Unmanned Aircraft Systems (UAS) for Humanitarian Aid and Emergency Response Guidance

U-AID

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Background

General

Humanitarian aid and emergency response operations, hereinafter referred to collectively as "U-AID", can include scheduled and unscheduled medical deliveries or provide emergency response to victims of natural or man-made disasters. An emergency response may be initiated by domestic or foreign governments, international agencies, or a grouping of both. Effective humanitarian aid and emergency response requires prior planning, careful coordination, and approved or qualified operators to ensure the needed aid is delivered safely, dependably, efficiently, and effectively. For any type of humanitarian mission using unmanned aircraft systems (UAS), it will be necessary for the civil aviation authority (CAA) to coordinate with other government departments and entities, including (but not limited to): the Ministry of Health, Dangerous Goods Cargo, National Emergency Response points-of-contact, and non-government organizations.

This guidance material is a resource for member States to enable humanitarian aid and emergency response operations using UAS, and to enable an expedited review process for urgent operations. It is applicable for States that have already implemented UAS regulations and for States who are in the beginning stages of promulgating UAS regulations.

The elements of an application for UAS operations included in this material, and that will be evaluated by the CAA, also inform the applicant preparing a submission. The CAA and UAS operators are encouraged to use this information as best practice methods for reviewing submissions and developing operational programs.

In addition to producing this guidance material, ICAO is part of an international effort to identify and streamline emergency preparedness at international airports. This is done in partnership with the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) and additional aviation and humanitarian partners. ICAO is also in a collaborative arrangement with the World Health Organization (WHO) for the prevention and management of Public Health events in civil aviation (CAPSCA). These efforts assist member States and align with the United Nations sustainable development goals.

Regulatory Framework

Many States have UAS regulations in place that an operator must comply with when UAS are operated under their jurisdiction for any purpose, including U-AID. This guidance material will support CAAs in their review of requests for UAS operational authorizations in response to humanitarian emergencies, regardless of the status of their UAS regulations.

ICAO has published model UAS regulations which are available for download at https://www.icao.int/safety/UA. The ICAO model UAS regulations are regulatory text and individual member States can choose to use some sections, or the full set, tailoring references to their existing regulatory framework.

A State interested in reviewing other national UAS regulations can access several on the ICAO UAS Toolkit. The toolkit also provides general information, lessons learned, and best practices. The toolkit is available online at https://www.icao.int/safety/UA/UASToolkit/. There are also regional efforts to

provide regulatory guidance to States; for example, the ICAO Asia/Pacific Unmanned Aircraft Systems Task Force (APUAS/TF) published guidance material in August 2019 to assist States in formulating regulations. This information provides States with essential considerations in creating UAS regulations. The link to this publication is available at https://www.icao.int/APAC/.

States are encouraged to write UAS regulations using performance-based criteria that indicate a level of safety to be achieved, rather than using prescriptive requirements, to the extent practicable. The means of compliance with established safety requirements may be achieved by the use of industry standards, advisory circulars, or other means of compliance accepted by the CAA. The CAA will determine whether the unmanned aircraft (UA) complies with the regulations, and whether the safety risk is considered acceptable, prior to issuing an authorization.

Operational Overview

Humanitarian missions as a result of a catastrophic event (for example, a natural disaster causing great urgency): During dire circumstances, expediting the approval of UAS operations will be paramount. Based on this level of urgency, a lengthy application submission and review process by the CAA would be inordinate, while an application with reduced requirements would be appropriate. Expediting a submission for an urgent event can be achieved with an online application (*U-AID Expedited Authorization for Urgent UAS Operations*), included here.

There may be other circumstances where an expedited submission may be applicable. In such cases, the CAA may identify "known UA operators", provided that the CAA has oversight experience with the UA operator. These known UA operators may be granted a conditional airspace approval. The CAA will still require the information included on the *U-AID Expedited Authorization for Urgent UAS Operations* application form. This information will be sent to the air navigation service provider (ANSP) unit for evaluation. The CAA will provide operational input, if necessary. In each case, the CAA will make the final determination as to the specific information they will require and whether the expedited application should be used.

Humanitarian missions for purposes of routine humanitarian delivery by UA: For those persons making an application for the first time to operate UA for U-AID, or for applicants that wish to pre-apply for an authorization for future U-AID, the submission required by the CAA may include:

1. The application form (*Application for U-AID Authorization)*, which becomes the concept of operations (CONOPS), (click here to access the downloadable form).
2. A declaration of compliance from the manufacturer identifying the demonstrated capabilities of the system.
3. An operational risk assessment and a dangerous goods risk assessment, if dangerous goods will be carried.
4. Supporting documentation (manufacturer instructions, operator training manuals, applicant's UAS operations manual, etc.) depending on the complexity of the operation.
5. An airspace authorization, if required.
6. Any additional documents or information deemed necessary by the State.

A UAS operational planning tool developed by GlobalMedic, a rapid response team, can be viewed at: https://www.dropbox.com/s/zokw7m57r5ks887/RescUAV_Flight_Data_Master.xlsx?dl=0. This

example may be a useful checklist to new operators in establishing emergency operational procedures. Two additional tools that may also be helpful to operators are the U-AID Societal Interactions – Long Term and UA Operations with Short Lead Time.

Airspace Rules

Until a system for UAS traffic management (UTM) is operational, and real-time information regarding airspace constraints and flight intentions are available, airspace will continue to require careful scrutiny by the UAS operator. The ICAO UTM Framework provides States that are considering the implementation of a UTM system with a framework and core capabilities of a "typical" UTM system. Click here to review the current version of the ICAO UTM Framework.

The type of airspace authorization requested for U-AID is directly related to the level of safety risk imposed by the operation. The applicant must carefully consider the proposed airspace and associated requirements to ensure safety of the operation.

There are two types of UA operations: visual line-of-sight and beyond visual line-of-sight.

Visual line-of-sight (VLOS) operation: An operation in which the remote pilot, or UA observer, maintains direct, unaided visual contact with the UA.

VLOS can cover extended areas, if the remote pilot is supported by UA observer(s), to identify conflicting traffic or other hazards in order for the remote pilot to take appropriate avoidance action. The UA observer(s) must be in continuous communication with the remote pilot. The method of communication between the UA observer(s) and the remote pilot must be described in the application and tested before commencing a flight.

Beyond visual line-of-sight (BVLOS) operation: An operation in which the remote pilot, or UA observer, does not use visual reference to the UA in the conduct of flight.

BVLOS operations may be approved on a case-by-case basis by the CAA. BVLOS not conducted in accordance with instrument flight rules (IFR) require special consideration. De-confliction with other traffic, manned or unmanned, must be addressed by instrumentation and equipment, or through airspace segregation, with safety assurances and details included in the submission.

As with each application, documentation on the reliability and construction of the UA is required. This may be a document issued by an approved aviation organization (AAO), authorized by the CAA to inspect and approve the reliability and construction of the UA, as referenced in the ICAO model UAS regulations, Part 149. A manufacturer Declaration of Compliance accepted by the CAA would also serve as documentation on the reliability and construction of the UA, as referenced in the ICAO model UAS regulations, Part 102. The Declaration of Compliance identifies the demonstrated capabilities of the system and is based on a means of compliance that is comprised of test data, industry standards, or other means used to establish the declaration. A review of the means of compliance may be required, at the discretion of the CAA.

The CAA must evaluate whether the planned operation and the technology used is suitable for the airspace in which the UA will operate. In the submission, the operator must describe how encounters with other traffic or known obstructions will be handled, and by what means (electronically or otherwise), to ensure safety will be maintained.

If segregated airspace is requested to facilitate the humanitarian operation, the local air traffic unit must approve the request before an authorization can be issued. Details of the approved segregated airspace request should be publicized by notice to airmen (NOTAM) or Aeronautical Information Publication (AIP) amendment.

Environmental Conditions

Each UA should have specifications for the environmental conditions that are applicable to its operation. The manufacturer shall determine the limitations for operating in varied weather conditions and include the information in their instructions and limitations. UA built for testing or home-built models must likewise possess documentation that specify environmental conditions or limitations.

UAS Contingency and Emergency Operational Status

A contingency is a non-normal state of the UAS with implications for the safety of flight. Loss of command and control link (C2 Link), failure or degradation of the detect and avoid (DAA) system, loss of airborne radio communications, and an emergency landing are some of the events that require preplanned procedures. The applicant must include in their submission procedures for contingency and emergency circumstances that address scenarios that may occur along their intended route of flight. Applicants may also be required by the CAA to document these procedures in their UAS Operations Manual, commensurate with the complexity of their organization.

System Specifications (Air, Ground, Cyber)

Flight characteristics that are unique to the UA should be detailed. Flight systems are generally comprised of three sub-systems: software, hardware, and communication. Each of the sub-systems must be thoroughly described in the application for authorization and include details related to performance, reliability, and potential failures. The following are common descriptions.

- *Software* – Dependability of the UAS software includes aspects of both safety and security. The software should have the capability to allow secure intervention by the remote pilot in the management of the flight during normal operations. The application should include any certification information and a safety assurance programme that validates that the latest version of the software has been loaded into the UAS and that the software performs as required.

- *Hardware* – The UAS should be designed and constructed to meet its limitations and performance capabilities in accordance with manufacturer instructions. Applicants should provide UAS maintenance records and flight logs to document performance trends. In the event of failure, a mechanism that addresses emergency conditions and provides redundant control features and power supplies will be beneficial.

- *Communication* – The C2 Link is dedicated to the exchange of information between the remote pilot station (RPS) and the UA for the purposes of managing the flight. The effective range of the C2 Link must be determined, ideally through testing in the intended area of operation. All operations of the UAS should be contained within that range.

- *Frequency Spectrum* - If using an unlicensed band, the operation is to be conducted in accordance with applicable regulations; if using a licensed band, approval is to be obtained from the appropriate governing agency. Frequency spectrum allocation varies by region. The UAS operator must verify using the appropriate bands in the location of operation.

- *Emergency Recovery & Contingency* – The operator should have a mechanism to recover or terminate the UA in flight in case the automated functionalities of the UA are lost or malfunction, resulting in a complete loss of control or sight of the UA.

Crew and Personnel Training and Descriptions

Training of the remote pilot and other personnel is an important element that must be included in the applicant's submission. ICAO has adopted Standards and Recommended Practices (SARPs), Annex 1 — *Personnel Licensing*, for the remote pilot licence. While these SARPs pertain specifically to instrument flight rule operations, they are scalable for BVLOS operations. A licence that meets international standards creates standardization, harmonization, and provides assurance that the remote flight crew is properly trained and capable to reduce the occurrence of incidents and accidents. A licenced remote flight crew serves as mitigation in the planning and conduct of the operation.

Other examples that provide assurance that the remote flight crew is prepared and capable to reduce the occurrence of incidents and accidents include: competency-based training and assessment conducted at an approved training organization (ATO), an AAO that includes the type of equipment, operation, and environment being proposed, or a manufacturer that provides training. These examples are also mitigating factors in the planning and conduct of the operation.

For UA operations, the CAA should expect the remote crew to, at a minimum:

- demonstrate an acceptable level of knowledge of operational and maintenance practices consistent with the manufacturer's recommendations and instructions, and meet any local requirements established by the CAA;
- understand the operational limitations of their UA and systems;
- recognize the capabilities and specifications of the sub-systems of the UAS;
- demonstrate knowledge in the operator's contingency/emergency procedures in the event of failure(s);
- demonstrate knowledge of human factor issues, meteorology, technologically-based communication and navigation, and general principles of flight for their aircraft;
- be able to prepare and submit a flight plan and a NOTAM according to the appropriate authority's requirements;
- demonstrate the ability to effectively manage all aspects of a UAS operation related to the application; and
- demonstrate knowledge in the handling and delivery of dangerous goods and perishable cargo.

Dangerous Goods: Understanding the Risks and the Responsibilities

Introduction

UA that are being used to transport goods for humanitarian aid and emergency response may include goods that have one or more inherent hazards and, therefore, are classified as dangerous goods. See Appendix 2 for examples of dangerous goods that may be carried for humanitarian aid or emergency response. ICAO develops international Standards and Recommended Practices (SARPs) which govern the safe transport of dangerous goods on civil aircraft. Most States adopt these standards into their national legislation for both international and domestic operations.

There may be circumstances when full compliance with ICAO SARPs on the safe transport of dangerous goods by air is inappropriate or unnecessary for UA operations. Conversely, there may be hazards unique to UA operations that are not addressed by these SARPs. The State of the Operator should ensure that both are taken into account before approving transport operations involving the carriage of dangerous goods on UA. Likewise, the State where operations occur, if different, should review the approval issued by the State of the Operator.

Scope

This guidance applies to circumstances when a State has determined that the use of UA to transport dangerous goods for humanitarian aid and emergency response is appropriate. If delivery of dangerous goods by other modes of transport to, or from, the location of the UA is necessary, all appropriate provisions of the national or international regulations for those modes of transport apply.

Regulatory Requirements for the International Transport of Dangerous Goods by Air on Civil Aircraft

The broad principles governing the international transport of dangerous goods by air are contained in Annex 18 to the Convention on International Civil Aviation — *The Safe Transport of Dangerous Goods by Air*. These broad provisions are amplified by detailed specifications contained in the *Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Technical Instructions, Doc 9284). States are obliged to take the necessary measures to achieve compliance with these documents for international civil aircraft operations and are encouraged to do the same for domestic civil aircraft operations.

Dangerous Goods — Description

Dangerous goods are articles or substances which are capable of posing a risk to health, safety, property, or the environment and which are shown in the list of dangerous goods in the Technical Instructions or which are classified according to those Instructions. Dangerous goods are classified according to nine classes based on their potential consequences. Some classes are further divided into divisions. Dangerous goods can have two or more potential consequences. Identifying dangerous goods is the first step towards safely transporting them. Based on this, the safety risks posed can be reduced through proper packaging, communication, handling, and stowage. The scope of dangerous goods needed for humanitarian aid or emergency response may be limited to specific items and classes. The

operator should identify these items and classes in their safety risk assessment. Dangerous goods classes and divisions are outlined in Appendix 1.

Transport of Dangerous Goods on UA

When appropriate, the State of the Operator may grant an approval to permit the carriage of dangerous goods without complying with the requirements of the Technical Instructions. This may occur when the CAA is satisfied with the operator's safety risk assessment, the operator has made a reasonable effort to identify all hazards, and the safety risks associated with the foreseeable consequences have been mitigated to an acceptable level.

There may be hazards unique to UA operations that are not addressed in the Technical Instructions. The CAA should ensure that these hazards are addressed through the operator's safety risk assessment. For example, adequate instruction should be provided to ensure that individuals who handle dangerous goods are competent to perform any function commensurate with their responsibilities, taking into account the level of safety risk.

Dangerous Goods Standard Operating Procedures

The State of the Operator, when granting an operator approval for carriage of dangerous goods, must ensure that the operator establishes standard operating procedures for the safe transport of dangerous goods (DG-SOP) on board or attached to the UA. The DG-SOP should include procedures for conducting a safety risk assessment for each operation. If operations are conducted other than in the State of the Operator, the CAA where the operations occur must determine if the SOP are acceptable.

The DG-SOP may be brief depending on the nature and urgency of the operation and on the level of safety risk. At a minimum, the DG-SOP should include:

a) procedures for carrying out responsibilities, including measures to identify hazards and their potential consequences and ensure risk can be managed to an acceptable level through the conduct of a safety risk assessment;
b) a training policy including the level of competency achieved once training is complete;
c) instructions for communicating to relevant persons information related to the dangerous goods being transported, in case of an accident or incident;
d) action to be taken in the event of emergencies involving dangerous goods; and
e) instructions for the collection of safety data related to dangerous goods accidents and dangerous goods incidents.

Appendix 3 to this document provides further guidance on elements that should be included in the SOP.

The safety risk assessment should include at least the:

a) identification of hazards associated with the dangerous goods;
b) type of operation;
c) containment characteristics of the UA;
d) packing and packaging;
e) quantity and type of dangerous goods to be transported; and
f) level of competence of those handling the dangerous goods.

Appendix 4 provides further guidance on elements that should be considered for the carriage of dangerous goods by UA. The next section explains how to perform a safety risk assessment.

Note.—The Safety Management Manual (SMM) *(Doc 9859, 4th edition) contains general guidance on implementation of Annex 19* — Safety Management*, including the conduct of safety risk assessments. A new manual entitled* Guidance for Safe Operations Involving Aeroplane Cargo Compartments *(Doc 10102) provides guidance on specific safety risk assessments on the transport of items, including dangerous goods, in the cargo compartments of an aeroplane, which may be useful for UA operations.*

Safety Risk Management: Understanding Risk Assessment, Responsibility, and Mitigation

Operational Risk Assessment for CAA Authorization

Based on the consequences of identified hazards, the operational risk assessment (ORA) is the assessment of the operational risks in a systematic, robust, and intellectually cohesive manner. It is followed by risk mitigation and, therefore, safety risks regarding the operation can be managed to be reduced as much as possible.

Per the requirement from the appropriate authority, an ORA of U-AID must be developed by the UA operator and submitted with the application for authorization. The appropriate authority must accept any remaining residual risk prior to issuing the authorization for U-AID. There are several methods that can be followed to create the ORA. Links to some available methods are listed at the end of this section.

Safety Risk Assessment Process

The following key points, tables, and matrices extracted from Safety Management Manual (SMM) (*Doc 9859, 4th edition)* demonstrate the steps regarding the safety risk assessment process which can be used in an ORA. The information should be adapted to the particular needs, activities, and complexities of each organization. Organizations might include both qualitative and quantitative criteria.

1. Begin with a list of common hazards as a starting point, then search the CONOPS to identify and document each hazard related to the proposed operation. The CONOPS, when completed, must describe the operation in detail, including the operational environment.

Note.— A hazard is a condition or an object with the potential to cause or contribute to an aircraft incident or accident. The process should also assess the interacting safety interfaces in a U-AID operation to identify the associated hazards. Subject matter experts and personnel involved in the operation should facilitate the identification. The outputs of previous identifications can be used to create a list of common hazards to support future risk assessments.

2. Assess each hazard and identify its potential consequences (the possible results derived from the hazard).

Note.— The hazard's capability to produce damage can be materialized in one or various consequences. Once the consequences are identified, the next step is to assess the safety risk, defined as the predicted probability and severity of the consequences or outcomes of a hazard.

3. Determine the probability, the likelihood or frequency that a safety consequence or outcome might occur, for each consequence.

Note.— It is important to envision a variety of scenarios so that all potential consequences can be considered.

Likelihood	*Meaning*	*Value*
Frequent	Likely to occur many times (has occurred frequently)	5
Occasional	Likely to occur sometimes (has occurred infrequently)	4
Remote	Unlikely to occur, but possible (has occurred rarely)	3
Improbable	Very unlikely to occur (not known to have occurred)	2
Extremely improbable	Almost inconceivable that the event will occur	1

4. Determine the safety risk severity for each consequence, defined as the extent of harm that might reasonably be expected to occur as a potential consequence or outcome of the identified hazard, in terms of degree or loss, taking into account the worst credible outcome.

Note.— The process should also consider how existing controls and additional mitigations change the UA or airspace/operating environment to reduce the severity.

Severity	*Meaning*	*Value*
Catastrophic	• Aircraft / equipment destroyed • Multiple deaths	A
Hazardous	• A large reduction in safety margins, physical distress or a workload such that operational personnel cannot be relied upon to perform their tasks accurately or completely • Serious injury • Major equipment damage	B
Major	• A significant reduction in safety margins, a reduction in the ability of operational personnel to cope with adverse operating conditions as a result of an increase in workload or as a result of conditions impairing their efficiency • Serious incident • Injury to persons	C

Severity	*Meaning*	*Value*
Minor	• Nuisance • Operating limitations • Use of emergency procedures • Minor incident	D
Negligible	• Few consequences	E

5. Determine the safety risk index using a safety risk assessment matrix or similar tool.

Safety Risk		*Severity*				
Probability		*Catastrophic A*	*Hazardous B*	*Major C*	*Minor D*	*Negligible E*
Frequent	5	5A	5B	5C	5D	5E
Occasional	4	4A	4B	4C	4D	4E
Remote	3	3A	3B	3C	3D	3E
Improbable	2	2A	2B	2C	2D	2E
Extremely improbable	1	1A	1B	1C	1D	1E

6. Determine safety risk tolerability by using a table that indicates the criteria of the organization (for example, acceptable, tolerable, or intolerable) to further evaluate mitigations.

Safety Risk Index Range	*Safety Risk Description*	*Recommended Action*
5A, 5B, 5C, 4A, 4B, 3A	INTOLERABLE	Take immediate action to mitigate the risk or stop the activity. Perform priority safety risk mitigation to ensure additional or enhanced preventative controls are in place to bring down the safety risk index to tolerable.

Safety Risk Index Range	*Safety Risk Description*	*Recommended Action*
5D, 5E, 4C, 4D, 4E, 3B, 3C, 3D, 2A, 2B, 2C, 1A	TOLERABLE	Can be tolerated based on the safety risk mitigation. It may require management decision to accept the risk.
3E, 2D, 2E, 1B, 1C, 1D, 1E	ACCEPTABLE	Acceptable as is. No further safety risk mitigation required.

Safety Risk Mitigation Strategies

After safety risks have been assessed, appropriate mitigation measures should be implemented.

Example strategies include the below.

(a) Avoidance: The operation or activity is cancelled or avoided because the safety risk exceeds the benefits of continuing the activity, thereby eliminating the safety risk entirely.

(b) Reduction: The frequency of the operation or activity is reduced, or action is taken to reduce the magnitude of the consequences of the safety risk.

(c) Segregation: Action is taken to isolate the effects of the consequences of the safety risk or build in redundancy to protect against them.

It is important to consider the full range of possible control measures to find an optimal solution.

Links to Risk Assessment Methods

Publisher	Document Title
International Civil Aviation Organization (ICAO)	*Safety Management Manual (SMM) Doc 9859, 4th edition* https://www.icao.int/safety/SafetyManagement
Joint Authorities for Rulemaking for Unmanned Systems (JARUS)	Specific Operations Risk Assessment (SORA) http://jarus-rpas.org/content/jar-doc-06-sora-package
ASTM	Operational Risk Assessment (ORA) https://www.astm.org/Standards/F3178.htm (Fees apply)
Federal Aviation Administration (FAA)	FAA Order 8040.6 *Unmanned Aircraft Systems Safety Risk Management Policy*
DRONE Industry Insights	DRONEII Safety Risk Assessment for UAS Operation https://www.droneii.com/uas-safety-risk-assessment

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APPENDIX 1

Classes and Divisions of Dangerous Goods

The following classes and divisions are used to identify hazards associated with the transport of articles and substances, by all modes of transport, based on the product's specific chemical and physical properties. They are named in accordance with the United Nations Recommendations on the Transport of Dangerous Goods (Model Regulations). The classification of an article or substance for transport by air needs to be done by competently-trained individuals, in accordance with the Technical Instructions. A good starting point for determining if your product might be dangerous is to obtain a Safety Data Sheet (SDS) from the manufacturer and check the "Transportation Information". This can provide valuable information on the transport risks related to your materials.

The numerical order of the classes and divisions does not equate to the degree of danger.

Class 1: Explosives
- Division 1.1: Substances and articles which have a mass explosion hazard
- Division 1.2: Substances and articles which have a projection hazard but not a mass explosion hazard
- Division 1.3: Substances and articles which have a fire hazard and either a minor blast hazard or a minor projection hazard, or both, but not a mass explosion hazard
- Division 1.4: Substances and articles which present no significant hazard
- Division 1.5: Very insensitive substances which have a mass explosion hazard
- Division 1.6: Extremely insensitive articles which do not have a mass explosion hazard

Class 2: Gases
- Division 2.1: Flammable gases
- Division 2.2: Non-flammable, non-toxic gases
- Division 2.3: Toxic gases

Class 3: Flammable liquids

Class 4: Flammable solids; substances liable to spontaneous combustion; substances which, on contact with water, emit flammable gases
- Division 4.1: Flammable solids, self-reactive and related substances, solid desensitized explosives, and polymerizing substances
- Division 4.2: Substances liable to spontaneous combustion
- Division 4.3: Substances which, on contact with water, emit flammable gases

Class 5: Oxidizing substances and organic peroxides
- Division 5.1: Oxidizing substances
- Division 5.2: Organic peroxides

Class 6: Toxic and infectious substances
- Division 6.1: Toxic substances
- Division 6.2: Infectious substances

Class 7: Radioactive material

Class 8: Corrosive substances

Class 9: Miscellaneous dangerous substances and articles, including environmentally hazardous substances

APPENDIX 2

Examples of Dangerous Goods that may be Necessary for Humanitarian Aid or Emergency Response

The following are examples of dangerous goods that may be needed for humanitarian aid or emergency response.

a) compressed gases, such as aerosols and gas cartridges;

b) flammable liquids, such as ethanol and ether;

c) sterilization materials, such as ethylene oxide;

d) infectious substances, such as samples for analysis;

e) toxic substances, such as certain medicines;

f) first aid kits;

g) medical or clinical waste, such as used needles and blood samples;

h) safety devices;

i) lithium batteries; and

j) dry ice.

This list is not exhaustive. Provisions for identifying and classifying dangerous goods are contained in the Technical Instructions.

APPENDIX 3

Elements that should be Included in a UA Operator's Policy and Procedures Manual for the Safe Transport of Dangerous Goods

Policy for the Safe Transport of Dangerous Goods on UA

The operator should provide a policy for the safe transport of dangerous goods on UA for the purpose of humanitarian aid or emergency response. The policy should include the need to conduct a safety risk assessment.

Procedures for Carrying Out Responsibilities Including Mitigation Measures to Proactively Manage Risks

These procedures should include measures taken and an indication of how these measures mitigate the potential consequences of identified hazards to an acceptable level. Procedures to mitigate hazards unique to UA operations should also be provided to ensure the dangerous goods are capable of withstanding the normal conditions of transport involved in the type of UA being used.

Training Policy

A training policy should be documented based on an assessment of the functions performed by persons involved in the UA operations. The policy should also include the competency level achieved once training is completed. A record indicating the competence of each person trained should be kept on file.

Instructions for Communicating Information Related to the Dangerous Goods Carried by the UA in the Case of an Incident or Accident

The Technical Instructions include provisions for communicating hazards of dangerous goods, through marking and labelling of the package and documentation, which are well-known to those involved in their transport. Individuals who are exposed to UAs involved in an incident or accident may not be aware of these hazard communication methods. The procedures should include instructions for effectively communicating hazards to those not familiar with dangerous goods marks and labels. They should also include contact information and instructions for informing appropriate authorities, including public health authorities, when necessary.

Action to be Taken in the Event of Emergencies Involving Dangerous Goods

Procedures should include an emergency response plan for dangerous goods incidents or accidents. A current list of contacts to be notified if either event occurs should be maintained.

Instructions for Collection of Safety Data

Procedures should include instructions for collecting safety data related to dangerous goods accidents and incidents. The CAA may provide a format for submitting this data.

APPENDIX 4

Elements to consider as Part of the UA Operator's Safety Risk Management Procedures

A safety risk assessment should be performed to address potential consequences of identified hazards and associated mitigations should an unintentional release occur. The following are elements that should be included, at a minimum, in the safety risk assessment.

Risks Associated With Dangerous Goods

Risks associated with the dangerous goods to be transported should be considered in relation to the consequence of their effect if they are released.

- Infectious substances that are capable of causing permanent disability or life-threatening or fatal disease, for which no vaccine or cure is available, have the highest consequences. They could potentially affect multiple persons or animals.

- Infectious pathogens that are spread by ingestion, for which prophylactic treatment or a cure is available, will have moderate consequences.

- Non-communicable pathogens, for which prophylactic treatment or a cure is available, will have a low consequence.

- Chemicals with high toxicity to human, animal, and aquatic life will have the highest consequences and may affect multiple persons or animals.

- Chemicals that are highly corrosive will have a high consequence to package handlers or receivers.

Type of Operation

The safety risk assessment should consider the potential consequences related to the transport over populated areas, remote areas, or environmentally sensitive land and waters. Other normal flight risks such as those associated with operating routes, obstacles, altitudes, or take-off and landing areas should also be considered. Dropping the dangerous goods from the UA also brings with it additional potential consequences for consideration.

Containment Characteristics of the UA (e.g. inside or outside the UA)

Carriage of the dangerous goods inside or outside the UA needs assessing. The securing of dangerous goods within the UA, by attachment directly to the UA or slung from the UA, will have varying levels of risk.

Packing and Packaging

Packaging methods used to contain dangerous goods may affect the likelihood of damage, leakages, spills, or unintentional release of contents. In considering the packing and packaging requirements for dangerous goods, the provisions of the Technical Instructions should be followed to the extent possible.

If the provisions of the Technical Instructions cannot be followed, an equivalent or greater level of safety should be established in accordance with the level of risk. At a minimum, the following should be taken into account.

a) The type of packaging should take into account the containment characteristics of the UA and damage that could be caused by exposure to airflow and weather, such as rain or snow. The effects of temperature and pressure variations and vibrations, which may be encountered during transport, should also be taken into account.

b) Generally, dangerous goods should be packed in the lowest volume container necessary for the intended purpose.

c) Measures to prevent leakage of liquid dangerous goods need to be taken into consideration. At a minimum, the packaging should include a leakproof liner or bag containing the dangerous goods, surrounded by absorbent material and placed into a receptacle in a rigid outer packaging. Inner packagings should be packed so that the closures are upward within the package. Closures on inner packagings must be leakproof and secured against loosening. Stoppers, corks, or other such friction closures must be held in place by positive means.

d) The contents of the packages should be documented and easily accessible in case of an incident or accident requiring emergency response. At a minimum, the UN number, container type, volume, and number of items should be documented. In the case of biological substances, pathogen data sheets or information about the hazards of infectious substances, including deactivation and waste disposal, should be made available.

e) If the dangerous goods are to be dropped by the UA, additional consideration of the effects on the dangerous goods and packaging materials should be considered due to the forces and shocks encountered.

Quantity and Distribution of Dangerous Goods to be Transported

The volume of dangerous goods to be carried, coupled with packaging methods used, may affect the likelihood of damage, leakages, spills, or unintentional release of contents. For certain dangerous goods, the quantities may influence the severity of the identified consequence of a hazard. The potential for incompatible dangerous or non-dangerous goods to react dangerously when mixed needs to be taken into account.

Level of Competence of Those Handling the Dangerous Goods

The level of competence of those handling the dangerous goods needs to be taken into account, in relation to the level of responsibility and risk. Without appropriately qualified personnel, there is the potential of insufficiently implementing mitigating strategies or potentially introducing additional hazards or unintended consequences.

APPENDIX 5

References

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Acronyms and Abbreviations

UA	Unmanned aircraft
UAS	Unmanned aircraft system
CAA	Civil aviation authority
CAPSCA	Collaborative arrangement for the prevention and management of public health events in civil aviation
CONOPS	Concept of operations
UTM	Unmanned aircraft system traffic management
IFR	Instrument flight rules
NOTAM	Notice to airmen
AIP	Aeronautical Information Publication
DAA	Detect and avoid
C2 Link	Command and control (C2) link
RPS	Remote pilot station
SARPS	Standards and Recommended Practices
ATO	Approved training organization
DG-SOP	Standard operating procedures for the safe transport of dangerous goods
ORA	Operational risk assessment
AAO	Approved aviation organization

— END —