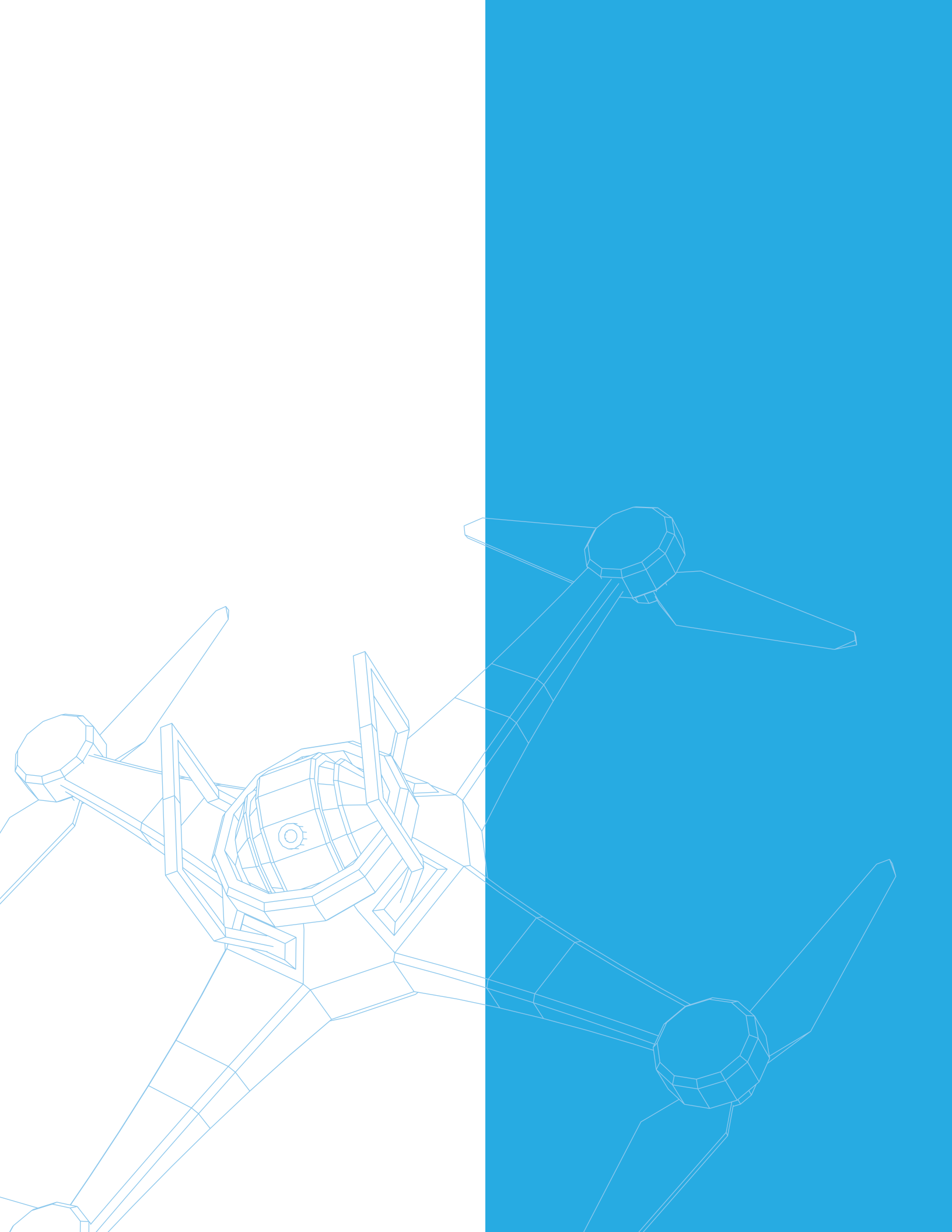




API Guide to  
**DEVELOPING AN  
UNMANNED  
AIRCRAFT  
SYSTEMS PROGRAM**



# American Petroleum Institute

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**“ THESE SYSTEMS  
HAVE THE POTENTIAL  
TO SIGNIFICANTLY  
REDUCE SAFETY RISKS  
TO PERSONNEL...”**



# API Guide for Developing an Unmanned Aircraft Systems Program

The case for using Unmanned Aircraft Systems (UAS) in the oil and natural gas industry has grown significantly over the last few years and continues to grow as new systems, applications, sensors, and techniques are developed to make UAS operations more tailored to the industry. These systems have the potential to significantly reduce safety risks to personnel, cut operational costs, and increase efficiencies across a variety of tasks. However, much is unknown and untested about these systems, the operators, and the potential limitations of their uses in complex industrial environments where safety is of paramount concern. The information in this guide can help companies in the oil and natural gas industry identify what questions they should be asking as they develop UAS programs, either internally, externally, or as a hybrid of both. The audience for this guide should include not only companies in the oil and natural gas sector that are considering developing a UAS program, but also service providers and others in the commercial UAS industry that are interested in working in the oil and natural gas industry. The basic concepts in this guide align with the industry's commitment to safety and responsible operations.

While UAS have many potential applications across the oil and natural gas industry, any use needs to be fit for purpose under the right operating conditions with the right operator and in line with company policies. The phenomenal growth in the commercial UAS industry can create a challenging environment for oil and natural gas companies attempting to determine what skills, abilities, and operations are real versus promised, and what systems and operators meet the level of safety, expertise, and experience they require. UAS also have the potential to collect significant amounts of data, which can be of significant value to operators, but can also create significant exposures if the data is not understood, cannot be processed in a useful way, and cannot be secured to protect a company's intellectual property and business confidential information. Cyber and physical security are also areas of great concern as federal regulations attempt to keep pace with the growing UAS industry and the vulnerabilities of these systems are potentially exposed.

# INTRODUCTION

The current limitations of federal regulations, largely promulgated and regulated by the Federal Aviation Administration (FAA) in the United States, are important to understand by any company that is considering the use of UAS in their operations. These systems and applications are most effective if fit for purpose, but there may still be considerable limitations that may disqualify them from being part of in any company's toolbox. Operations over people, beyond visual line of sight, and operations at night are not allowed in the U.S. as of early 2019, under Part 107. While the FAA does offer operational waivers for some of the restricted operations, companies may want to familiarize themselves with those processes, regulations, and limitations before attempting to develop a robust UAS program. This guide is intended to be used as a resource of common questions, considerations, and areas that a company may need to dig more deeply into as they consider how to develop or improve a UAS program.

## Here are some common examples of Part 107 sections that are subject to waiver:

Operation from a moving vehicle or aircraft (§107.25)

Daylight operation (§107.29)

Visual line of sight aircraft operation (§107.31)

Visual observer (§107.33)

Operation of multiple small unmanned aircraft systems (§107.35)

Yielding the right of way (§107.37(a))

Operation over people (§107.39)

Operation in certain airspace (§107.41)

Operating limitations for small unmanned aircraft (§107.51)

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# 1 DEFINING USE CASES

As with any operation introduced into complex industrial environments, the use case should be well understood to determine the potential value, impacts, and safety case.

While UAS can provide many advantages across the industry, there may be external issues that prohibit their use or lessen the value of those advantages. The following section will provide some guidance for companies that are beginning to explore the use of UAS.

## Examining Needs

Utilizing UAS may limit exposure to personnel, reduce costs, and improve response times, but there are several questions that should be considered before choosing to use UAS. **Following are a few key questions:**



**Are the operating conditions appropriate for UAS?**

**Will using UAS reduce risks to personnel?**

**Will using UAS reduce operational costs?**

**Are the UAS and the operator where they need to be, when they need to be?**

**Do company policies and procedures support and allow the use of UAS? Are UAS operations defined in policy?**

If these questions can be answered in the affirmative, the next step is to determine the best way for a company to utilize UAS. While some companies in the oil and natural gas industry have robust aviation programs, many do not, and even for those who do, UAS operations may not currently be considered in those programs. Any interest in using or developing a UAS program should be done in close consultation with company general counsel to ensure any new activities align with existing policies or to update policies to allow for new operations.

## Current Internal and External Capabilities

Companies with aviation programs that operate fixed-wing or rotary aircraft may have an advantage over companies that do not, due to their experience with federal regulations in the airspace, training, procedures, and pilots. However, because of the investments required to develop such programs, it may be more advantageous for a company to look to outsource UAS ownership and operations. Companies may want to examine the pros and cons of various business models for UAS operations.

**Below are a few of the ways some companies have decided to manage UAS:**

### INTERNAL

Utilizing personnel and assets internal to the company. This approach requires purchasing equipment, training/hiring personnel as UAS pilots, and developing policies that guide operations, address liabilities, and manage the operations and outcomes.

### EXTERNAL

Contracting with a third-party vendor to own, maintain, and operate UAS. Companies should still understand operator liability and insurance, safety procedures, and proficiency in the contracting process, and maintain program management.

### HYBRID

Companies may choose to maintain internal, trained personnel to operate owned assets for standardized tasks or at specific facilities where operations are more easily managed at the local level. Third-party vendors may then be brought in to supplement when operations become complicated or if a company does not have personnel or assets where operations may be unplanned or unexpected (such as emergency response operations).

## Additional Resource Considerations for Internal Programs:



Cost and variety of vehicles and payloads



Maintenance



Data security

## Internal vs. External vs. Hybrid Considerations:



Reputational costs/ stakeholder buy-in



Changing federal regulations



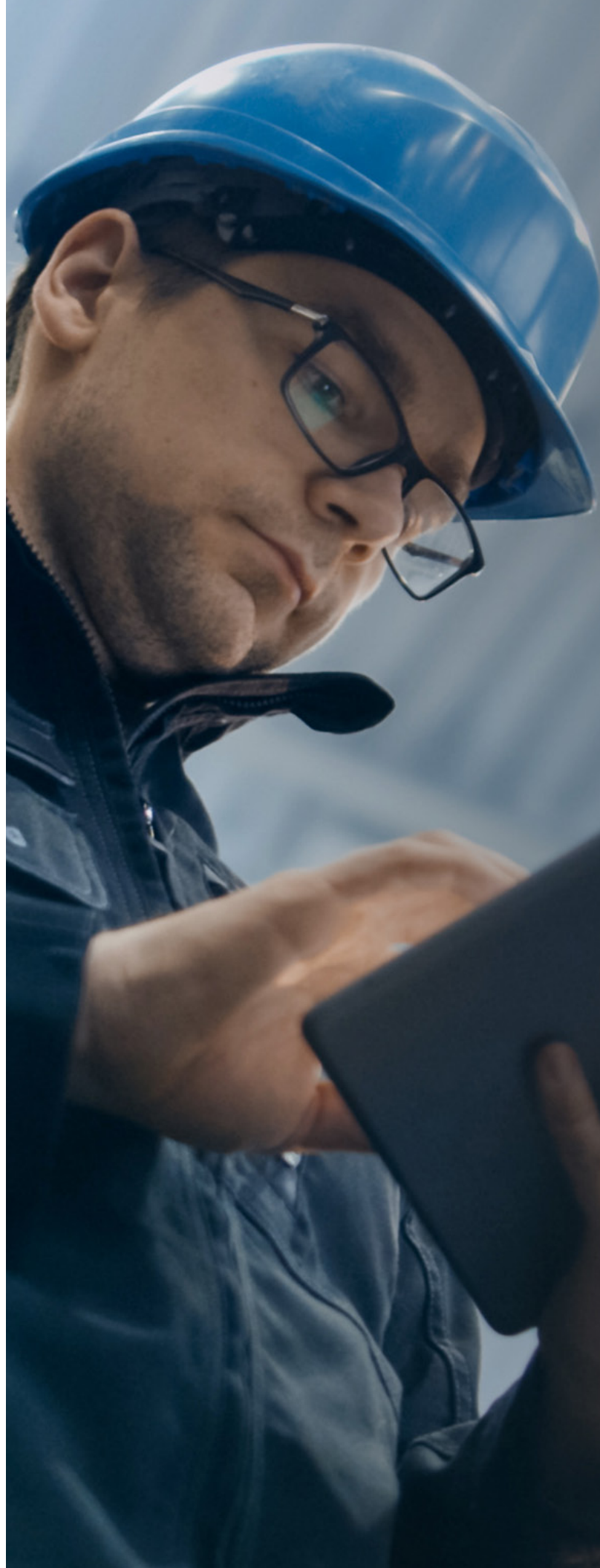
Regional variability of flight Standards field regulatory programs



Expertise needed to communicate effectively with FAA for waivers, COAs, etc.

## Identifying Gaps

Regardless of the approach taken, when developing a management plan, companies may want to consider various scenarios to test their plans and identify where gaps may exist. One example of where companies may not have capability, even if they have a program developed, is during an incident. The unexpected and/or unpredictable nature of incidents makes it difficult for any operator to plan for a response that may utilize UAS. While many UAS vendors have mobile control units that they can bring on scene, companies may want to have the processes in place to bring these vendors on quickly while ensuring the safety of operations and personnel. UAS have proven to be a useful tool during incident response, but it should also be noted that they may not always be the right tool based on conditions at the scene. Plans should have a process for making the decision whether or not to use UAS during steady state operations, as well as during incidents. If an organization does choose to incorporate UAS into response operations, UAS policies and procedures should be incorporated into response training and documented in response plans.





## 2 ASSESSING CAPABILITIES

While some oil and gas companies may have advanced UAS programs, others are just starting the journey. Even those with existing fixed-wing programs may not have developed a UAS branch to date. Companies looking to use UAS in their operations may want to consider three main implementation options as outlined in the preceding section: internal, external, or a hybrid of the two. Companies can decide which of these options gives them the best return on investment while maintaining safe operations, company-accepted levels of risk, safety management systems, and company culture.

### Determining Return on Investment

Before examining the potential options for developing a UAS program, companies may want to consider the mission and applications of UAS. All missions, both planned and contingent, can be outlined to give the company the potential value, impacts, and safety case. Defining the mission prior to flight operations may impact program implementation, the type of UAS selected, operator qualifications, regulatory requirements, and the size and scope of operations.

Once missions have been scoped, companies can conduct a cost-benefit analysis to determine the appropriate value for each option and select the best return on investment (ROI) as compared to cost savings from previous methods, such as fixed-wing flights. While ROI is frequently considered in dollar figures, safety of personnel and speed of response are also critical factors and should be factored into decision making.

Each of the three main options for developing a UAS program offers a varying return on investment for oil and gas operators. Using internal capabilities, companies train existing personnel and assets, purchase equipment, and develop policies to guide operations. Company personnel who may have little background or experience with fixed-wing aviation or UAS could be trained to become UAS experts. Additionally, companies will need to absorb the risks and costs of vehicles, payloads, and training, which could significantly increase costs. In an external program, a company could contract with a third-party vendor to operate UAS for its required applications. The company would be responsible for ensuring the vendor operates within the company's procedures and risk management and safety culture frameworks, and that vendors can bring to bear capabilities, data collection, and security as proposed. The hybrid option allows for companies to train internal personnel using specific equipment in predetermined missions, while also granting the ability to bring in a third-party vendor to support unplanned missions, such as emergency response operations. Each option has its costs and benefits, and operators will each need to determine the best value for their unique applications, operating environments, and internal policies.

Outlining the scope of missions will help determine the best return on investment for each option. For smaller-scale, repeatable missions, training internal personnel who can frequently operate a UAS could be the best option. If a company cannot devote internal staff to become UAS pilots or dedicate resources to implementing a full program, developing a third-party, external option may be the best route. For multi-use missions operating multiple pieces of equipment and platforms, a hybrid model may grant the most flexibility and responsiveness.

# Safety Management Systems

Safety management systems are typically comprised of policies, procedures, and processes a company uses to help it achieve its outlined mission and objectives. Safety management systems are used by many industries, including fixed-wing aviation and chemicals, to help manage the safety of complex processes that may require coordination to respond to dynamic circumstances or actions. Safety is the highest priority for the oil and gas industry, and safe operations should be at the forefront of any UAS application.

Regardless of the program option selected (internal, external, or hybrid), a company should consider using a management system or should consider developing a process for integrating UAS operations into an existing management system before operations begin. When developing a safety management system, operators may consider producing a Flight Risk Assessment Tool (FRAT) to differentiate between low- and high-risk flights, establish appropriate approval processes- and implement risk mitigation strategies. Management systems can address the following topics, among others:

 <p>LEADERSHIP &amp; MANAGEMENT COMMITMENT</p>	 <p>DECISION-MAKING PROCESSES</p>	 <p>STAKEHOLDER ENGAGEMENT</p>	 <p>RISK MANAGEMENT</p>	 <p>SELECTION OF EQUIPMENT OR PLATFORM</p>
 <p>OPERATOR QUALIFICATIONS</p>	 <p>MANAGEMENT OF CHANGE</p>	 <p>CONTINGENCY OR EMERGENCY RESPONSE OPERATIONS</p>	 <p>DOCUMENTATION</p>	 <p>INVESTIGATING INCIDENTS OR NEAR MISSES</p>

## Risk Tolerance

Risk tolerance represents the varying level of risk a company is willing to accept to safely conduct its mission. There is risk embedded in managing complex operations in the oil and gas industry, and companies should decide individually what level of risk is acceptable in their daily operations, based on guidance from management and legal counsel.

To start, once companies have selected their program implementation option, they should consider conducting a risk assessment to identify risks associated with identified safety hazards, operator training and qualification, equipment and platform selected, operating conditions, and others. Risks can be prioritized based on severity and probability, and a company's risk management strategy and FRAT may help determine what level of risk is acceptable and what risks require actions.

After conducting the initial assessment, companies can implement a risk mitigation strategy to categorize immediate and accepted risks. For high-priority risks, corrective actions should be determined and implemented to close any identified gaps; for lower-priority risks, measures to mitigate and maintain the risk at an acceptable level may be sought.

The FAA's Advisory [Circular](#) on Small Unmanned Aircraft Systems requires a host of activities by the pilot in command (PIC), which include risk mitigation actions, to prevent UAS from posing a safety hazard before conducting operations and to ensure the competency of the PIC. Companies should ensure that they, as well as contracted third-party vendors, have conducted a thorough risk assessment and implemented a risk mitigation strategy, as laid out in the circular and in compliance with company policies, before flying.



## Company Culture

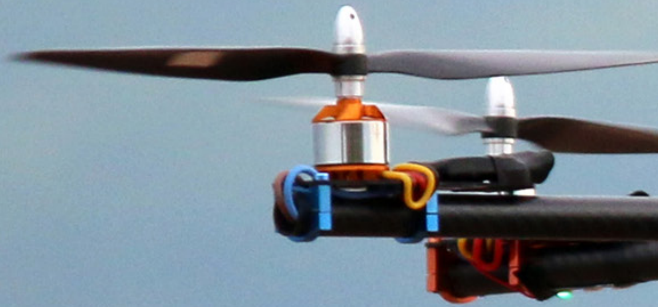
Culture in the oil and natural gas industry revolves around the way safety is prioritized and valued in an organization. Safety culture reflects the true commitment to safety throughout all levels of a company. A positive and reinforcing culture cannot be purchased but is produced and implemented by a company's top-down commitment and capacity to hold safety as its highest priority. A company should strive to maintain its positive company culture when utilizing the internal implementation option, as well as when working with third parties.

**A strong and positive company safety culture can, among others:**

1	<b>Inform employees and vendors about their role, as well as the operational, technical, and environmental factors that determine system safety and integrity</b>
2	<b>Encourage employees and vendors to report both accomplishments and errors</b>
3	<b>Provide flexibility that allows employees and vendors to adapt to organizational procedures</b>
4	<b>Empower employees and vendors to analyze safety information, identify gaps, and implement reforms</b>
5	<b>Embrace continuous improvement in safety performance</b>

Safety culture begins on the first day of developing a UAS program. A company's top management should commit to maintaining a strong culture through policies and procedures, as well as incorporating it into training and qualifications. If a company is implementing an external or hybrid UAS program, the third party should have a robust safety culture, as well. Safety management systems, documentation and record-keeping policies, and reporting criteria will all be integral to a positive safety culture.





## 3 PROGRAM ELEMENTS

A company's UAS program elements will be determined by its uses, resources, operating environment, and the FAA Circular mentioned in the preceding section. Once a company has identified its uses and selected an implementation model, it should develop individual program elements. Following are several elements to be considered:



### Safety Manuals

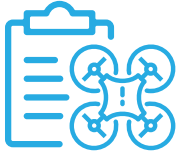
Before operating a UAS, a company should develop a safety manual based on the equipment and platform selected. There should be a manual for each piece of equipment used. Contents may include instruction on operating the UAS, its hardware, software, and potential contingency plans. The manual could also include points of contact from the manufacturer should the operator need to contact them to troubleshoot a problem. Safety manuals are a critical element of a program to have developed before commencing operations. Companies may want to require that any contracted third parties have a robust manual, as well.



### Insurance & Liability

Insurance and liability are critical factors when developing a UAS program. Companies should consider, with the advice of legal counsel, what insurance and liability coverage is needed before operating. Companies should also consider whether a third-party vendor is also similarly insured or could be covered under the company's plan. Commercial UAS insurance may cover potential accidents involving damage or loss of the UAS, manufacturer product liability, physical damages, personal injury, and coverage for UAS operators.

Insurance options may include liability, hull, or payload, and include supplements for ground equipment, non-owned coverage, and personal injury. A company and its legal counsel should determine the appropriate insurance and liability coverage, as well as coverage requirements for third-party vendors.



## Flight Standards & Procedures

A company should consider developing robust flight standards, procedures, and checklists based on its unique operating environment and aircraft systems. Flight standards, procedures, and checklists should be developed for both normal operating conditions and abnormal or extreme weather situations. Procedures should also address decision-making chains during both normal and emergency response operations. The FAA circular, mentioned in the preceding section, also has requirements for planning for changing weather conditions.

Companies may consider some or more of the following when developing pre-flight, in-flight, and post-flight procedures. See pages 14 and 15.





# Flight Standards & Procedures (continued)



<b>A ? Pre-Flight Considerations:</b> Have all approvals for operations been received and are they current?	
If someone is absent or unresponsive, how is approval or delegation of authority managed?	Are all equipment batteries in good condition, charged, and operational?
Have notifications regarding upcoming UAS operations (internal/external) been sent? (authorized flights vs. incursion/unauthorized breach)	Are Low Battery Power and Critical Battery Power alerts set properly within the flight control software?
Are you prepared to provide copies of pilot certificates, approved waivers, Certificates of Authorization (COA), vehicle registration(s), and flight/pilot logs to an FAA inspector upon arrival?	Does the system have GPS-related Return-to-Home (RTH) capabilities?
Does the operator have and are they familiar with the equipment's safety manual?	Is the autonomous RTH altitude set properly for the current mission based on altitudes of obstructions and surrounding fixed assets/equipment?
Are weather and wind conditions normal or abnormal?	Is there an adequate connection to the minimum number of satellites per OEM manual?
If abnormal, does your company have approval processes for abnormal conditions?	Are the external collision avoidance sensors in service?
Are there any temporary flight restrictions or active Notices to Airmen (NOTAMs) in the area?	Do stakeholders near the operating environment, including landowners and members of the community, need to be notified of the flight?
Are the PIC and any support staff properly trained/qualified, and current in their required flight hours for the vehicle being used?	

# Flight Standards & Procedures (continued)



<b>B</b>	<p><b>? Flight Considerations:</b> Does your company have a standard above ground level (AGL) altitude for safe operations?</p>
<p>Is there an accepted proximity (min/max distance, safety cushion, privacy concerns) to fixed installations, fencing, or physical security structures for your company?</p>	
<p>If flights are over non-company property, does your company notify affected public or private landowners below the UAS flight path that missions will be conducted?</p>	
<p>How does your company ensure that UAS will not be operated directly over people, beyond visual line of sight or at night, unless a specific warrant for these uses is granted?</p>	
<p>Is the UAV being operated under the 400-foot maximum altitude and under 100 miles per hour?</p>	

<b>C</b>	<p><b>? Post-Flight Considerations:</b> Are all the batteries turned off and stored in a safe container?</p>
<p>Has the UAS been disassembled or prepared for the next flight?</p>	
<p>Has data been transferred from the platform to a secure location?</p>	
<p>Does your company have a procedure for post-flight documentation and record-keeping?</p>	
<p>Are there any incidents or near misses that need to be reported?</p>	





## Contingency Plans

Companies may need to consider, when implementing a UAS solution, what may be needed if something goes wrong. Loss of signal, battery power, or sight of a UAS could potentially result in a harmful impacts to workers, assets, or operations. Planning for how to respond, if something goes wrong, may expedite recovery from loss of control, as well as response to any potential impacts beyond the UAS itself. The remote pilot should consider planning out potential scenarios for each operation, to develop a contingency plan that can be tested and vetted with all of those involved in the operation.

## Regulatory Compliance

Company and third-party UAS operators must comply with federal, state, and local regulations at all times. Companies should consider including baseline regulatory requirements into flight procedures to ensure minimal compliance. A company should comply with regulatory requirements before operating a UAS, as well as ensuring that any third-party also complies with federal, state, and local requirements.

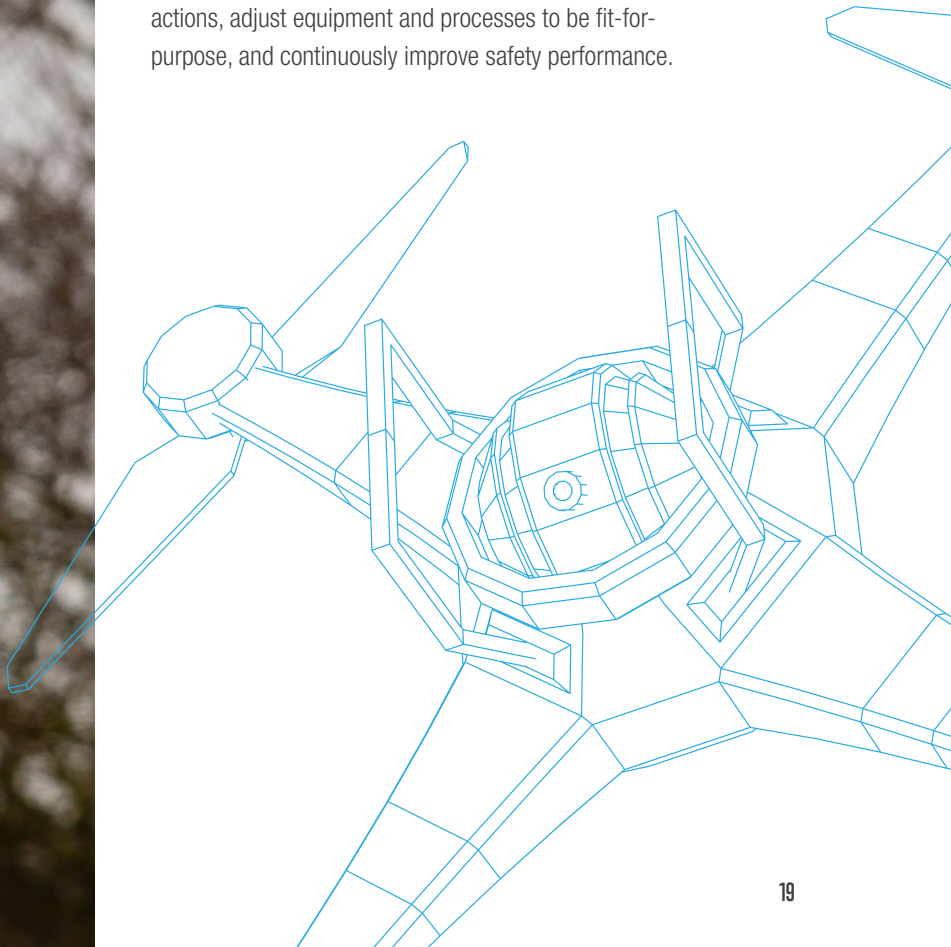
Part 107 of the Federal Aviation Regulation outlines minimal regulatory requirements for operating a small UAS (sUAS), or those systems weighing less than 55 pounds. Part 107 mandates that the UAS operator must always maintain visual line of sight of the UAS, there are no operations at night, the maximum altitude is 400 feet, the maximum speed is 100 miles per hour, and the UAS is not operated over people who are not directly participating in the flight without a waiver. A UAS may be operated in Class G airspace without air traffic control (ATC) permission; however, Class B, C, D, or E operations require ATC permission. External payloads may be attached to a UAS, permitted that it is securely fastened, does not negatively affect the flight characteristics, and keeps the UAS under the 55-pound maximum sUAS weight.



Part 107 requires that the UAS operator receive a remote pilot airman certificate or be in the presence of someone currently holding one. To receive a certificate, operators must pass an aeronautical knowledge test administered by the FAA or currently hold a Part 61 pilot certificate. Part 107 also contains requirements to report to the FAA any incident resulting in serious injury, loss of consciousness, or property damage greater than \$500 within 10 days.

## Testing & Authorization

Companies should consider building in a testing and authorization phase prior to beginning live operations. Trial runs could include pilots testing selected equipment in various weather and wind conditions in all of the selected missions using company-approved flight procedures. These dry runs could also test the timeliness and responsiveness of implemented decision-making and authorization processes. Trial runs could be conducted in both normal and abnormal conditions, such as simulated emergency response or unplanned operations, to gauge whether the equipment, procedures, and authorization processes are truly fit-for-purpose, efficient, and effective. Post-test run analyses could be conducted to identify actions, adjust equipment and processes to be fit-for-purpose, and continuously improve safety performance.





# 4 DATA & SECURITY



Unmanned aircraft systems provide a great opportunity to create efficiencies, reduce costs, and increase safety in the natural gas and oil industry. However, they also pose potentially significant risks. The potential lack of security of the software, hardware, and storage all present vulnerabilities and risks as these systems are deployed throughout the industry. This section will delve into some of the considerations related to data, data security, operational security, and cybersecurity when considering the use of UAS.

## DATA

Not all data is created equal! This is a critical tenant to start from as a program is developed. UAS, depending on their use, can create and collect vast amounts of data, from pictures, to sensor data, to business confidential data of high value to an organization. Organizations should identify the value of the data sets that will be collected prior to operations. Value identification can inform how the data is treated, either internally or in the direction and requirements given to the vendor. It will also help integrate UAS programs and operations into corporate information technology management and security frameworks.

## PROCESSING & ANALYSIS

As noted previously, UAS can collect vast sums of data, but data without analysis may not be of use. When considering using UAS, organizations should consider how they plan to use the results of the operations. For example, if the goal is to map the topography of a particular area and 10,000 images are collected, can those images be effectively processed into a product that can be of use? Sensor data may face the same challenges if there is an overwhelming quantity of results, but no one trained in how to analyze them. Understanding how to process and analyze the data is critical for both the internal or external provider. Many commercial UAS service providers are skilled in the operations aspects of data collection but are unlikely to have the expertise in the natural gas and oil industry to interpret and analyze the data they are collecting for the purposes of the customer. Therefore, organizations should consider from the beginning what subject matter expertise they may need to pull into the operations, and how those resources integrate with the UAS operations.



## STORAGE

The volume of data often collected through UAS operations should be considered when developing a UAS program. Understanding storage needs, based on volume and sensitivity, should inform how resources are allocated and systems designed. Data storage is also a critical point to address with a vendor. Organizations should consider the level of data protection they require, the technical requirements of a vendor's system, and the contract language that will enforce any requirements and provide protections and penalties for any loss of data. Again, the value of the data or the products produced from the data should inform the various requirements for storage. Organizations should also consider working with their records management groups to ensure these new types of data are maintained and stored according to existing company policies or, if necessary, new policies may need to be developed.

## CYBERSECURITY

Cybersecurity is increasingly a concern when considering the use of UAS. Cyber vulnerabilities can impact both the operations of the systems themselves and the integrity and protection of the data collected. Organizations developing UAS programs should consider the systems they are utilizing, the software used by the systems, the standard practices of the vendor and/or service providers, and the risk tolerance of their own organizations compared with the value of the data. Corporate IT policies should also be incorporated into any UAS programs to create the baseline policy for integration of UAS systems and data into corporate systems. Some of the potential threats to organizations from cyber-based compromises of UAS systems include:

- 1 **Taking remote control of a UAS**
- 2 **Signal interruption to orphan a system**
- 3 **Data compromise/corruption**
- 4 **Data/intellectual property exfiltration**
- 5 **Access to IT/OT systems through compromised systems or data that is on the network**

Any organization planning to use UAS, whether using an internal or external resource, should perform the appropriate risk assessment to determine their acceptable level of risk and the mitigations necessary to address risks.





## Security

Currently, while there are many UAS uses that are restricted or illegal, there are few ways for the FAA, law enforcement, or owners and operators to deter or defend against UAS in their areas of operation. Therefore, organizations should consider plans to understand how to respond to and report suspicious activity or intrusions by UAS at their facilities or field operations. UAS have been known to be used overseas as vehicle-borne improvised explosive devices (VBIEDs), activist groups have used UAS to monitor and collect information on construction projects, and unknown systems have been found within the fence line of facilities throughout the industry.

## SYSTEMS

When considering purchasing a UAS or evaluating a vendor's services, organizations should be aware of the origins of the systems, as well as known vulnerabilities. As noted in the cybersecurity section of this guide, both the hardware and software systems of UAS may be vulnerable to malicious actors. In addition, the proliferation of new and evolving UAS can make it difficult to know what the best system available may be based on the intended use. Organizations should have some type of quality control program in place, for both internal or external services, to ensure they are aware of any known risks or vulnerabilities of the systems used in their operations. Battery faults, loss of signal, and operator experience are just a few of the factors that should be known when choosing a UAS.

## POLICIES

Organizations' plans should address whether personnel should approach or handle systems, if found on site, who should be called to report suspicious activity, and what the policies are to pursue investigations, either internally or with law enforcement, if appropriate. Organizations should also consider integrating into their policies their understanding of existing statutes. Infringements on privacy, trespassing laws, and threatening behavior can all be applied to UAS operators. While there are limited ways to directly deter UAS over critical infrastructure, there are still legal options in place to engage law enforcement.

## PURCHASING/CONTRACTING GUIDANCE

Due to the previously stated risks of UAS to operations and personnel, as well as reputation, organizations should consider working with their legal counsels and procurement organizations to ensure the policies in place for quality control and vetting of systems and service providers are incorporated into their purchasing and contracting guidance. Having these policies in place before engaging with vendors may make the negotiations process clearer, as expectations and risk tolerance will be better understood going into the process.

## COUNTER-UAS PROTOCOLS AND TECHNIQUES

Under current U.S. regulations there are no legal counter-UAS protocols or techniques. As of October 2018, only the Department of Defense and the Department of Homeland Security have any authority to use counter-UAS measures. Any attempt to bring a UAS down in the national airspace is illegal.







# 5 PROGRAM IMPROVEMENT

Program improvement is a key aspect of any UAS program, regardless of internal, external, or hybrid program options. Continuously striving to improve UAS program operations can ensure systems are operating safely, with the protection of people, the environment, and critical assets as a core value, as well as capturing lessons learned and near misses to increase safety performance. UAS operators should consider creating an established process for documenting lessons learned and near misses, sharing them with industry and government partners, identifying risk and root causes, and adjusting operating procedures to mitigate the identified risk. This process could be shared with internal employees and vendors depending on the UAS program option, and the need for an anonymous reporting system could also be considered after reviewing benefits and drawbacks. Operators may want to consider monitoring fatalities, injuries, and property damage from UAS operations as key performance indicators to track risk mitigation and safety performance.

## Sharing Incidents and Near Misses

Sharing lessons learned from incidents and near misses to close unmitigated risks and improve safety is one of the oil and natural gas industry's core values. UAS operators and vendors should consider procedures for investigating incidents or near misses that led, or could have led, to an incident with serious consequences. Incident examinations should be initiated as promptly as possible following an incident or near miss, while considering the need to secure the incident scene and protect people and the environment.

Incident examinations may include some or all of the following considerations:



Identification of the cause of the incident or near miss and any contributing factors



Examination of findings and lessons learned



Review of the effectiveness of emergency response procedures



Recommendations for UAS safety performance improvement

Following an incident or near miss investigation, relevant and company-approved information could be shared with industry and government partners to improve future safety performance and identify common problems. Information on incidents and near misses could also be shared with industry operators and vendors to spread awareness of potential root causes and unmitigated risks. Incidents resulting in serious injury to any person or loss of consciousness, or damage to any property (other than the UAS) in excess of \$500 to repair or replace the property must be reported to the FAA's DroneZone Portal or to the FAA Flight Standards District Office (FSDO) within 10 days.

## Capturing Lessons Learned

Operators and vendors should consider having an established process for identifying and documenting the response to lessons learned determined by the incident investigation. Operators and vendors should also establish a process to track and complete recommendations and mitigate potential risk as identified in the lessons learned.

This process should facilitate the communication of contributing factors and lessons learned to company and contractor staff to prevent recurrence. To learn from past incidents, the operator may establish a process to periodically reexamine past incidents to measure risk mitigation initiatives and evaluate the effectiveness of organizational learning. Operators may also seek to establish a process to learn from external events, such as information sharing from peer operators, incident reports from FAA, the National Transportation Safety Board (NTSB) and other regulators, affected public, landowners, and emergency response personnel.

## Stakeholder Engagement

As organizations begin to deploy UAS in their operating environments, they may learn that engaging stakeholders can play a critical part in their use. Engagement will be of particular importance when operations take place outside of facilities, on right-of-ways, or in areas where property owners or the public are present. Companies should consider in their pre-flight planning how they plan to engage with stakeholders to potentially alert them to the operations, explain the purpose and authority for the operations, and communicate how the operator plans to ensure safe operations.

## Updating Procedures & Plans

After an incident or near miss and the corresponding investigation, operators should develop a process for updating procedures and plans with the identified lessons learned. Updates should seek to close any previously unmitigated risk to prevent recurrence. Following an operator's management of change process, these updates should be communicated to company and contractor (if relevant) staff to spread awareness of the change.





## Continuous Improvement

Operators should strive for continuous improvement in every aspect of their UAS operations. UAS operators may seek to emulate operators in other complex industries, such as aviation, in the utilization of the Plan-Do-Check-Act (PDCA) cycle of continuous improvement.

The PDCA cycle serves to encourage drafting procedures and policies, executing these procedures and policies, checking them for effectiveness, and analyzing data and results to adjust future procedures and policies.





# 6 FLYING IN CONTROLLED vs. UNCONTROLLED AIRSPACE

The U.S. has the most complex airspace in the world. UAS operations may occur in both controlled and uncontrolled spaces, and operators and vendors alike must be prepared to perform safely in both environments. Even during emergency response and contingency operations, companies and vendors must be cognizant of what airspace they are operating in and ensure compliance with federal and state regulations.

The FAA distinguishes airspace by Class levels, ranging from several feet above ground level (AGL) to above 18,000 feet. Classes A-E are considered “controlled” airspace, whereas Class G, which extends from the surface to the base of Class E airspace, is deemed “uncontrolled”, meaning air traffic control has no authority or responsibility to control air traffic. Before commencing operations, companies and vendors must be familiar with the airspace classifications and the varying requirements for operating in each. Please reference the FAA’s Airspace Classification for specific definitions of each airspace class.

## Outside in FAA Airspace

To operate a UAS in Class B, C, D, or E airspace, companies, after receiving their Part 107 certification, need to receive an airspace authorization or an airspace waiver. According to the FAA, an airspace authorization is “the mechanism by which an operator may seek Air Traffic Control (ATC) approval to operate in controlled airspace. Authorizations can be for a specific location or for broad areas governed by a single ATC jurisdiction.” Airspace waivers are located in 14 CFR 107.41 and may be issued when an operator can demonstrate that their system can safely conduct operations in controlled airspace without seeking ATC authorization before each flight. Applications for airspace waivers may take considerably more time than airspace authorizations.

Controlled airspace may also include airspace restrictions that could affect UAS flights. These restrictions include Security Sensitive Airspace Restrictions, Temporary Flight Restrictions, Restricted or Special Use Airspace, stadiums and sporting events, wildfires, and airports. The FAA maintains updated and interactive maps of current restrictions, and operators should ensure that UAS operations do not violate current restrictions.





## Uncontrolled Airspace

UAS must be utilized for missions below 400 AGL, which the FAA classifies as Class G airspace; operators may be granted permission to operate UAS 400 feet above the highest point of the target being inspected. Operations in Class G airspace do not require an airspace authorization or airspace waiver from FAA. Additionally, operators with a Part 107 waiver do not need to contact any airports in Class G airspace, but hobbyists without a Part 107 waiver would be required to notify all airports within five miles of their area of operation. While Class G may be deemed “uncontrolled”, operators must maintain a visual line of sight to their UAS under current regulations and must avoid interference with manned aircraft or aircraft operations.

## Inside Fixed Equipment

UAS may also be utilized for missions inside fixed equipment, including assessing system integrity and identifying necessary maintenance inside storage and vessel tanks. Flying inside fixed equipment is not considered operating in the national airspace and is thus free from FAA oversight and required licenses or waivers. Care must be taken to ensure that launch and recovery occurs within the equipment. All flights that are external of equipment must comply with all applicable UAS regulations. When conducting UAS operations inside facilities, operators and vendors should follow all company procedures and policies for safe operations, data collection, security, and program improvement.





# Conclusion

The potential for UAS integration into the oil and natural gas industry, as well as the potential risks of that integration, have been highlighted throughout this guide. We believe the value of this guide is to help organizations ask the appropriate questions and explore the potential considerations of risk, safety, liability, and security as they decide whether or not to develop a UAS program. As commercial applications mature, federal regulations lead to greater opportunities for uses in the industry, and technologies advance, it will be important for organizations to have a robust policy framework in place. An established, vetted framework of policies will allow organizations to quickly and safely take advantage of the growing suite of applications utilizing UAS. Safety is the No.1 goal of the oil and natural gas industry, and the approach to UAS integration should be designed with that goal in mind.





