U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

National Policy

ORDER 8040.6

Effective Date: 10/04/2019

SUBJ: Unmanned Aircraft Systems Safety Risk Management Policy

Safety Risk Management (SRM) is one of the main components of the Safety Management System (SMS). The objective of SRM is to provide information regarding hazards, safety risks, and safety risk controls to decision makers to enhance the Federal Aviation Administration's (FAA) ability to address safety risks in the National Aerospace System (NAS).

The FAA has been tasked with safely integrating Unmanned Aircraft System (UAS) operations in the NAS. Due to the pace of innovation and the new technology of UAS, the FAA is reviewing an increasing number of proposals for operation and risk assessments. This order supplements FAA Order 8040.4 Safety Risk Management Policy by establishing a methodology for conducting SRM for UAS requests to operate. This order establishes governance and triage steps for all UAS requests to operate received by FAA Lines of Businesses (LOBs), and SRM steps for the Office of Aviation Safety (AVS).

Steve Dickson
Administrator

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Chapter 1. General Information

1. Purpose of This Order. This order establishes the methods by which the Federal Aviation Administration (FAA) manages applicants' requests to operate Unmanned Aircraft Systems (UAS) and how the Office of Aviation Safety (AVS) performs SRM in accordance with FAA Order 8040.4, Safety Risk Management (SRM) Policy Requirements, for UAS requests for appropriate action to operate (e.g., waivers, exemptions, authorizations). This order defines the scope, roles and responsibilities, triage, governance, SRM triggers, and includes a template for documenting the steps of SRM. This process supports FAA Order 8040.4 and establishes a baseline with common hazards and mitigations. Use of the methods within this document enables the FAA to address safety risk associated with UAS operations in the NAS in a more consistent, coordinated, and timely manner.

2. Audience. The chapters in this document (except Chapter 4) apply to all FAA Lines of Business (LOBs). The SRM steps in Chapter 4 only apply to AVS.

3. Where to Find This Order. This order is available on the FAA website at http://www.faa.gov/regulations_policies/orders_notices/

4. Background. The FAA's mission is to provide the safest, most efficient aerospace system in the world. In support of this mission, the FAA uses a Safety Management System (SMS) – a formal, organization-wide approach to managing safety risk and assuring the effectiveness of safety risk controls. SRM is one of the four components of the FAA SMS that enables the Agency to manage safety within the NAS. As a newer technology, UAS do not have the depth of data that manned aircraft have. As such, existing manned aircraft risk assessments may not be suitable to evaluate risks for all UAS operations. The industry measures technology generations in months not years and has experienced rapid growth as demonstrated by the number of UAS registrations exceeding one million. The regulatory system for aviation has struggled to keep up with the pace of UAS technology and the unique nature of hazards and mitigations in some unmanned operations. Thus, this order establishes the safety review process for UAS requests and provides a generalized list of common hazards and possible mitigations that should be considered with each applicable assessment.

5. Scope. This document describes FAA activity from the point a UAS request (for appropriate action to operate) enters the FAA until it exits the FAA as a response to the applicant (granting, approving, or denying request). This document supplements, but does not supersede requirements contained within FAA Order 8040.4. This order focuses on safety risk to the NAS and nonparticipants on the ground. It does not address occupational safety/health and/or applicant's personnel safety, nor consider hazards at the individual UAS applicant level.

Chapter 2. Roles and Responsibilities

1. General. This section defines roles and responsibilities for the FAA, as a regulator, in assessing and identifying risks, and evaluating the effectiveness of the proposed risk mitigations in support of UAS requests for operation.

2. Roles and Responsibilities.

a. Receiving Organization. This is the FAA organization that receives requests concerning a UAS operation and is typically the Office of Primary Responsibility (OPR). The receiving organization follows their existing processes and ensures coordination with stakeholder organizations in the FAA.

b. Office of Primary Responsibility (OPR). In general, the OPR is the FAA organization with oversight responsibility for the regulation(s) from which the applicant is requesting appropriate action to operate. In the case of multiple OPRs, each OPR evaluates the portion they oversee and coordinates between the other OPRs.

c. UAS Program/Project Leads. The UAS program/project leads generally reside in the OPR and are responsible for:

(1) Following the existing processes and applying the appropriate SRM process to assess safety risk associated with the UAS approval (see Chapter 3 Section 3 (d)).

(2) Coordinating with applicable stakeholders in accordance with this order (see Chapter 3 Section 3 (d)).

(3) Communicating with the applicant, as appropriate, regarding the FAA response or responses to requests to ensure they are not receiving responses from multiple FAA offices.

(4) Briefing appropriate management and executives when SRM decisions need to be elevated.

d. Risk Acceptor(s). The risk acceptor is a management official or officials in the FAA OPR for overseeing the proposed UAS operation. Risk acceptor responsibilities include deciding whether the mitigation strategy is sufficient for the risk to be accepted.

e. The Safety Analyst and Team Members. These are FAA subject matter experts (SMEs) selected by the OPR to participate in the safety risk assessment. Each organization within the FAA with regulatory oversight responsibility for the regulation(s) associated with the request must have SME participation throughout the safety risk assessment. SME responsibilities include:

(1) Assisting with the safety risk analysis and/or verifying that the applicant's analysis is complete and accurate.

(2) Providing a clear and accurate picture of safety risk associated with approval of the UAS request.

(3) Substantiating severity and likelihood determinations by documenting the rationale used.

f. AVS Services and Offices (S/Os) and the Air Traffic Organization (ATO). In general, Flight Standards Service (FS) and the Aircraft Certification Service (AIR) in AVS, and the Mission Support Services (AJV) in the ATO are the main stakeholders for UAS requests. They are often the OPR, conduct SRM, and serve as the risk acceptor for requests regarding regulations within their purview. The responsibilities are further described below. However, to ensure a thorough well-rounded safety analysis, other AVS S/Os and FAA LOBs may be invited to serve as SMEs.

g. Flight Standards Service (FS). FS conducts SRM, and serves as the risk acceptor, when a UAS request pertains to the regulations FS oversees. FS ensures coordination across FAA organizations prior to providing a response to the applicant, as necessary. As the OPR and risk acceptor, FS uses judgment and available data to determine whether mitigations are sufficient for the appropriate action requested.

h. Aircraft Certification Service (AIR). AIR conducts SRM, and serves as the risk acceptor, when a UAS request pertains to the regulations that AIR oversees. When applicable, AIR ensures necessary coordination across FAA organizations prior to providing a response to the applicant. As the OPR and risk acceptor, AIR uses judgment and available data to determine whether mitigations are sufficient for the appropriate action requested.

i. Office of Aerospace Medicine (AAM). AAM conducts SRM, and serves as the risk acceptor, when a UAS request pertains to the regulations that AAM oversees. When applicable, AAM ensures necessary coordination across FAA organizations prior to providing a response to the applicant. As the OPR and risk acceptor, AAM uses judgment and available data to determine whether mitigations are sufficient for the appropriate action requested.

j. Office of Rulemaking (ARM). ARM receives and manages review and coordination of UAS exemptions.

k. Unmanned Aircraft Systems Integration Office (AUS). AUS has the following responsibilities:

(1) UAS Safety and Integration Division (AUS-400). AUS-400 supports FAA offices by facilitating and/or assisting in safety risk analyses in coordination with the OPR for UAS requests. When a project involves multiple organizations, AUS supports the intra-agency coordination as necessary. AUS-400 assigns a project manager for any UAS requests through partnership programs to facilitate a “one FAA voice philosophy”.

(2) AUS Project Manager (PM). The AUS PM supports coordination across FAA organizations, for any UAS requests through established partnerships. The PM engages with stakeholders and assists in finding solutions for technical issues.

l. Air Traffic Organization (ATO). The ATO conducts SRM and serves as the risk acceptor, when the ATO SMS Manual process applies in accordance with Chapter 3 section 3(d). The ATO ensures coordination across FAA organizations prior to providing a response to the applicant, as necessary. The ATO might also be asked to participate as a subject matter expert (SME) in AVS led SRM activities.

m. Office of Security and Hazardous Materials Safety (ASH). ASH conducts SRM to assess the safety risk for UAS requests that may include hazardous materials. ASH might also be asked to participate as a SME in AVS or ATO led SRM activities.

Chapter 3. Governance and Triage

1. What triggers SRM? In general, SRM is conducted when making planned changes to the NAS. Regulations are risk controls and requests for appropriate action from applicable regulations are considered planned changes to the NAS. Figure A below shows the five basic initiators for UAS related SRM; this document outlines safety review procedures for request for appropriate action from an applicable regulation(s) for a UAS operation.

Figure A – SRM Triggers

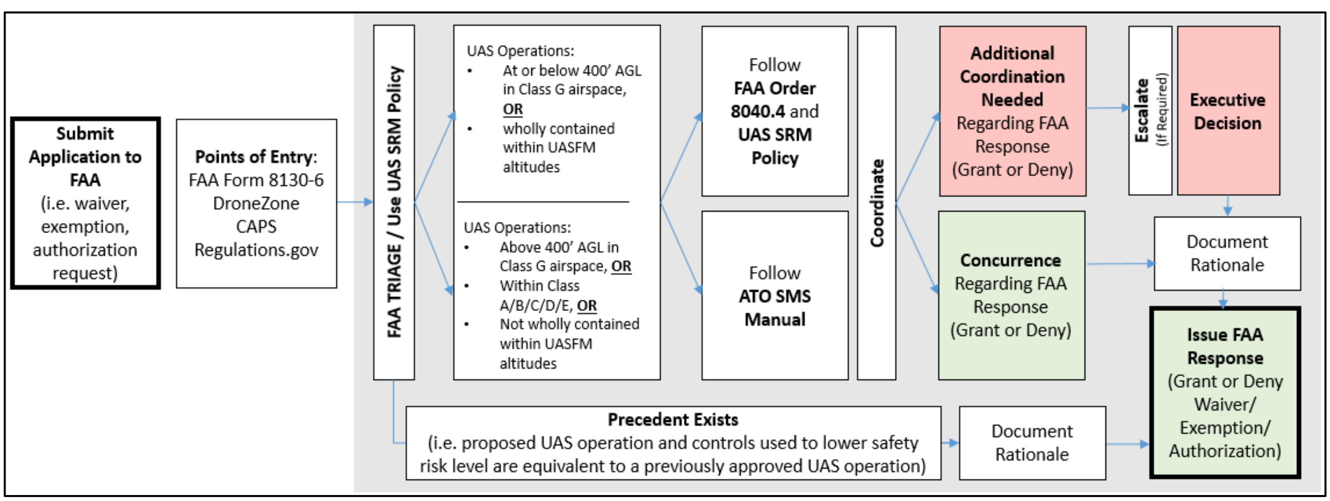
Safety Issue			Planned Change	
Potential Hazard (Identified by UAS related event/occurrence)	**Ineffective Control** (identified by UAS related event/occurrence)	**Non-Conformance** (e.g. noncompliance with UAS related regulation)	**Request** for appropriate action from an applicable regulation(s) for a UAS operation	**New/change** to UAS related regulation (e.g. part 107)

2. Governance.

a. UAS Program/Project Leads must apply the following governance model and triage steps in Paragraph 3 to help ensure timely coordination across FAA organizations, consistent application of SRM (if required), and uniformity of FAA responses to applicants for UAS requests. For additional details regarding roles and responsibilities, see Chapter 2.

b. A number of applications will be filtered through existing processes, for situations in which the proposed UAS operation does not result in new change or previously unidentified hazards being introduced into the NAS. In cases in which the proposed operations may introduce new unidentified hazards, SRM must be applied. SRM will be conducted in accordance with the applicable SRM order(s) (this Order, FAA Order 8040.4, and/or the ATO SMS Manual) (see Figure B below). The triage steps help the UAS Program/Project Leads determine which process applies. Chapter 4 of this order identifies how AVS meets requirements for situations in which FAA Order 8040.4 applies. The governance model depicted in Figure B, allows for the necessary escalation of safety decisions to FAA management, executives, and coordination with appropriate FAA stakeholders.

Figure B – UAS Request Governance



3. Triage Steps. Upon receipt of request for appropriate action, the receiving UAS Program/Project Leads must answer the following questions to ensure appropriate coordination and handling of the request (see Chapter 2 for additional roles and responsibilities).

Table A - Triage Steps

1. Has the safety risk associated with the operation been previously assessed and verified? Are there differences/changes from the precedent setting UAS approval? If no, SRM may not be necessary If yes, SRM on the differences/changes is required
2. Is there potential for the proposed UAS operation to introduce additional risk into the NAS?
3. Is the safety risk associated with the previously approved operation still valid (if applicable)?
4. Which SRM process applies (see Chapter 3 section 3(d)?

a. Has the safety risk associated with the proposed operation been previously assessed and verified? The UAS Program/Project Leads determine whether the proposed operation (i.e., safety case, concept of operations, etc.) and mitigations are equivalent to that of a previously approved and verified UAS request for which safety risk has been assessed/documented/accepted and; monitoring is complete and the predicted residual risk has been verified. If the hazards associated with the proposed operation have not been previously assessed and verified, SRM on the differences/changes to the NAS is required.

b. Is there potential for the proposed UAS operation to introduce additional risk to the NAS? When the safety risk associated with a proposed operation is compared to a previous analysis and is not known, the request is considered a change to the NAS because the FAA has not granted the request previously. In this case the request must undergo SRM. The resulting safety risk assessment and approval will set a new precedent for that type of operation resulting in an, “existing change," which may be referenced in the approval of future UAS requests for appropriate action.

c. Is the safety risk associated with the previously approved operation still valid (if applicable)?

(1) The UAS Program/Project Leads consider the validity of the previously approved safety risk for the proposed operation. Factors such as timeframe of last approval, and whether technological advances, changes in the acceptable risk level, and improved operational experience may impact the validity of the previously approved operations. The safety risk identified for a previously approved operation, which resulted in a change, may no longer be valid if the monitoring results indicate increased safety risk or inaccurate safety risk predictions. The goal is to have an accurate understanding of safety risk when deciding whether to approve a request for appropriate action.

(2) Safety risk analyses for previously approved operations simply provide a starting point for the rationale that the safety risk associated with a given request for appropriate action is controlled to a level of safety required by the existing processes.

(3) Previous approval does not eliminate the need for continuous monitoring of UAS related safety risk (i.e., safety assurance functions) or the potential need for assessing differences or changes between the previously approved operation and the request. The need to re-apply SRM based upon UAS related occurrence reports is at the discretion of FAA management (See figure A for other UAS SRM Triggers). Continuous monitoring of UAS related safety risk (e.g., collecting and reviewing occurrence reports, precursor data, etc.) must be conducted in accordance with FAA Order 8000.369 Chapter 3 and FAA Order 8040.4 (refer to Figure 2-1: SRM and Safety Assurance Processes) as well as the monitoring plan of each approved safety risk assessment. In the case of a UAS request renewal (e.g., annual UAS events, synchronized UAS lightshow performances, or previously approved UAS operations in a new geographic location), SRM needs only to be applied to changes within the environment, operation and/or mitigation strategy. When it is determined that a safety risk assessment is not required, the rationale for that decision must be documented. After the rationale has been documented and all stakeholders have been consulted, the OPR may process the request for appropriate action in accordance with the OPR process.

d. Which SRM process applies (if SRM is required)? Determine whether FAA Order 8040.4, the ATO SMS Manual, or an AVS S/O approved process applies by comparing characteristics of the proposed UAS operation to the conditions of the ATO/AVS agreement, below.

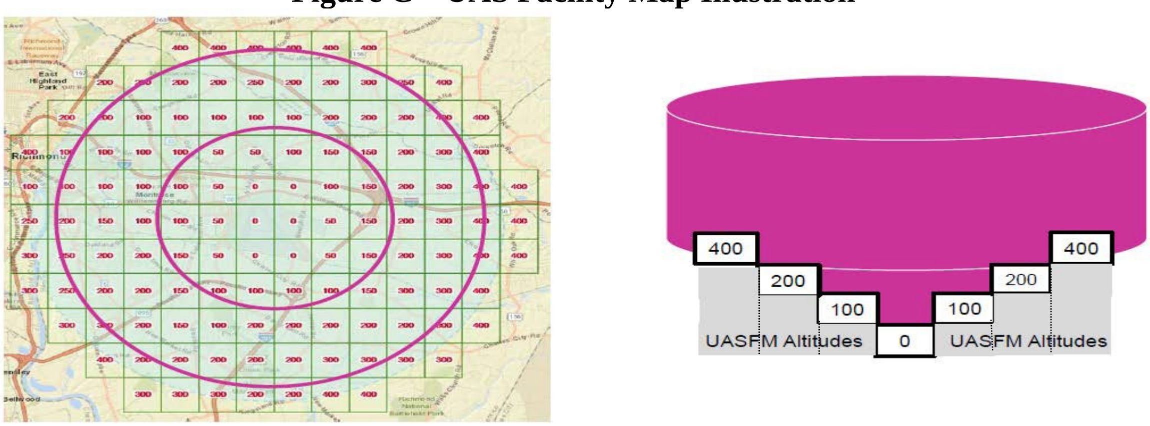
(1) AVS is responsible for using FAA Order 8040.4, this order, and any service/office approved detailed risk analysis process to conduct SRM for any request for UAS operation:

i. That occurs at or below UAS Facility Map (UASFM) altitudes, wholly within UASFM altitudes, or at or below 400 feet above ground level (AGL) in Class G airspace; and,

ii. Do not create a new requirement(s) for air traffic service provisions through the operation or through mitigations for the operation. When air traffic service provision requirements are required, coordinate with the ATO on all such operations upon receipt of application. Figure C (below) provides an example top view and side view of the UASFM altitudes.

(2) The ATO is responsible for Determining the altitude values that populate the UASFM and applying SRM in accordance with the ATO SMS Manual for any request for UAS operation that occurs *above* 400 feet AGL in Class G airspace, or within Class A/B/C/D/E airspace not wholly contained within UASFM altitudes (e.g., transitioning UAS), or when the provision of air traffic services during UAS operations are altered or required.

Figure C – UAS Facility Map Illustration



Chapter 4. AVS SRM for UAS Requests

1. Introduction. The steps in this chapter apply to UAS requests in AVS's purview as noted in Chapter 3 Section 3 (d). For AVS to approve a UAS related request for appropriate action, it's decision makers must be informed of the severity and likelihood of the hazards, with all mitigations in place, so that they may determine whether the residual risk level is acceptable. The SRM process and resulting documentation provides decision makers with a clear and accurate picture of the safety risk, informing their decision to grant, approve, or deny a request. AVS can either perform the SRM or verify the applicant has completed safety analysis. If the SRM is verified, AVS must concur with the SRM analysis. Once the SRM has been completed or verified, the analysis is documented and maintained in accordance with FAA Order 8040.4. The Sample Safety Risk Management Form for UAS Requests in Appendix D can be used to document the analysis. The UAS industry and data sources are still evolving, therefore, safety analysts or teams should use the best available data and subject matter expertise to make their determinations and document the rationale. This chapter expands upon, but does not supersede, information contained within FAA Order 8040.4. Questions regarding FAA order 8040.4 should be directed to the AVS Safety Management and Research Planning Division (AVP-300).

2. UAS SRM Process. A thorough understanding of the safety risk components requires an examination of the factors that increase or decrease the likelihood of system events (e.g., errors or failures) that can result in unwanted outcomes (e.g., accidents or incidents).

a. Identify Safety Analyst or Team Members. Depending on the request under consideration, the safety risk analysis may be conducted by an individual or a team. It is important that the person or team conducting the analysis have the appropriate subject matter expertise and that all necessary AVS and FAA stakeholder organizations are involved. If a team is necessary, it must include representatives from the various organizations who have regulatory responsibility or shared responsibility for the regulations presented in the waiver or exemption, and members must have experience in assessing risk related to the type of UAS request/operation assessed. The safety analyst or team reviews the application package and other available information to determine the expected level of safety risk. Each analyst's specific area of expertise must be documented (e.g., Joe Smith – 10 years commercial pilot, 5 years FAA waiver review team, 3 years recreational drone operator, etc.) to provide the reader with an understanding of who assessed the operation.

b. System Analysis. The applicant provides the technical and operational information needed for the safety analyst or team members to verify or perform SRM. The following information/documentation may be provided by the UAS applicant:

(1) Concept of Operations (CONOPS) description of operational scenarios/ environment, Operational Risk Assessment (ORA), the safety case, which includes a description of each hazard and mitigation, operational procedures/manuals, and test documentation. The applicants' submission should contain:

i. the hazards identified,

ii. the potential effects of the hazards (before mitigations),

iii. the mitigation rationale,

iv. a statement of how each mitigation is expected to reduce the severity, and likelihood of the hazard's effects,

v. the test results to validate the mitigations (if available),

vi. the predicted residual risk (after mitigations),

vii. the applicant's determined level of risk and rationale.

(2) The safety analyst or team reviews the CONOPS, ORA, and/or safety case, or other risk assessment tool to ensure completeness and accuracy. Additional hazards (i.e., not originally outlined in the applicant's documentation) may be identified by SRM analysts or the team. The safety analyst or the team documents the system assessment with information pertaining to each of the following elements of the operation:

i. Aircraft – What are the characteristics of the UAS that have the potential to affect the severity and/or likelihood? (e.g., equipment, size, aircraft weight, payload weight, speed, composition, configuration, software assurance, contingency features, airworthiness, camera/visual components, sensors, maintenance procedures, applicable limitations, command, control, communications (C2/C3) link, detect and avoid (DAA), etc.).

ii. Airman/Operator – What are the conditions pertaining to the airman/operator (e.g., responsible person for waiver, part 137 agriculture operator, part 135 air carrier certificate holder, etc.) that have the potential to affect the severity and/or likelihood? (e.g., other crew members, experience, certification, required training, pilot's location, visual observers, safety culture, track record, procedures, contingency actions, training manuals, training curriculum, ability of pilot to intervene if autonomous flight, applicable limitations, etc.).

iii. Airspace/Operating Environment – What is the airspace and environment being utilized for the request (e.g., class of airspace, traffic density, speed of other traffic, complexity of airspace, adjacent airspace, altitude of operations, communication with ATC, awareness of other operators, applicable limitations, types of manned aircraft the UA may encounter, etc.). What elements of the operating environment have the potential to affect the severity and/or likelihood? (e.g., population density, prevailing/possible weather conditions, season of operation, time of day, proximity to airports, type of operations (commercial/GA/rotorcraft) at nearby airports and in the area, terrain, structures, duration of operation, other UAS operations in the area, number of operations planned per day, applicable limitations, lateral and vertical boundaries of operating area, etc.).

(3) When an application does not provide adequate information, AVS may send a Request for Information (RFI) to the applicant requesting the information necessary to complete the safety risk assessment.

c. Identify Hazards, Causes, and Outcomes. During this step, the SRM analyst or team must identify hazards, causes, and outcomes.

(1) A hazard is a condition that could foreseeably cause or contribute to an aircraft accident. The safety analyst or team identifies the hazards using information from the applicant, the system assessment, and the common hazards in Appendix A. Hazards controlled by the rule being relieved must be assessed. For exemptions 14 CFR §11.81 requires that an alternative (to compliance) not adversely affect safety, or provide a level of safety at least equal to that provided by the rule being relieved. Waivers authorizing deviations from regulations can be issued if the UAS operation can be safety conducted under the terms of that certificate of waiver. The safety analyst and team must also identify and document the causes of the hazards. The list of hazards in Appendix A is a starting point; all hazards applicable to the operation must be identified and recorded. UAS hazards with the worst credible outcomes[2] listed below must be considered:

i. Collision between a UAS and a manned aircraft in the air

ii. Collision between a UAS or its detached cargo and a person on the ground, or moving vehicle

iii. Collision between a UAS or its detached cargo and critical infrastructure on the ground

(2) The safety analyst or team must also consider less severe outcomes of those listed above. Often times, less severe outcomes have higher likelihoods, and a higher risk level, than that of catastrophic outcomes with lower likelihoods. For example, although a Near Mid-Air Collision (NMAC) between a manned aircraft and a UAS would probably not be catastrophic, it is much more likely to occur thus, raising the residual risk level. These less severe outcomes must be assessed and documented within the safety risk analysis. Possible UAS hazards include, but are not limited to:

i. Unable to detect and avoid

ii. Human error

iii. Adverse operating conditions

iv. Technical issue with UAS

v. Deterioration of external systems supporting the UAS operation

d. Analyze Safety Risk. During this step, the safety analyst or team must determine the initial risk levels expected with the proposed UAS operation. The initial risk is based upon the proposed operation including applicant controls and existing controls. The initial risk level is used to determine the level of AVS management that may accept risk (see Table B below). Existing controls are always taken into account prior to determining credible outcomes. Existing controls are verified controls and may be provided by the FAA or by the applicant. For both the initial and residual risk, the safety analyst or teams rely upon information provided by the UAS applicants (e.g., the system assessment), and their own SMEs to determine the severity and likelihood of the hazard’s outcomes. The safety analyst or team’s rationale for how they arrived at their determination is just as important as the severity and/or likelihood determination itself. The severity and likelihood definitions and risk matrix are used to better define the safety impact of the proposed UAS operation.

(1) Severity – The potential consequence or impact of a hazard in terms of degree of loss or harm. Refer to Appendix C Table C-1: Severity Definitions.

i. What are the credible outcomes? (i.e., catastrophic, hazardous, major, minor, minimal)

ii. Why? (e.g., data, line of thought, expertise, rationale for how the safety analyst or team arrived at their determination)

iii. How do existing controls and additional mitigations change the aircraft, airman/operator, or airspace/operating environment, such that the severity is reduced?

(2) Likelihood – The estimated probability or frequency, in quantitative or qualitative terms, of the outcome(s) associated with a hazard. Refer to Appendix C Table C-2: Likelihood Definitions – General Aviation Operations/Small Aircraft and Rotorcraft Table. When sufficient empirical data exists, statistical probabilities should be used (e.g., airspace and ground density data).

i. What is the likelihood of the credible outcomes? (e.g., frequent, probable, remote, extremely remote, extremely improbable)

ii. Why? (e.g., data, line of thought, expertise, rationale for how the safety analyst or team arrived at their determination)

iii. How do mitigations change the aircraft, airman, airspace/operating environment, such that the likelihood is reduced?

e. Validity of Mitigations. The safety analyst or team must consider the validity of mitigations presented by the applicant as part of the layered approach to mitigating risk. What evidence does the FAA have that the mitigations are effective (e.g., test data, third party verification)? How are the mitigations dependent on each other? How much credit should be given for the mitigations? Is there a single point failure? This information must be included in the SRM documentation.

f. Assess Safety Risk. A risk matrix provides a visual depiction of the safety risk and enables prioritization in the control of the hazards. Appendix C Figure C-1: Risk Matrix – General Aviation Operations/Small Aircraft and Rotorcraft is the risk matrix used during this step. The safety analyst or team uses the determined severity and likelihood to plot the initial risk level on the risk matrix. The safety analyst or team documents initial risk level, the rationale of how the severity and likelihood was determined, and compares the level against the risk acceptance criteria.

g. Additional Safety Risk Controls and Residual Safety Risk. During this step, the safety analyst or team assesses the need for additional controls (i.e, conditions and limitations in exemptions and special provisions in waivers) to reduce the risk of the operation to an acceptable level. Conditions and limitations and special provisions are intended to document specific safety risk controls presented by the FAA. The safety analyst or team must record a description of the additional safety risk controls that were considered prior to analyzing and assessing the residual safety risk. The safety analyst or team documents the new severities, likelihoods, and residual risk level on the risk matrix taking into account the additional safety risk controls.

h. Safety Performance Monitoring and Hazard Tracking. When the safety risk assessment is complete, tracking and monitoring is required in accordance with FAA Order 8040.4 for medium and high residual risk levels. The intent of tracking and monitoring is to assure the risk controls are valid, and verifies the predicted residual risk of the approved operation. The safety analyst or team provides a description of the data to be collected, at specific intervals for a specific duration, defines safety performance targets for each hazard, and the Point of Contact (POC) responsible. The safety performance targets are used to verify the residual risk levels.

i. Documenting Assessments and Decisions. The safety analyst or team documents the safety risk assessment utilizing the form in Appendix D, related documents, and any other relevant information and provides it to the risk acceptor. The safety risk assessment documentation is important for the risk acceptor to make a decision.

j. Residual Safety Risk Acceptance. Accepting risk is a management decision. Safety risk must be accepted at the appropriate AVS management level in Table B (below). By accepting risk, the management official is deciding to authorize the operation with the residual safety risk levels presented. Previously accepted risks may be referenced during future safety risk assessments. The decision to accept safety risk will result from the level of risk that the operation presents. The risk acceptor must have confidence that the mitigation strategies will reduce the safety risk to an acceptable level. The risk acceptor accepts the risk by signing the safety risk management document.

Table B – UAS Safety Risk Acceptance

Initial Safety Risk Level	UAS Safety Risk Acceptance
High Risk	AVS Associate Administrator
Medium Risk	Division or appropriate office manager (i.e., the appropriate management official within the AVS who has the positional responsibility and authority for the issue or change being assessed)
Low Risk	

k. Safety Risk Documentation. Once SRM is completed, the information must be documented in accordance with FAA Order 8040.4.

l. Safety Performance Monitoring. Per the monitoring plan, safety performance monitoring is conducted to verify the risk assessment and the safety controls.

Chapter 5. Administrative Information

1. Distribution. This order is distributed to all offices in Washington Headquarters, regions, and centers, with distribution to all field offices and facilities of the applicable FAA organizations (identified in Chapter 1, subparagraph 2).

2. Related Publications. This order is consistent with the latest versions of the following aviation safety documents in effect at the time the order was published:

a. FAA Order 8040.4, Safety Risk Management Policy,

b. FAA Order 8000.369, Safety Management System,

c. FAA Order 1100.154, Delegations of Authority,

d. FAA Order VS 8000.367, Aviation Safety (AVS) Safety Management System Requirements,

e. FAA Order JO 1000.37, Air Traffic Organization Safety Management System; and,

f. Air Traffic Organization, Safety Management System Manual.

Appendix A. UAS Hazards, Mitigations, Outcomes

This list of common hazards is a starting point; all hazards applicable to the operation must be identified and documented.

Hazards	Hazard Definition	Causes (if applicable)	Mitigations[4]	Outcomes
Technical Issue with UAS	Malfunction of any technical component of the UAS, which causes a deviation from planned operations.	• Motor failure • Software failure • Hardware failure • Lost Link • GPS Failure • Communications failure • Flyaway • Geofence failure • Ground station failure • Battery/power failure • Avionics failure • UA leaves planned route • Failure of C2/3 change over	• Competent applicant/operator • UAS manufactured by competent or proven entity • UAS maintained by competent or proven entity • UAS developed to authority recognized design standards • C2/3 link performance appropriate • Preflight checks of UAS • Operational procedures validated • Remote crew trained and current • Safe recovery from technical issue • Methods to reduce kinetic energy • Ground population density • Emergency response plan in place • Reduce effects of ground impact • Technical containment in place and effective • Parachute or frangible aircraft	• Collision between UAS and a manned aircraft in the air • Collision between a UAS and person on ground or moving vehicle • Collision between a UAS and critical infrastructure on the ground
Deterioration of external systems supporting the UAS operation	Malfunction of any component that is not a part of the UAS but supports safe operations.	• ADS-B signal degradation • GPS signal degradation • UAS Traffic Management (UTM) failure	• Procedures are in place to handle the deterioration of external systems supporting the UAS operation • UAS is designed to manage the deterioration of external systems supporting the UAS operation • External services supporting the UAS operation are adequate to the operation	• Collision between UAS and a manned aircraft in the air • Collision between a UAS and person on ground or moving vehicle • Collision between a UAS and critical infrastructure on the ground
Human Error	A person's mistake rather than the failure of a machine, which causes a deviation from planned operations.	• Pilot errors • Maintenance Errors • Preflight Planning Errors • Mission and route planning errors • Cargo Loading Errors • Flight into unplanned weather	• Operational procedures are defined, validated, and adhered to • Remote crew trained and current and able to control abnormal situation • Multi-crew coordination • Remote crew fit to operate • Automate protection of the flight envelope from human error • Safe recovery from human error • A human factors evaluation has been performed and the human machine interaction (HMI) found appropriate to the mission. • Crew resource management practices	• Collision between UAS and a manned aircraft in the air • Collision between a UAS and person on ground or moving vehicle • Collision between a UAS and critical infrastructure on the ground

[4] This column includes any mitigation known or expected to reduce the severity and/or likelihood of the hazard's effect.

Adverse Operating Conditions	Operating into or within conditions that the UAS wasn't intended to, which causes a deviation from planned operations.	• Unforecasted weather • Reduced visibility • Climate and topography unique weather	• Operational procedures are defined, validated and adhered to • The remote crew is trained to identify critical environmental conditions and to avoid them • Environmental conditions for safe operations are defined, measurable and adhered to • UAS designed and qualified for adverse environmental conditions	• Collision between UAS and a manned aircraft in the air • Collision between a UAS and person on ground or moving vehicle • Collision between a UAS and critical infrastructure on the ground
Unable to Detect and Avoid	Beyond Visual Line of Sight (BVLOS) operations and the design of the UAS give the aircraft a limited ability to sense intruding aircraft and yield right of way as required by 14 CFR Parts §91.113 and §107.37	• Transponder failure • Communication failure between VOs • Traffic conflicts; helicopter routes/uncharted landing surfaces • Inability to comply with 14 CFR Parts §91.113 and §107.37 • Low altitude General Aviation (GA) operations • Manned aircraft unable to see UA (due to the small size of the UA) • Pilot and crew errors • UA maneuverability (due to UA performance limitations)	• Visual Observers (VOs) (communication between pilot and observers) • Detect and avoid (DAA) system • Airspace of operation and adjacent airspace • Time of day • Operating restrictions • Restricting operations within certain boundaries or airspace volumes • Restricting operational flight time • Low altitude • ATC separation services • Traffic Alert and Collision Avoidance System (TCAS) • Proximity to structures	• Collision between UAS and a manned aircraft in the air

Appendix B. Terms and Definitions

1. Accident – An unplanned event or series of events that results in death, injury, or damage to, or loss of, equipment or property.

2. Aircraft Accident – An occurrence associated with the operation of an aircraft that takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage. UAS accidents are defined in 14 CFR §107.9 Accident Reporting and by the National Transportation Safety Board (NTSB) in 49 CFR §830.

3. Analysis – The process of identifying a question or issue to be addressed, examining the issue, investigating the results, interpreting the results, and possibly making a recommendation. Analysis typically involves using scientific or mathematical methods for evaluation.

4. Assessment – Process of measuring or judging the value or level of something.

5. Common Cause Failure – A failure that occurs when a single fault results in the corresponding failure of multiple system components or functions.

6. Control – See Safety Risk Control. The terms *Control*, *Mitigation*, and *Safety Risk Control* are used synonymously

7. Critical Infrastructure[5] – systems and assets, whether physical or virtual, so vital to the United States that the incapacity or destruction of such systems and assets would have a debilitating impact on security, national economic security, national public health or safety, or any combination of those matters.

8. Existing Control – A control that currently exist and has been verified. Existing controls can be a FAA control or an applicant control and will be considered prior to determining the initial risk.

9. Outcome – The real effect that has occurred or the credible predicted effect expected if the hazard exists in the defined system state.

10. Hazard – A condition that could foreseeably cause or contribute to an aircraft accident.

11. Incident – An occurrence other than an accident that affects or could affect the safety of operations.

12. Likelihood – The estimated probability or frequency, in quantitative or qualitative terms, of a hazard's effect or outcome.

[5] Critical infrastructure is defined in 42 USC § 5195c(e)

13. Mitigation – A means to reduce or eliminate the effects of hazards. *See Safety Risk Control*. The terms *Control*, *Mitigation*, and *Safety Risk Control* are used synonymously.

14. Monitoring – Tracking and keeping information under systematic review.

15. National Aerospace System (NAS) – The common network of U.S. 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. Included are system components shared jointly with the military.

16. Office of Primary Responsibility (OPR) – The organization with regulatory responsibility that manages and tracks the issue or change through closure; responsibilities include leading and managing the safety risk assessment, identifying the appropriate management officials to accept safety risk and approve mitigations, coordinating any necessary approvals and safety risk acceptance decisions, and entering results and decisions into Hazard Identification Risk Management and Tracking (HIRMT), as required.

17. Initial Risk - The risk level determined by accounting for the applicants proposed mitigations and preexisting controls in the current environment.

18. Residual Risk – The remaining risk level that exists after all safety risk controls (applicant and FAA) have been implemented.

19. Risk – *See Safety Risk.* The terms *Risk* and *Safety Risk* are used synonymously.

20. Risk Acceptance. *See Safety Risk Acceptance*. The terms *Risk Acceptance* and *Safety Risk Acceptance* are used synonymously.

21. Safety Assurance – Processes within the SMS that function systematically to ensure the performance and effectiveness of safety risk controls and that the organization meets or exceeds its safety objectives through the collection, analysis, and assessment of information.

22. Safety Performance Target – A measurable goal used to verify the predicted residual safety risk of a hazard's effect.

23. Safety Risk – The composite of predicted severity and likelihood of the potential effect of a hazard. The levels of safety risk are:

a. High Risk – Severity and likelihood map to the red cells in the risk matrix (in FAA Order 8040.4 Appendix C). This safety risk requires mitigation, tracking, and monitoring, and it can only be accepted at the highest level of management within LOBs and Staff Offices.

b. Medium Risk – Severity and likelihood map to the yellow cells in the risk matrix (in FAA Order 8040.4 Appendix C). This safety risk is acceptable without additional mitigation; however, tracking and monitoring are required.

c. Low Risk – Severity and likelihood map to the green cells in the risk matrix (in FAA Order 8040.4 Appendix C). This safety risk is acceptable without restriction or limitation; hazards are not required to be actively managed, but they must be documented and reported if a safety risk assessment has been performed.

24. Safety Risk Acceptance – The decision by the appropriate management official to authorize the operation without additional safety risk mitigation.

25. Safety Risk Analysis – The first three steps of the SRM process (analyze the system, identify hazards, and analyze safety risk).

26. Safety Risk Assessment – The first four steps of the SRM process (analyze the system, identify hazards, analyze safety risk, and assess safety risk).

27. Safety Risk Control – A means to reduce or eliminate the effects of hazards. The terms *Control*, *Mitigation*, and *Safety Risk Control* are used synonymously.

28. Safety Risk Management (SRM) – A process within the SMS composed of describing the system; identifying the hazards; and analyzing, assessing, and controlling safety risk.

29. Severity – The consequence or impact of a hazard's effect or outcome in terms of degree of loss or harm.

30. Single Point Failure – An element of a system or operation for which no backup (i.e., redundancy) exists. Single-pilot operations are an exception.

31. System – An integrated set of constituent elements that are combined in an operational or support environment to accomplish a defined objective. These elements include people, hardware, software, firmware, information, procedures, facilities, services, and other support facets.

Appendix C. Severity, Likelihood, and Risk Matrix

Table C1 Severity Definitions*

Minimal 5	Minor 4	Major 3	Hazardous 2	Catastrophic 1
Negligible safety effect	– Physical discomfort to persons – Slight damage to aircraft/vehicle	– Physical distress or injuries to persons – Substantial damage to aircraft/vehicle	Multiple serious injuries; fatal injury to a relatively small number of persons (one or two); or a hull loss without fatalities	Multiple fatalities (or fatality to all on board) usually with the loss of aircraft/ vehicle

* Excludes vehicles, crew, and participants of commercial space flight.

Table C2 Likelihood Definitions General Aviation Operations/Small Aircraft and Rotorcraft

	Qualitative	Quantitative – Time/Calendar-based Occurrences Domain-wide/System-wide
Frequent A	Expected to occur routinely	Expected to occur more than 100 times per year (or more than approximately 10 times a month)
Probable B	Expected to occur often	Expected to occur between 10 and 100 times per year (or approximately 1-10 times a month)
Remote C	Expected to occur infrequently	Expected to occur one time every 1 month to 1 year
Extremely Remote D	Expected to occur rarely	Expected to occur one time every 1 to 10 years
Extremely Improbable E	Unlikely to occur, but not impossible	Expected to occur less than one time every 10 years

Figure C1 Risk Matrix General Aviation Operations/Small Aircraft and Rotorcraft

Severity / Likelihood	Minimal 5	Minor 4	Major 3	Hazardous 2	Catastrophic 1
Frequent A	[Green]	[Yellow]	[Red]	[Red]	[Red]
Probable B	[Green]	[Yellow]	[Yellow]	[Red]	[Red]
Remote C	[Green]	[Green]	[Yellow]	[Yellow]	[Red]
Extremely Remote D	[Green]	[Green]	[Green]	[Yellow]	[Red] * / [Yellow]
Extremely Improbable E	[Green]	[Green]	[Green]	[Green]	[Yellow]

High Risk [Red]
Medium Risk [Yellow]
Low Risk [Green]

* High Risk with Single Point and/or Common Cause Failures

Appendix D. Sample Safety Risk Management Form for UAS Requests

Overview of the Operation

Brief description of the operation and waiver/exemption request

Example: FlyHigh proposes to conduct power line inspections in Central Pennsylvania. The operation will take place using a single 75 pound UA during daylight hours only in an unpopulated rural area of power lines. The flight path is approximately 30 miles long and the operating altitude with be up to 100 feet above the power lines, but not greater than 400 feet above ground level (AGL). A ground-based radar will be used as a means to detect and avoid manned aircraft.

System Analysis (short overview of the proposed operation)

Aircraft: Describe the aircraft and any limitations (e.g., below)

- The aircraft is a UA with a maximum takeoff weight of 75 pounds powered by a gas engine. The gas engine has been used on ultralight and light sport aircraft
- The aircraft has been operating since 2008 in various other countries. Equipped with GPS, an ADS-B receiver
- Accumulated 3000 successful flight hours in various countries around the world. This time includes damage assessments to power lines after hurricanes.
- Equipped with a parachute in case of engine or flight control failure
  Redundant electrical power supplies
- Command and Control link has been tested by a third party (university)
- Software has been tested and proven during the flight tests 3000 successful flight hours. Equipped with a camera for power line inspection

Airman/Operator: *Describe the personnel involved and any limitations*

Airspace/Operating Environment: *Describe the all airspace and operating environment in which the operation will take place and any limitations*

Description of the trigger that resulted in the SRM analysis

SRM was triggered for the proposed operation due to:

Example: Flyhigh petitioned for exemption in December of 2018. The OPR determined SRM was required to ensure new risks are not introduced into the NAS as the operation is a BVLOS operation using a new ground based radar to see an and avoid and as a backup for navigation.

Identify Hazards and Outcomes

Hazard	Hazard Cause	Credible Outcomes	Existing Controls/Docume	Control Owner
#1 Technical Issue with UAS	• motor failure • software error • lost C2 link • flyaway • GPS receiver failure	Collision between UAS and a manned aircraft in the air collision between a UAS and person on ground, collision between a UAS and critical infrastructure on the ground)	• proven motor (safety case) • parachute (safety case) • certified software (S1 Software assurance test document) • auto land (S1 Software assurance test document) • C2 tested and validated (University	Flyhigh
#2 Deterioration of external systems supporting the UAS operation				
#3 Human Error				
#4 Adverse Operating Conditions				
#5 Unable to see and avoid				
#6 Additional Hazard				
#7 Additional Hazard				

Analyze Safety Risk Hazard #1 Technical Issue with UAS (controls example)

Motor

The gas internal combustion engine has been proven on ultra-light and light sport aircraft. The pilot and flight engineer monitor engine parameters. If the engine indications go outside of the parameters pilot will land the UA at the nearest landing zone. If the engine fails, the parachute automatically deploys. FlyHigh will overhaul the engine before the Time Between Overhauls (TBO) of 2000 hours. See FlyHigh Maintenance Manual and Flight Manual.

Software

The software has been proven with over 3000 hours of logged flight and is certified to DO-178B Software Considerations in Airborne Systems and Equipment Certification. A software assurance program is in place to ensure the latest version has been loaded onto the UAS and the software performs as required. The aircraft and software are powered by redundant power supplies.

C2 Link

The C2 link has been tested and proven as documented in the University Test Report. The maximum range has been determined to be 55 miles (almost twice the 30 mile route). There is direct line of sight as there are no hills between the control station and the UA. The latency has been tested and determined to be less than 5 seconds for 90% of the tests. If the C2 link fails, the aircraft will hover and attempt to reestablish the signal. If the C2 link is reestablished, the UA continues the flight. If the link cannot be reestablished the aircraft lands at the closest landing zone. See the Command and Control Specification Document and CONOPs.

Flyaway

If the UA moves to 200 feet on either side of the flight path, the pilot will take control of the UA. In the event the aircraft moves 500 feet on either side of the planned flight path, the aircraft will automatically land at the closest designated landing area. See FlyHigh Flight Manual. In the event of a flight control failure resulting in the aircraft moving beyond 500 feet from either side of the flight path the parachute will automatically deploy terminating the flight.

GPS

The remote pilot will monitor the GPS signal. If the signal degrades or in the event of GPS failure, the aircraft will hover for 45 seconds and attempt to reestablish a signal. If a signal cannot be reestablished, the software is programmed so the UA goes into a slow descent at 30 feet per minute until landing.

Hazard	Severity	Likelihood
#1 Technical Issue with UAS	(e,g.,Hazardous)	(e.g., Remote)
#2 Deterioration of external systems supporting the UAS operation		
#3 Human Error		
#4 Adverse Operating Conditions		
#5 Unable to see and avoid		
#6 Additional Hazard		
#7 Additional Hazard		

Assess Safety Risk

Hazard	Initial Risk Level	Rationale
#1 Technical Issue with UAS	(e,g, Medium (2D)	(e.g., The severity is determined to be **hazardous** based on the operations in the surrounding area traffic being general aviation only and the UA having a frangible tail boom, and parachute. With the mitigations in place the likelihood is determined to be **extremely remote**. The UAS been tested and mitigations are in place to ensure a technical issue will be extremely remote. The software has been certified to DO-178B and the engine has been proven. There is an auto land feature is activated for technical issues and backup systems onboard) The C2 link has been tested and proven.
#2 Deterioration of external systems supporting the UAS operation		
#3 Human Error		
#4 Adverse Operating Conditions		
#5 Unable to see and avoid		
#6 Additional Hazard		
#7 Additional Hazard		

Additional Safety Risk Controls and Residual Safety Risk

Hazard	Additional Controls	Severity	Likelihood	Residual Risk Level
#1 Technical Issue with UAS	(e,g, number of flights is limited to 3 a week),	Hazardous	Extremely Improbably	Green (2E)
#2 Deterioration of external systems supporting the UAS operation				
#3 Human Error				
#4 Adverse Operating Conditions				
#5 Unable to see and avoid				
#6 Additional Hazard				
#7 Additional Hazard				

Safety Performance Monitoring and Hazard Tracking

Hazard	Monitoring Activity	Frequency	Duration	Safety Performan	POC Responsible for Monitoring
#1 Technical Issue with UAS	System failures resulting in deviation from planned route	Quarterly	Two Years and/or 2000 flight hours	No more than one deviation per quarter	Flyhigh Chief Pilot
#2 Deterioration of external systems supporting the UAS operation					
#3 Human Error					
#4 Adverse Operating Conditions					
#5 Unable to see and avoid					
#6 Additional Hazard					
#7 Additional Hazard					

Safety Analyst or Team Members

List the team members or individual verifying or performing the analysis

Name	Organization	Experience
Jim Smith	AFX-1	10 years commercial pilot, 5 years FAA waiver review team, 3 years recreational drone operator, etc

Residual Safety Risk Acceptance.

(e.g., Jane Smith/Manager AFX-001 Flight Standards Service

Name/position of management official(s)/executives(s) approving any safety risk controls in accordance with Table D