need to be collected to support FISP inspections, the impact on privacy issues may be minimal.

C. Economic Benefits for Façade Inspections

Assessing the economic benefits of using drones for façade inspections proved challenging for several reasons. First, use of the technology is still very new and consequently, there is not that much data from which decisive conclusions can be drawn. DOB found that most architectural or engineering firms that do have a drone program in place offer it as a service to clients mostly to supplement a traditional façade inspection program. Second, as stated throughout this report, a close-up inspection will still be required, even if a drone is used to support a façade inspection. This means that the other services related to a façade inspection are still being provided and budgeted for.

However, to assess what economic benefits drones could have on façade inspections, DOB presented two case studies for FISP inspections to three organizations, each of which had a different relationship to the current façade inspection program.

i. Analysis of Case Studies

Our baseline data were proposals provided by the New York City Housing Authority (NYCHA), a public housing authority, for the traditional inspections of two types of campuses. NYCHA has thousands of buildings in the city, of which about 1,500 are required to file FISP reports. They typically contract with about ten architectural and engineering firms to perform this work. Many of their properties are campuses comprised of multiple buildings. Each case study consists of two campuses, each with slightly different characteristics.

DOB provided the three companies a description of the campuses and their locations and asked them to provide a sample job estimate for a FISP inspection involving a drone inspection of each campus. The direction was that the drone inspection would only replace the visual inspection component of a FISP inspection.

ii. Description of Projects

Both projects are campuses consisting of multiple buildings greater than six stories in height. Case 1 consists of 23 buildings that are all eight stories high and have cavity wall construction. Case 2 consists of 13 buildings ranging in height from six to thirteen stories all with solid wall construction. The proposals provided by the housing authority for the actual inspection campaigns cover a visual inspection, the required close-up inspections every 60 feet and filing a FISP report with DOB. The scope for Case 1 also includes the required number of probes at the cavity walls. It is important to keep in mind that we are basing this study on the presumption that a drone inspection does not replace the hands-on inspection. Therefore, to be able to conduct as close to a viable comparison as possible, it is necessary to be clear about our assumptions and caveats and those of the firms providing us with their estimates.

iii. Comparing the Proposals

Both proposals for the housing authority are for a *traditional* (i.e., without drones) inspection and break out the fees in a similar fashion. The base fee includes the visual inspection and reports with *add-ons* provided to include the close-up inspections. Since a drone survey only augments the visual inspection and does not replace the close-up inspection, it is reasonable to compare the proposed fees to the base fee only.

All three firms which provided us their estimates as part of our case studies included post-processing in their estimates, and the two engineering firms included filing with the Department. Therefore, additional fees would need to be allotted to Company C's estimate to account for the fee to file. Note Company A provided us with two sets of estimates based on two separate scenarios, which are described below.

The estimates are summarized in the following table:

		CASE 1	CASE 2
Company	**Company Description**		
Baseline case: Consultants to Public Housing Authority	Engineering companies that regularly file FISP	$141,450.00	$161,500.00
Company A *(drone with FISP filing)*	Engineering company that regularly files FISP	$218,500.00	$141,500.00
Company A *(drone only)*		$27,715.00	$30,215.00
Company B *(drone with FISP filing)*	Engineering company that does not regularly file FISP	$18-$30K	$18-$30K
Company C *(drone only)*	Drone data capture company	$92,000.00	$68,000.00

As can be seen from the range of estimates, the above noted estimates are hypothetical in that each organization is approaching the project from slightly to significantly different perspectives. To provide some context and to attempt to assess any economic benefits that a drone supplemented FISP inspection may provide, explanations for the estimates provided are provided below.

iv. Description of Companies Providing Estimates

Company A is based solely in New York City and their services include building envelope investigations, structural engineering, architectural design, and forensic surveys. They file hundreds of FISP reports per cycle and have filed thousands of FISP reports over the years. Consequently, Company A is very familiar with our FISP processes, and their president is a member of the Administrative and Enforcement Advisory committee which was intricately involved with the development of the latest revision to 1 RCNY 103-04 that went into effect in February of 2020. They provide drone inspection services to areas outside of New York City. These services are performed by their in-house drone department which consists of four licensed pilots.

Company A provided DOB with two sets of estimates, one for a non-FISP drone survey only and one that accounts for the preparation and filing of a FISP report which would include images taken from a drone. It should also be noted that Company A has experience with performing FISP inspections for public housing buildings and provided us with their baseline fees for this work. It should not be surprising that the numbers are in line with the actual numbers prepared for the public housing authority by consultants that are also very familiar with FISP processes and filing requirements.

Company B is an engineering firm specializing in the design and rehabilitation of structures, building enclosures, and materials. They have multiple offices around the country, including one in New York City. Though building enclosures is one of their specialties, they are not regular filers with FISP, having only submitted two reports in the past 10 years. They have one drone operator who performs the inspections under the guidance of an engineer, and they subcontract out drone inspections when necessary.

Company B's cost range was similar for both campuses, with the principal of the firm citing that "data collection between the two campuses is really not that significantly different – the larger number of short, rectangular buildings on the Case 1 campus is balanced by the small number of larger, more H-shaped buildings on the Case 2 campus. Post processing and engineering time for evaluation and reports evens out in the same manner." The numbers noted above do include post processing analysis and filing.

Company C, located in upstate New York, is a provider of drone-enabled services and technology. They provide complete building envelope inspections including thermal imaging of roofs, building mapping and high-resolution photography. They are not an architectural or engineering firm and have never been involved in the FISP program.

v. Assessing the Drone Data Capture Company

The figures in the table are those for the initial inspection and include reporting and analysis, though neither the content of the report nor the nature of the analysis meets FISP requirements. Per Company C, their standard analysis includes highlighting any obvious damage or missing elements in the photographs. This work is performed by engineering students or recent graduate yet to obtain licensure. This in and of itself would preclude it from being a FISP report that would be accepted by our FISP plan examiners.

The information gets aggregated into an interactive PDF that is provided to the client, usually the property owner. Company C's reports allow the end user to navigate between different parts of the report, elevation drawings to detail photos, within the PDF document. While the report is technologically sophisticated, its content lacks the technical expertise required for a FISP report. There is no discussion of potential causes or underlying conditions of the noted damages. Note that 1 RCNY 103-04 (c)(3)(iii)(H) requires that QEWIs include "an analysis of the causes of the conditions reported as unsafe or SWARMP" in the report.

Presuming that Company C is providing the visual examination part of a FISP report, the documents as currently provided would then need to be processed and evaluated by a QEWI. This QEWI would then need to translate this information into a FISP report for each building, which would increase the overall fee to provide a FISP report that is included in Company A's and Company B's fees already.

There is also a FISP requirement that the QEWI must conduct a final visual inspection within 60 days before filing the report. Thus, a separate site visit by the QEWI would be required in any case.

vi. Comparing Company C to Another Drone Data Capture Company

For an inspection campaign for summer 2021, a different authority, this one for schools, solicited imagery suppliers that use drones to inspect one of their schools. The school is only four stories in height but occupies an entire block with a footprint of roughly 80,000 square feet. A different drone-based data capture company, this one located in Brooklyn, estimated a cost of $8,514 to provide services "based on Local Law [11]." Case 2 is comprised of buildings of varying heights and footprints. Company C broke out their per building price by building size with the largest (with a footprint of 11,000 square feet) priced at $6,000 per building. Scaling this estimate to account for the one, larger building does somewhat result in a similar total estimate as the public housing example provided by Company C.

vii. Conclusion to the Case Studies

Based on these responses to the proposed case studies, it is apparent that, at least with experienced FISP filers, including a drone to supplement a FISP inspection campaign has minimal impact on the final cost. Company C's relatively high fee may be due to the fact that they are not based in New York City and are unfamiliar with the physical environment in which they would be flying. As was mentioned, their final interactive report is rather sophisticated, but does not meet FISP requirements. Potentially, in our hypothetical case, if Company C were going to pursue providing drone imagery for FISP reports, they could quite easily tailor their report to meet FISP requirements.

In summary, DOB's evaluation of the economic impact of drone use to facilitate or supplement the visual inspection component of a FISP inspection program is that there is likely no tangible direct cost savings. Having said that, without a side-by-side comparison of the same sets of buildings for a comprehensive traditional FISP inspection program with the permitted use of drones it is difficult to accurately assess economic impact with the limited information currently available.

viii. Summary of Economic Impact

There is little question that drones offer greater access to high resolution visual documentation, such as photographs and videos which when properly used will be able to enhance a FISP report. However, even with the use of other technologies such as IR and LiDAR, current drone technology cannot replace hands-on inspections, which allows qualified individuals direct contact with the building façade. As such, whether the use of drones in façade inspections could have beneficial economic impacts cannot be determined at this time, especially considering the requirements for probes and hands-on inspections will still be in place.

C. Impact on Pedestrian Safety and Reduction of Sidewalk Sheds

One of the aspects DOB has been asked to evaluate is the potential reduction of the number of sidewalk sheds in the city should drones be allowed for use in façade inspections. It is important to distinguish between the methods used to protect the public from unsafe façade conditions, which are sidewalk sheds, and those used to conduct a façade close-up inspection, which is scaffolding. Sidewalk sheds, when correctly designed and installed, protect pedestrians and passers-by from potential falling debris. In this regard, sidewalk sheds should be considered as a symptom of an underlying condition (i.e., an unsafe façade or ongoing construction work). Sidewalk sheds, when used to support scaffolding, also provide access to the façade of the building to perform repairs, with supported scaffolding serving as a frame for safety netting in addition to access. Both sidewalk sheds and scaffolding must be designed and installed in accordance with the NYC Building Code and filed by registered design professionals.

i. Sidewalk Sheds and FISP

The landscape of sidewalk sheds in the city can be described by how many there are, how long, on average, they've been in place, and why they are there in the first place. Also, we will address when a building subject to FISP would require for a shed to be in place and when it would not.

As of July 15, 2021, there were 9,019 active sidewalk shed permits.

- 3,321 or 37% are in place due to Local Law 11.
- 975 or 11% are in place in connection with the construction of a new building.

- 5,698 or 63% are in place in connection with another reason, which most commonly includes maintenance. Other reasons include:
  - a minor alteration (1,634 or 18%);
  - a major alteration (695 or 8%);
  - demolition work (145 or 2%); or
  - only a sidewalk shed permit and no other work at the building (2,249 or 25%).

Within FISP, when a compliance report is filed classifying the building as **unsafe**, that building will likely require public protection, which usually takes the form of a sidewalk shed. A building with an unsafe classification would not require a shed if the QEWI explicitly states in the report that public protection is not required (i.e., the unsafe conditions are not located over a public right of way). Also, if the building is filed with uncorrected SWARMP conditions from the previous cycle, it is required to be filed as **Unsafe**, but if those conditions do not present an immediate hazard, public protection is not required, though these cases are rare.

Sidewalk Shed


Scaffolding

Other cases in which a FISP building would have a sidewalk shed in place is if the building does not have a report filed and unsafe conditions were reported with the filing of an Unsafe Notification form or were discovered upon inspection. In the cases of an Unsafe Notification form, a FISP inspector visits the building to confirm the presence of public protection and issues violations or other Commissioner's Orders when necessary. In cases where the owner is unwilling or unable to have the shed installed within 24 hours of discovery of the condition, the FISP unit will issue an Immediate Emergency Declaration to allow for the New York City Department of Housing and Preservation (HPD) to install the shed. In either case, upon discovery of an unsafe condition for a building with no report filed, public protection must be installed.

Another instance when a FISP building may have a shed is when a repair campaign to correct SWARMP conditions is underway. In these cases, often building owners install these protective measures prior to construction or repair work to provide public protection before a contractor is hired. On occasion, the sheds then linger as funds and project schedules are or become limited. Even as drones may provide earlier detection of façade defects, minimizing the time to complete repairs once potential issues are identified is a separate course of action for building owners that greatly impacts the duration of the presence of a sidewalk shed or scaffolding. To address this situation, in 2020 DOB increased the penalties relating to the failure of owners to correct the underlying conditions causing the need for a shed, thereby reducing the incentive to merely leave the shed in place instead of doing repairs.

In the past two years, DOB has been pursuing enforcement on the underlying unsafe conditions causing all sidewalk sheds that have been in place longer than five years, for both FISP and non-FISP buildings, which do not have an active permit for repairs of the façade. There are approximately 230 locations which fall under these criteria. This enforcement is done through a combination of outreach, where one of our administrative staff calls or emails the property owners to ascertain their repair schedule, and inspection, where a FISP inspector visits the locations every six months to confirm whether the repair work is in progress. In this fashion, the Department has been aggressively pursuing the abatement of the unsafe conditions and consequent removal of these long-standing sheds, in many cases pursuing legal action against the building owners in court.

ii. Building Code Requirements for Sheds

Building Code section 3307.6.2 specifically addresses where sheds are required. In this section, there are seven exceptions listed where sidewalk sheds are not required except as directed by the Commissioner, two of which are related to building façades. The façade-specific exceptions are:

- inspections, including a façade inspection, provided no work occurs during the inspection

- subject to the approval of the Commissioner, work of limited scope and duration provided that:
  - during the course of the work the area immediately under the work zone is temporarily closed to the public by means of barriers, cones, or caution tape, and flag persons are provided to direct pedestrian traffic; or
  - at the end of the day the façade of the building is left in a safe condition and fully enclosed.

The second point would apply to FISP buildings with regards to the new rule provision enacted in February 2020 that probes are required every other cycle at buildings with masonry cavity walls. By going through the appropriate channels and submitting the necessary paperwork, a QEWI could get the requirement for a shed waived when doing probes. A sidewalk shed will be installed at a building subject to FISP only under the circumstances described previously. Thus, FISP inspections in and of themselves do not necessitate a sidewalk shed.

ii. Potential Unintended Consequences of Drone Use Increasing Occurrence of Sheds and Scaffolds

As documented elsewhere in this report, with regards to façade inspections drones are most effective when used to enhance the visual component of the investigation. The combination of the high-resolution cameras as well as the up-close perspective can relay potentially deleterious conditions with a greater accuracy than when performed with binoculars from the ground. While this is very beneficial for the goal of a façade inspection, namely to identify potential hazards in the interest of public safety, there is a possibility that with more hazards being readily identified, more public protection would need to be installed.

However, potentially with more accurate and precise information about the nature and location of hazardous conditions, the type and extent of public protection could be further refined. For example, instead of providing a sidewalk shed at two faces of a building, the drone inspection, after being evaluated by the QEWI, may demonstrate that a shed is only needed at a portion of one face of the building. Without any data, a direct correlation cannot be determined whether using drones for façade inspections would result in fewer sidewalk sheds or scaffolds.

It may be the case that with the clear, precise images obtained by the drone, owners may be more inclined to repair unsafe or borderline unsafe conditions. Additionally, drones have a clear advantage over visual inspections from the ground in that a drone can look at a condition from above. A firm DOB spoke with had performed a façade inspection initially from the ground with binoculars and did not see any significant conditions. Subsequently they performed a visual inspection with a drone and found that 70% of the windowsills were cracked on the top.

iii. Are Drones a Threat to Pedestrian Safety?

When the FAA introduced its rules on drones in 2016, commonly referred to as Part 107, as discussed earlier in this report, one of their explicit restrictions was that drones could not be flown over persons or moving vehicles. Most recently in April 2021, the FAA revised its rules on flights over people to account for the different sizes, types and situations of a drone flight. The FAA acknowledges that as the technology advances and drones become more ubiquitous, there will need to be more flexibility in the regulations. Currently, the rules regarding flights over people are broken down into four categories which vary depending on the level of risk the operation would pose to pedestrians. The rules are also contingent on the operations compliance with Remote ID.

At its least restrictive (Category 1), a drone which weighs a total (the aircraft itself plus anything on board) of less than 0.55 pounds and contains no exposed rotating parts can operate over people. Category 4 operations require an airworthiness certificate for sustained flight over open-air assemblies which can include either hovering, flying back and forth, or circling above the assembly.

The Alliance for System Safety of UAS through Research Excellence (ASSURE) is comprised of research institutions, industry, and government partners whose mission is *to provide high-quality research and support to autonomy stakeholders both within the US and beyond to safely and efficiently integrate autonomous systems into the national and international infrastructure*. They collaborate with and are provided research, education, and training grants by the FAA's congressionally mandated Center of Excellence for Unmanned Aircraft Systems. It is their studies that informed the revision to the *flying over people* guidelines.

In 2017, the group published its **Final Report: UAS Ground Collision Severity Evaluation**, which was then followed up by further study, based on the recommendations of the previous report, published in **Task 14: UAS Ground Collision Severity Evaluation 2017-2019**. The former report addressed several questions establishing the hazard severity criteria for a drone collision and the potential severity of drone collisions in different ground scenarios. They also identified knowledge gaps which the subsequent report was intended to start to address.

The latter study was comprised of multiple different testing sites, mostly universities, who conducted different types of tests on a variety of commercially available drones. In total there were over 500 tests performed on both multi-rotor and fixed wing drones, some with varying payloads including a few tests done with SLR cameras, which is relevant to this report.

The study used the Abbreviated Injury Scale (AIS) which is used by medical professionals most commonly for assessment of injury due to automotive accidents. The majority of the testing was performed using anthropomorphic test devices (colloquially known as *crash test dummies*), ubiquitous in the evaluation of automotive vehicle safety. While the study points out that ground collisions from drones and automotive crashes are not the same thing, they acknowledge that evaluation of the injury severity from drones against the parameters of automotive accidents will suffice until there is enough crash test data for drones.

What they found is that the severity of human injury due to drone collision varies depending on the size and material construction of the drone being tested as well as what the drone is carrying. The lighter and more flexible aircraft resulted in a lower risk of skull fracture upon impact than the heavier, stiffer models, though concussions may still result. However, they point out that concussions are mostly evaluated by performing a series of tests on the injured subject, impossible with crash test dummies, and that there is significant disagreement about the metrics of concussions within the scientific community. Therefore, they recommend delaying regulatory standards based on concussions at this time. In general, the report notes that "few strong conclusions can be drawn" due to the array of vehicles being tested and under several different testing conditions.

One specific recommendation ASSURE made in the A14 report that is relevant to this study is the potential danger of mounted equipment onto a drone, such as an SLR camera. They noted that the equipment can become dislodged and present more of a substantial risk towards injury due to the inherently stiffer construction of a camera versus a drone. To that end, they recommend the FAA develop "performance-based standards for component mounting latches and other mechanisms."

The report notes that failure of drones resulting in ground collisions do not pose a human risk in and of themselves as there is no pilot or passengers. Should a drone crash in the middle of an empty open field, such as in the case of agricultural use, there is no threat to human life or health. Obviously, that will rarely, if ever, be the case in the context of a façade inspection related to FISP requirements. Consequently, a study such as ASSURE's, the first of its kind, is of particular interest to the evaluation of the feasibility for the use of drones. One overarching conclusion, and one that has become a familiar refrain in the research of various aspects of drone use, is that more research is needed to develop robust data to inform regulations developed for the use of drones in general.

2. DEVELOPING TOOLS

A. Alternate Technologies for Façade Inspections

This report has covered the process and requirements of façade inspections and the potential for drone use within those existing procedures. As part of its research, DOB would also like to highlight other tools and technologies that may assist façade inspectors and building owners to identify areas of concern. While drones have proven capabilities for capturing data, drones by themselves cannot determine whether there are defects or unsafe conditions. Information gathered by drones must be processed, reviewed, and analyzed in order to distinguish deterioration or defects and determine appropriate next steps. The following section is meant to describe potential tools or technologies that should be considered either in combination with or as an alternate to drone use in façade inspections.

i. Street-level visualizations

New York City has previously contracted with a company that provides street-level visualizations for services to capture real time data and documentation. The company uses a special patented camera system, which is mounted on vehicles, to capture and record visual data of public spaces. The vehicle travels at normal speeds on public rights-of-way and allows the camera system to create 360° panoramic images as well as capture LiDAR data.

DOB, as part of the City's contract, used this company to survey retaining walls that are visible from public streets. The photographic data can then be used to determine wall height and potential defects (e.g., bulges). Because the company captures images every six months, the data received is relatively recent and can inform timely enforcement response on otherwise long-term projects.

ii. Robotic Camera Mount

A robotic camera mount is a tripod-based apparatus that can accommodate a standard camera. In the case of façade inspections, the tripod mount enables the camera to capture multi-frame panoramas and high-resolution imagery by working in a grid pattern. The mount allows for horizontal panning and has a 180° vertical tilt, which offers a range of movements, often capable of 360 degrees. The camera is then able to capture images in varying positions, which can be overlapped and then stitched together by a processing software.

The advantage to this type of tool is that it can be set up anywhere with relative ease. Also, the images can be stored and viewed as simple JPEGs. Some disadvantages are that, in a dense urban environment and depending on the setup relative to the overall height of the building being photographed, there may be a parallax effect in that the objects towards the bottom may appear larger than those at the top. The company we spoke with that uses this type of technology said that they don't quite rely on this technology just yet and use it in conjunction with a binocular inspection. They also offered that they would use it in conjunction with a drone if it were allowed, and then do the hands-on inspection based on the information gained through the drone and robotic camera mount images.

iii. Imaging Robots

Imaging robots use a framed mechanism which uses cables or rails to lower a set of cameras along the façade for visual documentation, much like an unoccupied, mini-suspended scaffold. The robots are typically lightweight with modular designs which makes them easy to transport and assemble and allows for the robot to be customized to fit the situation in which they're working. The cameras used can collect high resolution images, have zoom capabilities and can provide multiple fields of view. A live camera feed permits the operator on the ground to execute runs. Some robots have digital and mechanical stabilizers which can allow for usable video even in high turbulence winds. Engineers reviewing the images can pause, zoom, and enhance any given frame from a remote location. Some also have the capability to conduct infrared and ultraviolet imaging.

Imaging robots may be used by QEWIs to aid in the critical examination that is required for a FISP compliance report as described elsewhere in this report. In particular, this technology may be useful in providing high resolution images of areas that before had only been able to be viewed with binoculars. This will allow inspectors to see conditions from above, such as the top of a cracked windowsill, and help them better plan for areas in need of the required physical examination. Images collected by an imaging robot may be used to satisfy the requirements for photographs and any location data collected may be used to produce the mapping.

iv. Acoustic Sensors

One company that we spoke with pairs its proprietary damage assessment software with drone-based data collection technology to inspect and detect issues in infrastructure. This technology was recently used to inspect dams in British Columbia and the company is hoping to expand its services to bridges and tunnels. Generally, their current focus is on structures with concrete as the primary material and in horizontal applications.

Previously, the combination of drones with high resolution cameras has allowed inspectors to visually inspect difficult to reach areas and surfaces. However, defects and deficiencies in façades and various materials, such as concrete, are not often visible on the surface.

The drones used in this company's data collection have a small attachment tethered to the main drone body, which houses an acoustic sensor. In addition to the visual and thermal data that the drone can already collect, this sensor captures the acoustic profiles of the material on which the attachment lands. The data collected, including the acoustic profile of a specific location, is then input into software that uses a deep machine learning model, discussed in more detail elsewhere in this section, to determine and quantify potential defects. The multilayered data allows for surface and subsurface analysis, which provides greater insight into the extent of deficiencies in structures. Note that the accuracy of the software results is verified by a qualified person to ensure that defects are correctly identified and quantified.

The company plans to expand its applications to vertical surfaces and to other materials such as solid brick, though it may be more complicated to expand this technology into façade inspections. Façades typically consist of different materials assembled in various configurations. Façades are also significantly thinner than say, a dam, which means the sensor would encounter open air closer than it would in an element of infrastructure. This means that there are significantly more variables in materials that will need to be accounted for in developing acoustic profiles for accurate detection. However, the company’s work so far is a signal that similar technologies may evolve for façade inspections and although this technology may not be ready for use today, it is worth watching how it develops and if it can become a tool for façade inspections.

v. Learning Software

Several of the companies we spoke with are developing self-learning software platforms, also known as artificial intelligence, that are each at a different level of development. Some are just beginning their projects, whereas some are running pilot programs. Even the more advanced of the companies that have these programs in development are still at the stage where they have a licensed professional review the program's findings.

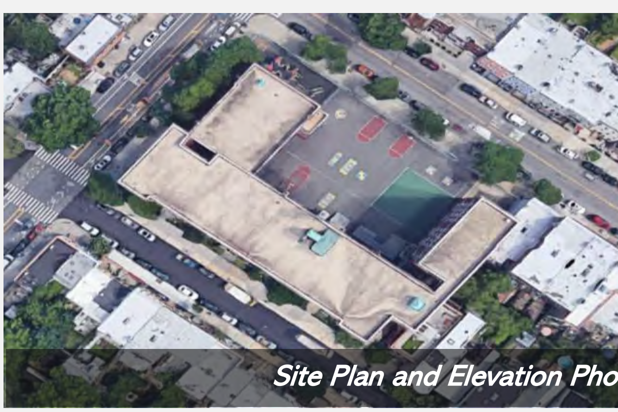
This new alternative to conventional methods of building envelope condition assessment uses an AI-powered system to conduct assessments. The software platform was built using deep neural networks trained on tens of thousands of annotated images and applies computer vision technology to image analytics, allowing it to automatically identify a wide range of material defects. The company also provides an online portal, enabling building owners, management, and maintenance teams to monitor deterioration of buildings for early remediation through time-stamped records of all detected conditions.

The program can identify most common building envelope materials, including brick masonry, concrete, glass curtain wall, steel, stone masonry, stucco, and terracotta. It can also detect a wide range of defects, such as corrosion, cracked or open mortar joints, cracks, displaced masonry, efflorescence, moisture, peeling spalls and stains.

FISP Unit Test of Machine Learning

DOB had the opportunity to compare the accuracy and ease of use of technology in façade inspections against a traditional, literal boots on the ground approach. The New York City School Construction Authority (SCA) contracted with the company responsible for the development of this software to perform a test evaluation of the façade for a public grammar school in Brooklyn, New York.

The building is a four story, C-shaped building with a footprint approximately 250 feet long by 150 feet wide. The exterior walls are comprised of brick masonry and limestone coping stones and decorative elements. There are two brick chimneys at the main yard as well as a metal pipe chimney. Most of the windows at the 1st and 2nd floors have a metal mesh grating in front of them. The window lintels are almost exclusively steel.



Site Plan and Elevation Photo of Subject School Building

Team A and Team B's analyses were focused on completing the inspection in accordance with FISP requirements while the machine learning software's users were given no such directive. As a result, there are other considerations addressed that may not necessarily be captured in a FISP narrative. Also, the private company was given images to input into the program and, thus, had no control over how the images were taken such as whether the photos were taken at angles or if attempts were made to get behind obstructions such as trees. The company also noted that their typical approach is to produce orthomosaics from the images but were unable to do so from the images provided to them. The result is there is some overlap in images and conditions noted which they state may contain "10%-15% contingency."

One other factor to note is that the three inspections took place during three different times of the year. Those of the image capturing company were performed in summer 2020, Team A in March 2021, and Team B in May 2021. The different timing meant that each inspection team had different foliage conditions with which to contend, which could mean some blocked conditions. Also, with almost a year from the first inspection to Team B's, some conditions may have degraded, been remedied, or changed completely.

Once DOB's teams completed their review, one notable difference emerged between the AI results and a close-up visual inspection with the human eye. During their inspection, Team A discovered a dislodged coping stone on the return façade of the side entry that was not identified as such in the machine learning program's report or during Team B's visual inspection. This location was photographed and analyzed in the program, which tagged it as a crack rather than being loose material. Images of this area were captured at direct angle and from above, which masked the extent of the defect. Team A's photograph from the ground shows the dislodged stone more clearly.

Team B also did not find this defect in their inspection since their goal was to compare the program's results with their findings. The machine learning program's report identified 8,597 separate defects, and Team B reviewed sample categories of each type of deficiency. The discrepancy in how this defect was classified by the AI software highlights the need for façade inspectors to control how data is collected, and how an abundance of data may not always result in more meaningful inspections. Team A's inspector was able to remove the broken piece to prevent a future accident.

In summary, we acknowledge that machine learning software such as this will more than likely be part and parcel with using drones for façade inspections as both technologies develop. What this study has demonstrated is that, as of now, the human element cannot be discounted in either the taking of photographs or the analysis of defects.

SECTION IV: CONCLUSION

- **FINDINGS**

Drones are clearly a useful tool in many industries, and the City Council's interest in applying drones specifically to façade inspections is a worthwhile pursuit. Throughout this report, DOB presented the existing façade inspection process, explored how current drone capabilities can be integrated into required façade inspections, and studied what obstacles would need to be addressed. As a result of this work, DOB presents the following findings to the City Council.

A. Drones are a Useful Tool for Collecting Visual Data

Drones are useful tools for collecting significant amounts of visual data such as photographs, videos, thermal images, and similar outputs. Drones can also access angles that are more difficult to achieve using other methods of visual inspection, which is particularly helpful for the inspection of larger buildings.

DOB acknowledges that drones are relatively easy to deploy and, when operated according to all applicable rules and regulations, provide safe and efficient access to otherwise difficult to access locations. Drones also come equipped with additional capabilities to help capture finer details with greater ease and consistency. High-resolution cameras and other sensors are now typically included with the aircraft, which can capture precise visual data. The integral positioning system commonly found in newer models allows the aircraft to locate specific points in space and allows the pilot to return to an exact location at a later date. This combination allows for significant amounts of data to be collected without significant manpower. Drones may be useful to façade inspectors in their work by ensuring more comprehensive data collection. Portions of façades that are only visible with a hanging scaffold or from neighboring buildings would not be as challenging to view, thus making the visual inspection easier to conduct and more thorough.

B. Façade Inspections Require More than Just Visual Images

For façade inspections, visual data collected by drones could include photographs and location information to easily pinpoint where a defect is located on a building. However, visual data, whether collected by drones or other tools, cannot replace the current requirement for physical examinations. Physical examinations by qualified professionals include sounding and probes that are necessary to accurately identify façade defects. Physical examinations also allow qualified professionals to immediately mitigate hazards.

The most common output format from drones is two-dimensional images, specifically photographs. High resolution images can still mask the extent of defects by flattening the viewpoint, and even videos may miss critical angles that an inspector may need to determine whether there is a significant defect and its extent or underlying cause. While having visual access can help locate where a potential issue may be, DOB as well as industry stakeholders still find that hands-on inspections by qualified individuals are needed to accurately verify façade conditions.

C. Façade Inspections Require More than Just Data Collection to Inform Building Maintenance & Repairs

Drones can collect data efficiently, but the data needs to be reviewed and analyzed in order to inform decisions regarding building maintenance and repairs. In the case of required façade inspections, a qualified professional must review available data and determine how to address deficiencies. Data by itself, whether collected by drones or using other tools, does not translate into actionable façade repairs.

In the context of façade inspections, which require classifying the condition of a façade as safe, unsafe, or safe with a repair and maintenance program, collecting data is only part of the process. Whether collected by drones or traditional inspection, any façade data collected requires analysis to determine where there are potential hazards to public safety. While a façade inspector may reduce the time spent in the field making observations with the use of drones, the analysis of images and other data may require more time or other tools to sort and accurately identify deficiencies.

At the same time, more data may not necessarily result in more repairs performed or explicitly lead to safer façades. Building owners and managers are ultimately responsible for maintaining safe buildings, including their façades. Outside of immediately hazardous conditions, there are other factors that impact when repairs are made, such as finding funds for repairs, scheduling qualified contractors, or finding materials. While data and professional analysis of façade conditions may sway some owners into action sooner, there is no guarantee that every building owner is willing or able to promptly address all deficiencies identified just because that information was obtained more quickly by a drone. In these cases, public protection (e.g. sidewalk sheds) would still be required. The owner's façade inspectors will need to provide more analysis and help them with decisions on how best to take on repairs. Drones may be used as a tool in this process, but the ultimate decisions about, and responsibility for, the inspections, maintenance and repair of a building are made by the building owner.

D. Current Regulations Limit Drone Use in New York City

Current regulations limit drone use in New York City and are outside of DOB's purview. From Part 107 of the Code of Federal Regulations to provisions of the New York City Administrative Code, drone use must already comply with various laws and rules at the local and federal level. Such regulations have resulted in limited experience with drone operations in the City, including to conduct façade inspections.

DOB's mission is to promote safe buildings in New York City through regulation and enforcement of the City's rules and regulations. FISP serves this mission with a focus on façades of buildings over six stories in height. To keep façades safe, owners of these types of buildings must have exterior walls and appurtenances inspected every five years and must file a technical façade report with DOB. While DOB can regulate the depth and integrity of the information provided in such reports, it is not solely within DOB's purview to dictate how that information is obtained. The laws and regulations in place pertaining to drone use are beyond DOB's expertise and authority.

E. Lack of Data & Experience with Using Drones to Conduct Façade Inspections

There is limited experience with the use of drones to conduct façade inspections in New York City and in other jurisdictions, which makes it difficult to determine precisely how drone use might support the existing façade inspection requirement and to assess related issues that may arise, including privacy concerns, whether drones could have an impact on the use of sidewalk sheds and scaffolding, and whether drone use could result in any economic benefits.

While there are known obstacles, such as legislative changes to remove the prohibition on drone flight in New York City, there is also a lack of information on how drones can specifically benefit façade inspections. DOB researched and reviewed which industries have incorporated drones into their operations and how drones were employed in their workflows. Industries such as agriculture and mining use drones to cover expansive area and provide safe access for workers. In construction, drones are most commonly used to gather data from large sites to assess progress and not necessarily to identify finer details. While there is interest in using drones to support façade inspections, this particular use of drones is still relatively new and there is limited information on whether façade inspections would benefit from drone use. Further, in discussions with other cities with similar building stock, DOB found that even in places where drone operations are permitted, drone use for façade inspections has been rare. Without more concrete information, any benefits or increases to public safety from the use of drones remain incalculable.

DOB recognizes drones may support the existing requirement to conduct façade inspections in a beneficial way and would invite further study on how this tool, with its accompanying technologies, can be employed. Specifically, the areas that may benefit from further study include the following:

- **Time and costs.** Whether drone operations reduce the time spent on collecting and reviewing façade conditions, and whether this lowers the cost of façade inspections for building owners. Also, whether repairs and remediation occur in a more expedited fashion if the use of drones allows for deficiencies to be more easily identified during required inspections.
- **Types of deficiencies.** What types of façade deficiencies are more easily identified using drone data. For example, cracks in masonry may be easier to determine than displacement or bulges from photographs or videos captured by drones.
- **Additional or more targeted hands-on inspections.** Whether additional hands-on inspections would be required because more areas of concerns can be identified by drones. Similarly, whether an inspector can better target which areas require hands-on inspections for more accurate examination of façade conditions.
- **Frequency of drone inspections.** Whether periodic use of drones can help to identify if movement or degradation has occurred as compared to previous inspections.
- **Types of buildings.** What type of building or building material would drone inspections be most beneficial for. For example, a building with a glass and steel façade may have readily identifiable deficiencies that can be captured by a drone, whereas a building with an ornate masonry façade would require close-up inspection to ensure that defects are not hidden in images. Also, whether drone use would be better for taller high-rise buildings, which may not have alternate means of access such as permanent window washing rigs, or smaller ones, which may not benefit from drone use due to scale.
- **Other applications.** Whether drones can be used in other applications.
    - Drones are sometimes deployed in emergency response and expanded use would be useful in more localized incidents such as building fires or explosions.
    - Drones could identify open roofs in a structurally compromised building without endangering DOB responders.
    - Drones equipped with thermal imaging cameras may be beneficial in improving the energy efficiency of façades and may assist in retro-commissioning efforts.

By studying these issues further and gathering concrete data, the City would garner a clearer understanding of drone use in façade inspections and possibly other applications related to building maintenance. Further study would also offer a glimpse into how drones can be safely operated for broader use in dense city environments. Drone use will inevitably continue to expand into commercial industries, and the City will want to investigate additional rules or guidelines needed to ensure public safety in the future from a wide range of perspectives beyond those addressed in this report.

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GLOSSARY

Appurtenance
An exterior wall element including, but not limited to, fire escapes, exterior fixtures, ladders to rooftops, flagpoles, signs, parapets, railings, copings, guard rails, window frames (including hardware and lites), balcony and terrace enclosures, including greenhouses or solariums, window guards, window air conditioners, flower boxes, satellite dishes, antennae, cell phone towers, and any equipment attached to or protruding from the facade.

Cavity Wall Construction
An exterior wall system consisting of an exterior veneer with a backup wall whereby the exterior veneer relies on a grid of metal ties to the backup wall for lateral stability. The two layers of wall are separated by an air cavity which may or may not be filled with insulation.

COA
Certificate of Waiver or Authorization, available to government entities that want to fly a UAS in civil airspace. Common uses include law enforcement, firefighting, border patrol, disaster relief, search and rescue, military training and other government operational missions.

Critical Examination
An examination conducted to review the exterior of a building and all parts thereof to determine whether the exterior walls (facades) and the appurtenances [thereto] are either safe, unsafe, or safe with a repair and maintenance program (SWARMP) and whether, in the judgment of a Qualified Exterior Wall Inspector, they require remedial work.

Drone
Colloquial term for unmanned aircraft systems (UAS) or unmanned aerial vehicles (UAV). Although most associated with UAS, the term includes any vehicle that can travel autonomously, including on land and water.

FAA
Federal Aviation Administration, federal agency responsible for the safe use of the aerospace system.

Façade

Outside or all of the external faces of a building

Facade Inspection Safety Program (FISP)

A program administered by DOB requiring owners of buildings higher than six (6) stories to have exterior walls and appurtenances inspected every five (5) years and a technical façade report electronically filed with DOB through DOB NOW: *Safety*.

LAANC

Low Altitude Authorization and Notification Capability, a collaboration between FAA and Industry. It directly supports UAS integration into the airspace. LAANC provides drone pilots with access to controlled airspace at or below 400 feet, awareness of where pilots can and cannot fly, and Air Traffic Professionals with visibility into where and when drones are operating.

National Airspace System (NAS)

The common network of United States airspace—air navigation facilities, equipment and services, airports or landing areas; aeronautical charts, information and services; rules, regulations and procedures, technical information; and manpower and material.

Part 107

Colloquial term for the Federal Aviation Administration's rule for operating small Unmanned Aerial Systems (sUAS, also known as drones) in the United States and is found in Title 14 Code of Federal Regulation (CFR) Part 107.

Payload

The weight of occupants, cargo, and baggage.

Physical Examination (Close-up Inspections)

Inspections that occur along a path from grade to top of an exterior wall fronting each public right-of-way, using at least one scaffold drop or other observation platform configuration, including all exterior wall setbacks.

Probes

Locations of a building where small areas of finishes had been temporarily removed to expose the underlying structure for investigative purposes.

Qualified Exterior Wall Inspector (QEWI)
A qualified exterior wall inspector as defined in Section 101-07 of the Rules of the [department] Department.

Remote ID
Ability of a drone in flight to provide identification and location information that can be received by other parties.

Remote Pilot in Command
A person who holds a remote pilot certificate with an sUAS rating and has the final authority and responsibility for the operation and safety of an sUAS operation conducted under part 107. Also known as Remote PIC or Remote Pilot.

Safe With a Repair and Maintenance Program (SWARMP)
A condition of a building wall, any appurtenances thereto or any part thereof that is safe at the time of inspection but requires repairs or maintenance during the next five years, but not less than one year, in order to prevent its deterioration into an unsafe condition during that five-year period.

Scaffold
Any temporary elevated platform and its supporting structure (including points of anchorage) used for supporting workers or workers and material, including but not limited to supported scaffolds, suspended scaffolds, and mobile scaffolds.

Sidewalk Shed
A temporary standalone structure that provides overhead protection to pedestrians from unsafe conditions, construction, or demolition activities.

Small Unmanned Aircraft
An unmanned aircraft weighing less than 55 pounds on takeoff, including everything that is on board or otherwise attached to the aircraft.

sUAS
Small Unmanned Aircraft Systems, a small unmanned aircraft and its associated elements (including communication links and the components that control the small unmanned aircraft) that are required for the safe and efficient operation of the small unmanned aircraft in the national airspace system.

UA

Unmanned Aircraft, an aircraft operated without the possibility of direct human intervention from within or on the aircraft.

UAS

Unmanned Aircraft System, 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 in the national airspace system.

UAV

Unmanned Aerial Vehicle, an aircraft piloted by remote control or onboard computers.

UTM

Unmanned Aircraft System Traffic Management, a *traffic management* ecosystem for uncontrolled operations that is separate from, but complementary to, the FAA's Air Traffic Management (ATM) system.

Visual Observer

A person who is designated by the remote pilot in command to assist the remote pilot in command and the person manipulating the flight controls of the small UAS to see and avoid other air traffic or objects aloft or on the ground.

APPENDICES

1 RCNY §103-04

CHAPTER 100

Subchapter C Maintenance of Buildings

§103-04 Periodic Inspection of Exterior Walls and Appurtenances of Buildings.
(a) ***Definitions.*** For the purposes of this section, the following terms have the following meanings.

Acceptable report. A technical examination report filed by a Qualified Exterior Wall Inspector that meets the requirements of the Administrative Code and this rule as determined by the Department.
Amended report. A technical examination report filed by a Qualified Exterior Wall Inspector who certifies that the unsafe conditions reported in the initial report have been repaired and that no unsafe conditions exist at the building.
Appurtenance. An exterior wall element including, but not limited to, fire escapes, exterior fixtures, ladders to rooftops, flagpoles, signs, parapets, railings, copings, guard rails, window frames (including hardware and lites), balcony and terrace enclosures, including greenhouses or solariums, window guards, window air conditioners, flower boxes, satellite dishes, antennae, cell phone towers, and any equipment attached to or protruding from the facade.
Cavity wall construction. An exterior wall system consisting of an exterior veneer with a backup wall whereby the exterior veneer relies on a grid of metal ties to the backup wall for lateral stability. The two layers of wall are separated by an air cavity which may or may not be filled with insulation.
Critical examination. An examination conducted to review the exterior of a building and all parts thereof to determine whether the exterior walls (facades) and the appurtenances are either safe, unsafe, or safe with a repair and maintenance program (SWARMP) and whether, in the judgment of a Qualified Exterior Wall Inspector, they require remedial work.
Filed report. A report shall be deemed filed with the Department when it has been received by the Department. The filed report must be completed in accordance with the provisions of paragraph (3) of subdivision (c) of this section.
Filing window. The two-year period during which a report for a particular building may be filed without penalty.
Public right-of-way. A public street, avenue, sidewalk, roadway or any other public place or public way.
Qualified Exterior Wall Inspector (hereinafter "QEWI"). A qualified exterior wall inspector as defined in section 101-07 of the rules of the Department.
Report filing cycle. The five-year time interval established by the Commissioner for the filing of each successive report for each successive critical examination of every building subject to the requirements of Article 302 of Title 28 of the Administrative Code.
Safe condition. A condition of a building wall, any appurtenances thereto or any part thereof not requiring repair or maintenance to sustain the structural integrity of the exterior of the building and that will not become unsafe during the next five years.
Safe with a repair and maintenance program (hereinafter "SWARMP"). A condition of a building wall, any appurtenances thereto or any part thereof that is safe at the time of inspection, but requires repairs or maintenance during the next five years, but not less than one year, in order to prevent its deterioration into an unsafe condition during that five-year period.
Staggered inspection cycle. The separate time intervals for filing reports of critical examinations as determined by the last digit of the building's block number, beginning February 21, 2010, and continuing thereafter for each subsequent report filing cycle.
Subsequent report. A technical examination report that is filed by a QEWI after an acceptable report in order to change the status of the building for that report filing cycle to reflect changed conditions or the recommended time frame for repairs of SWARMP or unsafe conditions .
Unsafe condition. A condition of a building wall, any appurtenances thereto, or any part thereof that is hazardous to persons or property and requires repair within one (1) year of completion of critical examinations. In addition, any condition that was reported as SWARMP in a previous report and that is not corrected at the time of the current inspection must be reported as an unsafe condition.

(b) ***Responsibilities of qualified exterior wall inspectors.***

(1) A QEWI must conduct critical examinations and file reports in accordance with this section and Article 302 of Title 28 of the Administrative Code.

(2) A QEWI must maintain records of inspections and tests for at least six years and must make such records available to the Department upon request.

(3) A QEWI must maintain insurance coverage as set forth in paragraph (7) of subdivision (b) of section 101-07 of these rules. Copies of such insurance policies must be made available to the Department upon request.

(c) *Critical examinations.*

(1) *Periodic inspection requirements.* In order to maintain a building's exterior walls and appurtenances in a safe condition, and in accordance with Article 302 of Title 28 of the Administrative Code, a critical examination of all parts of all exterior walls and any appurtenances of all existing buildings greater than six stories in height or buildings hereafter erected that are greater than six stories in height, except for those parts of any exterior wall that are less than twelve inches (305 millimeters) from the exterior wall of an adjacent building, must be conducted at periodic intervals.

(2) *Inspection procedures.*

(i) Before any exterior wall for any building is critically examined, the QEWI retained by or on behalf of the owner of the building must carefully review the most recent report and any available previous reports. The Department will maintain a file of such reports submitted in conformance with Article 302 of Title 28 of the New York City Administrative Code, and furnish copies upon payment of fees set forth in the rules of the Department.

(ii) Examination of a building's exterior walls and appurtenances thereof pursuant to section 28-302.2 of the Administrative Code must be performed by or under the direct supervision of a QEWI retained by the owner of the building or his or her representative.

(iii) The QEWI must design an inspection program for the specific building to be inspected, which must include, but not be limited to, the methods to be employed in the examination. The inspection program shall be based on the considerations of the type of construction of the building's envelope, age of the material components, the façade's specific exposure to environmental conditions and the presence of specific details and appurtenances. Consideration shall be given to the façade's history of maintenance and repairs as described in previous reports and submittals to the Department. Architects, engineers, individuals with a bachelor's degree in architecture or engineering and three (3) years of relevant FISP inspection experience, or individuals with five (5) years of relevant FISP inspection experience working under the QEWI's direct supervision, may be delegated to perform selected inspection tasks.

(iv) The methods used to examine the building must permit a complete inspection of same. Except as herein required, the use of a scaffold or other observation platform is preferred, but the QEWI may use other methods of inspection as he/she deems appropriate. Physical examinations from scaffolding or other observation platform ("close-up inspections") must be performed at intervals of not more than 60'-0", with the minimum number of physical examinations per total length of facade elevation noted in the table below. If the building does not front a public right-of-way, physical examinations are to be performed at a representative sample of the façade elevations with a minimum of one examination per building. All physical examinations shall occur along a path from grade to top of an exterior wall fronting each public right-of-way, using at least one scaffold drop or other observation platform configuration, including all exterior wall setbacks. The QEWI shall determine the most deleterious locations and perform physical examinations at those locations. The use of drones, high resolution photography, non-destructive testing, or other similar methods does not eliminate the requirements for close-up inspections.

Length of Facade Elevation Fronting Public Right of Way (L)	Minimum # of Physical Examinations
L <60'-0"	1
60'-0"≤ L <120'-0"	2
120'-0"≤ L <180'-0"	3
180'-0"≤ L <240'-0"	4
240'-0"≤ L <300'-0"	5
300'-0"≤ L <360'-0"	6
For every additional 60'-0" of length of facade, one additional close-up inspection is required.	

(v) The known history of the building, the nature of the materials used and the conditions observed will dictate the extent of the critical examination. The QEWI must apply a professional standard of care to assess the building's condition and the individual building systems that comprise the facades, including splitting or fracturing of terra cotta on buildings, cracking of masonry and brick work in brick faced buildings, mortar and other joint materials, loosening or corrosion of metal anchors and supports, water entry or flow within cavities, mineral build-up, coping materials, movement of lintel/shelf angles, and must ascertain the cause of these and such other conditions detected. The QEWI must order any special or additional inspections and/or tests, including sounding procedures, that may be required to support investigations and to determine the causes of any defects. Starting with the ninth cycle, probes must be performed on all cavity wall construction, and, at a minimum, during every subsequent odd-numbered cycle. The QEWI shall determine the location of the probes, which shall be in areas not previously renovated. At a minimum, a single probe must be completed along each required close-up inspection interval. The QEWI must ensure that the number and size of the probes are sufficient to report the presence, condition, and spacing of wall ties. The removal of portions of the façade in order to facilitate the performance of tests may require a permit from the Landmarks Preservation Commission.

Exceptions:
The requirement for probes may be waived in the following cases:

1. When a repair campaign addressing cavity wall ties has been completed within ten (10) years of the filing deadline and the owner or QEWI provides proof of such repair including, but not limited to, photographs, special inspection reports, and construction documents, which must be submitted and found acceptable by the Department.
2. When the first Temporary Certificate of Occupancy or Certificate of Occupancy for a new building was issued within ten (10) years of the filing deadline and the owner or QEWI provides evidence of tie installation including, but not limited to, photographs, special inspection reports, and construction documents, which must be submitted and found acceptable by the Department.
3. Where a QEWI proposes an alternate method of determining tie condition and spacing, which must be submitted and found acceptable by the Department.

(vi) Photographs must be taken and/or sketches made during the course of the Critical Examination to properly document the location of all conditions observed that are either unsafe or SWARMP.

(vii) Upon discovery of any unsafe condition, the QEWI must immediately notify the Department and the owner of the building. The QEWI must identify the location of any unsafe condition, advise the owner on the appropriate protective measures to be taken, and include the recommended type and location of public protection in the notification to the Department.

(viii) Completion of a critical examination means that the QEWI has conducted a final physical inspection to determine that the building conditions as described in the report are consistent with the actual conditions. Such final inspection must, at a minimum, include an actual visual examination and a walk around with binoculars or other inspectorial equipment. A drive-by inspection is not acceptable.

(3) *Report requirements.*

(i) The QEWI must file with the Department a written report describing the result of the critical examination, clearly documenting all conditions noted during the inspection and stating that the inspection was performed and completed in accordance with the Administrative Code and this rule. A separate acceptable report must be prepared and filed for each building with a control number, as provided by the Department, even if it shares a Block and Lot number with other structures. The QEWI must also submit a copy of the report to the owner of the building.

(ii) Technical information in the report must adhere to and follow the sequence and the labeling of the report requirements as listed in subparagraph (iii) of this paragraph, and must be provided on such forms and in such format as the Department requires. Additional information may be provided. If a requirement is not applicable, this must be indicated on the report.

(iii) The report must include an executive overview that consists of a summary of findings and recommendations, a concise statement of the scope of the inspection and findings, the conclusions and recommendations and a determination as to whether the building is categorized as "safe," "SWARMP," or "unsafe." The report must also include, but not be limited to:

(A) The address, any a.k.a. addresses, Block and Lot number, the Building Identification Number ("BIN"), the landmark status of the building, and the location from the nearest cross street;

(B) The name, mailing address and telephone number of the owner of the building, or, if the owner is not an individual, the name, mailing address, telephone number, position/title of a principal of the owner;

(C) A description of the building, including the number of stories, height, plan dimensions, Certificate of Occupancy number if available, usage, and age and type of exterior wall construction, specifying all materials present in the exterior wall;

(D) A detailed description of any distress, settlements, repairs, or revisions to exterior enclosures since the previous report, including, but not limited to, settlement, splitting or fracturing, displacement, bulging, cracking of any exterior wall elements, loosening of metal anchors and supports, water entry, movement of lintel or shelf angles, or other defects or changes;

(E) A detailed description of the procedures used in making the critical examination;

(F) The following information:

1. The extent and location of all physical examinations performed, including odd-numbered cycle cavity wall probes;
2. The names, addresses, telephone numbers, and license or registration numbers for riggers, contractors, and consultants involved in the critical examination;
3. A location diagram of a discernable scale and with a north arrow, indicating the main entrance, dimensions of the length of each façade elevation, including all setbacks and returns, and nearest cross street and locations and dates of close-up inspections;
4. Dates of the start and completion of the critical examination; and
5. Dated photo documentation of the QEWI and/or his or her employees performing physical ("close-up") inspections.

(G) A description, classification, and mapping of each significant condition observed including deterioration and any movement detected and the apparent water-tightness of the exterior surfaces. The description must also include a list of all the exterior appurtenances and their condition. Each condition must be classified as safe, unsafe or SWARMP. If the building is classified as unsafe or SWARMP, the report must include the locations and descriptions of all unsafe or SWARMP conditions. If unsafe conditions are noted, the report must recommend the type and location of public protection. Photographs must be labeled and the report must include key plans, key elevations and locator drawings documenting these conditions. Guards and railings, including, but not limited to, balconies, must be inspected to ensure that their components (balusters, intermediate railings and panel fillers) are positively secured against movement (e.g. by welds, bolts or screws). If any guard or railing, balcony enclosure, or greenhouse structure is found not to be positively secured, the condition is classified as unsafe and must be made safe pursuant to the requirements of paragraph (5) of subdivision (c) of this section.

(H) An analysis of the causes of the conditions reported as unsafe or SWARMP.

(I) A detailed status report of maintenance work performed up to the date of submission of the report and the maintenance plan implemented for building facades;

(J) A comparison of currently observed conditions with conditions observed during the previous report filing cycle examinations, including the status of the repairs or maintenance performed with respect to the prior conditions. The following must be included and discussed:

1. Work permit numbers relating to façade repairs, including permits for sheds;
2. Job numbers, status and sign-off dates for any façade related jobs, where applicable; and
3. Violation numbers of any open Environmental Control Board ("ECB") façade violations and the status of the repairs of the conditions cited in the ECB violations;

(K) Recommendations for repairs or maintenance of SWARMP and unsafe conditions, including:

1. If a building is categorized as SWARMP:
   A. The recommended time frame for such repairs or maintenance to be performed, which must indicate the date by which the work must be performed (MM/DD/YYYY) to prevent the conditions from becoming unsafe and not the date on which work is planned or scheduled;
   B. Time frames of less than one (1) year, "ASAP," or "immediately," shall not be accepted.

2. If a building is categorized as unsafe:
   A. The QEWI must provide a recommended time frame for repairs to be performed to bring the building to SWARMP or safe status, and must indicate the date by which the work will be completed (MM/DD/YYYY);
   B. Time frames of more than five (5) years will not be accepted.

(L) A list and description of the work permits required to accomplish the necessary work. If no work permits will be required, the reason must be indicated;

(M) All photographs must be color, clearly legible, dated, and high resolution. Digital photos must be a minimum of 800 x 600 pixels. Photographs must be arranged into PDF uploads of no larger than 11" x 17". The following photos must be submitted:

1. Elevation photos. Color photographs of the primary house number and at least one view of the entire street front elevation for all reports regardless of the building's filing condition.

2. Detailed condition photos. Color photographs of specific conditions must be clearly labeled and indicate the status designation. Detailed conditions must be located on the mapping of the building's facade required by item G of this subparagraph (iii).

   A. All SWARMP and unsafe must be catalogued.
   B. If building status is safe, submit a minimum of three typical conditions.

3. Cavity wall probe photos. Color photographs of the following items:

   A. each probe opening showing the location and size of the probes;
   B. the interior of the probe showing the cross section of the wall;
   C. the measurement of the spacing of the wall ties;
   D. a close-up of the wall tie type and installation;
   E. any other condition that indicates the soundness of the wall ties and cavity wall;
   F. condition of relieving angle, including flashing and connection; and
   G. condition of substrate.

(N) The classification of the building for the current report filing cycle, as determined by the following guidelines:

1. If there are no unsafe conditions and no conditions that are SWARMP, then the building shall be classified as safe;
2. If there is at least one unsafe condition, then the building shall be classified as unsafe.
3. If there is at least one condition that is SWARMP and there are no unsafe conditions, then the building shall be classified as SWARMP. A report may not be filed describing the same condition at the same location as SWARMP for two consecutive report filing cycles. The QEWI must certify that all of the conditions identified in the previous report as requiring repair have been corrected or the building shall be classified as unsafe;

(O) The seal and signature of the QEWI under whose direct supervision the critical examination was performed.

(4) *Report filing requirements.*

(i) The requirements of this rule apply to all buildings with exterior walls or parts thereof that are greater than six stories, regardless of the information in the Certificate of Occupancy. For buildings that contain six (6) stories above grade plane plus a cellar, where more than half the height of that cellar as measured at any individual exterior wall is above the adjacent ground level, including but not limited to areaways, yards, and ramps, all walls of such building shall be subject to façade inspection. Conditions requiring façade inspections may also include other structures that add to the height of the building as per section BC 504. The Commissioner shall determine which additional buildings and/or parts thereof are required to file in accordance with this rule.

(ii) Buildings required to file a report must do so at least once during each five-year report filing cycle established by the Department.

(iii) An acceptable report must be filed within the applicable two-year filing window to avoid a late filing penalty.

(iv) The report must be submitted to the Department along with a filing fee as specified in the rules of the Department.

(v) Staggered inspection cycle. For every five-year report filing cycle an acceptable report is due in accordance with the following filing windows:

(A) For buildings located within a block ending with the number four (4), five (5), six (6), or nine (9), an acceptable report must be filed within the two-year filing window starting February 21 of years ending in zero (0) and five (5) and ending February 21 of years ending in two (2) and seven (7).
(B) For buildings located within a block ending with the number zero (0), seven (7), or eight (8), an acceptable

report must be filed within the two- year filing window starting February 21 of years ending in one (1) and six (6) and ending February 21 of years ending in three (3) and eight (8).

(C) For buildings located within a block ending with the number one (1), two (2), or three (3), an acceptable report must be filed within the two-year filing window starting February 21 of years ending in two (2) and seven (7) and ending February 21 of years ending in four (4) and nine (9).

Exception: Starting in Cycle 10, owners whose buildings have their most recent status as "No Report Filed" may file a report prior to the start of their designated filing window provided that all applicable civil penalties set out in subdivision (d) of this section are paid at the time of filing.

(vi) Initial reports for new buildings greater than six stories in height must be filed as follows:

(A) The report must be filed five years from the date the first Temporary Certificate of Occupancy or Certificate of Occupancy was issued, if that five year date falls within the applicable filing window according to the last digit of the building's block number as provided in subparagraph (v) of this paragraph; or

(B) If five years from the date the first Temporary Certificate of Occupancy or Certificate of Occupancy was issued falls outside the applicable filing window according to the last digit of the building's block number as provided in subparagraph (v) of this paragraph, then the initial report must be filed within the applicable two-year filing window for the next five-year cycle.

(vii) If contiguous zoning lots under single ownership or management contain multiple buildings that are considered one complex where at least two buildings of more than six stories in height fall into different filing windows as described above in items (A), (B) and (C) of subparagraph (v) of this paragraph, the owner or management must choose one of the following report filing options:

(A) An acceptable report for each building to which this rule applies may be filed separately according to the filing window corresponding to the last digit of that individual building's block number; or

(B) The owner or his or her representative may choose one of the applicable filing windows and file a report for all of the buildings within that filing window, regardless of that building's individual filing window. The owner or his or her representative must inform the Department 180 days prior to the end of the assigned filing window if this option is chosen. If an owner or representative chooses this option, the owner or representative must continue to file under this same filing window for the duration of the owner's ownership of the property.

(viii) A report must be filed within sixty (60) days of the date on which the QEWI completed the critical examination (final inspection date), as defined in subparagraph (viii) of paragraph (2) of subdivision (c) of this section. Failure to file a report within sixty (60) days of the completed critical examination requires a new critical examination.

(ix) A report may not be filed more than one (1) year after completion of the close-up inspection.

(x) If the report is not acceptable and is rejected by the Department, a revised report must be filed within forty-five (45) days of the date of the Department's rejection, after which the original file date will no longer be valid. If the report is not acceptable after two (2) rejections, a new initial filing fee as specified in the rules of the Department is required. Failure to submit a revised report addressing the Department's objections within one (1) year of the initial filing requires a new critical examination, including a new close-up inspection.

(xi) A subsequent report indicating revised conditions may be filed within a five-year report filing cycle to change a building's filing status or the recommended time frame for repairs of SWARMP or unsafe conditions for that cycle.

(5) *Unsafe conditions.*

(i) Upon filing a report of an unsafe condition with the Department, the owner of the building, his or her agent, or the person in charge of the building must immediately commence such repairs or reinforcements and any other appropriate measures such as erecting sidewalk sheds, fences, and safety netting as may be required to secure the safety of the public and to make the building's walls and appurtenances conform to the provisions of the Administrative Code.

(ii) All unsafe conditions must be corrected within ninety (90) days from the submission of the critical examination report.

(iii) If, due to the scope of the repairs, the unsafe conditions cannot be corrected within the required 90 days, the QEWI must recommend a timeframe for repairs as noted in item (K) of subparagraph (iii) of paragraph (3) of subdivision (c). The owner of the building is responsible for ensuring that the conditions described in the critical examination report as unsafe are corrected and all actions recommended by the QEWI are completed within this timeframe. The owner must notify the Department of any deviation from the timeframe to make corrections as specified in QEWI's report. The subsequent report must include supporting documents from the QEWI justifying the request for a new time frame.

(iv) Within two weeks after repairs to correct the unsafe condition have been completed, the QEWI must inspect the premises. The QEWI must promptly file with the Department a detailed amended report stating the revised report status of the building, along with a filing fee as specified in the rules of the Department and the owner must obtain permit sign-offs as appropriate. If the report is not acceptable and is rejected by the Department, a revised report must be filed within forty-five (45) days of the date of the Department's rejection. If the report is not acceptable after two (2) rejections, a new amended filing fee as specified in the rules of the Department is required. Sheds or other protective measures must remain in place until an amended report is accepted; however, the QEWI may request permission for the removal of the shed upon submission of a signed and sealed statement certifying that an inspection was conducted, the conditions were corrected and the shed is no longer required. Permission to remove the shed may be granted in the Commissioner's sole discretion.

(v) The Commissioner may grant an extension of up to ninety (90) days to complete the repairs required to remove an unsafe condition upon receipt and review of an initial extension application submitted by the QEWI, together with:

(A) Notice that the premises have been secured for public safety by means of a shed, fence, or other appropriate measures as may be required;
(B) A copy of the contract indicating scope of work to remedy unsafe conditions;
(C) The QEWI's estimate of length of time required for repairs;
(D) A statement of all applicable permit requirements;
(E) A notarized affidavit by the owner of the building that work will be completed within the time of the QEWI's stated estimate; and
(F) A fee as specified in the rules of the Department.

Note: Financial considerations shall not be accepted as a reason for granting an extension.

(vi) A further extension will be considered only upon receipt and review of a further extension application, together with notice of:
(A) An unforeseen delay (e.g., weather, labor strike) affecting the substantially completed work; or
(B) Unforeseen circumstances (e.g., fire, building collapse); or
(C) The nature of the hazard that requires more than ninety (90) days to remedy (e.g., new wall to be built): or
(D) Progress photos showing current façade repairs.

Note: Financial considerations shall not be accepted as a reason for granting an extension.

(6) *Conditions that are safe with a repair and maintenance program (SWARMP).*
(i) The owner of the building is responsible for ensuring that the conditions described in the critical examination report as SWARMP are corrected and all actions recommended by the QEWI are completed within the time frame recommended by the QEWI, and are not left to deteriorate into unsafe conditions. It is the owner's responsibility to notify the Department of any deviation from the timeframe to make corrections as specified in QEWI's report. The subsequent report must include supporting documents from the QEWI justifying the request for a new time frame.

(ii) A report may not be filed describing the same condition and pertaining to the same location on the building as SWARMP for two consecutive report filing cycles.

(iii) The QEWI must certify the correction of each condition reported as requiring repair in the previous report filing cycle, report conditions that were reported as SWARMP in the previous report filing cycle as unsafe if not corrected at the time of the current inspection, or report corrections that were made in the previous cycle as unsafe if they need further or repeated repair at the time of the current cycle.

(d) *Civil Penalties.*

(1) *Failure to file.* An owner who fails to file the required acceptable inspection report shall be liable for a civil penalty of five thousand dollars ($5,000) per year immediately after the end of the applicable filing window.

(2) *Late filing.* In addition to the penalty for failure to file, an owner who submits a late filing shall be liable for a civil penalty of one thousand dollars ($1,000.00) per month, commencing on the day following the filing deadline of the assigned filing window period and ending on the filing date of an acceptable initial report.

(3) In addition to the penalties provided in this section, an owner who fails to correct an unsafe condition shall be liable for a civil penalty as detailed in the table below, until the unsafe condition is corrected. Unless the Commissioner grants an extension of time to complete repairs pursuant to this section, the penalties will be incurred as detailed in the table below. This penalty shall be imposed until receipt of an acceptable amended report by the Department indicating the unsafe conditions were corrected, the sidewalk shed has been removed and the associated permits are signed off with the Department, including shed permits, or an extension of time is granted by the Commissioner.

	Base penalty	Plus
Year 1	$1000/month	NA
Year 2	$1000/month	$10/linear foot (l.f.)of shed/month
Year 3	$1000/month	$20/l.f. shed/month
Year 4	$1000/month	$30/l.f. shed/month
Year 5	$1000/month	$40/l.f. shed/month

(4) *Failure to correct SWARMP conditions.* An owner who fails to correct a SWARMP condition reported as requiring repair in the previous report filing cycle and subsequently files the condition as unsafe shall be liable for a civil penalty of two thousand dollars ($2,000).

(5) *Challenge of civil penalty.*

(i) An owner may challenge the imposition of any civil penalty authorized to be imposed pursuant to this subdivision by providing proof of compliance. Examples of such proof must include, but are not limited to, a copy of an acceptable initial report, a copy of the acceptable amended report, copies of approved extension of time requests while work was/is in progress or written proof from a QEWI that the unsafe conditions observed at the building were corrected and the violation was dismissed.

(ii) Challenges must be made in writing within thirty (30) days from the date of service of the violation by the Department and send to the office/unit of the Department that issued the violation. The decision to dismiss or uphold the penalty shall be at the sole discretion of the Department.

(e) ***Full or partial penalty waivers; eligibility and evidentiary requirements.*** Owners may request a full or partial waiver of penalties assessed for violation of Article 302 of Title 28 of the Administrative Code, the New York City Building Code and/or rules enforced by the Department. Requests must be made in writing and must meet eligibility and evidentiary requirements as follows:

(1) *Owner status.*

(i) A new owner requesting a waiver due to change in ownership must submit proof of a recorded deed evidencing transfer of ownership to the current owner after penalties were incurred, as well as any other documentation requested by the Department, and only in one of the following circumstances:

(A) A new owner of a property previously owned by a government entity requesting a waiver due to change in ownership must submit official documentation from the government entity affirming that the premises was entirely owned by the government entity during the period for which a waiver is requested.

(B) A new owner who receives a notice of violation for failure to comply with the requirements of this section or Article 302 of Title 28 of the Administrative Code that was issued to the property after the transfer of ownership must submit a recorded deed showing the date that the property was acquired or transferred. The waiver period shall be from the date of the deed to the date of the violation issuance.

(ii) An owner may be granted a waiver of penalties upon submission of a copy of an order signed by a bankruptcy court judge.

(iii) If a state of emergency is declared that prevents an owner from conducting an inspection, filing a report or correcting unsafe conditions, an owner may be granted a waiver of penalties.

(2) *Building status.* An owner requesting a waiver because the building was demolished must submit city or departmental records evidencing the demolition of the building prior to the filing deadline.

(f) ***Posting of Conditions Certificate.*** A conditions certificate issued by the Commissioner must be posted in a frame with a transparent cover in the lobby or vestibule of the subject building within thirty (30) days of issuance. The certificate must indicate the most recent condition of the building's exterior walls and appurtenances.