Federal Aviation Administration

U.S. Department of Transportation

Pipeline and Hazardous Materials Safety Administration

Guidance for Transporting Hazardous Materials by Unmanned Aircraft Systems (UAS)

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This guidance is intended for Unmanned Aircraft Systems (UAS) operations conducted in compliance with Title 14 of the Code of Federal Regulations (14 CFR) part 135, *Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons On Board Such Aircraft*, and existing certificate holders interested in expanding their certification to include the carriage of hazardous materials.

This guidance is not intended for operations conducted in compliance with 14 CFR part 137, *Agricultural Aircraft Operations,*[1] or 14 CFR part 107, *Small Unmanned Aircraft Systems.* Under part 137, any incidental hazardous materials carriage is specifically contemplated by the operating and certification regulations therein, and there are additional safety mitigations built into the applicable regulatory structure. Under part 107, the carriage of hazardous materials is prohibited and not subject to waiver.

[1] For additional information on these operations, please visit: Dispensing Chemicals and Agricultural Products (part 137) with UAS.

What are hazardous materials?

Hazardous materials—also known as dangerous goods—are defined as any substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce,[2] and is subject to the Hazardous Materials Regulations (HMR) codified in 49 CFR parts 171–180. These regulations include requirements such as hazard communication and packaging. For additional details on transporting hazardous materials in air transportation, see Federal Aviation Administration (FAA) guidance titled, Learn How to Ship, Pack, and Carry Dangerous Goods Safely and What are Dangerous Goods?

Common examples of hazardous materials include, but are not limited to:

- Ammunition;
- Compressed gases, such as aerosols and gas cartridges;
- Flammable liquids, such as paint, ethanol, and gasoline;
- Infectious substances, such as blood samples known or reasonably expected to contain an infectious pathogen;
- Toxic substances, such as certain medicines;
- First aid kits that contain flammable liquids or alcohol-based products;
- Medical or clinical waste;
- Corrosive liquids, such as battery acid, drain opener, and tile cleaner;
- Safety devices, such as flares;
- Lithium ion or metal batteries, including those contained in equipment, such as computers, laptops, cell phones, or Automated External Defibrillators; and
- Dry ice.

This list is not exhaustive, and just because a material is not listed here does not mean that it is not hazardous. For more, see Pipeline and Hazardous Materials Administration (PHMSA) Guidance titled, Check the Box: Is it Hazmat?

[2] 49 U.S.C. § 5103 and 49 CFR § 171.8. Specifically, a hazardous material means "a substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and has designated as hazardous under Section 5103 of Federal hazardous materials transportation law (49 U.S.C. § 5103). The term includes hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials designated as hazardous in the Hazardous Materials Table (see 49 CFR § 172.101), and materials that meet the defining criteria for hazard classes and divisions in [49 CFR Part 173]."

Some of these products may seem harmless; however, when transported by air, they can pose a risk. Vibrations, static electricity, and environmental conditions can cause them to leak, generate toxic fumes, start a fire, or even explode.

It is the responsibility of the person offering a material for transportation (i.e., the "offeror" or "shipper") to classify and describe a material properly prior to transportation.[3] However, no aircraft operator may transport hazardous materials improperly offered for transportation.[4]

Identifying whether a material or product is a hazardous material is the first step to identifying the applicable regulations in place to help reduce the risks to the National Airspace System (NAS). A common way to determine whether an item is considered a hazardous material, or to find other pertinent classification and description information about a hazardous material, is to refer to the manufacturer's Safety Data Sheet (SDS). An SDS may be located either on the manufacturer's website or by contacting it directly. The SDS may list transportation information in Section 14, including whether an item is classified as a hazardous material and, if so, the classification of the hazardous material. The classification will determine the proper packaging, marking, labeling, and other applicable requirements.

How to carry and transport packages containing hazardous materials via UAS

UAS operators choosing to transport and deliver hazardous materials must obtain an air carrier operating certificate (14 CFR part 135) from FAA and must comply with all applicable requirements of the HMR (49 CFR parts 171–180).

To become a part 135 UAS operator authorized to transport hazardous materials (i.e., a "will-carry operator" with an operations specification to transport hazardous materials), the applicant must have an approved hazardous materials training program and an accepted hazardous materials manual. The hazardous materials manual should contain processes and procedures derived from a safety analysis showing how to transport the hazardous materials safely. To learn more about safety analyses, see the next section titled "How to manage risk when transporting hazardous materials via UAS."

For more information on the hazardous materials manual and hazardous materials training program requirements, see Advisory Circular (AC) 121-40, *14 CFR Part 121 and Part 135 Dangerous Goods Transportation Operations.*

Other resources are:

- FAA Guidance on 14 CFR Part 135 Air Carrier and Operator Certification
- FAA Guidance on How to Ship Dangerous Goods

[3] 49 CFR § 173.22.

[4] 49 CFR § 175.3.

- FAA Guidance on Package Delivery by Drone (Part 135)

How to manage risk when transporting hazardous materials via UAS

UAS operators should consider hazardous materials-related risk as part of their Safety Management System (SMS) program, described in 14 CFR § 5.1(b), to account for novel UAS-related factors.

This section highlights the framework for developing and implementing Safety Risk Management (SRM) (one of the four SMS components) for transporting hazardous materials by UAS.

This section may also be helpful to operators seeking a DOT special permit, as defined in the HMR in 49 CFR § 105.5(b).[5] 49 CFR § 107.105(d) requires applicants for a special permit to demonstrate an equivalent level of safety to that required by regulation or, if a required safety level does not exist, to demonstrate that the DOT special permit is consistent with public interest. For more information on DOT special permits, see the section below titled "Is a DOT special permit needed? And, if so, how to apply for one?"

During the SRM process, an operator identifies, analyzes, and develops mitigation strategies for potential hazards and risks associated with the intended operation, an operation with UAS in this case. The five steps of the SRM process are:

1. Conduct a System Analysis (SA);
2. Identify hazards;
3. Analyze safety risk;
4. Assess safety risk; and
5. Control safety risk.

During the SRM process, an operator evaluates the need for safety risk controls for new and existing safety hazards that could harm an operation. As described in FAA Orders,[6] standard principles used in the SRM process enhance the operator's ability to assess

[5] A DOT special permit is a document issued by the Pipeline and Hazardous Materials Safety Administration (PHMSA) Associate Administrator for Hazardous Materials Safety, the Associate Administrator's designee, or as otherwise prescribed in the HMR, under the authority of 49 U.S.C. § 5117 permitting a person to perform a function that is not otherwise permitted under subchapter A or C of this chapter, or other regulations issued under 49 U.S.C. § 5101 *et seq.* (*e.g.*, Federal Motor Carrier Safety routing requirements). See 49 CFR § 107.1.

[6] FAA Order 8040.6A—Unmanned Aircraft Systems (UAS) Safety Risk Management (SRM) Policy, FAA Order 8040.4C—Safety Risk Management Policy, AC 120-92D—Safety Management Systems for Aviation Service Providers.

safety risk in terms of the likelihood and severity of the hazard's[7] effect. The operator obtains information (quantitative and qualitative) and supporting documentation before making an informed decision about changes to procedures or the operation to address identified hazards. While changes to a system will trigger the SRM process, the size of the change will determine the appropriate level of SRM scrutiny. In other words, small changes to a system may require significantly less scrutiny than major changes.

It is best to apply an SRM process when any of the following occur:

- Implementing new systems or changes to existing systems;
- Developing new operational procedures;
- Identifying a hazard; and
- Identifying ineffective risk controls.

Examples of when to apply SRM include:

- Transporting additional types of hazardous materials;
- Adding new vendors;
- Changing the way hazardous materials are accepted into an operator's system (*e.g.*, acceptance and loading at a shipper's location instead of an operator's base of operations); or
- Adding unmanned aircraft to an existing fleet that will deliver packages differently (*e.g.*, by releasing them from above ground level instead of by tether).

The first four steps of the SRM process are known as a Safety Risk Assessment (SRA).

An SRA determines the likelihood and severity of potential hazards by examining various factors specific to the intended operation, including environmental conditions, technical capabilities, operational procedures, and regulatory compliance. The scale and complexity of the mission and the scope of the operator's hazardous materials program will also affect the SRA. In addition to identifying hazards and risks associated with a particular operation, the SRA also helps identify tailored actions to mitigate the risks posed by hazardous materials and related hazards. By identifying potential dangers and vulnerabilities, the SRA facilitates the development of proactive strategies and safety measures to ensure safe and responsible operations while prioritizing the protection of people and property on the ground and the surrounding environment. When completed,

[7] 14 CFR § 5.3 defines a hazard as "a condition or an object that could foreseeably cause or contribute to an aircraft accident, as defined in 49 CFR § 830.2." Whenever analysis reveals that a condition could cause damage to an aircraft or injury to a person, regardless of the severity, it should be assumed that the condition could cause an accident and, therefore, meets the definition of a hazard. See FAA SRM Guidance for the technical definition.

an SRA is used to mitigate identified risks in the fifth and final step in the SRM process: Control Safety Risk.

System Analysis (SA)

Step 1: An SA refers to examining an issue or change in terms of what it affects and what is affected by the issue or change. A well-executed SA describes and models the system and operation in sufficient detail to understand and identify the hazards that can exist in the system, as well as their sources and possible effects. It is used to identify and address potential problems proactively, before new or revised systems or procedures are put into place. An SA will define the constraints and conditions of the operation, requirements that must be met, and the equipment and other support functions that are directly related to the organization's safety activities. These can include the operator's structure, policies, procedures, resources, operating environment, and stakeholders. The more details the operator can provide upfront, the more thorough the hazard analysis will be, making it easier to identify corrections later if required. The goal of an SA is to examine the various components of the systems and determine how they interact to influence safety.

Subsystems are often included within system descriptions. Examples of subsystems include training curricula and programs, audits, and process controls. A flowchart or checklist is a good tool for describing the system.

In an SA for UAS carrying hazardous materials, the operator may document:

- Scope or parameters of the system;
- Type of operations performed;
- Operating environment;
- UAS reliability and capability;
- Containment capabilities onboard the UAS;
- Methods of package delivery or unloading (*e.g.*, releasing/dropping, tether, parachute, landing with the vehicle, etc.);
- Quantity and type(s) of hazardous materials to be transported;
- Emergency procedures;
- Processes to report hazardous materials incidents;
- Ability to detect a release of hazardous materials, or a dangerous evolution of heat, fire, or smoke event while in flight;
- Flight path and risk to people and property on the ground;

- Level of competence and proficiency of those offering, accepting, loading, and handling the hazardous materials as appropriate;
- Any offering, accepting, loading, and handling of hazardous materials performed by a contractor or third-party personnel; and
- Identification of all stakeholders (*e.g.*, employees, customers, suppliers, regulators).

The list above is not exhaustive. The operator will likely identify additional items for inclusion.

During the SA, the operator should also gather relevant data and information to understand the risks listed above. This data and information, including any original data and studies, should be part of the SRA. Examples of pertinent data and information include:

- Incident, accident, and other safety-related data;
- Analyses and assessments of system components, delivery methodologies (including releasing/dropping), or packaging enhancements;
- Processes and procedures to perform pre-transportation functions;
- Use of DOT special permits or FAA exemptions or waivers; and
- Other requirements, rules, and regulations.

Identify the Hazards

Step 2: The operator should identify all potential hazards that could reasonably arise during the carriage or releasing/dropping of hazardous materials. Hazards may include:

- **Package Failure:** The packaging used to transport or to release/drop the package could fail, leading to the release of a hazardous material. Hazardous materials could leak or spill during transport or the releasing/dropping process, which could threaten human health and the environment.
- **Physical Damage:** The UAS or the package containing the hazardous material could sustain physical damage during transport or the release/drop process, leading to the unintended release of the hazardous material. This could also include damage to the package sustained from air resistance.
- **Environmental Conditions:** Varying environmental conditions during transport or the release/drop process could impact the UAS or package containing hazardous materials, resulting in various other hazards.

- **Chemical Reactions:** There could be a risk of co-mingled hazardous materials within the container or within the UAS and package, reacting with each other and thereby leading to fires, explosions, or the release of gases, causing inhalation hazards.

- **Technical Failures:** The UAS carrying hazardous materials or equipment could experience technical failures or anomalies during transportation, resulting in a risk to human health and the environment.

- **Human Error:** Human error during the loading or packaging of hazardous materials or other human error could pose a risk to human health and the environment.

Analyze Safety Risk

Step 3: Analyzing the risk of transporting, releasing, or dropping hazardous materials involves evaluating the likelihood and severity of each hazard and its effect. This analysis can be used to help prioritize safety measures, to inform decision-making, and to improve continuously the safety performance of operations.

Several methods can be used to analyze risk. Examples of methods to analyze overall risk are the As Low as Reasonably Practicable (ALARP) principle, the Bow-Tie Method, and Root Cause Analysis (RCA).

- **ALARP Principle:** The ALARP principle is a risk management framework that aims to ensure that risks associated with a hazard are reduced to a level that is as low as reasonably practicable. This principle considers both the likelihood of a hazard occurring and the potential consequences of that hazard to determine the overall level of risk.

- **Bow-Tie Method:** The Bow-Tie Method provides a visual representation of the risks associated with a particular hazard. It involves mapping the causes of an incident (the “threats”) to the consequences that would result from that incident (the “impacts”). This helps to clearly identify the key risks associated with the UAS operation and to prioritize mitigation efforts accordingly.

- **RCA:** The RCA is a problem-solving method designed to be applied after an incident to identify systemic root causes that can be mitigated or eliminated from recurring. Though it uses reactive data collection methods, it is a proactive prevention technique.

Assess Safety Risk

Step 4: Assessing risk involves converting the assessment of risk into a numerical value, such as a probability or severity score, which can then be plotted on a risk matrix. A risk matrix is a graphical representation of the results of a risk assessment that allows for easy comparison and prioritization of risks. Risk matrices can vary based on the risk quantification method used. For example, if the likelihood and severity of a hazard are

assessed using a standard scale (*e.g.*, a 5-point scale), the risk matrix can be divided into cells that correspond to different levels of risk. The hazards can then be plotted within the matrix based on their likelihood and severity scores, and the cells can be color-coded to provide a visual representation of the overall level of risk. When using a risk matrix, it is possible to compare and prioritize the risks associated with the transportation of hazardous materials and to make informed decisions about the appropriate safety measures and mitigation strategies to implement them.

This completes the SRA. The final step in the SRM process is to continue to "control safety risk."

Control Safety Risk

Step 5: Controlling safety risk means that the operator should:

- Identify mitigation strategies for the identified risk;
- Develop a plan to monitor the mitigation strategies; and
- Implement the monitoring plan.

The operator should identify mitigation strategies to control safety risks. These strategies should then be implemented and monitored to ensure their effectiveness. They can reduce the likelihood and severity of an undesirable outcome involving hazardous materials.

The specific mitigation strategies that are most appropriate will depend on the results of the risks and hazards identified when conducting the SRA, as well as the specific circumstances of each UAS operation. Some examples of common mitigation strategies include, but are not limited to:

- **Avoidance:** The operation or activity is canceled or suspended because the safety risks are intolerable or deemed unacceptable.
- **Maintenance Programs:** Refining the maintenance procedures of a UAS can help minimize the risk of technical failures and ensure the UAS is operating within its design parameters.
- **Operational Procedures:** Implementing standard operating procedures that outline the steps to be taken before, during, and after each UAS operation can help to minimize the risk of incidents. Procedures may include steps to ensure that hazardous materials are packaged, marked, and labeled correctly and have no indications of spills, or leaks.
- **Reduction:** The frequency of the operation or activity is reduced, or action is taken to reduce the magnitude of the consequences of the accepted risks; some safety risk is accepted.

- **Segregation of Exposure:** Action is taken to isolate the hazard's impacts, or redundancy is built in to protect against them.

- **Training:** Addressing identified safety risks can help minimize the risk of undesirable outcomes related to hazardous materials. This may include providing more detailed training on the proper handling and loading procedures of hazardous materials, the operation of unmanned aircraft and associated delivery capabilities, and the response to emergencies.

The SRM process is ongoing and relies on continuous monitoring, review, and improvement. Regular reassessments of safety risks and mitigation strategies ensure that the assessments remain effective and continuously improve safety and reduce risks. This may involve regularly reviewing the SRA to identify any new or changed hazards related to the transportation of hazardous materials. Then, the operator updates the mitigation strategies to address these risks.

Continuous improvement of the SA process can help to effectively manage the risk associated with UAS transportation of hazardous materials and reduce the risk of incidents. It also helps to ensure that the SRM processes remain relevant and effective, considering changes in technology, packaging solutions, and operating conditions.

Is a DOT special permit needed? If so, how to apply for one?

UAS operators that meet all requirements of the HMR (49 CFR parts 171–180) are not required to obtain a DOT special permit. However, any UAS operator that cannot meet a specific HMR requirement because of the nature of its UAS operations or for any other reason must first be granted a DOT special permit by PHMSA before transporting hazardous materials. 49 CFR part 107, subpart B establishes the requirements for obtaining a DOT special permit. An application for a DOT special permit should provide regulatory citations for the specific requirements of the HMR from which relief is sought. A PHMSA-issued DOT special permit cannot waive provisions established in the FAA regulations.[8]

The FAA and PHMSA consider DOT special permits for UAS operations an appropriate near-term option to evaluate and to tailor safety requirements to new operators who cannot meet specific HMR requirements. Tailoring requirements are necessary because each operator has unique attributes, practices, business models, and approaches for risk mitigation. Package-based, aircraft-based, or operations-based mitigations could all be practical, depending on the circumstances. Examples of operations-based mitigations are operating over specific routes or operating exclusively in certain environments. The FAA and PHMSA recognize that UAS operations are relatively novel, and unique considerations may apply. An example of a relevant consideration would be UAS delivery of a lower-risk hazardous materials package (*e.g.*, excepted quantities) that is

[8] A petition for exemption is a request by an individual or entity for relief from the requirements of a regulation in 14 CFR. The FAA may grant an exemption if it is in public interest and provides an equivalent level of safety. See 49 U.S.C. § 44701(f) and 14 CFR § 11.81(e). For additional information, also see FAA guidance: Petition for Exemption or Rulemaking FAQ.

transported in a closed system without passengers or crew onboard. Another example is the method of delivery, whether by short-distance airdrop, ground placement, or some other method.

DOT special permit applicants, including UAS operators, must demonstrate that they can achieve a level of safety at least equal to that required by HMR (*e.g.*, an equivalent level of safety) or, if a required safety level does not exist, is consistent with the public interest. An equivalent level of safety can be determined by evaluating a number of factors. These can include the fact that passengers and crew are not present on the aircraft, technical factors, operational controls, or a combination of these. Methodically identifying hazards and assessing risk mitigations (and ultimately the level of risk being accepted) with an appropriate level of analysis may potentially help to satisfy both the requirements of 14 CFR part 5 and 49 CFR § 107.105(d).

To apply for a DOT special permit, see 49 CFR part 107, subpart B, and the Special Permits Program Desk Guide: Special Permits Overview and Special Permits Program Desk Guide.

Future and Ongoing Efforts

[This section was last updated and is current as of November 2025.]

On August 7, 2025, the FAA, along with the Transportation Security Administration (TSA), published a Notice of Proposed Rulemaking (NPRM)[9] titled, "Normalizing Unmanned Aircraft Systems Beyond Visual Line of Sight Operations" (2120-AL82; 1652-AA80), which proposes to normalize certain low-altitude UAS operations while ensuring the safety and efficiency of the NAS.[10] If finalized, this rule would be the next step in integrating UAS into the NAS, providing significant safety, societal, and economic advantages and benefits. Additionally, this action would be expected to expedite the introduction of Beyond Visual Line of Sight UAS operations in the NAS dramatically, including UAS cargo delivery for compensation or hire.

In addition, PHMSA is working with the FAA and other agencies to develop an Advanced Notice of Proposed Rulemaking (ANPRM)[11] titled "Hazardous Materials: Modernizing Regulations to Facilitate Transportation of Hazardous Materials Using Highly Automated Systems" (2137-AF68). The rulemaking intends to clarify the applicability of the HMR for the handling, transportation, and hazard communication of hazardous materials transportation by autonomous transport systems. PHMSA will coordinate closely with its modal partners within the FAA, Federal Motor Carrier Safety Administration, Federal Railroad Administration, and U.S. Coast Guard to ensure a comprehensive approach that allows for the seamless movement of goods across multiple modes of transportation while addressing each mode's specific safety needs.

[9] Normalizing Unmanned Aircraft Systems Beyond Visual Line of Sight Operations.

[10] 90 Fed. Reg. 38212.

[11] Hazardous Materials: Modernizing Regulations to Facilitate Transportation of Hazmat Using Autonomous Systems.