CNAF M-3710.9

TRAINING AND OPERATIONS MANUAL
GROUP 1 AND 2 UNMANNED AIRCRAFT SYSTEMS



DEPARTMENT OF THE NAVY
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DEPARTMENT OF THE NAVY
COMMANDER NAVAL AIR FORCE
BOX 357051
SAN DIEGO CALIFORNIA 92135-7051

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From: Commander, Naval Air Forces

Subj: TRAINING AND OPERATIONS MANUAL FOR DEPARTMENT OF NAVY GROUP 1 AND 2 UNMANNED AIRCRAFT SYSTEMS

1. Purpose. To issue policy and procedural guidance applicable to a broad spectrum of users of Group 1 and 2 Unmanned Aircraft Systems (UAS).

2. Background. The Naval Air Training and Operating Procedures Standardization (NATOPS) program is a positive approach toward improving combat readiness and achieving a substantial reduction in the UAS mishap rate. Standardization, based on professional knowledge and experience, provides the basis for the development of sound operating procedures. The standardization program is not intended to stifle individual initiative, but rather to aid commanding officers in increasing their unit's combat potential without reducing command prestige or responsibility. With the objective of maintaining agile standardization guidance, Commander, Naval Air Forces (CNAF) accepted responsibility for the NATOPS program management as directed in OPNAVINST 3710.7.

3. Point of Contact. CNAF Program Administrator (CNAP N455), (619) 545-2845.

4. Records Management. Records created as a result of this instruction, regardless of media or format, must be managed per Secretary of the Navy Manual 5210.1.

5. Review and Effective Date. Per OPNAVINST 5215.17A, CNAF will review this instruction annually around the anniversary of its issuance date to ensure applicability, currency, and consistency with Federal, Department of Defense, Secretary of the Navy, and Navy policy and statutory authority using OPNAV 5215/40 Review of Instruction. This instruction will be in effect for 10 years, unless revised or cancelled in the interim, and will be reissued by the 10-year anniversary date if it is still required, unless it meets one of the exceptions in OPNAVINST 5215.17A, paragraph 9. Otherwise, if the instruction is no longer required, it will be processed for cancellation as soon as the need for cancellation is known following the guidance in OPNAV Manual 5215.1.

D. C. VERISSIMO

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LIST OF EFFECTIVE PRINTED CONTENT

CHAPTER 1	Group 1 and 2 UAS Program Responsibilities and Authorities	1 OCTOBER 2026
CHAPTER 2	Systems	1 OCTOBER 2026
CHAPTER 3	Service and Handling	1 OCTOBER 2026
CHAPTER 4	Operating Limitations	1 OCTOBER 2026
CHAPTER 5	Indoctrination	1 OCTOBER 2026
CHAPTER 6	Flight Preparation	1 OCTOBER 2026
CHAPTER 7	Shore-Based Procedures	1 OCTOBER 2026
CHAPTER 8	Ship-Based Procedures	1 OCTOBER 2026
CHAPTER 9	Special Procedures	1 OCTOBER 2026
CHAPTER 10	Emergency Procedures	1 OCTOBER 2026
CHAPTER 11	Extreme Weather	1 OCTOBER 2026
CHAPTER 12	Weaponized UAS	1 OCTOBER 2026
CHAPTER 13	Cybersecurity Safety/Cybersecurity	1 OCTOBER 2026
CHAPTER 14	Operational Risk Management	1 OCTOBER 2026
APPENDIX A	BUQ Levels	1 OCTOBER 2026
APPENDIX B	Operating Locations, Right of Way Rules, and Airspace Operations	1 OCTOBER 2026
APPENDIX C	UAS Groups	1 OCTOBER 2026
APPENDIX D	Sample Operational Risk Management Matrix	1 OCTOBER 2026
APPENDIX E	Sample Mission Briefing Guide	1 OCTOBER 2026
APPENDIX F	Sample EMC SOFT Checklist	1 OCTOBER 2026
APPENDIX G	Safety Management and Safety Reporting	1 OCTOBER 2026
APPENDIX H	Establishment of a Flying Activity	1 OCTOBER 2026
APPENDIX I	Crew Resource Management (CRM)	1 OCTOBER 2026

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TRAINING AND OPERATIONS MANUAL GROUP 1 AND 2 UNMANNED AIRCRAFT SYSTEMS

CONTENTS

Page No.

CHAPTER 1 — GROUP 1 AND 2 UAS PROGRAM RESPONSIBILITIES AND AUTHORITIES

1.1 GROUP 1 AND 2 UAS PROGRAM RESPONSIBILITIES 1-1
1.1.1 ACC/DAA Responsibilities 1-1
1.1.2 UAS Programs Establishment 1-1
1.1.3 Inventory Responsibilities 1-1
1.1.4 UAS Crewmember Designation Authority 1-1
1.1.5 NATOPS Advisory Group 1-1
1.2 UNIT/COMMAND-LEVEL AIRCRAFT REPORTING CUSTODIAN AUTHORITIES AND RESPONSIBILITIES 1-2
1.2.1 ARC Responsibilities 1-2
1.2.2 UAS Crewmember Designations 1-2
1.2.3 UAS Crewmember Training and Qualifications 1-2
1.2.4 Naval Aviation Safety Policies 1-3
1.3 INTERMEDIATE COMMANDS — AUTHORITIES AND RESPONSIBILITIES 1-3
1.4 CONTRACTOR OPERATIONS 1-3
1.4.1 Contractor Operations of Government Owned UAS (GOCO) 1-3
1.4.2 Contracting for Contracted Air Services (CAS) Deemed State or PAO (COCO) 1-3
1.4.3 Contract Performance for CAS COCO 1-4

CHAPTER 2 — SYSTEMS

2.1 SYSTEM 2-1
2.1.1 General 2-1
2.2 UNMANNED AIRCRAFT 2-1
2.2.1 Types of Group 1 and 2 UAS 2-1
2.3 CONTROL STATION (CS) 2-2
2.3.1 Level of Interoperability (LOI) 2-2

		Page No.
2.4	POWER AND PROPULSION SYSTEMS	2-2
2.4.1	Electrical Power	2-2
2.5	LAUNCH AND RECOVERY SYSTEMS	2-3
2.6	PAYLOADS	2-3
2.7	LASER REQUIREMENTS	2-3

CHAPTER 3 — SERVICE AND HANDLING

3.1	LITHIUM BATTERY USAGE, CHARGING, HANDLING AND STORAGE	3-1
3.1.1	Facilities and Installations Requirements	3-1
3.1.2	Transportation	3-2
3.1.3	Charging	3-2
3.1.4	Storage	3-3
3.1.5	Operational Use	3-4
3.1.6	Safety	3-4

CHAPTER 4 — OPERATING LIMITATIONS

4.1	GENERAL	4-1
4.2	UA GROSS WEIGHT LIMITATION	4-1
4.3	ALTITUDE LIMITATIONS	4-1
4.4	WIND LIMITATIONS	4-1
4.5	WEATHER	4-2
4.6	SAFETY HAZARD KEEP OUT ZONES	4-2
4.6.1	SHKOZs For Flight	4-2
4.6.2	SHKOZs For Launch, Recovery and Ground Operations	4-2
4.7	HERO, HERF AND HERP STANDOFF DISTANCES	4-6
4.7.1	Fuel Leak Checks	4-6
4.8	LASER EYE PROTECTION AND HAZARD DISTANCES	4-7
4.9	RADIO FREQUENCY (RF) STAND OFF DISTANCES	4-7
4.10	AEROBATIC FLIGHT MANEUVERS	4-7
4.11	PUBLIC FLIGHT DEMONSTRATIONS	4-7
4.12	DISPERSAL OF PESTICIDES	4-7

CHAPTER 5 — INDOCTRINATION

5.1	GENERAL	5-1
5.2	TRAINING SYLLABUS	5-1
5.2.1	Unit Training	5-1
5.2.2	Basic UAS Qualification (BUQ) Levels	5-1

		Page No.
5.3	UAS CREW CLASSIFICATIONS, DESIGNATION OF UAS CREW PERSONNEL AND DESIGNATING AUTHORITY	5-2
5.3.1	Designation	5-2
5.3.2	General UASC Positions	5-2
5.3.3	UAS AVO Qualification Standards	5-3
5.4	AEROMEDICAL REQUIREMENTS	5-3
5.4.1	Human Performance and Aeromedical Qualification for Flight and Flight Support Personnel	5-3
5.5	CREW REQUIREMENT	5-4
5.6	UAS PROFICIENCY REQUIREMENTS	5-4

CHAPTER 6 — FLIGHT PREPARATION

6.1	MISSION PLANNING DESCRIPTION	6-1
6.1.1	Mission Planning Considerations	6-1
6.1.2	Mission Planning Documents	6-1
6.1.3	Range Operations within Restricted and Warning Areas	6-2
6.1.4	Airspace Operations	6-2
6.1.5	Flight Operations	6-2
6.1.6	Mission Endurance **Requirements**	6-3
6.1.7	Fuel Range and Battery Endurance Capabilities	6-3
6.1.8	Frequency Approval	6-4
6.1.9	Frequency Coordination	6-4
6.1.10	Night Operations	6-4
6.1.11	Ship-Based Operations	6-4
6.1.12	Multiple UA and Swarming Operations	6-5
6.1.13	Notice to Airmen	6-5
6.2	MISSION BRIEFING	6-5
6.2.1	Preflight Briefing	6-5
6.2.2	Crew Replacement Briefings	6-5
6.3	MISSION DEBRIEFING	6-5
6.3.1	General Debriefing	6-5

CHAPTER 7 — SHORE-BASED PROCEDURES

7.1	SHORE-BASED OPERATIONS INTRODUCTION	7-1
7.1.1	Personnel Protective Equipment	7-1
7.1.2	Safety Observer	7-1
7.1.3	Visual Line of Sight (VLOS) Operations	7-2
7.1.4	Safe-For-Flight Box	7-2
7.2	ASSEMBLY AND PREFLIGHT	7-3

		Page No.
7.2.1	UA Assembly	7-3
7.2.2	Radio Control and Control Station (CS) Setup	7-3
7.2.3	Preflight	7-3
7.2.4	Fail-Safe Modes	7-3
7.2.5	GNSS Preflight	7-4
7.2.6	Recovery Parameter Checks	7-4
7.3	LAUNCH	7-5
7.3.1	Multi-rotor Hand Launch and Recovery Procedures	7-5
7.3.2	Launch and Recovery from a Moving Vehicle	7-6
7.4	FLIGHT	7-6
7.4.1	Manual Flight	7-7
7.4.2	Autonomous Flight	7-7
7.4.3	Command and Control Lost Link Avoidance	7-7
7.4.4	Mid-Air Collision Avoidance	7-8
7.4.5	UA Handoff Procedures	7-8
7.5	RECOVERY	7-8
7.5.1	Degraded or Lost Command and Control Link	7-8
7.5.2	Shutdown/Post-Flight	7-9
7.6	COUNTER-UAS (C-UAS) OPERATIONS	7-9

CHAPTER 8 — SHIP-BASED PROCEDURES

8.1	SHIP-BASED OPERATIONS INTRODUCTION	8-1
8.1.1	Ship-Based Environmental Considerations	8-1
8.1.2	Ship Obstructions	8-1
8.1.3	Hazards to Personnel and Equipment	8-1
8.1.4	Ship Site Survey	8-2
8.1.5	Electromagnetic Interference	8-2
8.2	FLIGHT OPERATIONS	8-2
8.2.1	Tethered UAS	8-2
8.2.2	Preflight Procedures	8-2
8.2.3	Launch and Recovery	8-3
8.2.4	Launch and Recovery Procedures	8-3
8.3	SHIPBOARD EMERGENCY CONSIDERATIONS	8-3
8.4	SHIPBOARD-RELATIVE ROUTES AND AREA SPILLAGE	8-4

CHAPTER 9 — SPECIAL PROCEDURES

9.1	ELECTROMAGNETIC COMPATIBILITY (EMC) SAFETY-OF-FLIGHT TEST (SOFT)	9-1

		Page No.
9.2	MULTI-VEHICLE OPERATIONS AT THE OPERATING AREA	9-1
9.3	MULTI-VEHICLE OPERATIONS BY A SINGLE UAC/AVO	9-2
9.4	SWARMING OPERATIONS	9-2
9.5	LASER OPERATIONS	9-3
9.5.1	Configuration	9-3
9.5.2	Limitations	9-3
9.5.3	Procedures and Warnings	9-3
9.6	ELECTRICALLY POWERED TETHERED UAS ELECTRICAL SHOCK MITIGATION	9-4

CHAPTER 10 — EMERGENCY PROCEDURES

10.1	INTRODUCTION	10-1
10.2	CONVENTIONS	10-1
10.2.1	Critical Steps/Immediate Actions	10-1
10.3	CREW RESPONSIBILITIES IN AN EMERGENCY	10-1
10.3.1	Standard Aviation Sequence	10-1
10.3.2	General Responsibilities	10-1
10.3.3	AVO Responsibilities	10-2
10.3.4	Unmanned Aircraft System Aircraft Crewmember (UASC) Responsibilities	10-2
10.4	GENERAL EMERGENCY PROCEDURES	10-2
10.4.1	Critical System Failure	10-2
10.4.2	Flight Termination	10-3
10.4.3	Degraded GPS	10-3
10.5	IN-FLIGHT EMERGENCIES	10-3
10.5.1	Emergency Landing Site Selection	10-3
10.5.2	Lost or Degraded Command and Control Link	10-3
10.5.3	Loss of GPS	10-4
10.5.4	Unexpected Autonomous Behavior	10-4
10.5.5	Departure from Assigned Airspace	10-4
10.5.6	Inadvertent Flight In Icing Conditions	10-4
10.5.7	Loss of VLOS (If VLOS is Required by Airspace Approval Authority)	10-4

CHAPTER 11 — EXTREME WEATHER

11.1	ICING	11-1
11.2	COLD WEATHER	11-1
11.2.1	Ground Operation	11-1
11.2.2	In-Flight Operation	11-1
11.3	HOT WEATHER	11-1

		Page No.
11.3.1	Ground Operation	11-1
11.3.2	In-Flight Operatons	11-1
11.4	DESERT AND DRY WEATHER	11-4
11.5	WIND SHEAR, GUSTS, AND TURBULENCE	11-4
11.6	THUNDERSTORMS AND LIGHTNING	11-4
11.7	VISIBLE PRECIPITATION	11-4

CHAPTER 12 — WEAPONIZED UAS

12.1	UAS WEAPONIZATION	12-1

CHAPTER 13 — CYBERSECURITY SAFETY/CYBERSECURITY

13.1	CYBERSECURITY	13-1

CHAPTER 14 — OPERATIONAL RISK MANAGEMENT

14.1	GENERAL	14-1
14.2	OPERATIONAL RISK MANAGEMENT (ORM)	14-1
14.3	THREE LEVELS OF APPLICATION	14-1
14.4	FOUR PRINCIPLES OF APPLICATION	14-1
14.5	UAS MISSION RISK ASSESSMENT	14-2

APPENDIX A — BUQ LEVELS

A.1	PURPOSE	A-1
A.2	BUQ LEVELS I-IV TRAINING	A-1

APPENDIX B — OPERATING LOCATIONS, RIGHT OF WAY RULES, AND AIRSPACE OPERATIONS

B.1	OPERATING LOCATIONS	B-1
B.2	RIGHT OF WAY RULES	B-1
B.2.1	Background	B-1
B.2.2	DON Group 1-2 UA Right-of Way Rules	B-1
B.3	AIRSPACE OPERATIONS	B-1
B.3.1	Flight Operations in U.S. National Airspace System (NAS) Outside of Active Restricted Areas and Warning Areas	B-1
B.3.2	Flight Operations in Active Restricted Areas and Warning Areas	B-2
B.3.3	Flight Operations in Prohibited Areas	B-2
B.3.4	Flight Operations in International Airspace	B-2
B.3.5	Flight Operations in Foreign National Airspace	B-2
B.3.6	Flight Operations in Joint Operating Areas, Combat and Contingency Airspace	B-2

Page No.

APPENDIX C — UAS GROUPS

C.1 EXPLANATION OF UAS GROUPS C-1

APPENDIX D — SAMPLE OPERATIONAL RISK MANAGEMENT MATRIX

D.1 UAS MISSION RISK ASSESSMENT D-1

APPENDIX E — SAMPLE MISSION BRIEFING GUIDE

E.1 UAS MISSION BRIEFING GUIDE CHECKLIST E-1

APPENDIX F — SAMPLE EMC SOFT CHECKLIST

F.1 EMC SOFT SAMPLE CHECKLIST F-1

APPENDIX G — SAFETY MANAGEMENT AND SAFETY REPORTING

G.1 PURPOSE G-1

G.2 INCIDENTS, HAZARDS, AND AVIATION MISHAPS G-1

G.2.1 Incidents G-1

G.2.2 Hazards G-1

G.2.3 Aviation Mishaps G-1

G.2.4 Mishap and Hazard Reporting G-2

G.2.5 Web-Based Safety System G-2

G.2.6 Systems Logs and Recordings G-2

G.3 UA RECOVERY AFTER MISHAP G-2

G.3.1 External Tracking Devices G-2

APPENDIX H — ESTABLISHMENT OF A FLYING ACTIVITY

H.1 MINIMUM REQUIREMENTS FOR PURSUIT OF AN IFC AUTHORIZING THE OPERATION OF A SPECIFIC UAS H-1

H.2 ACC OR DAA RESPONSIBILITY CHECKLIST H-1

H.3 ARC RESPONSIBILITY CHECKLIST H-1

H.4 UNIT SOP CHECKLIST H-2

APPENDIX I — CREW RESOURCE MANAGEMENT (CRM)

I.1 GENERAL I-1

I.2 CRITICAL BEHAVIORAL SKILLS I-1

I.3 CRM TRAINING I-2

INDEX Index-1

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LIST OF ILLUSTRATIONS

Page No.

CHAPTER 3 — SERVICE AND HANDLING

Figure 3-1. Flammable Cabinet Storage Capacity 3-3

CHAPTER 4 — OPERATING LIMITATIONS

Figure 4-1. SHKOZs For Flight 4-3

Figure 4-2. Group 1 Multi-rotor UA SHKOZ for Launch and Recovery. 4-4

CHAPTER 11 — EXTREME WEATHER

Figure 11-1. Temperature Conversion Chart 11-2

Figure 11-2. Density Altitude Chart 11-3

APPENDIX A — BUQ LEVELS

Figure A-1. BUQ Level I A-1

Figure A-2. BUQ Level II A-3

Figure A-3. BUQ Level III A-4

Figure A-4. BUQ Level IV A-5

APPENDIX C — UAS GROUPS

Figure C-1. Unmanned Aircraft Systems Categorization Chart C-1

Figure C-2. UAS Operating Parameter Legend C-1

APPENDIX D — SAMPLE OPERATIONAL RISK MANAGEMENT MATRIX

Figure D-1. UAS Mission Risk Assessment D-1

APPENDIX E — SAMPLE MISSION BRIEFING GUIDE

Figure E-1. Sample Mission Briefing Guide E-1

APPENDIX F — SAMPLE EMC SOFT CHECKLIST

Figure F-1. EMC Soft Checklist F-1

APPENDIX H — ESTABLISHMENT OF A FLYING ACTIVITY

Figure H-1. Unit Standard Operating Procedures Checklist H-2

Figure H-2. DAA Self Designation Letter H-3

Figure H-3. Higher Probability of Loss (HPOL) Letter H-4

Figure H-4. Inventory Data Requirements Example H-5

Figure H-5. ARC Designation Letter H-6

Figure H-6. UASC Designation Letter H-7

Figure H-7. UAS Airspace Access Applicant Designation Letter H-8

Figure H-8. Procurement to Flight Checklist H-9

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GLOSSARY

A

Above ground level (AGL). The altitude measured with respect to the underlying ground surface.

Aerobatic flight maneuvers. An intentional maneuver involving an abrupt change in aircraft attitude, intentionally performed spins, or other maneuvers requiring pitch/dive angles greater than 45°, bank angles greater than 60°, or accelerations greater than 2 g. A maneuver that conforms to the model NATOPS manual (e.g., break, weapons delivery, autorotations, etc.) is not considered to be aerobatic flight.

Air vehicle operator (AVO). The person who has been trained, qualified, and properly designated as an AVO, is physically located at a UAS GCS, and is in positive control of the aircraft. The AVO is responsible for the safety of flight that includes but is not limited to: exercising safe and positive control of the aircraft, monitoring and announcing flight parameters when applicable, and if time and workload permit maintaining diligent lookout doctrine with available sensors. Assists UAC as directed.

Airmen's meteorological information. A concise description of weather phenomena that are occurring or may occur (forecast) along an air route that may affect aircraft safety. Also call AIRMET.

Airspace approval authority. Entity responsible for authorizing UAS access to a given airspace category (e.g., FAA for FAA-controlled airspace in U.S. national airspace; using agency and/or scheduling agency, as applicable, for active U.S. warning and restricted areas; responsible commander for combat/contingency airspace, etc.)

Alternating current (AC). An electric current which periodically reverses direction and changes its magnitude continuously with time in contrast to direct current (DC) which flows only in one direction.

Ambient air temperature. The temperature of the surrounding environment; technically, the temperature of the air surrounding a power supply or cooling medium.

B

Basic unmanned aircraft system qualification (BUQ). Certification that an individual possesses the general aviation, and UAS knowledge-based, skills to operate a UAS safely, as required by crew duties or position (i.e., Pilot/Aircraft Operator). The training standards for the four BUQ levels are found within CJCSI 3255.01 "Joint Unmanned Aircraft Systems Minimum Training Standards".

C

Civil aircraft operations (CAO). Aircraft operations other than those deemed as public aircraft operations. CAO are conducted IAW Federal Regulations under Federal Aviation Administration (FAA) authority.

Clear deck. Or Green deck indicated by a green light on the Rotary Beacon Signal System or Deck Status Light System indicating safe for takeoff, launch, and landing.

Command and control (C2). The exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission. Also called C2.

Crew resource management (CRM). The use of specifically defined behavioral skills as an integral part of every flight to improve mission effectiveness by minimizing crew preventable errors, maximizing crew coordination, and optimizing risk management.

D

Density altitude. Pressure altitude corrected for temperature. When conditions are standard, pressure altitude and density altitude are the same. Consequently, if the temperature is above standard, the density altitude is higher than the pressure altitude. If the temperature is below standard, the density altitude is lower than the pressure altitude. Also called DA.

Digital terrain elevation data (DTED). A uniform matrix of terrain elevation values which provides basic quantitative data for systems and applications that require terrain elevation, slope, and/or surface

roughness information developed by the National Geospatial-Intelligence Agency (NGA).

Direct current (DC). The unidirectional flow of electric charge. Direct current is produced by sources such as batteries, thermocouples, solar cells, and commutator-type electric machines of the dynamo type.

Dry configuration. The zero-fuel weight (defueled) unmanned aircraft with all mission systems and payloads installed. The dry configuration includes any trapped fuel within the unmanned aircraft fuel system.

E

Electromagnetic environment (EME). The resulting product of the power and time distribution, in various frequency ranges, of the radiated or conducted electromagnetic emission levels that may be encountered by a military forces, system, or platform when performing its assigned mission in its intended operational environment. It is the sum of electromagnetic interference; electromagnetic pulse; hazards of electromagnetic radiation to personnel, ordnance, and volatile materials; and natural phenomena effects of lightning and precipitation static.

Electromagnetic environmental effects (E3). The impact of the electromagnetic environment upon the operational capability of military forces, equipment systems, and platforms. It encompasses all electromagnetic disciplines including electromagnetic compatibility and electromagnetic interference; electromagnetic vulnerability; electromagnetic pulse; electronic protection, hazards of electromagnetic radiation to personnel, ordnance, and volatile materials; and natural phenomena effects of lightning and precipitation static.

Essential personnel. Flight team required or directly supporting the safe operation of the Air Vehicle. This normally includes the Vehicle Operator, Safety/Visual Observers, Ground Crew Members, or the Unmanned Mission Commander. Personnel have been specifically briefed on their flight team position and responsibilities.

F

Flight demonstration. A dynamic demonstration of an aircraft's performance and mission capability which is visible to, conducted for the benefit of, and in relatively close proximity to ground observers. This includes tactical maneuvering, aerobatic flight or high performance takeoffs and landings other than those required for the administrative conduct of the flight.

Flyover. A flyover is the flight of one or more aircraft (normally a maximum of four) over a fixed point at a specified time. Flyovers do not include takeoff and landing demonstrations. A flyover does not involve dynamic maneuvering, and is not considered a flight demonstration.

Foul deck. Or Red deck indicated by a red light on the Rotary Beacon Signal System or Deck Status Light System indicating unsafe for takeoff, launch, and landing.

G

Geo-fencing (geofencing). A feature in a software program that uses the global positioning system (GPS) or radio frequency identification (RFID) to define geographical boundaries.

Global navigation satellite system (GNSS). A general term for satellite-based position and timing system. GNSS encompasses various constellations such as GPS, GLONASS, Galileo and BeiDou. Commercially available positioning systems are available which utilize more constellations to provide a positioning solution.

Global position system (GPS). A satellite-based radio navigation system operated by the Department of Defense to provide all military, civil, and commercial users with precise positioning, navigation, and timing.

Green deck. Or clear deck indicated by a green light on the Rotary Beacon Signal System or Deck Status Light System indicating safe for takeoff, launch, and landing.

H

Hazards of electromagnetic radiation to fuel (HERF). The potential hazard that exists when fuel vapors are exposed to an electromagnetic field of sufficient intensity to cause ignition of the fuel vapors.

Hazards of electromagnetic radiation to ordnance (HERO). The potential hazard that exists when ordnance systems are exposed to an electromagnetic field of sufficient intensity to cause sensitive electrically initiated devices (EIDs), classically (EEDs), contained in ordnance systems to actuate prematurely.

Hazards of electromagnetic radiation to personnel (HERP). The potential hazard that exists when personnel are exposed to an electromagnetic field of sufficient intensity to heat the human body.

Higher probability of loss (HPOL). Category 3 UAS flight clearances are issued for UAS that are not

designed to meet accepted engineering standards and/or where there is insufficient engineering data to assess compliance with established airworthiness criteria or standards. As such, Category 3 UAS flight clearances are issued with owner or sponsor acknowledgement of a higher probability of loss of the UA, and acceptance of system safety risks associated with material loss of the air system.

I

Infrared (IR). Invisible radiant energy, electromagnetic radiation with longer wavelengths than those of visible light, extending from the nominal red edge of the visible spectrum at 700 nanometers.

L

Level of interoperability. The degree of control that a user has over the unmanned aircraft, payload or both. These levels are NATO Compliant STANAG 4586.

Line of sight (LOS). A clear (obstruction free) path between any two positions in space.

M

Mean sea level (MSL). The average level for the surface of one or more of Earth's oceans which is the datum for measurement of elevation and altitude derived by the WGS84 geoid.

Minimum airspeed. The slowest airspeed at which the unmanned aircraft can maintain level flight.

N

Non-participating personnel. Persons or groups that are disconnected from the SUAS operations. These persons may be people or persons driving or walking through the airspace the SUAS is operating in without being briefed on its status, or military units working adjacent to the SUAS operations.

P

Participating personnel. All personnel involved in the operation that SUAS is participating in. This includes but is not limited to the SUAS flight team, the command section, the ground personnel the SUAS may be supporting, or other aviation assets. Some factors that may be used to determine if a person or group are Participating Personnel include: are they briefed on the SUAS operation, is the group supporting or being supported by the SUAS, or are the group or persons involved in airspace deconfliction or support.

Pressure altitude (PA). The vertical distance from the standard datum. This is a theoretical plane where air pressure (corrected to 15 °C) is equal to 29.92 inches of mercury (Hg). The indicated pressure altitude may not be the actual height above sea level due to variations in temperature, lapse rate, atmospheric pressure, and errors on the sensed pressure.

Public aircraft operations (PAO). Operations conducted in all DoW owned and leased aircraft, to include pre-accepted aircraft, and may apply to contracted aircraft services while conducting a mission for the DoW.

R

Red deck. Or foul deck indicated by a red light on the Rotary Beacon Signal System or Deck Status Light System indicating unsafe for takeoff, launch, and landing.

S

See and avoid. A visual procedure wherein pilots of aircraft flying in visual meteorological conditions, regardless of type of flight plan, are charged with the responsibility to observe to presence of other aircraft and to maneuver their aircraft as required to avoid the other aircraft.

Sense and avoid (SAA). A SAA system allows UAS to operate safely around other aircraft. Group 1 and 2 UAS do not have SAA systems installed.

Small unmanned aircraft system(s) (SUAS). For the purposes of the manual, SUAS are defined as Group 1 and 2 UA.

Standard operating procedure (SOP). A clearly written set of instructions for methods detailing the procedures for carrying out a routine or recurring task.

Static displays. A static demonstration of the physical appearance and characteristics of an aircraft at an event, which does not involve the subject aircraft in flight. To meet the definition of a static display, aircraft must be on deck and properly secured prior to the beginning of the static display, and can only depart after visitors have left the event area.

T

True airspeed. The airspeed of an aircraft relative to undisturbed air.

U

Unmanned aircraft (UA). A rotary, fixed-wing, or lighter-than-air aircraft which is capable of flight without an on-board crew. UA can be operated autonomously or remotely, can be expendable or recoverable, and can carry a lethal or nonlethal payload. Ballistic or semi-ballistic vehicles, cruise missiles, artillery projectiles, torpedoes, mines, satellites, and unattended sensors (with no form of propulsion) are not considered unmanned vehicles. Unmanned aircraft are the primary component of unmanned aircraft systems (UAS).

Unmanned aircraft system(s) (UAS). The system, whose components include the necessary equipment, data communication links, and personnel to control and employ an unmanned aircraft (UA).

V

Visual meteorological conditions (VMC). Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling that are equal to or better than specified minimums for basic weather conditions that are prescribed for flight under visual flight rules (VFR).

LIST OF ABBREVIATIONS AND ACRONYMS

A

AC. Alternating current; advisory circular.

ACC. Aircraft controlling custodian.

ACO. Airworthiness and CYBERSAFE office.

AFMAN. Air Force manual.

AGL. Above ground level.

AIRMET. Airmen's Meteorological Information.

AIRRS. Aircraft inventory readiness reporting system.

AIRS. Airworthiness Issues Resolution System.

AME. Aviation medical examiner.

AMOC. Alternate means of compliance.

ARC. Aircraft reporting custodian.

ARWG. Aeromedical reference & waiver guide.

ASBCA. Armed services board of contract appeals.

ATC. Air traffic control.

ATIS. Automatic terminal information service.

ATO. Air tasking order; authorization to operate.

AVGAS. Aviation gasoline.

AVO. Air vehicle operator.

AVO-R. AVO (new) only authorized to fly in Mil ranges COAs. No ship or testing.

AVOUI. AVO under instruction.

B

BIT. Built-in test.

BUQ. Basic UAS qualification.

C

C. Celsius.

C2. Command and control.

CAO. Civil aircraft operation.

CAS. Contracted air services.

CAT 1. Category 1 UAS flight clearance.

CAT 2. Category 2 UAS flight clearance.

CAT 3. Category 3 UAS flight clearance.

CFIT. Controlled flight into terrain.

CFR. Code of federal regulations.

CG. Center of gravity; guided missile cruiser.

CJCSI. Chairman of the Joint Chiefs of Staff instruction.

CNO. Chief of naval operations.

CO. Commanding officer.

COA. Certificate of waiver or authorization.

COCO. Contractor owned, contractor operated aircraft.

COGO. Contractor owned, government operated aircraft.

COLTS. Configuration, operations, lifecycle, total asset visibility, and property accountability system.

COMMS. Communications.

COMNAVAIRFORINST. Commander, Naval Air Forces instruction.

COMNAVAIRSYSCOM. Commander, Naval Air Systems Command.

COMSC. Commander, Military Sealift Command.

CONOPS. Concept of operations.

COTS. Commercial off the shelf.

CRM. Crew resource management.

CS. Control station.

CVN. Aircraft carrier [nuclear propulsion].

D

DA. Density altitude.

DAA. Designated approval authority.

DAU. Defense acquisition university.

DBI. Decibels relative to isotropic radiator.

DC. Direct current.

DCMA. Defense Contracting Management Agency.

DD. Defense Department.

DDG. Guided missile destroyer.

DFARS. Defense federal acquisition regulation supplement.

DGPS. Differential global positioning system.

DoDD. Department of Defense directive.

DoDI. Department of Defense instruction.

DON. Department of the Navy.

DON AAA. Department of the Navy airspace access authorization.

DoW. Department of War.

DTED. Digital terrain elevation data.

E

E3. Electromagnetic environmental effects.

EM. Electromagnetic.

EMC. Electromagnetic compatibility.

EMCON. Emissions control.

EME. Electromagnetic environment.

EMI. Electromagnetic interference.

EMV. Electromagnetic victim.

F

F. Fahrenheit.

FAA. Federal Aviation Administration.

FAA COA. FAA certification of waiver or authorization.

FAR. Federal acquisition regulation; federal avaiation regulation.

FCC. Federal Communication Commission.

FCP. Foreign clearance program.

FL. Flight level.

FMC. Full mission capable.

FT. Feet.

G

GCA. Ground controlled approach.

GCS. Ground control station.

GCSS-MC. Global combat support system – Marine Corp.

GFE. Government furnished equipment.

GFR. Government flight representative.

GFRC. Ground and flight risk clause.

GHz. Gigahertz.

GOCO. Government owned, contractor operated aircraft.

GPS. Global positioning system.

GSE. Ground support equipment.

H

HAZCOM. Hazard communication.

HAZMAT. Hazardous material.

HAZREP. Hazard report.

HERF. Hazards of electromagnetic radiation to fuel.

HERO. Hazards of electromagnetic radiation to ordnance.

HERP. Hazards of electromagnetic radiation to personnel.

HF. High frequency.

HPOL. Higher probability of loss.

I

IATT. Interim authority of loss.

IAW. In accordance with.

ICAO. International Civil Aviation Organization.

ID. Identification.

IFC. Interim flight clearance.

IFF. Identification, friend or foe.

IFR. Instrument flight rules.

IMC. Instrument meteorological conditions.

INS. Inertial navigation system.

INST. Instrument.

IR. Infrared.

iRAPT. Invoicing receipt, acceptance and property transfer.

ISR. Intelligence, surveillance, and reconnaissance.

J

JFC. Joint force commander.

JKO. Joint knowledge online.

JP. Jet propulsion; joint publication.

JSOP. Joint standard operating procedures.

JUMTS. Joint UAS minimum training standards.

K

kHz. Kilohertz.

KIAS. Knots indicated air speed.

KTS. Knots.

KW. Kilowatt.

L

LB. Pound.

LBSP. Lithium battery safety program.

LEP. Laser eye protection.

LOI. Level of interoperability.

LOS. Line of sight.

LSRB. Laser safety review board.

LZ. Landing zone.

M

M. Meter.

MANMED. Manual of the medical department.

MCO. Marine Corps order.

MCRP. Marine Corps reference publication.

MDA. Minimum decent altitude.

MEF. Marine expeditionary force.

MGTOW. Maximum gross take-off weight.

MHz. Megahertz.

MILVAN. Military owned demountable container.

MIRR. Material inspection and receiving report.

MOA. Memorandum of agreement.

MOGAS. Motor gasoline.

MOU. Memorandum of understanding.

MPO. Mission payload operator.

MR. Multi-rotor.

MSDS. Material safety data sheets.

MSL. Mean sea level.

MTD. Mission training device.

N

NAATSEA. Naval airspace and air traffic control standards and evaluation agency.

NAE. Naval Aviation Enterprise.

NAS. National Airspace System.

NASTP. Naval aviation survival training program.

NATO. North Atlantic Treaty Organization.

NATOPS. Naval Air Training and Operations Procedures Standardization.

NAVAIR. Naval Air Systems Command.

NAVAIRINST. NAVAIR instruction.

NAVMED. Navy medicine.

NAVMEDINST. Navy medicine instruction.

NAVSEA. Naval Sea Systems Command.

NAVSEAINST. Naval Sea Systems Command instruction.

NAWCAD. Naval Air Warfare Center, Aircraft Division.

NFPA. National fire protection association.

NM. Nautical mile.

NMC. Non-mission capable.

NMSC. Navy and Marine Corps Spectrum Center.

NOHD. Nominal ocular hazard distance.

NOTAM. Notice to airmen.

NSHD. Normal skin hazard distance.

NTTP. Naval tactical technique and procedures.

O

OAT. Outside air temperature.

OD. Optical density.

OEM. Original equipment manufacturer.

OPAREA. Operations area.

OPNAV. Office of the Chief of Naval Operations.

OPNAVINST. Office of the Chief of Naval Operations Instruction.

OPREP. Operational report.

ORM. Operational risk management.

OSD. Office of the Secretary of Defense.

OSHA. Occupational safety and health administration.

P

PAO. Public aircraft operation.

PIC. Pilot in command.

PIREP. Pilot report.

PMC. Partial mission capable.

PMSV. Pilot to metro service.

POC. Point of contact.

POR. Program of record.

PPE. Personal protective equipment.

R

RC. Remote control.

RF. Radio frequency.

RIB. Rigid inflatable boat.

RPM. Revolutions per minute.

RTB. Return to base.

RTH. Return to home.

RTL. Return to launch.

RTSA. Reconnaissance, surveillance, and target acquisition.

S

SA. Situational awareness.

SAA. See and avoid.

SAASM GPS. Selective availability anti-spoofing module GPS.

SAR. Search and rescue.

SATCOM. Satellite communications.

SDS. Safety data sheet.

SES. Senior executive service.

SHKOZ. Safety hazard keep out zones.

SIGMET. Significant meteorological information.

SIREP. Sensitive information report.

SITREP. Situation report.

SM. Statute mile.

SMR. Single main rotor.

SMS. Safety management system.

SO. Safety observer.

SoC. State of change.

SOF. Safety of flight.

SOP. Standard operating procedure.

SS. Spectrum supportability.

STANAG. Standard agreement NATO.

STANAG 4586. Standard Interface of the Unmanned Control System UCS for NATO UAV Interoperability.

SUA. Special use airspace.

SUAS. Small unmanned aircraft system.

SUASMAN. Small unmanned aircraft manager.

T

TAI. Target area of interest.

TALSA. Training and logistics support system.

TAS. True airspeed.

TECOM. Training and Education Command.

TM. Technical manual.

T/M/S. Type/model/series.

TOS. Time on station.

TRP. Target reference point.

TX. Transmitter.

U

UA. Unmanned aircraft.

UAC. Unmanned aircraft commander/UAS commander.

UAS. Unmanned aircraft system.

UASC. UAS crewmember.

UAV. Unmanned aircraft vehicle.

UGV. Unmanned ground vehicles.

UHF. Ultra high frequency.

UMC. UAS mission commander.

USDOT. United States Department of Transportation.

USMC. United States Marine Corps.

USN. United States Navy.

USV. Unmanned surface vehicles.

UUV. Unmanned underwater vehicles.

V

VDP. Visual descent point.

VHF. Very high frequency.

VLOS. Visual line of sight.

VMC. Visual meteorological conditions.

VO. Visual operator.

VTOL. Vertical takeoff and landing.

W

W. Watt.

WAMHRS. WESS aviation mishap and hazard reporting system.

WESS. Web-enabled safety system.

WOD. Wind over deck.

Wx. Weather.

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PREFACE

SCOPE AND PURPOSE

CNAF M-3710.9 establishes the Group 1 and 2 UAS Training and Operations Standards.

This manual contains detailed information supporting safe flight operations, airspace operations, and crew qualifications. This manual contains flight clearance information, operating procedures and limitations necessary for flight crews to operate their UAS safely and effectively. The manual serves as a framework for Navy and Marine Corps commands to establish and maintain safe and effective Group 1 and 2 UAS flying activities. This manual applies to all Navy and Marine Corps activities operating Group 1 and 2 UAS, to include laboratories. UAS crewmembers and ground support personnel involved with UAS operations shall have a thorough knowledge of the contents of this manual. However, no manual can address every situation completely or be a substitute for sound judgment.

The Interim Flight Clearance (IFC) for specific UAS may expand or restrict limitations and procedures compared to what is contained in this manual and/or Original Equipment Manufacturer (OEM) manuals. If there is a discrepancy, contact NAVAIR POCs listed in the IFC for clarification.

For the purposes of this manual, Department of the Navy (DON) UAS include DON-owned, DON leased and contractor operated UAS performing public or State operations.

This manual is applicable to Group 1 and 2 UAS not operating under instrument flight rules (IFR); IFR operations being beyond the scope of this manual.

Unless specifically delegated, operational waiver requests for the requirements set forth in this manual shall be routed to Commander, Naval Air Forces. Copies of all waivers shall be forwarded to COMNAVSAFECOM Aircraft Operations (Code 11).

NAVAIRSYSCOM (ACO) is the final authority within the Navy and Marine Corps on airworthiness issues.

NAVAIRSYSCOM (ACO) should be consulted for assistance in determining if a deviation from this manual would necessitate an operational waiver and/or a flight clearance request. All waivers shall always indicate the purpose for which granted and include a time limit. If a waiver must be continually renewed, it is a good indication that the particular procedure, requirement, or limitation should be revisited.

Group 3 UAS are outside the scope of this manual. With the endorsement of the NAVAIR platform Class Desk, Commander, Naval Air Forces, Commandant of the Marine Corps, and Commander, Naval Air Systems Command may approve certain limited Group 3 UAS to operate in accordance with this manual via a waiver package. Approval of the waiver request will take into account the unit operating the Group 3, the unmanned aircraft operating characteristics, the training and skills possessed by the operating unit and pilots, and the units proposed concept of operations. Any such approved authorization will be annotated in the IFC.

PUBLIC AIRCRAFT OPERATIONS (PAO) VERSUS CIVIL AIRCRAFT OPERATIONS (CAO)

PAO include operations conducted in all DoW owned and leased aircraft, to include pre–accepted aircraft, and may apply to contracted aircraft services while conducting a mission for the DoW. The status of a particular aircraft operation depends on multiple factors, to include ownership, configuration, and the operations being conducted.

U.S. Code defines aircraft operations in the National Airspace System (NAS) as either public or civil.

COCO (contractor owned, contractor operated), COGO (contractor owned, government operated) and GOCO (government owned, contractor operated) aircraft may be either PAO or CAO depending on numerous factors.

CAO are defined as anything other than public aircraft operations. CAO are conducted in accordance with (IAW) Federal Regulations under the Federal Aviation Administration's (FAA) authority.

The U.S. Armed Forces considers an aircraft operation "Public" when the aircraft is owned, leased, operated by the Armed Forces, or is used by the Armed Forces and operates outside of the purview of its FAA airworthiness certificate (e.g., configuration or operational use).

PAO Determinations. For Contracted Aircraft Services, the Procuring Contracting Officer or Program Manager is responsible for notifying the contractor if an aircraft operation is PAO. Prior to Contract Award Contracting Agencies should ensure a PAO (or State) Assessment is conducted by a competent organization such as NAVAIR.

Aircraft, other than public aircraft. The FAA is the Airworthiness Authority for all civil aircraft, as well as the licensing of civil pilots and mechanics, when operations are in U.S. NAS.

For additional information on Public or Civil Aircraft Operation determinations, refer to the NAVAIR PAO knowledge portal: https://myteam.navair.navy.mil/corpapps/ams/home/pao/sitepages/default.aspx.

Note

A contracted aircraft and aircrew could conduct a civil operation in the morning and then that same crew operating the same aircraft, could be tasked to conduct a PAO in the afternoon based on changes to the aircraft configuration and/or the operation being conducted. Any command considering employing contracted aircraft services that may be conducting PAO is encouraged to contact COMNAVAIRSYSCOM (Airworthiness Office) for assistance.

Airworthiness Authority for PAO

The FAA has limited authority over DoW owned, leased, or contracted aircraft while those aircraft are conducting PAO. The FAA's authority over PAO is limited to flight operating rules IAW Title 14 Code of Federal Regulations (CFR) Part 91 while operating within the U.S. NAS. While the vast majority of DoW owned or leased aircraft operations are PAO, contracted aircraft services may or may not be PAO depending on the operation and aircraft configuration. The DoW has both the authority and responsibility for the airworthiness certification and continuing airworthiness (operations, maintenance, and safety) of aircraft owned, leased, or under contract to the DoW when operating as a PAO. It is essential that organizations contracting for aviation services (e.g., range operations, threat simulation, training support, aerial refueling) understand when the operations being conducted are PAO and when they are CAO. Military operators should not assume that the contractor or government contracting agency understands this, and must understand that FAA-issued civil certificates do not convey if the operations are PAO or State.

State Aircraft

The concept of PAO does not apply outside of U.S. NAS. In international airspace, including airspace controlled by sovereign nations, aircraft are considered either State aircraft or Civil aircraft. DoW aircraft are U.S. State aircraft when operating in international and foreign airspace. This determination does not include aircraft conducting CAO, but may include certain contracted air services. Similar to PAO, DoW assumes certain responsibilities and risks for aircraft determined to be a State aircraft by DoW.

UAS Department of the Navy Policy

NAVAIRINST 13034.1 (series) outlines UAS Airworthiness considerations as follows. The overarching UAS airworthiness principles are safety of personnel during launch and recovery, safety of personnel on the ground during flight, airspace and operating areas containment, and midair collision avoidance.

FLIGHT CLEARANCES

CNAF M-3710.7 requires that all United States Navy (USN) and United States Marine Corps (USMC) UAS of any size that are owned, leased, operated, used, tested, or demonstrated by DON activities, or any other DON public aircraft operation conducted by or for DON (including contracted UAS services) shall have an airworthiness certification in the form of a flight clearance document promulgated/issued by COMNAVAIRSYSCOM.

NAVAIRINST 13034.1 (series) delegates the execution of airworthiness authority for the issuance of flight clearances to the NAVAIR Airworthiness and CYBERSAFE Office (ACO) and provided further guidance concerning flight clearances. NAVAIR ACO is the single delegated authority for the issuance of interim and permanent flight clearances for all DON unmanned aircraft (UA) and unmanned aircraft systems (UAS).

This manual shall be used in conjunction with an IFC for specific UAS TMS operations. All current flight clearances may be found on the NAVAIR Airworthiness website, https://airworthiness.navair.navy.mil. NAVAIRINST 13034.1 (series) provides further guidance concerning flight clearances. NAVAIRSYSCOM Airworthiness Directorate is the final authority within the Navy and Marine Corps on airworthiness issues.

UAS Flight Clearances are organized as Category 1-3 in terms of the airworthiness standards that the UAS have been designed to meet.

Category 1 UAS Flight Clearances are provided for UAS that meet airworthiness criteria, engineering standards and data requirements, equivalent to that of manned aircraft while taking into account UAS-unique design considerations.

Category 2 UAS Flight Clearances are provided for UAS utilizing a tailored set of airworthiness criteria, engineering standards, and data requirements.

Category 3 UAS Flight Clearances are provided for UAS that are not designed to meet accepted engineering standards and/or where there is insufficient engineering data to assess compliance with airworthiness criteria or standards. Since Category 3 UAS flight clearances do not meet established airworthiness criteria, they are issued with owner or sponsor acknowledgement of higher probability of loss (HPOL) of the UA, and acceptance of system safety risks associated with material loss of the air system.

Most Group 1 and 2 UAS operate under CAT 3 UAS IFCs due to the challenge of meeting a high level of airworthiness within the limited weight and lower intended cost for a Group 1 and 2 UAS.

ACKNOWLEDGEMENT OF HIGHER PROBABILITY OF LOSS

Operation of Group 1 and 2 UAS have a lower level of inherent airworthiness and higher probability of catastrophic failure than manned aircraft. As such, Group 1 and 2 UAS are issued Category 3 UAS flight clearances with owner, sponsor and/or Aircraft Reporting Custodian (ARC) acknowledgement of HPOL, and acceptance of system safety risks associated with material loss of the air system. Acknowledgement of higher probability of loss does not alleviate Owner/Sponsor/Aircraft Reporting Custodian from OPNAV M-3750.6 Naval Aviation Safety Management System reporting requirements.

DETERMINING THE CURRENT VERSION AND OBTAINING COPIES OF GROUP 1 AND 2 UAS TRAINING AND OPERATIONS MANUAL

Before using this product, ensure that you have the latest version by checking the revision change information. A pdf format of this manual is available on the NAVAIR Airworthiness and CYBERSAFE website at https://airworthiness.navair.navy.mil.

SUBMITTING CHANGE RECOMMENDATIONS

To be effective, this manual must be kept current through an active manual change program. Corrections, additions to, deletions from, and suggestions for improving contents should be submitted to the NAVAIR ACO (Airworthiness and CYBERSAFE Office). The preferred means of submitting change recommendations is through the Airworthiness Issues Resolution System (AIRS). AIRS may be accessed online at https://airworthiness.navair.navy.mil. In the event that a connection to AIRS is not available, change recommendations can be made by emailing NAVAIR ACO via Airworthiness Global Customer Support Team, at airworthiness.gm.fct@navy.mil. Change recommendations shall be worded specifically as possible. Change recommendations may be submitted by any authorized user.

CHANGE SYMBOLS

Revised text is indicated by black vertical line in the margin of the page, like the one adjacent to this paragraph. The change symbol shows where there has been material added or information restated. Change symbols are not normally used to mark the locations of deleted information. Change symbols in the margin by the chapter number and title indicate a new or completely revised chapter.

SPECIAL TERMINOLOGY IN THE MANUAL

The following special terminology and meanings apply to the contents of this manual:

Warnings, Cautions, and Notes. The following definitions apply to WARNINGS, CAUTIONS, and Notes:

WARNING

Explanatory information about an operating procedure, practice, or condition, etc., that may result in injury, death, or loss of aircraft if not carefully observed or followed.

CAUTION

Explanatory information about an operating procedure, practice, or condition, etc., that may result in damage to equipment if not carefully observed or followed.

Note

Explanatory information about an operating procedure, practice, or condition, etc., that must be emphasized.

Requirement for compliance.

"Shall" is used only when application of a procedure is mandatory.

"Should" is used only when application of a procedure is recommended.

"May" and "need not" are used only when application of a procedure is optional.

"Will" indicates futurity and never indicates any degree of requirement for application of a procedure.

Requirement for landing aircraft.

"Land Immediately" means execute a landing without delay.

"Land as Soon as Possible" means land at the first site at which a safe landing can be made.

"Land as Soon as Practicable" means extended flight is not recommended. The landing site and duration of flight are at the discretion of the pilot in command.

OTHER RELEVANT PUBLICATIONS

The applicable Aircraft Controlling Custodian (ACC) or Designated Approval Authority (DAA) is responsible for the flight of an unmanned aircraft (UA) and shall ensure compliance with pertinent UAS-related documents and directives to include, but not limited to the following:

CJCSI 3255.01 Joint Unmanned Aircraft Systems Minimum Training Standards (JUMTS). Defines JUMTS and identifies the minimum knowledge required for a UAS crewmember (UASC) to support joint force commanders (JFC) objectives. The Instruction standardized the minimum knowledge of basic UAS and joint UAS mission qualifications for UASCs.

CNAF M-3710.7 NAVAL Air Training and Operating Procedures Standardization (NATOPS) General Flight and Operating Instructions Manual. This manual establishes the NATOPS program and prescribes general flight and operating instructions and procedures of all naval aircraft and related activities included UAS Policies and Operations requirements. Chapter 14 is specific to UAS operations and states that "non-program of record UAS may need to operate under deviations from the strict limitations of this instruction".

DCMA Instruction 8210.1 (Also known as NAVAIRINST 3710.1) Series, Contractor's Flight and Ground Operations. Establishes requirements for flight and ground operations involving all contracted work performed on aircraft, as well as procedures to be followed by the Government Flight Representatives (GFR).

DODD 4500.54E DoW Foreign Clearance Program (FCP). DoW policy that defines the requirements for DoW aircraft operating in Foreign Airspace.

DODI 4540.01 Use of International Airspace by U.S. Military Aircraft and for Missile and Projectile Firings. Establishes policy and assigns responsibilities governing U.S. military aircraft operations and missile and projectile firing activities in international airspace.

DoW/FAA Memorandum of Understanding (MOU) Concerning the Operation of DoW Unmanned Aircraft Systems in the NAS. This MOU sets forth provisions that will allow, IAW applicable law, increased access for DoW UAS into the NAS outside of Restricted, Warning, or Prohibited Areas through accommodation, implementation of advanced mitigation, and integration, where applicable.

FAA Advisory Circular AC-00-1.1 Public Aircraft Operations—Manned and Unmanned. The AC provides information to assist in determining whether government-owned or government-contracted manned and unmanned aircraft operations conducted within the territory of the United States are public or civil aircraft operations.

Joint Publication 3-52 Joint Airspace Control Provides doctrine for the planning, execution and assessment of airspace control during joint operations across the full range of military operations.

NAVMED P-117 Manual of the Medical Department U.S. Navy (MANMED). Provides guidance for obtaining and maintaining medical qualifications to operate Group 1 and 2 UAS.

NAVAIRINST 13034.1 (series) Airworthiness Policy. This instruction provides UAS specific airworthiness policy, defines UAS Flight Clearance Categories and criteria.

NAVSEAINST 9310.1 Naval Lithium Battery Safety Program. This instruction provides policy and responsibilities concerning the safety of all aspects for all types of lithium batteries, lithium cells, and lithium battery powered equipment or systems.

NAVMC 3500.107 Small Unmanned Aircraft Systems Training and Readiness Manual. This manual provides standards that describe and define Marine Corp unit's capabilities and requirements necessary to maintain proficiency in SUAS operations.

NAVSEA TM S9310-AQ-SAF-010 Technical Manual for Navy Lithium Battery Safety Program Responsibilities and Procedures. This document requires UAS owned by the USN/USMC or located on USN ships/facilities to have a Lithium Battery Safety Certificate.

OPNAVINST 2400.20 Electromagnetic Environmental Effects (E3) and Spectrum Supportability Policy and Procedures. Establishes Navy policy, procedures, and assign responsibilities for Electromagnetic Environmental Effects (E3) and Spectrum Supportability (SS).

OPNAVINST 3710.7 Naval Air Training and Operating Procedures Standardization (NATOPS) Program. Establishes the NATOPS Program and implements and authorizes the Chief of Naval Operations policy and procedural guidance.

OPNAVINST 3500.39 Operational Risk Management (ORM). This instruction establishes policy guidelines, procedures, and responsibility to standardize the ORM process across the Navy and establishes the ORM training continuum.

OPNAV M-3750.6 Naval Aviation Safety Management System. This instruction includes methods of detection, investigation and elimination of hazards in naval aviation. It also provides information on risk mitigation and requirements for safety reporting of an aviation mishap.

OPNAVINST 5100.27 Navy Laser Hazards Control Program. Prescribes Navy and Marine Corps policy and guidance in the identification and control of laser radiation hazards. The provisions of the instruction are mandatory for all Navy and Marine Corps activities.

Range Safety Review Questions for UAs Projects, Document 323-99 (RCC-323-99). Provides common approach for the Range Commander to make decisions regarding UAS flight operations. Contains questions intended to identify potential hazards and ensure safeguards are put in place that are consistent with existing local policy to reduce risk while operating UAS on ranges.

Aeromedical Reference and Waiver Guide (ARWG). Published by the Navy Medicine Operational Training Command, the ARWG provides aviation physical standards to ensure the most qualified personnel are accepted and retained by Naval Aviation.

Requirements and Guidance for Access to and Operations with in United States Civil Airspace by Department of the Navy Unmanned Aircraft Systems. This document serves as record of requirements, processes and procedures for all Department of the Navy UAS in order to obtain airspace access authorization for operations within U.S. airspace outside Prohibited, Restricted or Warning Area airspace. Published by: OPNAV N98 Airspace and Air Traffic Control Director, Naval Airspace and Air Traffic Control Standards and Evaluation Agency (NAATSEA) and is available via email request to NAATSEA@navy.mil.

U.S. Armed Forces PAO Decision Tool. This document provides the essential framework and decision criteria of a competent organization, such as NAVAIR, to conduct a PAO (or State) Assessment.

OTHER SOURCE DOCUMENTS

Some reference documents called out within this manual may not be applicable to the operation of Group 1 and 2 UAS at this time.

FAA Part 107 Operation and Certification of SUAS. Applies to aircraft under 55 lbs, similar to the military classification of Group 1 and 2 UAS. Outlines civil operations and certification requirements to allow UAS under 55 lbs to operate for non-hobby and non-recreational purposes in the National Airspace System with specific limitations.

Note

DON PAO cannot be conducted under FAA Part 107.

CHAPTER 1

Group 1 and 2 UAS Program Responsibilities and Authorities

1.1 GROUP 1 AND 2 UAS PROGRAM RESPONSIBILITIES

UAS Command Responsibilities. There are two essential command authorities assuming responsibility for UAS operations: the Aircraft Controlling Custodian (ACC) or Designated Approval Authority (DAA) and Aircraft Reporting Custodian (ARC).

1.1.1 ACC/DAA Responsibilities

Within the Naval Aviation Enterprise (NAE), the management and operation of aircraft, including Group 1 and 2 UAS, is the responsibility of an ACC. An ACC is responsible for exercising administrative control of assignment, employment and logistic support of Group 1 and 2 UAS under their cognizance. A DAA is the flag or general officer, SES, or SES equivalent, who assumes ACC authorities and responsibilities when the operation of an ARC falls outside of the NAE and the cognizance of a designated ACC. The ACC or DAA is responsible for designating in writing UAS ARCs under their cognizance. ACC responsibilities can be found in CNAF M-3710.7, OPNAVINST 4790.2 and OPNAV M-3750.6. The ACC or DAA must ensure the designated ARC maintains the requisite personnel, training, equipment and infrastructure to support safe flight operations in compliance with DON Policies and instructions. Compliance must be ensured through ACC or DAA periodic evaluations of approved UAS programs. (See Appendix H).

1.1.2 UAS Programs Establishment

Each command establishing a Group 1 or 2 UAS operation must provide written notification to COMNAVAIRFOR (N45) and NAVAIR AIRWorks documenting the establishment of the DAA and ARC. This notification should include DAA contact information and a list of designated ARC(s) under the cognizance of the DAA, (e.g., Marine Expeditionary Force (MEF) would designate/approve subordinate ARCs within the Division, Regiment, and Battalion levels).

1.1.3 Inventory Responsibilities

The ACC or DAA must maintain an inventory of all Group 1 and 2 UAS in subordinate commands and units. Inventories must, at a minimum, include UAS configuration and status, and the ARC is responsible to manage inventory and divestitures such as DD-250, DD 1149s, etc. of unit UAS and report to the ACC or DAA. UAS inventory may be tracked in the Small Unmanned Aircraft Manager (SUASMAN), Configuration, Operations, Lifecycle, Total Asset Visibility, and Property Accountability System (COLTS), Global Combat Support Systems — Marine Corps (GCCS–MC), or other method deemed appropriate by the ACC or DAA.

1.1.4 UAS Crewmember Designation Authority

The ACC or DAA is responsible for delegating UAS crewmember designation authority to the ARC or higher echelon commander. This delegation may be included in the documentation establishing the ARC.

1.1.5 NATOPS Advisory Group

NATOPS Advisory Group member relationships, responsibilities and procedures are contained in CNAF M-3710.7. The following commands are designated as members of the NATOPS Advisory Group for this manual:

a. Chief of Naval Operations

b. Commander, Naval Air Forces

c. Commandant of the Marine Corps
d. Commander, Naval Surface Force
e. Commander, Naval Surface Force, Atlantic
f. Commander, Naval Air Force, Atlantic
g. Commander, U.S. Marine Forces Command
h. Commander, U.S. Marine Forces Pacific
i. Commander, Naval Air Systems Command
j. Commander, Naval Safety Command
k. Commander, Naval Air Training
l. Chief, Bureau of Medicine and Surgery
m. Program Manager, Program Manager Air 263

1.2 UNIT/COMMAND-LEVEL AIRCRAFT REPORTING CUSTODIAN AUTHORITIES AND RESPONSIBILITIES

1.2.1 ARC Responsibilities

The ARC is the lowest echelon of command accepting responsibility for Group 1 and 2 UAS operations, as designated by the Chief of Naval Operations (CNO), ACC, or DAA. ARC responsibilities can be found in CNAF M-3710.7, CNAF 3710.9 and OPNAV M-3750.6. An ARC is typically an O-5 level Commanding Officer, but may be a military officer or government civilian leading an organizational component as deemed appropriate by the ACC or DAA. The ARC is responsible for the safe operation and security of assigned UAS, to include classified equipment or material. The ARC will ensure assigned UAS AVOs are trained on, and comply with, Domestic Use policy contained in SECNAV Instruction 3700.2. The ARC maintains the requisite personnel, training, equipment and infrastructure to support safe flight operations in compliance with DON policies and instructions. Compliance will be ensured through ACC or DAA conducted periodic evaluations of approved UAS programs.

OPNAVINST 4790 Series requirements do not apply to Group 1 and 2 UAS. Group 1 and 2 UAS shall be operated and maintained IAW applicable manufacturer operating manuals, maintenance manuals, service bulletins, safety bulletins, and operations advisories. This includes applicable overhaul, replacement, inspection and life limit requirements for the UAS. When required, the ARC is responsible for documenting and maintaining records of UAS maintenance, preventive maintenance, and status of replacement/overhaul component parts.

1.2.1.1 Requirement for Flight Authorization

A Naval UAS shall not be operated by any person unless authorized by the reporting custodian, unit commander, or a delegated authority exercising control over the UAS concerned.

1.2.2 UAS Crewmember Designations

When designated by the ACC or DAA, ARCs are authorized to approve UAS crewmember qualifications and certifications after ensuring each UAS crewmember has completed the requisite training for the applicable crewmember classification. UAS crewmember designations are provided in Chapter 5 of this manual. Copies of each designation letter must be retained in the individual crewmember's training jacket.

1.2.3 UAS Crewmember Training and Qualifications

The ARC is responsible for following ACC/DAA or other higher echelon training and qualification requirements and establishing local UAS crew training and qualification requirements. Chapter 5 of this manual contains the minimum air vehicle operator (AVO) requirements as set forth by COMNAVAIRFORINST 3710.9.

1.2.4 Naval Aviation Safety Policies

The ARC is responsible for following ACC/DAA or other higher echelon safety program requirements and complying with applicable safety policies, provisions and mishap reporting requirements provided in OPNAV M-3750.6. (See Appendix G).

1.3 INTERMEDIATE COMMANDS — AUTHORITIES AND RESPONSIBILITIES

Commands in the administrative chain of command between the ACC or DAA and the ARC should have an appropriate working knowledge of UAS operations commensurate with their level of responsibility, to include general oversight, funding, manning, training, operations, safety, standardization, maintenance and any other topic areas that may apply. These commands are considered part of the safety and endorsement chain of command in the event of a mishap that meets mishap reporting thresholds as identified in OPNAV M-3750.6.

1.4 CONTRACTOR OPERATIONS

1.4.1 Contractor Operations of Government Owned UAS (GOCO)

Commands exercising contracting authority over the acquisition, maintenance, or operation of aircraft and UAS shall ensure that the DFARS 252.228-7001 GROUND AND FLIGHT RISK CLAUSE (GFRC) is incorporated into all UAS contracts.

By including the GFRC in a contract, the Government assumes the financial cost of any mishap by indemnifying the contractor (with the exception of the deductible). When the Government is willing to assume that cost, the GFRC mitigates that risk by requiring the contractor to be bound by the combined regulation/instruction entitled NAVAIRINST 3710.1 (Series) "Contractor's Flight and Ground Operations" issued by the DoW components. To comply with the combined regulation/instruction, the contractor must develop safe and effective procedures to cover all aspects of its ground and flight operations. The Government retains the authority to approve or disapprove these procedures. Under the combined regulation/instruction, the authority to approve the contractor's procedures lies with the assigned GFR, who must complete a Defense Acquisition University (DAU) administered GFR Certification Course prior to appointment. The GFR also monitors contractor compliance for the contracting officer. In sum, as the Armed Services Board of Contract Appeals (ASBCA) explained, the Government assumes risks, which generally entail unusually high insurance premiums if the risk were to be assumed by the contractor. In turn, the Government's goal is to reduce its risks by exercising certain controls," most notably, implementation and government oversight associated with the combined regulation/instruction and the contractor's approved procedures. Contractors perform their contract in accordance with the requirements of the contract and those of the combined instruction (NAVAIRINST 3710.1 (Series)). The most notable exception to the use of the GFRC is when the UAS is procured under a FAR Part 12 contract. This is a commercial purchase and the aircraft does not become Navy property (or a Navy liability) until the aircraft is paid for and formal acceptance is completed. Therefore, the GFRC is not put on a commercial acquisition contract. The DD Form 250 is the Material Inspection and Receiving Report (MIRR) which traditionally signifies government acceptance. Today, this is typically incorporated into a secure Web-based system called Invoicing, Receipt, Acceptance, and Property Transfer (iRAPT). Please note that any follow-on support contracts involving contractor efforts to maintain or operate Navy purchased commercial off the shelf (COTS) UAS, would require the GFRC, as discussed above.

1.4.2 Contracting for Contracted Air Services (CAS) Deemed State or PAO (COCO)

As a means to mitigate the risks associated with continuing airworthiness and operation of a UAS in support of PAO or State CAS, contracting agencies will ensure compliance with their DFARS 242.302(a)(56) Contract Administration Functions by incorporating into the contract, task order, or delivery order the requirements of the NAVAIRINST 3710.1 (Series) on all contracted air services contracts for which NAVAIR intends to issue an IFC in support of PAO or State aircraft operations. These COCO CAS Contracts shall contain DFARS Clauses 252.228-7007 Public Aircraft and State Aircraft Operations—Liability and DFARS 252.228-7005 Mishap Reporting and Investigation Involving Aircraft, Missiles, and Space Launch Vehicles.

As indicated in FAA Advisory Circular (AC) 00-1.1, subject: Public Aircraft Operations—Manned and Unmanned, contracting government entities must be aware that PAO (and State operations outside the NAS) performed by civil

operators, create a significant transfer of responsibility to the contracting government entity, and that most FAA oversight ceases. The shift in responsibility that the AC is referring to is the shift of responsibility associated with the Airworthiness of the aircraft. When DON issues an IFC to support PAO or State operations, neither the FAA or the contractor retain responsibility for the engineering, design and operation of the UAS. Most responsibilities, including those of continuing airworthiness (e.g., maintenance and operational procedures, training, qualifications, safety) shift to the DON.

1.4.3 Contract Performance for CAS COCO

Contractors operating their own aircraft in support of CAS contracts may not be bound by the same rules that DON reporting custodians are bound. The contractor uses his own mix of government, commercial industry, and company policies and procedures. Only Instructions required by the contract, or those required by NAVAIRINST 3710.1 (Series), are binding on the contractor. With the proposed procedures, that the assigned GFR accepts as safe and effective, the contractor may achieve the same performance as the government aircraft, but in a different manner. A COCO contractor may or may not be operating in support of a designated ARC, but will follow the requirements of the contract. When the contracting authority establishes a services contract without the benefit of an assigned supporting reporting custodian, it is that contracting agencies responsibility to designate the GFR, and ensure that the contractor meets DON standards and is safe to operate before commencing operations. Clearly, it is important that proper preparation go into the writing of the contract (see Preface discussion). While this instruction will likely be a part of the contract, there are sections of it that will not apply to a particular contract. The assigned GFR shall ensure the intent of the contract and this instruction is carried out, allowing for the individual requirements/methods to be modified when necessary.

CHAPTER 2

Systems

2.1 SYSTEM

2.1.1 General

This manual is applicable to Group 1 and 2 UAS identified in the scope of this manual. See Appendix C UAS Groups for specific categorization.

2.2 UNMANNED AIRCRAFT

2.2.1 Types of Group 1 and 2 UAS

This manual contains limitations, procedures, warnings, cautions, and notes that apply in general to Group 1 and 2 UAS operations as well as to specific types of UAS. It is the responsibility of the ARC to determine which type of UAS is being operated, and therefore which operating rules apply. Types of UAS addressed by the manual include:

2.2.1.1 Multi-rotor UAS

Multi-rotor UAS feature more than one lifting rotor. Multi-rotor UAS can have both rotary and fixed wing characteristics. If the aircraft can be transitioned to wing-borne flight, then fixed wing operating limits shall apply during all fixed wing flight phases.

2.2.1.2 Fixed Wing UAS

Fixed wing UAS feature one or more stationary wings. Fixed wing UAS fly by utilizing the lift generated by the UA's forward motion. They can be self-propelled, gliders, or a mixture of both.

2.2.1.3 Single Main Rotor UAS

Single Main Rotor UAS feature two or more large rotor blades that revolve around a single or coaxial rotor hub. Except for coaxial rotorcraft, a small tail rotor is typically required to provide counter-torque and directional stability/control. Tandem rotor UAS have two separate rotors, and are considered Multi-rotor UAS for the purposes of this manual.

2.2.1.4 Tethered UAS

Tethered UAS are attached to the ground, ship or other such anchor point via a cable or line. Tethered UAS are capable of propulsion and control. Oftentimes, electrical power and command and control is transmitted via the cable. The UA gross weight includes the weight of the tether as payed out.

Tethered or untethered Balloons and Aerostats are not equipped with propulsion and control systems. These systems are not considered UAS unless they have active propulsion and control systems.

2.2.1.5 Unmanned Lighter Than Air UAs Capable of Propulsion and Control

Lighter than air UA such as blimps and balloons that are capable of propulsion and control are governed by this policy. When categorizing these UAS by group, the weight of the UA with an empty envelope shall be used.

2.2.1.6 Unmanned Ground Vehicles (UGV), Unmanned Surface Vehicles (USV) and Unmanned Underwater Vehicles (UUV)

UGVs, USVs and UUVs are not governed by this instruction unless the vehicle is capable of flight and intended to fly during the sortie.

2.2.1.7 UAS Flown Indoors or Within Other Enclosures

An airworthiness approval is not required for UA flight operations inside an unoccupied enclosed structure (or other physical boundary) where there is no potential for open-air flight. All other requirements of this manual still apply.

2.2.1.8 Armed UAS

Armed UAS are weaponized UAs approved for carriage or employment of weapons, explosives, or other energetics functions.

See Chapter 12 for Weaponized UAS operating rules.

2.3 CONTROL STATION (CS)

The CS may include a laptop and or tablet/E-device and a ground datalink transceiver. The CS may be portable for shore-based and shipboard operations. CS specifications for each UAS T/M/S will be documented in the governing flight clearance.

2.3.1 Level of Interoperability (LOI)

Control station capabilities will vary based on operational requirements. The five levels identified below are promulgated in the NATO STANAG 4586.

Level 1: Indirect receipt and/or transmission of sensor product and associated metadata, for example Key Length Value Metadata Elements from the UAS.

Level 2: Direct receipt of sensor product data and associated metadata from the UAS.

Level 3: Control and monitoring of the UAS payload unless specified as monitor only.

Level 4: Control and monitoring of the UAS, unless specified as monitor only, less launch and recovery.

Level 5: Control and monitoring of UAS launch and recovery unless specified as monitor only.

Operator training requirements will vary based on the LOI of the control station capabilities.

2.4 POWER AND PROPULSION SYSTEMS

2.4.1 Electrical Power

UAS Electrical power may be provided by any of the following sources:

2.4.1.1 Batteries

Power storage devices such as batteries (e.g., Nickel Cadmium, Lead Acid, Lithium Chemistry, etc.) have the potential to introduce hazards to personnel and property. Follow OEM manual instructions for charging, handling, storage and transportation. Be sure to read and follow Material Safety Data Sheets (MSDS) if applicable.

2.4.1.1.1 Lithium Chemistry Batteries

The UA and CS may rely on lithium battery energy sources such as lithium batteries, lithium cells, and battery-powered systems or equipment. NAVSEA Instruction 9310.1 (series) is the policy that applies to all DON Commands and activities responsible for the design, acquisition, use, maintenance, storage, transportation, or disposal of lithium batteries. See Chapter 3 for specific details for servicing and handling of lithium batteries.

Lithium Chemistry battery charging, handling and storage is addressed in Chapter 3.

2.4.1.2 Engine Driven Generator(s)

UAS engine driven generator(s) will be addressed for specific UAS T/M/S within the governing IFC.

2.4.1.3 External Power Sources

UAS external power sources will be addressed for specific UAS T/M/S within the governing IFC.

2.4.1.4 Fuel Cells

Fuel cells are an alternative electric source to batteries that generate energy on demand instead of storing it. Fuel cells provide a direct electrical current by utilizing separate fuel and oxidant streams not stored in a case. They can be powered by hydrogen gas or propane gas. UAS fuel cells will be addressed for specific UAS T/M/S within the governing IFC.

2.5 LAUNCH AND RECOVERY SYSTEMS

UAS launch, recovery and ground support equipment (GSE) will be addressed for specific UAS T/M/S within the governing IFC.

2.6 PAYLOADS

UAS payloads will be addressed for specific UAS T/M/S within the governing IFC.

2.7 LASER REQUIREMENTS

OPNAVINST 5100.27 (series) outline mandatory requirements for all Navy and Marine Corps activities. It applies to the design, use, and disposal of all equipment and systems capable of producing laser radiation, including laser fiber optics and system support equipment. Directed energy weapons that emit laser radiation and other high-energy laser systems are subject to the above instruction and limitations listed in Paragraph 9.5.

All laser operations shall be reviewed and approved via the Navy Laser Safety Review board (LSRB) and will be addressed for specific UAS T/M/S within the governing IFC.

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CHAPTER 3

Service and Handling

DAAs should ensure compliance with their Lithium Battery Safety Site Certification issued by NAVSEA under the authority of NAVSEAINST 9310.1 (series). The hazardous information in this chapter is provided for general operator awareness and for units that do not have a NAVSEA-issued Lithium Battery Safety Site Certification. Refer to the applicable OEM operator manual or maintenance instructions for platform specific approved servicing, handling, assembly and operating procedures.

3.1 LITHIUM BATTERY USAGE, CHARGING, HANDLING AND STORAGE

The term "lithium battery" used in this manual includes lithium batteries, lithium cells, and lithium battery-powered systems or equipment. All Lithium Chemistry Batteries utilized in the UAS shall have a Lithium Battery Safety Certification prior to embarkation on a naval facility or ship. This includes all batteries utilized in the UA (power and propulsion or payloads), Control Station (CS), Hand Controllers, Launchers, emergency power supplies etc. Consult NAVSEA S9310-AQ-SAF-010 Technical Manual for Navy Lithium Battery Safety Program Responsibilities and Procedures.

WARNING

Lithium chemistry batteries (ruggedized or non-ruggedized) have the potential to release vapor clouds of chemically active toxic, flammable, or corrosive materials which may cause injury to personnel, damage to equipment, and/or loss of UA.

Note

Flight Clearance approval does not imply, nor satisfy, Lithium Battery Safety Certification Compliance.

3.1.1 Facilities and Installations Requirements

The NAVSEA S9310-AQ-SAF-10 Technical Manual for Batteries, Navy Lithium Safety Program applies to all Navy and Marine Corps activities and all lithium battery powered devices intended for use or transportation on Navy facilities, submarines, ships, vessels and aircraft. Prior to bringing lithium batteries onto DON Installations, personnel must consult with installation safety officers and fire department services. Consultation is required to establish and/or conform to local installation ordnance and safety procedures for lithium battery operations. Emergency Responders should be provided battery specific emergency response guidance (Safety Data Sheets). Lithium battery use, maintenance, and storage shall be IAW the site Hazardous Communication Plan (HAZCOM). Contact the site safety officer and/or the hazardous material representative for specific local requirements. Local SOPs should address the following:

1. Access to each storage and use area.
2. Locations of emergency equipment.
3. Location where established lithium battery liaison will meet emergency responders.
4. Facility evacuation meeting point location.
5. The general purpose of other areas within the building.
6. Location of all above-ground and underground hazards.

7. The hazard classes in each area.
8. Emergency exit locations.

Approved locations shall be pre-established for safe lithium battery storage and charging as approved by installation and IAW this safety plan and the site HAZCOM plan.

Facilities where lithium batteries are handled and charged should consider the best practices listed below.

1. Charging rooms constructed of fireproof material such as cinder block are preferred. The use of a dedicated MILVAN with adequate climate control for charging is another alternative. Charging room temperature shall be maintained IAW battery/UAS manufacturer recommendations.
2. Isolate charging areas from storage areas. Compartmentalization or distribution strategies may be appropriate for minimizing the hazard.
3. Isolation of heating, ventilation, and air conditioning system air from adjacent work areas is preferred. Emergency ventilation to dump smoke and fumes in conjunction with fire suppression system is desirable.
4. Establish a clear exit path from the work and charge stations.
5. Ensure access to an emergency hand pull alarm.
6. An automatic sprinkler system, actuated by smoke and/or flame is preferred.

Lithium Battery mishap reporting procedures will be established by the ARC with both installation personnel, and the Navy Lithium Battery Safety Program (LBSP) Technical Agent(s).

3.1.2 Transportation

Prior to transporting lithium chemistry batteries, inspect each battery pack and verify the lithium batteries charged state is IAW the battery/UAS user/operator manuals. Doing so ensures that the batteries are stable enough to transport.

If the batteries are stable to transport, protect output terminals, pins and connectors from contact with conductive surfaces and/or personnel in such as manner as to prevent electric shock and/or short circuits. Individually secure batteries in flame retardant pouches. Transport batteries in a sealed metal container to prevent damage from a drop or puncture, and to mitigate fire risk.

NAVSEA S9310-AQ-SAF-010 provides specific transportation regulations depending upon the chosen means of transportation.

3.1.3 Charging

Thoroughly inspect batteries for apparent damage prior to charging. Batteries that appear to be compromised or exhibit unusual behavior shall not be charged, and shall be disposed of IAW manufacturer recommendations and local installation HAZCOM plan. Contact the site hazardous material representative for specific battery disposal instructions.

Operators should be briefed on lithium-ion battery safety hazards and should understand the basic electrical interface between the battery and the charger to which it is connected and how to isolate the battery accordingly.

Lithium chemistry batteries shall be charged IAW manufacturer's recommendations. Only manufacturer-approved chargers shall be used to recharge batteries. Desired features and fail-safes for chargers include polarity mismatch, current limiting and cell balancing. Chargers specifically designed for lithium batteries shall be used. Batteries shall not be left unattended during charging and will be placed in a flame retardant pouch to minimize fire risk. When batteries are removed from a system, insulate all exposed terminals to prevent short circuits.

Battery state of charge (SOC) should be reduced to a storage or long-term maintenance level when not intended to be used within 30 days. Battery and charger manufacturer instructions/recommendations for long duration storage shall be followed.

If a unit has not received a NAVSEA-issued Lithium Battery Safety Site Certification, charging locations inside of facilities should meet the following minimum standards, to include:

1. Charging should not occur in office areas.
2. Charging locations should be isolated from storage areas. Compartmentalization or distribution strategies may be appropriate for minimizing the hazard when charging multiple batteries. A minimum of a 24-inch gap for batteries larger than 300 Wh should be considered where feasible. Barrier methods may allow reduction of minimum separation distances.
3. Charging locations should have adequate climate control to protect batteries from temperature extremes (<32 °F, >120 °F).
4. Charging locations should be clean, well-organized areas, and void of excessive combustibles, including other energy storage devices (batteries).
5. Charging locations should have water or other aqueous agents available to suppress a fire.
6. Charging stations should be located a minimum of 5 feet away from combustible materials.
7. Charging stations should be an appropriate operating distance from valuable equipment in case of fire.
8. An emergency hand pull alarm should be easily accessible (communications equipment meets this requirement [e.g., cell phone, two-way radio, etc.]) in the event of a battery failure.
9. A clear exit path should be established from the work and charging location.
10. Impact to co-located operations should be considered.
11. Charging area should have a visible sign indicating the chemistry, the specific hazards, the electrical power shut-offs, primary and secondary points of contacts, as well emergency response notification procedures.
12. The local SOP and emergency response SOP should be on location and supplement this chapter as a supporting reference.

3.1.4 Storage

When not in use, lithium batteries shall be removed from the UAS and should be stored in flammable cabinets designed to meet OSHA and NFPA standards in flammable cabinets of appropriate size, per Figure 3-1 within a temperature-controlled environment as approved by the local installation. Batteries shall not be stacked or packed tightly together and shall not rest directly on metal surfaces. Instead, battery packs shall be placed on ceramic tiles or inside a fire retardant pouch within the established flammable storage container. Storage should ONLY include lithium batteries, no mixed storage with HAZMAT is allowed. No combustible materials should be within 5 feet of the flame cabinet. Terminals should be isolated from short circuit potential against metal cabinets. Cabinet should be labeled as Class 9 Lithium-ion Battery Storage and include an inventory.

Figure 3-1. Flammable Cabinet Storage Capacity

Flammable Cabinet Capacity (gal)	Maximum Energy Content Stored (kWh)
4	1
12	3
30	7
45	10
60	10

CAUTION

If a thermal runaway event occurs within a cabinet, there is the possibility that all contents will be compromised. It is recommended to consider compartmentalization of assets across multiple containers.

While flammable storage lockers are required for long term storage, other metal containers and ammo cans are acceptable for short durations. A minimum standoff distance of 5 feet is required from combustible material and any adjacent cabinet/container. Material is prohibited on top of the cabinet/locker/container. If the battery Watt-hour rating is not printed on the battery, it can be calculated by multiplying the nominal voltage and amp-hour capacity. Metal cabinets, lockers, and containers shall be marked with hazard class 9 placards.

Lithium battery charging, handling, and storage procedures shall be IAW with a Lithium Battery Safety Certification, appropriate UAS T/M/S OEM manual and/or command/operating local procedures or SOPs.

3.1.5 Operational Use

3.1.5.1 Preflight

Lithium chemistry batteries shall be thoroughly inspected for any damage prior to being installed on the UAS for flight. Do not install if the battery has been compromised. Dispose damaged batteries IAW manufacturer's recommendation(s) and local installation Hazard Communications (HAZCOM) plan procedures.

Lithium batteries shall be installed in the UAS IAW the UAS manufacturer's instructions. Batteries shall be kept isolated from heat sources and operated IAW manufacturer's limitations. Operating the battery at temperatures greater than manufacturer's limits may cause cells to become unstable and present an increased risk of ignition. Batteries shall not be located/stored near moving components that may cause physical damage.

3.1.5.2 Flight

Operating lithium chemistry batteries in environments exceeding manufacturer's specified limits shall be avoided.

3.1.5.3 Postflight

After a flight has concluded, lithium chemistry batteries shall be removed and placed in an established location away from direct sunlight. Carefully inspect the battery for damage, overheating, swelling, or leakage before transportation and storage. Charging and storage procedures shall be followed.

3.1.6 Safety

3.1.6.1 Fire

In the event of a fire, a constant source of water or other aqueous agents should be used to provide cooling to the surrounding lithium cells, and to direct and suppress the smoke cloud until the battery fire has become extinguished. Report mishaps IAW local installation ordnance procedures, and UAS ARC requirements.

3.1.6.2 Freshwater Exposure

Unless otherwise specified in the operator's manual, if the lithium chemistry battery comes in contact with water, immediately dry the battery using a clean towel. Store the battery in a fire resistant container, away from flammable substances, for a minimum of 24 hours as a safety precaution. Perform a thorough inspection of the battery for any apparent damage. Dispose if damage is apparent.

3.1.6.3 Saltwater Exposure

Saltwater exposure must be handled differently than freshwater exposure. Unless otherwise specified in the operator's manual, lithium batteries that come in contact with saltwater should be disposed of. Saltwater has the potential to form an electrical path and may ignite the battery when not handled properly. This unsafe condition

may result in a delayed response, and therefore can result in an unexpected fire at the disposal site. If a Lithium chemistry battery comes into contact with saltwater, rinse the battery with distilled or deionized water followed by a wipe down with a clean towel. Store the battery in a fire resistant container, away from flammable substances, for a minimum of 24 hours as a safety precaution. In all cases dispose after 24 hours.

WARNING

Lithium batteries immersed in water may outgas, resulting in overheating and/or fire causing damage to UA and/or injury to personnel.

3.1.6.4 Crash Procedures

Lithium batteries involved in a crash shall be handled with extreme caution. Although it may appear that no physical damage has occurred during a crash, lithium batteries can have a delayed chemical reaction. Lithium batteries shall be placed in a fire proof location and observed for safety reasons. When practical, the battery shall be left in the safe location for a minimum of 24 hours. Perform a thorough inspection of the battery for any apparent damage. Dispose if damage has occurred. Report mishaps IAW local installation ordnance procedures, and UAS ARC requirements.

3.1.6.5 Electrolyte Contact Exposure

If electrolytes in the cells should come in contact with skin or eyes, follow the exposure instructions located in the battery's Safety Data Sheet (SDS). Immediately seek medical attention. Report exposure/mishap IAW with local installation procedures and ARC guidance.

3.1.6.6 Disposal

Disposal of lithium batteries shall be conducted in accordance with S9310-AQ-SAF-010 rev 3 CHAPTER 11 and local Installation HAZCOM procedures.

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CHAPTER 4

Operating Limitations

4.1 GENERAL

Unless otherwise specified in the governing IFC, the operating limitations in this chapter apply. This chapter covers important operating limitations and restrictions to be observed during ground and flight operations. Limitations are the direct result of UA design and operating experience. Compliance with these limitations and restrictions will permit safe and effective employment of the UA.

WARNING

This manual bases its launch, recovery, and flight limitations on source data that has not been validated by NAVAIR. Flight characteristics and performance of the UAS have not been independently assessed by NAVAIR or verified against established airworthiness standards. Loss of UA control resulting in loss of UA may occur while operating within the Chapter 4 usage envelope.

4.2 UA GROSS WEIGHT LIMITATION

The maximum gross weight for takeoff of Group 1 UA shall not exceed 20 lbs.

The maximum gross weight for takeoff of Group 2 UA shall not exceed 55 lbs.

The maximum gross weight for tethered UAs includes the weight of the tether as payed out.

4.3 ALTITUDE LIMITATIONS

Normal operating altitudes for Group 1 and 2 UAS can be found in Appendix C. Specific altitude limitations shall be specified in the governing IFC, applicable DON DAA/FAA COA, or special use airspace (SUA) management directives.

4.4 WIND LIMITATIONS

Wind limitations may apply for winds from any direction and include steady state and gusts. Gust are considered any wind variations above the measured sustained value. For launch and recovery operations from a moving platform/ship relative wind (vector sum of moving platform/ship speed and true wind) shall be used. During flight, maximum winds shall not exceed UA maximum allowable airspeed.

Unless otherwise specified in the governing IFC, the following limitations apply. For additional shipboard operations, refer to Chapter 8:

1. The maximum winds (including gusts) during takeoff, launch, landing, and recovery operations shall not exceed 30 kts.
2. The maximum gusts during takeoff, launch, landing, and recovery operations shall not exceed 10 kts for fixed-wing UAS.
3. The maximum gusts during takeoff, launch, landing, and recovery operations shall not exceed 5 kts for multi-rotor and SMR UAS.

4. The maximum crosswind component for fixed-wing or SMR UAS during takeoff, launch, landing, and recovery operations shall not exceed 10 kts, including the gust component.

WARNING

Fixed-wing or SMR UAS takeoff, launch, landing, and recovery operations with a tailwind may result in loss of the UA.

4.5 WEATHER

Unless otherwise specified by the governing IFC, the following weather limitations apply:

1. Visual meteorological conditions (VMC) operations only.
2. UAS operations within 20 NM of thunderstorms or observed lightning is prohibited.
3. Flight operations in forecast or observed icing conditions is prohibited.

WARNING

Environmental qualification of UAS covered under this manual has not been conducted. Flight operations in rain, icing, or at extreme temperatures may result in loss of UA or damage to equipment or structures.

4.6 SAFETY HAZARD KEEP OUT ZONES

Safety hazard keep out zones (SHKOZs) are the immediate areas surrounding the launch and recovery of the UA. A SHKOZ will be defined for essential and non-essential personnel. Unless otherwise specified in the governing IFC, the following SHKOZs apply.

Specific T/M/S UAS may have reduced or zero SHKOZs due to their extremely lightweight nature and associated reduced likelihood of causing injury to personnel or property.

4.6.1 SHKOZs For Flight

Minimum 500 feet lateral separation (Figure 4-1) from all non-essential personnel unless:

1. Barriers or structures are present that protect non-essential personnel from the UA and/or debris in the event of a mishap, or the AVO has made an ORM Assessment and determined the operation will not create unnecessary risk of injury to non-essential personnel.
2. Minimum 500 ft. lateral separation from all vessels, vehicles and structures unless the AVO has made an ORM assessment and determined the operation will not create unnecessary risk of damage to vessels, vehicles or structures.

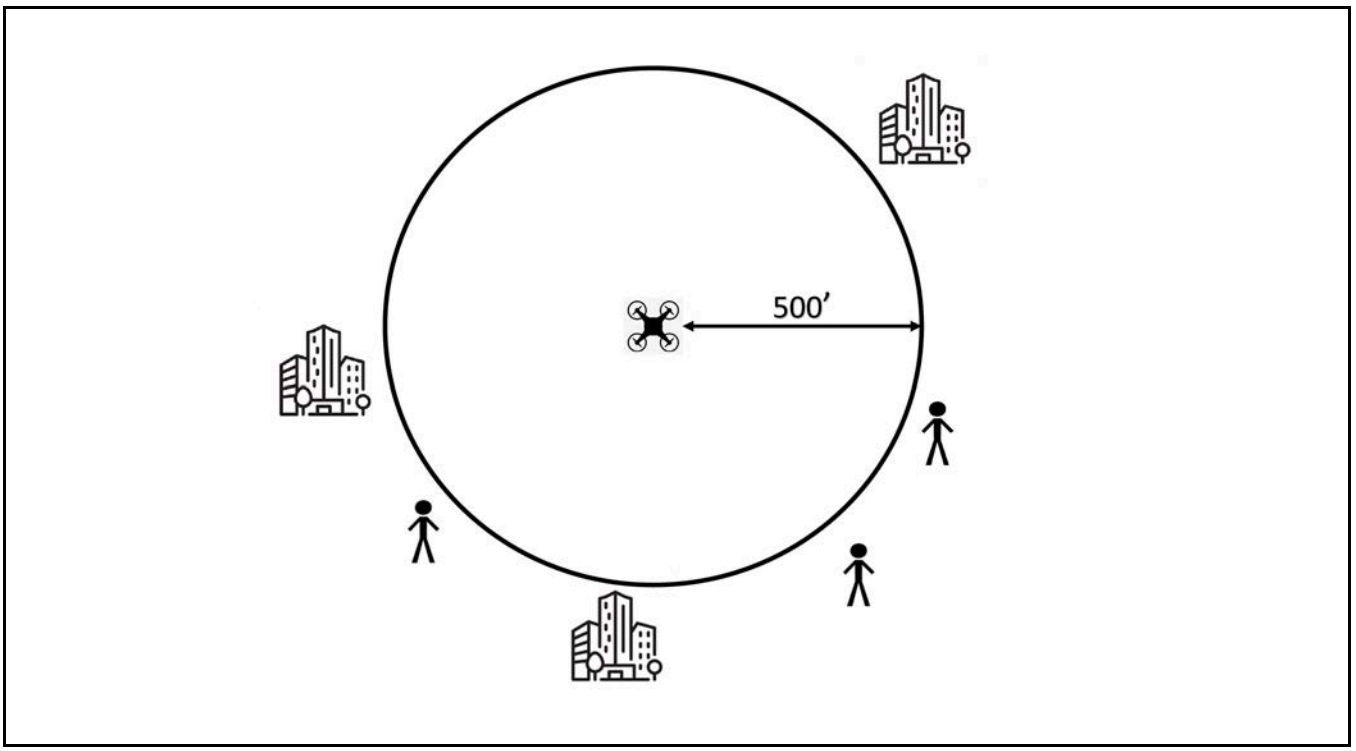
4.6.2 SHKOZs For Launch, Recovery and Ground Operations

For launch and recovery, SHKOZs differ for each type of UAS. See Paragraph 7.3 for Personnel Protective Equipment (PPE) requirements and Hand Launch and Recovery Procedures for Group 1 UAS.

Note

- UAS capable of vertical takeoff and landing and wing-born flight shall use Multi-rotor UAS SHKOZs during launch and recovery.
- Rotor downwash is created by the rotor system of all rotorcraft UAS. Special care should be taken to ensure safety of personnel and equipment during launch and recovery of VTOL UAS.

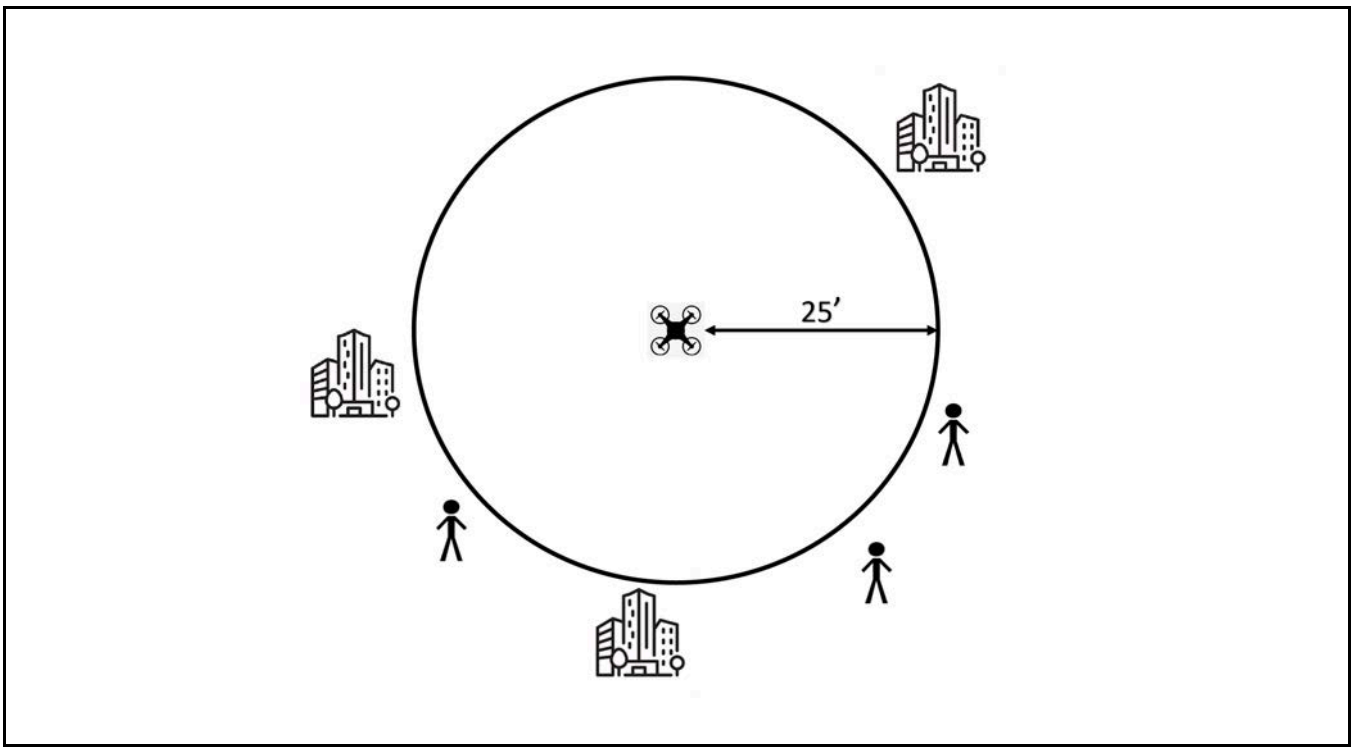
Figure 4-1. SHKOZs For Flight



4.6.2.1 Multi-rotor UAS

1. Launch and Recovery of Group 1 Multi-rotor UA (Figure 4-2):
   a. Non-essential personnel prohibited within a 25 ft. radius exclusion circle centered on the air vehicle while it is below 50 ft. AGL.
   b. Essential personnel prohibited within a 10 ft. radius exclusion circle centered on the air vehicle while it is below 50 ft. AGL, unless PPE is worn.
   c. Essential personnel shall maintain visual contact with the UA at all times while within the 25 ft. radius exclusion circle.
2. Launch and recovery of Group 2 Multi-rotor UA:
   a. Non-essential personnel prohibited within a 75 ft. radius exclusion circle centered on the air vehicle while it is below 50 ft. AGL.
   b. Essential personnel prohibited within a 25 ft. radius exclusion circle centered on the air vehicle while it is below 50 ft. AGL, unless barriers or structures are present that protect essential personnel from the UA and/or debris in the event of a mishap.
   c. Essential personnel shall maintain visual contact with the UA at all times while within the 75 ft. radius exclusion circle.
   d. Hand launch/recovery is prohibited.

Figure 4-2. Group 1 Multi-rotor UA SHKOZ for Launch and Recovery.



4.6.2.2 Fixed Wing UAS

1. Group 1 Fixed Wing UAs:

   a. Takeoff/launch: except while hand-launching UAS IAW OEM approved procedures, essential personnel shall maintain a minimum lateral stand-off distance of 30 ft. from the runway centerline or takeoff/launch path, and no closer than the runway edge, unless barriers or structures are present that protect essential personnel from the UA and/or debris in the event of a mishap.

   b. Except while hand-launching UAS IAW OEM approved procedures, essential personnel shall maintain minimum lateral stand-off distance of 30 ft. from the UA flight path at altitudes less than 50 ft. above ground level, unless barriers or structures are present that protect essential personnel from the UA and/or debris in the event of a mishap.

   c. When hand-launching UAS IAW OEM approved procedures, a launch safety zone of a minimum of 500 ft. downrange by 60 ft. wide, centered on the flight path, shall be cleared of personnel prior to and during launch.

   d. Takeoff/launch: essential personnel less than 65 ft. from the runway centerline or takeoff/launch path, and forward of the aircraft (as measured along the runway centerline or takeoff path) shall be provisioned with an obstacle or movable protective barrier located in close proximity or inside a structure that protects essential personnel from the UA or debris in the event of a mishap.

   e. Landing/recovery: essential personnel less than 65 ft. from the runway centerline or landing/recovery path shall be provisioned with an obstacle or movable protective barrier located in close proximity or inside a structure that protects essential personnel from the air vehicle or debris in the event of a mishap.

   f. Non-essential personnel shall maintain a minimum lateral stand-off distance of 65 ft. from runway centerline or takeoff/launch/landing/recovery path, and no closer than the runway edge (as measured from the aircraft or runway centerline).

g. Non-essential personnel shall maintain a minimum lateral stand-off distance of 65 ft. from the aircraft/runway centerline, and UA flight path while at altitudes less than 50 ft. above the ground.

h. For landing/recovery, safety zones extend the length of the active runway or landing path.

i. For takeoff/launch, the safety zone begins at the UA and extends the length of the active runway or takeoff/launch path.

j. Hand recovery is prohibited.

2. Group 2 Fixed Wing UAs:

a. Takeoff/launch: essential personnel shall maintain a minimum lateral standoff distance of 50 ft. from the runway centerline or takeoff/launch path, and no closer than the runway edge unless barriers or structures are present that protect essential personnel from the air vehicle and/or debris in the event of a mishap.

b. Essential personnel shall maintain minimum lateral standoff distance of 50 ft. from the air vehicle flight path at altitudes less than 50 ft. above ground level, unless barriers or structures are present that protect essential personnel from the UA and/or debris in the event of a mishap.

c. Takeoff/launch: essential personnel less than 100 ft. from the runway centerline or takeoff path, and forward of the aircraft along the runway centerline or takeoff/landing path shall be provisioned with an obstacle or movable protective barrier located in close proximity or inside a structure that protects essential personnel from the UA or debris in the event of a mishap.

d. Landing/recovery: essential personnel less than 100 ft. from the runway centerline or landing/recovery path shall be provisioned with an obstacle or movable protective barrier located in close proximity or inside a structure that protects essential personnel from the air vehicle or debris in the event of a mishap.

e. Non-essential personnel shall maintain a minimum lateral standoff distance of 100 ft. from runway centerline or takeoff/launch/landing/recovery path, and no closer than the runway edge (as measured from the aircraft or runway centerline).

f. Non-essential personnel shall maintain a minimum lateral standoff distance of 100 ft. from the aircraft/runway centerline, and UA flight path while at altitudes less than 50 ft. above the ground.

g. For landing/recovery, safety zones extend the length of the active runway or landing/recovery path.

h. For takeoff/launch, the safety zone begins at the UA and extends the length of the active runway or takeoff/launch path.

i. Hand launch/recovery is prohibited, unless authorized by governing IFC.

4.6.2.3 Single Main Rotor UAS

Single Main Rotor (SMR) UAS SHKOZs are driven primarily by the worst case expected blade throw distance. Blade throw occurs when the blade retention mechanism fails while rotors are turning. The distances below are based upon the general characteristics of blades typically found on SMR UAS. A ballistic calculation was performed for a typical blade based on an assumed throw velocity (angular velocity) from a height of 50 ft. AGL.

Reduced blade throw distances, and therefore reduced SHKOZs, may be specified within the flight clearance for specific SMR UAS where actual blade throw test results are provided to NAVAIR.

1. Non-essential personnel prohibited within a 200 ft. radius exclusion circle centered on the air vehicle unless located inside a structure that protects non-essential personnel from the UA or debris is the event of a mishap.

2. Essential personnel within the 200 ft. radius exclusion circle shall be provisioned with an obstacle or protective barrier located in close proximity or inside a structure that protects essential personnel from the UA or debris in the event of a mishap.

3. Essential personnel shall maintain visual contact with the UA at all times while within the 200 ft. exclusion circle

4. Hand launch/recovery: prohibited, unless authorized by the IFC.

4.6.2.4 Tethered UAS

Tethered UAS SHKOZ are identical to the type of UA being tethered. Oftentimes, tethered UAS are either of the Multi-rotor or SMR type.

4.6.2.5 Armed UAS

Armed UAS shall be addressed within specific Flight Clearance and other appropriate safety documentation. For additional guidance, contact the appropriate program office.

4.7 HERO, HERF AND HERP STANDOFF DISTANCES

Unless otherwise specified in the governing IFC, for UAS transmitters on Air Vehicle and Control Station, if the transmitter power is less than 8W and the antenna gain is less than 12dBi and the operating frequency is greater than 1600 MHz the following HERO (Hazards of Electromagnetic Radiation to Ordnance), HERF, (Hazards of Electromagnetic Radiation to Fuel), and HERP, (Hazards of Electromagnetic Radiation to Personnel), Standoff Distances apply:

1. HERO standoff is 10 FT (3 M).
2. HERF standoff for MOGAS or AVGAS is 50 FT (15 M). For JP-5 or JP-8 and marine diesel fuels, there is no risk.
3. HERP standoff is 3 FT (0.9 M).

The following Air Vehicle and Control Station transmit systems have no HERP standoff distance. ARCs shall ensure all of the following requirements are met prior to use when operating UAS without HERP standoffs.

1. Transmit systems which transmit in a frequency band greater than 900MHz with less than 5W transmit power and with an antenna with no more than 0dBi gain.
2. Unmodified, FCC authorized COTS handheld devices such as cell phones, laptops, tablet devices and handheld controllers.

System operation in the presence of flammable vapors is prohibited.

Note

Considerations for limitations and/or standoff limitations specific to UAS may be required to address specific HERF, HERO and HERP safe standoff distances.

4.7.1 Fuel Leak Checks

UAS utilizing liquid or gaseous fuels shall be checked for fuel leaks prior to power up, especially in areas near batteries.

WARNING

- Undetected fuel leaks may result in ignition of fuel vapors under certain conditions causing damage to or loss of UA or injury to personnel.
- The UAS covered under this manual have not undergone safety of flight explosive atmosphere testing. A serious fire or explosion may occur if the UAS is powered while flammable vapors are present during ground or flight operations, which may cause damage to or loss of UA and injury or death to personnel.

4.8 LASER EYE PROTECTION AND HAZARD DISTANCES

UAS equipped with lasers will have Nominal Ocular Hazard Distances (NOHDs), diffused NOHDs, and Nominal Skin Hazard Distance (NSHDs) for personnel defined by the authorizing LSRB package and documented in the specific UAS T/M/S governing flight clearance.

Laser eye protection with the appropriate optical density (OD) and wavelength for protection against direct illumination or reflections shall be documented in the specific UAS T/M/S governing flight clearance. See Chapter 9 for Laser Operations.

4.9 RADIO FREQUENCY (RF) STAND OFF DISTANCES

Unless otherwise specified in the governing IFC, operations near antennas of other system radio transmitters and radars, especially those which emit high levels of power:

1. Maintain a slant-range standoff distance of 2 NM (3,700 M) from operating main beams of very-high-powered air-search and fire-control radars, and satellite communications (SATCOM) uplink terminals, especially those which emit high levels of power (greater than 1 KW and antenna gains greater than 20 DBI).
2. Maintain a slant range standoff distance of 100 ft (30 M) from operating HF/VHF/UHF communications transmitters (greater than 300 W) with low gain antennas.
3. During surface combatant shipboard ops, conduct all takeoff/launch/recoveries from fan tail, and remain below main beams of directional antennas by flying below a maximum height above water of 60 ft. until reaching a standoff distance of 2 NM; or, a distance of 3 NM for CG-47, DDG-51, DDG-1000, and CVN-78 class ships. Otherwise, for ship close-in flight, secure all HF radio and radar transmissions. Avoid SATCOM uplink main beams.

4.10 AEROBATIC FLIGHT MANEUVERS

Outdoor aerobatic flight maneuvers shall be limited to AVO training conducted in US Restricted or Warning Areas, or IAW an airspace access authorization (e.g., FAA COA or DON AAA, etc.).

4.11 PUBLIC FLIGHT DEMONSTRATIONS

Flight of UAS during public flight demonstrations except for static display is prohibited unless expressly authorized by COMNAVAIRFOR or Commandant of the Marine Corps. COMNAVAIRSYSCOM is delegated the authority to approve demonstrations of unmanned aircraft operating under COMNAVAIRSYSCOM control.

All requests for events that will be open to the general public require a U. S. Navy Office of Information (CHINFO) approval number. Requests involving media participation should be properly vetted through the command or program office public affairs officer to the appropriate CHINFO points of contact.

Note

- Flight demonstrations outside of special use airspace may require coordination with the FAA.
- Technology demonstrations and operational experiments are generally not considered public flight demonstrations unless the event has wide public interest outside the scientific and/or operational community.

4.12 DISPERSAL OF PESTICIDES

Utilization of DON UAS to disperse Pesticides is prohibited.

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CHAPTER 5

Indoctrination

5.1 GENERAL

This chapter describes the minimum training and refresher training required to achieve and maintain qualifications in key UAS operating billets/positions.

5.2 TRAINING SYLLABUS

The ARC is responsible for following ACC/DAA or other higher echelon training and qualification requirements and establishing local UAS crew training and qualification requirements. An example of other higher echelon training is the Marine Corp Training and Readiness manual.

5.2.1 Unit Training

After completion of the appropriate initial training syllabus at an approved training and logistics support activity (TALSA) schoolhouse, other approved vendor provided training, or locally approved syllabus the trainee will complete tactical and/or operational training at the local command IAW the current training manual and local directives. Commands may promulgate additional training depending on expected employment, but should in all cases include UAS-specific crewmember skills and mission training.

Safety reporting and ORM training. AVO training must include both safety management and reporting and ORM requirements stipulated in OPNAV M-3750.6 and OPNAVINST 3500.39, respectively.

Operating area familiarization. Regardless of the intended airspace environment, AVOs must receive operating area familiarization training prior to flight operations. This training should be coordinated with the appropriate operating area authority or using agency.

ARCs shall ensure UAS Crewmember (UASC) are familiar with the guidance regarding the domestic use of UAS as outlined in SECNAVINST 3700.2.

5.2.2 Basic UAS Qualification (BUQ) Levels

Detailed qualification requirements for UASC classifications, initially developed in CJCSI 3255.01, are listed in Appendix A. These BUQ levels are presented as minimum training standards that are to be utilized when developing requirements for specific UASCs. The diversity of UAS designs, missions, and vehicle technologies makes it impossible to prescribe a standard set of training requirements applicable to all crewmembers. For example, highly automated systems may not include manual controls, but instead use keyboard or “point” and click” entry methods. In such cases, training certification requirements for navigation should reflect the use of global positioning system (GPS) skills. Therefore, not all knowledge, skills, abilities and training tasks listed in the BUQ levels will be applicable to all UASCs and UAS.

An adequate level of Crew Resource Management (CRM) training, as determined by the service or if not specified by service then by the ARC, shall be provided to all UAS crewmembers. See Appendix I for CRM information.

Additional information on BUQ qualifications can be found in Appendix A of this manual, CNAF M-3710.7 and CJCSI 3255.01.

5.3 UAS CREW CLASSIFICATIONS, DESIGNATION OF UAS CREW PERSONNEL AND DESIGNATING AUTHORITY

5.3.1 Designation

ARCs are authorized to establish UAS crewmember (UASC) positions appropriate for specific UAS being operated and the missions being performed. ARCs approve UASC qualifications and certifications after ensuring each UASC has completed the requisite training for the applicable crewmember classification. ARCs must issue a written designation letter to each qualified individual upon their designation. Copies of each designation letter must be retained in the individual crewmember's training jacket. Prior to authorizing a UAS flight, unit commanders shall ensure that person(s) designated to perform UASC duties are, in all respects, qualified to control the specific UAS T/M/S and that UAS crewmember currency requirements have been met. In accordance with NAVAIRINST 3710.1 (series), contractor UAS crew should be approved by a GFR prior to conducting operations on government aircraft if the GFRC is included in the contract.

5.3.2 General UASC Positions

The following terms are generally recognized throughout the Group 1 and 2 UAS community. Other terms may be authorized for use by the DAA, ARC or IAW higher echelon guidance (e.g., NAVMC 3500.107 Small Unmanned Aircraft Systems Training and Readiness Manual).

5.3.2.1 UAS Commander (UAC)

A naval UAS shall be flown under the command of a UAC so designated by the ARC or delegated authority. The UAC shall be responsible for the safe, orderly flight as related to the positive control of one or more UAs. The UAC may direct the actions of an AVO. The positional authority of the UAC is analogous to that of an "Aircraft Commander" of a manned aircraft, yet the UAC need not be a winged aviator nor an officer. UAC shall be designated AVOs but not all AVOs are necessarily qualified UAC. As with manned aircraft, a single individual may act as both UAC and perform other UASC duties.

5.3.2.2 Air Vehicle Operator (AVO)

The person who has been trained, qualified and properly designated as an AVO, is physically located at a UAS CS, and in positive control of the UA.

5.3.2.3 Safety Observer

The Safety Observer (SO) assists the AVO ensuring the UA maintains safe distances from persons, equipment, infrastructure, and other aircraft in proximity to the launch and recovery site. A Safety Observer may be required by the IFC, ARC, and/or airspace approval authority. If qualified, the Safety Observer may also serve as a Visual Observer (see Paragraph 5.3.2.4). Where authorized, the UAC or AVO may simultaneously perform Safety Observer functions.

5.3.2.4 Visual Observer (VO)

The Visual Observer (airborne or surface-based) assists the AVO in performing see and avoid responsibilities required by an airspace approval authority. This requirement may be established in an airspace access authorization (e.g., FAA COA, DON AAA, etc.) The Visual Observer supports Visual Line of Sight (VLOS) operations (see Paragraph 7.1.3) while maintaining effective communication with AVO.

The AVO shall ensure mission planning addresses the potential need for additional visual observers to maintain VLOS. If qualified, the Visual Observer may also serve as a Safety Observer (see Paragraph 5.3.2.3). Where authorized, the UAC or AVO may simultaneously perform Visual Observer functions.

Note

Several factors can make it difficult to maintain VLOS, including the operational environment, the size of the UA, and operating altitude.

5.3.2.5 UAS Mission Commander (UMC)

The UMC shall be responsible for all phases of the assigned mission except those aspects of safety of flight that are related to the control of the UA and are within the prerogative of the UAC. The UMC may exercise command over a single or multiple UAS. The UMC shall be properly qualified and designated, but need not be a winged aviator nor a commissioned officer. Specific UMC qualification requirements shall be defined by the ARC. The UMC shall direct a coordinated plan of action and be responsible for effectiveness of the mission.

5.3.2.6 Mission Payload Operator (MPO)

Mission Payload Operator (MPO). The person who has been trained, qualified, and properly designated to control the payload of a UAS. The payload may include a sensor package and/or a weapon system on the assigned UA(s).

5.3.3 UAS AVO Qualification Standards

Minimum BUQ level training for AVO qualifications must be met prior to Group 1 and 2 UAS operations inside of national class D, E or G airspace, U.S. special use airspace (e.g., military operating areas, prohibited areas, restricted areas, warning areas), joint operating areas, combat or contingency airspace, or international airspace. Additional AVO qualifications are required to conduct operations inside national class A, B or C airspace and under IFR.

See Appendix A BUQ Levels for additional information.

5.3.3.1 Airspace Operations Procedures Training

AVOs shall be trained in procedures applicable to the airspace in which they will operate. See Appendix B for more information.

5.4 AEROMEDICAL REQUIREMENTS

In consideration of FAR, Part 107, personnel that operate Group 1 and 2 UAS are subject to the following medical requirements: No person may manipulate the flight controls of a small unmanned aircraft system or act as a remote pilot in command, visual observer, or direct participant in the operation of the small unmanned aircraft if he or she knows or has reason to know that he or she has a physical or mental condition that would interfere with the safe operation of the small unmanned aircraft system.

5.4.1 Human Performance and Aeromedical Qualification for Flight and Flight Support Personnel

5.4.1.1 Flight Time Limits

The ARC must understand the risk factors inherent in flight operations, and should define appropriate unit policies and other countermeasures to assure that flight safety and risk are managed to an acceptable level in support of the assigned mission. Numerous complex factors affect the performance of flight personnel, such as: weather, extremes of temperature, nighttime operations, use of vision imaging systems, mission delays, personal equipment, duration of the duty period, quality and duration of sleep (prior to duty), number of hours flown during the previous several duty periods, time of day relative to the body's internal circadian clock, physical health, additional duties, misuse of alcohol, caffeine, tobacco, or dietary supplements and adequacy of crew rest facilities.

5.4.1.2 Exceeding Established Flight Time Standards

When the tempo of operations requires that individual flight time exceed the established maximum flight time standards, UAS personnel shall be closely monitored and specifically cleared by the unit commander.

5.4.1.3 Pregnancy

Normal uncomplicated pregnancy for female UAS crewmembers is not considered physically disqualifying in itself. Specific duty modifications during the pregnancy, if required, should be managed locally.

5.4.1.4 Immunizations and Injections

Unless experiencing a reaction, UAS crewmembers receiving an immunization or injection may participate in normal UAS operations. Those showing protracted or delayed reaction shall be grounded until cleared by a medical provider.

5.4.1.5 Blood Donation

UASCs who have donated blood may participate in normal UAS operation 24 hours after donating blood, unless experiencing side effects or a reaction. Unit Commanders shall establish guidelines on how often blood may be donated by UASCs without affecting crewmembers readiness.

5.4.1.6 Hypobaric and Hyperbaric Exposure

Restrictions for hypobaric and hyperbaric exposure do not apply to UASCs unless such activity produces side effects that would otherwise impair their ability and/or judgment to conduct normal UAS operations.

5.5 CREW REQUIREMENT

The minimum crew requirement to conduct flight operations is one UAC who is a qualified AVO. The ARC shall assign additional crew required based upon the UAS being flown and the type of operations being conducted.

Considerations shall be given to the following:

1. All instructional flights will be under the supervision of a certified instructor for the crew position receiving instruction.
2. During split site operations a certified AVO shall man the CS whenever the air vehicle may be controlled at that CS.
3. For multiple UA operations at the same location, the ARC should assign a qualified individual to provide overall coordination and deconfliction between UAs.
4. For Swarming Operations, the minimum crew required will be determined by the nature of the swarming operation as defined in the IFC.

5.6 UAS PROFICIENCY REQUIREMENTS

The unit designated training officer shall maintain the UAC/AVO log books and training records, and keep unit commanders informed of the currency of all assigned UASCs.

To ensure that an acceptable level of readiness is maintained to enhance safety, the UAS training officer shall ensure established annual proficiency standards for each T/M/S UAS and specific UASC designation are followed.

CHAPTER 6

Flight Preparation

6.1 MISSION PLANNING DESCRIPTION

Mission planning involves the strategic and tactical aspects of the pending flight. Comprehensive planning requires knowledge of the operational characteristics of the UAS to be employed and its operating environment. The operation of UASs shall be conducted with due consideration of the hazard they present. In planning and conducting flights to, in, and from operating areas, activities operating UASs shall select and adhere to those tracks and altitudes that minimize the possibility of UASs falling into a congested area in the event of an electronic or material malfunction. Whenever practicable, UASs shall be operated at altitudes and on flight paths that minimize danger to other aircraft in flight, and to personnel and property on the surface.

6.1.1 Mission Planning Considerations

Mission planning and flight preparation shall take into account the following considerations, as applicable:

1. Airspace operations.
2. Mission endurance requirements.
3. Fuel range and battery endurance capabilities.
4. Navigation capabilities.
5. Communications capabilities (C2 and Voice).
6. Launch and Recovery profiles/location selection.
7. Search patterns.
8. Detection.
9. Tactics.
10. Night operations.
11. Ship-based operations.
12. Multiple UA operations.
13. Forecast or observed weather conditions to include cloud ceiling, visibility, and winds.
14. Security of the UA and the safe handling of classified material and equipment.
15. Transfer of UAC responsibilities during flight (CS Handoff).
16. Safe-For-Flight box. See Paragraph 7.1.4.
17. Environmental precautions and considerations (Wildlife and RF Emitters).
18. Local course rules.
19. Spectrum authorizations.

6.1.2 Mission Planning Documents

Mission planning is an important part of risk assessment and risk mitigation. Preparation for flight operations is a multi-step process and must be completed before any mission is flown. AVOs shall comply with the guidance in this section and, if practical, prepare a mission plan document that, at a minimum, addresses the following items:

1. Date and times of the flight.
2. Name and contact information of ARC.
3. Primary and secondary objectives (if applicable).
4. Sensor payloads required (if applicable).
5. Crewmembers involved and locations during flight operations.
6. Geographical location of the flight and, if applicable, a map of the area with sufficient detail to assess possible obstacles or hazards (RF emitter locations).
7. Maximum operating altitude.
8. Contact information for local first responders such as fire and rescue or police.
9. Listing of any airports or heliports within 5 nautical miles of the proposed flight area.
10. Contact information for local Air Traffic Control (ATC) facility (if applicable).
11. Copy of the NOTAM for the flight operations (if applicable).
12. Copy of airspace access authorization (e.g., FAA COA, DON AAA, etc.) and/or confirmation from applicable SUA using agency.
13. Approval from the base/facility. Ensure prior coordination with both Air Operations and Physical Security.
14. Forecast or observed weather conditions to include cloud ceiling, visibility, and winds.
15. Spectrum Authorizations.
16. For Contracted Operations, GFR Approvals (if applicable).

Mission planning documents, if required for the assigned mission, shall be kept with the AVO.

6.1.3 Range Operations within Restricted and Warning Areas

Each Range control activity is responsible for the scheduling and controlling sea, land, and airspace within the range.

The Range will ensure that hazard control measures, communication requirements and safety limits are incorporated into the test plan and/or range procedures before approving the test or operation. Range Safety will provide real-time mission safety support. In the event the UA unintentionally departs the UAS operating area or Safe-For-Flight box, range control authority shall be notified immediately and, if required, the aircraft ditched over a pre-selected point. In the event of loss of communications between the AVO and local range control, the AVO shall follow local procedures.

6.1.4 Airspace Operations

Appendix B contains requirements and limitations for operating within specific airspace parameters.

6.1.4.1 Airspace Coordination and Deconfliction

AVOs are responsible for ensuring the airspace in which they are operating is clear of airborne traffic and does not constitute a hazard to other aviation assets including civilian aircraft. Airspace scheduling and deconfliction will be IAW the airspace access authorization (e.g., FAA COA, DON AAA, etc.) and/or applicable SUA using agency procedures. If procedures are not published, AVOs should consult with the local ATC.

6.1.5 Flight Operations

Flight operations are defined anytime the intent or potential for flight exists (high-speed taxi for fixed wing, engagement of rotor system for rotary wing or VTOL aircraft).

6.1.5.1 Operating Limitations

Unless exceptions are provided in the applicable flight clearance, flight operations shall be conducted IAW the most restrictive limitations and procedures of the flight clearance, operator's manuals and checklists, and this document. Units may contact the Class Desk with questions regarding which "most restrictive limitation" applies. The Class Desk may decide to grant relief from a specific COTS flight manual limitation due to differences between the COTS intended use and the military CONOPS/use case. The AVO shall adhere to the above limitations and the following general safety rules:

1. Unmanned aircraft (UA) shall weigh less than 55 lbs.
2. Keep the UA within visual line of sight at all times, unless permitted by airspace access authorization (e.g., FAA COA, DON AAA, etc.) or applicable SUA using agency.
3. Do not exceed maximum altitude limits imposed by the flight clearance, airspace access authorization (e.g., FAA COA, DON AAA, etc.), and/or SUA using agency. Remain clear of surrounding obstacles.
4. Do not exceed maximum airspeed limits imposed by the flight clearance, airspace access authorization (e.g., FAA COA, DON AAA, etc.) and/or SUA using agency.
5. Remain well clear of and do not interfere with manned aircraft operations unless airspace deconfliction procedures have been approved by the airspace coordinating authority.
6. Laser Operations shall be IAW the flight clearance and the applicable unit specific LSRB Approval Letter.

6.1.5.2 Operational Risk Management (ORM)

ORM shall be discussed by all UAS operation participants during preflight brief and incorporated into all flight planning/execution decisions. Identification and assessment of hazards and their associated risks, implementing controls, and supervising operations, is critical to safely executing the UAS mission. Refer to Chapter 14 for more information.

6.1.5.3 Mishap Procedures

Mishap plans shall be established for each operating installation (e.g. range/facility) or as directed by the ARC. Prior to flight, the AVO shall be responsible for familiarity with the mishap plan. A copy of the mishap plan shall be available on site for all flight operations.

6.1.6 Mission Endurance Requirements

Mission endurance is determined by:

1. Fuel load. Mission fuel includes fuel allowances for preflight, launch, climb out, mission flight, and recovery.
2. Battery Reserve. The UA shall have sufficient usable battery charge to complete the planned flight and land before reaching minimum useable battery capacity as defined by OEM or local SOPs.
3. Weather conditions. Extreme weather conditions can adversely affect mission endurance. Conditions that can impact endurance include but are not limited to:
   a. Icing. Airframe icing increases drag and weight and can cause erratic flight and degraded engine performance.
   b. Hot weather. Hot weather raises density altitude (DA). As a result, UA performance can be significantly reduced during hot weather operations.
   c. Thunderstorms. Flight within 20 NM of thunderstorms may interrupt the datalink/GPS system.

6.1.7 Fuel Range and Battery Endurance Capabilities

During mission planning, the following considerations should be given to fuel range and battery endurance:

1. Maximum allowable fuel load as a function of payload weight/MGTOW.
2. Transit time to area(s) of interest. The transit time to the area of interest determines the airspeed required to reach the target. Higher airspeeds reduce the fuel range and endurance capability.
3. Loiter time over targets.
4. Weather conditions and winds. The effect of anticipated ingress/egress winds at altitude shall be accounted for during flight planning. Ingress headwinds may significantly impact arrival time on station and egress headwinds shall be accounted for during bingo fuel calculation.
5. Contingency operations. Secondary mission objectives may be completed in addition to the primary mission objectives. These objectives can impact distances traveled and weather conditions enroute to contingency locations.
6. Air traffic limitations. Air traffic constraints during launch and recovery may require delays or holds.
7. Hub/spoke operations. Handoffs and coordination loiter can require additional flight time and changes in airspeed and altitude, which impact fuel consumption.
8. Capture weight limits. Returning to approach hold orbit with excessive fuel will require spending additional time orbiting to burn down fuel to meet capture energy limit.
9. Environmental factors that could cause planned and unplanned wave-offs and go arounds during recovery.

6.1.8 Frequency Approval

Radio frequency spectrum used by UAS requires frequency approval from Navy and Marine Corps Spectrum Center (NMSC) prior to transmitting. Contact local Spectrum Management Office or NMSC for operation requirements per OPNAVINST 2400.20. For assistance in the spectrum approval process, proponents should direct questions to navyspectrum.fct@navy.mil.

Note

All DoW UAS to include Part-15 compliant systems (UAS considered non-licensed devices by the FCC because of their low power emitters) still require submission of a DD 1494 to NMSC for approval.

6.1.9 Frequency Coordination

The AVO shall coordinate frequency usage IAW local spectrum management procedures and verify via command review the operational requirement and commitment within the mission planned UA operational area.

WARNING

Command and control datalink interference may occur when datalinks are operating within the same frequency bands or hopsets, and are within reception range. Datalink interference may cause loss of the command and control datalink and may result in loss of the UA.

6.1.10 Night Operations

For night operations, UASCs must comply with the Interim Flight Clearance and airspace access authorization (e.g., FAA COA, DON AAA, etc.) and/or applicable SUA using agency procedures.

6.1.11 Ship-Based Operations

Additional considerations for ship-based operations are discussed in Chapter 8.

6.1.12 Multiple UA and Swarming Operations

Refer to Chapter 9 for Multi-Vehicle Operations and Swarming Operations.

6.1.13 Notice to Airmen

AVOs shall check Notice to Airmen (NOTAMs) that may potentially impact safety of flight, to include GPS NOTAMs and temporary flight restrictions.

6.2 MISSION BRIEFING

6.2.1 Preflight Briefing

Planning and flight briefings will be conducted by the AVO or flight leader (UAC/UMC). Briefing is an essential part of conducting UAS operations in a safe and efficient manner. On the day of the flight and prior to the start of the UAS operations, the AVO or UAC/UMC shall brief all flight personnel on the goals, objectives, and the key safety considerations of the planned UAS operation. The intent is to cover all operational aspects of the mission and promote a full understanding among all flight personnel. A briefing guide or syllabus card may be used to conduct the brief and it should be clear, concise, and accurate, allowing input from all crewmembers.

6.2.2 Crew Replacement Briefings

The nature or length of the UAS mission may dictate the requirement to change crew positions during flight. ARCs shall establish procedures for crew replacement/relief to ensure that a qualified UAC is in positive control of the UAS at all times.

Note

Crew position changes during emergencies or aircraft-in-distress situations are discouraged.

UAS crew replacement briefings shall address at a minimum the following information:

1. UAS location, airspeed, altitude, type of airspace, any active airspace restrictions and weather.
2. Flight time remaining in current configuration and operating conditions.
3. Mission considerations.
4. Status of systems including any UAS problems or discrepancies.

6.3 MISSION DEBRIEFING

6.3.1 General Debriefing

The AVO or flight leader (UAC/UMC) shall ensure that a thorough debrief of the mission is conducted to include mission planning, briefing, execution, crew management, and overall mission performance. Also logging or documenting flight time and any maintenance action items. The debrief may help prevent future mistakes and improve future performance.

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CHAPTER 7

Shore-based Procedures

7.1 SHORE-BASED OPERATIONS INTRODUCTION

Most Group 1 and 2 UAS are capable of both Ship and Shore-based operations. This chapter addresses normal UAS operations applicable to shore-based locations, but these principles and procedures may also apply to shipboard operations. Information intended to augment or tailor these normal operations for the shipboard environment is provided in Chapter 8.

7.1.1 Personnel Protective Equipment

Protective eyewear should be considered during launch and recovery and ground operations of UAS. Refer to UAS T/M/S specific OEM and/or Operational organizations SOP for specific requirements.

WARNING

A catastrophic rotor/propeller failure or loss of UA control may result in injury to personnel.

Hearing protection should be considered during launch and recovery and ground operations of UAS. Refer to T/M/S specific OEM and/or Operational organizations SOP for specific requirements.

WARNING

Noise characterization testing may not have been completed on UAS covered under this manual. Prolonged exposure to UA noise at close proximity may contribute to hearing loss.

Note

For hand launched or recovered UAS, consideration shall be given to use of protective gloves, long sleeve jacket, and cranial/helmet with eye protection. Refer to UAS T/M/S specific OEM and/or Operational organizations SOP for specific requirements.

7.1.2 Safety Observer

A Safety Observer shall maintain verbal communication with the AVO and shall maintain visual line of sight contact with the UA during launch and recovery operations as stated below.

1. The Safety Observer shall be capable of initiating a launch abort or wave-off by direct communication with the AVO.
2. The Safety Observer shall assess the vehicle flight path for excessive errors in vehicle tracking or navigation, and if the errors appear to be unreasonably large or growing quickly, the Safety Observer shall initiate a launch abort or wave-off call to the AVO.
3. The Safety Observer shall assess the area around the recovery location to ensure proper airspace deconfliction and that SHKOZs are clear of personnel.

WARNING

Excessive delay initiating a wave-off may result in loss of UA, death, injury, and/or damage to property.

Note

- The Safety Observer should consider the time required to assess a wave-off condition and command a wave-off.
- The effectiveness of a Safety Observer during night recovery operations is very limited and additional conservatism should be used when assessing the need to perform a wave-off during night recovery operations.

7.1.3 Visual Line of Sight (VLOS) Operations

With vision that is unaided by any device other than corrective lenses, the UASC performing see and avoid responsibilities must be able to see the UA throughout the entire flight in order to:

1. Know the unmanned aircraft's location;
2. Determine the unmanned aircraft's attitude, altitude, and direction of flight;
3. Observe the airspace for other air traffic or hazards; and
4. Determine that the UA does not endanger the life or property of another.

CAUTION

The use of binoculars as a situational awareness tool shall not replace the requirement for unaided see and avoid. Binoculars restrict the field of view and may result in complacency if used as the primary means of maintaining visual line of sight.

Note

- The UASC performing VLOS operations may use vision aids such as binoculars momentarily to enhance situational awareness (e.g., to avoid flying over persons or conflicting with other aircraft).
- Several factors can make it difficult to maintain VLOS, including the operational environment, the size of the UA, and operating altitude.

7.1.4 Safe-For-Flight Box

A UAS operating area or Safe-For-Flight Box shall be established within the airspace boundaries that ensures that the UA is contained within the airspace boundaries at all times. When UAS are required to operate in proximity to manned aircraft or when a Safe-For-Flight Box is otherwise impractical, ARCs may approve alternate deconfliction measures with concurrence of the airspace control authority. The below points of concern should be considered when constructing the UAS operating areas or safe-for-flight box:

1. Above ground level operating altitudes.
2. Loss of communication/loss of link/GPS time out periods.
3. Loss of communication/loss link profiles.
4. UA engine-out/loss of thrust glide ratios.
5. Motor failure or loss of electrical power decent profiles.

6. Return home profiles.
7. UA maximum airspeed.
8. UA maximum range/endurance.
9. Maximum wind limits.
10. Flight termination procedures and footprint.
11. Flight termination procedures/failsafe procedures and footprint.
12. Command and control communication ranges.
13. External RF emitters stay clear distances and adjacent channel separation requirements for UAS data links.
14. For tethered UAS, the operating area or safe-for-flight box is defined by the length of the payed out tether. The UA shall fly within the spherical section defined by the tether length. For moving platforms/ship operations the tether shall remain clear of obstructions.

Note

A system failure, environmental factor, or lack of UA performance can leave the UA in an uncontrolled state resulting in the vehicle unintentionally departing the operating area or safe-for-flight box, and/or excursions into personnel safety hazard keep-out zones.

7.2 ASSEMBLY AND PREFLIGHT

7.2.1 UA Assembly

Refer to UAS operator manuals for assembly instructions. Ensure wiring is routed out of the way of moving parts and secured in place using adhesives or strapping. Flight controller and sensors should be installed per operator manuals specifications. Ensure motors are installed to spin the correct direction and that the correct propellers have been installed on the motors (i.e. clockwise/counterclockwise rotation).

7.2.2 Radio Control and Control Station (CS) Setup

Setup the radio controller and, if applicable, the CS using recommended operator manual guidelines. For each telemetry system, follow operator manual instructions for configuration. Perform a test connection between the UA and the CS to ensure correct operation. If possible, perform a radio calibration using the CS. Ensure the correct channels and orientations are set on the radio and received as the flight controller expects.

7.2.3 Preflight

Prior to each flight, the AVO shall conduct a preflight inspection and determine that the UAS is in condition for safe operations.

7.2.4 Fail-Safe Modes

The primary purpose of fail-safe modes is protection of personnel and containment of the UA within the designated airspace. The fail-safe strategy may vary from one UAS to another depending on the autopilot and/or command and control strategy. At least one fail-safe mode shall be used for each flight operation.

AVOs are responsible for ensuring that the fail-safe strategy takes into account the specific UAS, designated airspace, surroundings, and personnel involved. Fail-safe and containment modes of each UA shall be programmed and checked prior to each flight as part of the pre-flight inspection as appropriate.

Fail-safe modes shall be set to be automatically initiated in the event of a low battery limit, lost link, lost GPS location, or airspace boundary/geo-fence breach. Fail-safes may also be initiated by the AVO if he/she becomes disoriented or otherwise loses control of the UA.

Refer to operator manual instructions on fail-safe modes. If none are provided, adhere to the guidance in this section for fail-safe containment modes.

7.2.4.1 Lost Link Fail-Safe

Lost link fail-safe mode should be initiated in the event that RC or telemetry link has been lost with the UAS. Lost link behaviors will vary depending on if the UAS has autonomous capabilities or not.

If the UAS does not have autonomous capabilities, a kill power mode can be programmed such that the UAS receiver commands zero throttle to the flight controller. This mode can be programmed to trigger automatically by the flight controller or receiver, or manually by the AVO. This method may also be triggered if the RC transmitter is powered off or if the UA has flown out of effective RC range. UAS capable of autonomous flight may be programmed to Return-to-Home (RTH), Return-to-Launch (RTL) or land immediately in the event of a lost link. These modes can be programmed to trigger automatically by the flight controller, or manually by the AVO.

1. UAS with autonomous capabilities should be programmed to RTH, RTL, or land immediately.
2. For UAS without autonomous capabilities, the RC and receiver should be programmed to command zero throttle.

7.2.4.2 Geo-Fencing Fail-Safe

This mode may be used as a containment method for UAS capable of autonomous flight. The UAS can be programmed to RTH, RTL, or land immediately upon breach of the pre-programmed distance from home or launch point, and altitude above ground level.

7.2.4.3 Battery Fail-Safe

For UAS with battery fail-safe functions, battery fail-safes can be set to disarm motors, RTH/RTL or land immediately. If operator manuals do not specify a minimum battery percentage for recovery, set to a threshold no lower than 30 percent of battery charge.

7.2.5 GNSS Preflight

Proper operation of the GNSS shall be verified prior to each flight. The GNSS shall be free of degrading interference (i.e., interference that would result in a loss of GNSS) prior to flight.

WARNING

The autopilot software has not been validated by NAVAIR against established airworthiness standards. NAVAIR has not assessed software and/or existing defects that affect flight operations. Loss of UA control resulting in loss of vehicle, injury or death to personnel, and/or damage to property.

7.2.6 Recovery Parameter Checks

When entering or changing recovery parameters and settings, the AVO shall verify the settings to be correct and proper prior to sending to the UA.

WARNING

Incorrect entry of recovery parameters can result in loss of the UA, injury to personnel, and/or damage to property.

7.3 LAUNCH

7.3.1 Multi-rotor Hand Launch and Recovery Procedures

WARNING

Flight Characteristics and performance for hand launch and recovery of UAS covered under this manual have not been independently assessed by NAVAIR or verified against established airworthiness standards. Operator error, UA handling quality limitations, and flight dynamics may result in loss of vehicle, injury to personnel, and/or damage to property.

These operations are typically used aboard small vessels or other moving vehicles that do not have a flight deck or other large area from which launch and recovery from the deck is practicable or when other mission requirements dictate the need to hand launch and/or recover the UA. Instead of maneuvering the UA to or from a landing spot, the AVO maneuvers the UA to or from the hands of a SO. Certain UAS are designed and approved for AVO hand launch and recovery without a Safety Observer. The AVO shall assess the feasibility of hand launch or recovery of the UA and moving vehicle combination, if applicable.

Hand launch and recovery shall only be conducted when mission requirements dictate the need. The AVO shall first make an ORM assessment and determine that the operation will not create undue risk of injury to personnel or property damage.

7.3.1.1 Recommended Crew Requirements

When conducting hand launch and recovery operations, the recommended crew is as follows:

1. AVO.
2. Safety Observer (as required by unit CO for particular model). Certain micro-UAS are designed to be hand-launched and recovered by the AVO.
3. Vehicle Driver (ground vehicle driver, small vessel or ship coxswain) applies to moving vehicle operations. The AVO shall not operate a moving vehicle and the UAS at the same time.

7.3.1.2 Crew Coordination

The AVO shall brief the Safety Observer and vehicle driver on all launch and recovery procedures including safety/wave-off calls and ORM considerations.

7.3.1.3 Personal Protective Equipment

The UASC who is doing the actual hand-launching or recovering of the UA shall wear PPE capable of protecting him/her from a direct impact of the UA and/or rotor blades. Appropriate PPE shall be established by the ARC unless otherwise stated in the Flight Clearance. Certain Micro UAS may require little or no additional PPE, but most Multi-rotor UAS are capable of severely lacerating the skin and/or eyes. Recommended PPE for typical Group 1 Multi-rotor UAS is as follows:

1. Helmet or Cranial with eye protection.
2. Neck covering.
3. Protective Gloves (Welder's gloves or similar are recommended).
4. Long Sleeves (A jacket or similar garment is recommended).
5. Sturdy footwear.

7.3.1.4 Hand Launch

Unless otherwise stated in the flight clearance or OEM manual, the ARC will establish local hand launch procedures for each model. The following is an example hand launch procedure with suggested communications between the AVO and the Safety Observer:

1. UA — Hold overhead (SO).
2. AVO — "Standby for takeoff power."
3. SO — "Ready for takeoff power".
4. Takeoff Power — Set (AVO).
5. SO — "UA released".
6. Climb-out from launch point — As required (AVO).

7.3.1.5 Hand Recovery

Unless otherwise stated in the flight clearance or OEM manual, the unit CO will establish local hand recovery procedures for each model. The following is an example hand recovery procedure with suggested communications between the AVO and the Safety Observer:

1. AVO — "Standby to recover the UA."
2. SO — "Ready to recover the UA."
3. UA — Positioned within arm's reach of SO (AVO).
4. SO — "UA captured".
5. UA — Kill Power (AVO).

7.3.2 Launch and Recovery from a Moving Vehicle

UAs shall not be launched, recovered or operated by the driver of any moving vehicle. Other passengers may launch, recover or operate UAS from any moving vehicle while operating IAW OEM operating manual and within the flight envelope provided the AVO has made an ORM assessment and determined the operation will not create unnecessary risk of injury to personnel or damage to vessels, vehicles or structures.

7.4 FLIGHT

Once the AVO has completed their pre-flight inspections, the AVO will ensure that all operating limits are satisfied and that all crewmembers are ready for flight.

All personnel shall remain at his or her station during takeoff, landing, recovery, and other critical phases of flight, except when performing those duties required for safe operation of the aircraft. The AVO shall continuously ensure that the UAS maintains adequate reserve power for recovery as stated in the flight clearance or UAS flight manual.

WARNING

Category 3 UAS have an increased likelihood of flight critical failures which may lead to loss of control or loss of UA, increasing the risk of injury or death to persons on the ground. The AVO is responsible for ensuring that UA operations will pose no undue hazard to other aircraft, people or property/ship in the event of loss of control of the aircraft for any reason.

7.4.1 Manual Flight

For UA that do not have an autonomous fail-safe, the UA should be flown in manual or assisted mode. Manual mode fail-safes for link loss should be set to cause the vehicle to land or terminate flight immediately.

7.4.2 Autonomous Flight

These modes require careful mission planning ahead of time. The AVO shall approve all flight paths before initiating autonomous flight modes. Autonomous flights require that fail-safes be utilized. Fail-safes should be set to cause the vehicle to RTH, RTL, or land immediately. Ensure RTH/RTL locations/home location/rally points are set to safe landing areas. Battery fail-safe should be set to allow sufficient time to RTH/RTL at any point in the mission.

If the system is capable of manual control the AVO should be prepared to take manual control of the aircraft at any time during an autonomous flight. When taking off in autonomous modes using the CS, ensure the RC TX is also set to the equivalent auto mode so that the aircraft does not abruptly change flight modes.

Flight controller default settings may sacrifice UA altitude to attain commanded speed settings. The AVO shall ensure commanded speeds do not exceed the UA's ability to attain and maintain them in level flight.

WARNING

Commanding speeds that the UA cannot attain may result in the UA diving. This may result in controlled flight into terrain (CFIT) and subsequent loss of UA and/or hazards to personnel on the ground.

7.4.3 Command and Control Lost Link Avoidance

The UA operator shall update the lost comms plan throughout the flight as appropriate to ensure that the aircraft will remain in the UAS operating area defined in the Safe-for-Flight box during a lost comms event.

1. The AVO should avoid intentional flight in a loss-of-link condition.
2. The AVO shall confirm UA automatic lost link settings (e.g., return home, land) prior to flight.

WARNING

- Loss of link may result in loss of UA, death, injury, and/or damage to property.
- Operation between high-rise buildings or in urban canyons in a city environment may result in loss of the vehicle and/or injury due to high wind gusts, reduced room to maneuver, loss of link, and a lack of collision avoidance capability.

Note

- Flight beyond visual line-of-sight or behind objects and terrain features increases the risk of loss of link.
- If the lost comms plan is not updated during the flight the UA may inadvertently overfly populated areas during a lost comms event.
- If unable to restore downlink promptly, any delay in commanding lost link procedures through functional uplink increases uncertainty of UA position and flight status.

7.4.4 Mid-Air Collision Avoidance

UAS covered under this manual do not have organic sense and avoid systems. To minimize the risk of mid-air collision:

1. AVO shall coordinate airspace use with the airspace controlling authority and be in communication with this authority to actively deconflict the airspace when operating the UA.
2. AVO shall initiate a Return to Base (RTB) or execute flight termination procedures, as conditions permit, if the location of the UA is in question.
3. In the event of loss of communications between the AVO and local ATC/Range control, the AVO shall follow local procedures.

WARNING

- A mid-air collision with a manned aircraft may result in loss of the UA, injury or death to personnel, and/or damage to or loss of the manned aircraft.
- During night operations the UAS exterior lighting system has not been characterized by NAVAIR and may not meet Federal Aviation Administration standards for minimum intensity or area of coverage, increasing the risk of midair collision and injury or death to personnel.

Note

The AVO is responsible for ensuring that there is a safe operating distance between manned aircraft and the UA.

7.4.5 UA Handoff Procedures

UA control handoff between AVOs from one CS to another shall be performed IAW OEM operating manual procedures. CS to CS handoff shall only be conducted between CS with identical software configurations IAW OEM operating manuals and only after two-way verbal communication has been established between CS/AVOs prior to handoff.

7.5 RECOVERY

The AVO shall declare RTB when all mission objectives have been achieved or as safety concerns dictate. AVOs shall coordinate with all crewmembers involved in an effort to clear the landing site. Landing and recovery procedures will be accomplished IAW the relevant UAS operator manual.

WARNING

Flight characteristics and performance of the UAS covered under this manual have not been independently assessed by NAVAIR or verified against established airworthiness standards. Loss of UA control resulting in loss UA, injury or death to personnel, and/or damage to property may occur.

7.5.1 Degraded or Lost Command and Control Link

For recovery operations during times of known degraded link, the AVO shall monitor the UA at all times through recovery, up to a successful capture event, in order to gain increased situational awareness regarding expected UA behavior and position.

WARNING

The inability to accurately predict UA behavior due to a degraded or lost link reduces AVO situational awareness and may result in flight outside the safe-for-flight box or engine kill radius, resulting in loss of UA injury or death to personnel and/or damage to property.

Note

During a lost comms event the UA may use either a track-to or direct-to command to capture the nearest waypoint closest to home, possible causing it to fly outside the safe-for-flight box.

7.5.2 Shutdown/Post-Flight

Shutdown and post-flight actions will be taken IAW the applicable UAS operator manual and UAS Lithium Polymer Battery Storage, Handling, and Charging Procedures and Naval Lithium Battery Safety Program. If applicable to the mission, the AVO shall conduct a post-flight debrief.

7.6 COUNTER-UAS (C-UAS) OPERATIONS

Flight Operations in support of C-UAS testing, training, or other intentional operations in a GPS or Command and Control (C2) jamming environment are outside the scope of this manual. These types of operations will be addressed in the applicable IFC.

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CHAPTER 8

Ship-based Procedures

8.1 SHIP-BASED OPERATIONS INTRODUCTION

Operating a Group 1 and 2 UAS from a vessel is similar to shore based operations but requires consideration of three unique aspects: a change in environmental conditions as seen by the Group 1 and 2 UAS; ship obstructions which restrict launch and/or recovery operations of the UAS; and limited operating space that may result in risk to ship's company. One unique advantage to ship-based operations is the ability in an emergency to ditch the UAS in the water without risk to ground personnel. In general, most of the procedures for land-based operations will also apply to vessel operations. However, the following procedures are intended to address those which differ and offer mitigating factors so that shipboard operations can be conducted in a safe and efficient manner.

8.1.1 Ship-Based Environmental Considerations

Maritime vessels are usually in constant motion even when not steaming, due to swell, wind, and waves. How the vessel moves depends on both the vessel characteristics (size, hull shape, etc.) and the environmental conditions. The landing point for the UAS and associated control station must be viewed as moving, usually away from the approaching UAS, and not stationary. Ship motion does not present a stable landing area and the ability of the UAS, if landed on the deck, must account for or tolerate something other than a flat, stable surface. Since the ship is in motion, equipment needs to be secured using tie down points. Tie downs should be installed according to approved engineering procedures to ensure safety of nearby personnel.

Wind flow around ship topside structure and obstructions can create localized flow exceeding the controllability limits of a Group 1 and 2 UAS. Consideration for launch and recovery paths should review wind-over-deck (WOD) analysis developed for manned aircraft, when available, to inform flight paths.

Finally, servicing and supply considerations on the ship are limited; and may determine acceptability of using and storing certain HAZMAT fuel sources such as lithium batteries and mogas. A clear understanding of the ship's storage capabilities for anything considered hazardous material needs to be addressed prior to embarking the Group 1 and 2 UAS aboard ship.

8.1.2 Ship Obstructions

Vessels have superstructures, cranes, nets, and other items that must be avoided during flight operations. The metal structures in vessels can also negatively impact magnetometer performance on the Group 1 and 2 UAS. Also, ship decks can be busy areas, with various operations occurring simultaneously.

Placement of launch and recovery support equipment and control station communications antennas must not interfere with installed shipboard systems.

8.1.3 Hazards to Personnel and Equipment

Due to the very small size and weight of the aircraft, risk of injury to personnel or damage to equipment (other than the aircraft itself) is low. However, precautions shall be taken to minimize the potential for injury to personnel and/or damage shipboard equipment. Hazard zones during launch and recovery are dependent both on the UAS and the launching vessel, and shall be defined, understood, and briefed prior to the operation. The AVO is responsible for keeping all personnel aboard the vessel appraised of the hazard zone and intended launch and recovery directions. If control of the UAS is in question or collision appears imminent, consideration shall be given to executing an immediate wave-off or ditching the AV.

8.1.4 Ship Site Survey

Maritime vessels can range in size from 12-foot-long RIB-style outboard motor boats, to large surface combatants or research ships. As such, they have different deck and superstructure arrangements, therefore flight operations must be specifically tailored to reflect the particular vessel, recovery areas, obstructions, etc. Topside drawings and/or ship facilities resumes shall be consulted before the initiation of Flight Operations. Each type of UAS will have different SHKOZs, and consequently, the keep out zones may exceed the overall length of the vessel. Therefore, personnel may be required to shelter inside the ship or locate themselves behind barriers when within the SHKOZ. Modifications to vessels listed in the United States Naval Vessel Registry or Military Sealift Command inventory, either permanent or temporary, are outside the scope of this manual. Consult NAVSEA to request any ship modifications.

8.1.5 Electromagnetic Interference

Electromagnetic Environment (EMEs) created by high power radars and other transmitters can interfere with Group 1 and 2 UAS datalinks, RF, avionics, flight controls, and control station data exchanges. Electromagnetic Victim (EMV) testing should be accomplished on both the control station and the vehicle.

An Electromagnetic Compatibility (EMC) Safety of Flight Test (EMC SOFT) shall be conducted prior to commencing flight operations. Ship's personnel shall secure all RF emitters; then, while the AV is in a flight representative state on deck, the ship shall energize each emitter one at a time so that it may be determined if there are any Electro-Magnetic Interference issues. It should be noted this type of quick look EMV/EMC test does not expose the UAS to main beam level electric fields which are much higher field levels and provides limited risk mitigation. Ship emitters that can be secured throughout the entire test may be omitted from the EMC SOFT as long as it is clear to ship's company that they cannot energize those systems during flight ops. Emitters in the general use, unregulated, 2.40 GHz to 2.48 GHz range bands can be of particular concern if the transmitter/receivers are older generation and do not employ features such as spread spectrum, or frequency hopping technology to decrease their susceptibility to other "general band" users. It is often not possible to specify the exact RF systems that are expected to be problematic during operations, therefore the Group 1 and 2 UAS crew has to be flexible to adapt to each vessel's RF systems. Avoiding mean beams of radars, frequency separation, and avoiding higher power systems will help with EMC. Flight operations shall not be performed until all EMC issues are resolved or mitigated satisfactorily.

8.2 FLIGHT OPERATIONS

8.2.1 Tethered UAS

For shipboard operations, the tether base station shall be mounted to the ship deck. Tethered flight paths that cross over the ship superstructure are prohibited.

Due to the associated electrical shock hazards of a broken powered tether, shipboard UAS operations shall be conducted IAW the governing IFC.

8.2.2 Preflight Procedures

1. Obtain weather brief. Consult weather forecasts; observe current weather and sea state conditions. Look for any sea spray that may be reaching operation areas. If it is suspected that the UAS has been exposed to salt water, it should not be operated until proper maintenance action is performed. UAS Operations shall not occur if sea state conditions create horizontal or vertical motions exceeding launch criteria, if relative wind speeds are greater than platform limits, thunderstorms are within 20 miles of the vessel, or if there are any other conditions preventing safe operations as specified in the flight clearance.
2. Identify collision hazards. Check to make sure there are not delicate electronics, antenna arrays, or other items that could be damaged by the UAS within proximity of the launch and recovery location. Be aware of any such items anywhere on the ship's exterior and avoid flight above or near these.
3. Conduct wind speed & direction check. In addition to using wind sensors on the ship (which are usually located high on a mast), the wind speed should be checked at the launch and recovery locations using

hand-held or nearby mounted sensors. UAS crew should also check turbulence levels and presence of wind shear using applicable flow-visualization methods, bubbles, etc.

4. Conduct ship motion check. Observe the ship motions and anticipate changes that may occur if sea state conditions change or the ship changes direction or speed. Ship personnel should be briefed to avoid course and speed changes during UA launch and recovery and to inform UAS crew at once if such changes become necessary.
5. Set EMCON with ship's crew/officer of the deck. Ask ship personnel to turn-off all unnecessary systems that emit EM radiation. If systems can only be temporarily turned off, test the UAS communications while these systems are turned off and on. Ask ship personnel to contact the UAS operator before turning on any EM systems during flight ops.
6. Establish COMMS with ATC or airspace approval authority (if required). Notify appropriate ATC or airspace approval authority prior to launch (if required).
7. Request flight quarters from ship's crew/officer of the deck. Ship's crew should be aware of commencement of flight operations and non-participating personnel should be clear of the launch hazard area. Request ship personnel to make a public announcement that aircraft recovery operation will be commencing shortly and all decks should be cleared of non-essential personnel.
8. Verify wind over deck is within limits. Use of a hand held anemometer is recommended if a meteorological station observation is unavailable to ensure wind over deck is within limits.

   Let ship's crew/officer of the deck know what ship actions are required to get winds within the Launch and Recovery Envelope. In most cases, the ship should stop steaming and face into the winds and/or swell to minimize ship motions.

8.2.3 Launch and Recovery

1. Launch and recovery concurrent with manned or unmanned aircraft launch or recovery operations are prohibited.
2. For shipboard launch and recovery operations, relative wind (vector sum of ship speed and true wind speed) shall be used.
3. Consideration should be given to ship's obstructions for intended flight paths and contingency paths, such as wave-off.
4. Essential personnel required on deck during launch and recovery shall maintain visual line of sight of UAS at all times.

8.2.4 Launch and Recovery Procedures

1. For aviation capable ships, request "Green Deck" from ship's crew/officer of the deck. "Green Deck" means that the UAS is cleared to launch or recover. "Red Deck" means that the UAS is not cleared to launch or recover.
2. Conduct VTOL Controllability Check. If possible, perform initial flights with increasing higher altitudes, over open deck space (such as fantail) to gain confidence in the UAS operations before attempting operations over open water. If aircraft does not appear to be responding as expected, and a controlled recovery is not possible, execute termination procedures.

8.3 SHIPBOARD EMERGENCY CONSIDERATIONS

Emergencies while flying from vessels are addressed in much the same way as land operations; however, the primary difference while underway is that the CS will likely be moving; therefore, if the UAS enters "lost communication" mode it may not return to the exact launch/recovery location on the vessel and may miss the vessel entirely. It is therefore extremely important that the operator understand the Return Home methodology the UAS employs and either update the Return Home point periodically throughout the flight or invoke a safe lost communication mode

which will command the UAS to first go to a safe altitude before it returns to the last provided Return Home waypoint location before descending. While the UAS is attempting to return automatically, the vessel crew can often maneuver so that the UAS can descend onto an open deck. Larger ships may have difficulty performing these maneuvers or vessels may not be able to move due to other constraints, in which case the UAS will land in the water, resulting in loss of aircraft, but avoiding potential injury or damage to the ship. Consideration should be given to the feasibility of a shore based return home point.

8.4 SHIPBOARD-RELATIVE ROUTES AND AREA SPILLAGE

When operating UAS capable of ship-relative routes, ship positioning may cause the UAS to exit designated airspace. Ship personnel shall be made aware of UAS requirements such as boundary standoff ranges. If a system is capable of displaying UA position over boundaries and/or charts, that feature shall be used to the maximum extent practicable.

CHAPTER 9

Special Procedures

(SEE OEM operating manual and T/M/S flight clearance for special procedures).

9.1 ELECTROMAGNETIC COMPATIBILITY (EMC) SAFETY-OF-FLIGHT TEST (SOFT)

An EMC SOFT shall be performed prior to first flight with newly installed equipment (for sample EMC SOFT checklist see Appendix F). This includes new transmitter frequencies that have not been previously checked for compatibility. An EMC SOFT is not complete until all unacceptable EMC anomalies have been corrected.

WARNING

- NAVAIR has not characterized the UAS covered under this manual for susceptibility to internal or external electromagnetic fields, including those produced by radio transmitters and radars. RF energy may disrupt engine or electric motor control, GPS receiver function, C2 datalinks, or flight control, which may cause loss of UA control, or degraded navigation. Operation near antennas of active radio transmitters, SATCOM, uplinks, and radars, especially those operating at high power levels (greater than 1 KW and antenna gains greater than 20 DBI) may result in loss of air vehicle, injury to personnel, and/or damage to property.
- Operation near active antennas may result in loss of link, engine or motor RPM reduction or uncommanded shut down, flight control surface fluctuation, and autopilot disruption, leading to loss of UA, injury to personnel, and/or damage to property.

Note

- The UA and CS, when illuminated by RF energy have experienced disruptions such as uncommanded movement of flight-control surfaces, loss of communications, CS malfunctions, and uncommanded changes of throttle or motor speed.
- Successful completion of an EMC SOFT is a check, but not a guarantee, that system operation will not be disrupted by its own, or nearby electronic equipment.

9.2 MULTI-VEHICLE OPERATIONS AT THE OPERATING AREA

Mission planning for concurrent UA operations is required to account for separation of the UAs during all phases of flight. Spatial separation of individual UA flight paths is required to be maintained at all times during the flight, and separation plans are required to account for planned contingency flight routes. The exception to this requirement occurs when multiple UAs have the same emergency recovery and runway approaches assigned. Multiple UAs controlled from the same site shall be operated on different C2 frequencies, channels, or other UA unique identifiers.

General Operating Procedures:

1. Prior to takeoff, the AVO shall review the flight plan and UA settings to ensure proper C2 and flight path deconfliction (i.e., altitude and/or lateral separation) of all participating UAs.

2. Geo-fence containment boundary is confirmed during pre-flight checklists by UAC and UMC to be adequately within authorized airspace.
3. Individual in-flight UA identification can be performed visually, by sending control inputs to observe UA motions for confirmation.

Note

UAS datalinks may be impaired by operation of multiple UAS within their respective RF ranges.

9.3 MULTI-VEHICLE OPERATIONS BY A SINGLE UAC/AVO

Multi-vehicle operations are comprised of multiple UAS flown simultaneously by a single AVO from one or more CS. Mission planning for concurrent UA operations is required to account for separation of the UA during all phases of flight. Spatial separation of individual UA flight paths is required to be maintained at all times during the flight; and separation plans are required to account for planned contingency flight routes. The exception to this requirement is when multiple UAs have the same emergency recovery and runway approaches assigned. Multiple UAs controlled from the same site shall be operated on different C2 frequencies, channels, or other UA unique identifiers.

General Operating Procedures:

1. Prior to takeoff, the UAC conducting the Multi-Vehicle operations will confirm each UA settings to ensure proper C2 and flight path deconfliction (i.e., altitude and/or lateral separation) of all participating UA.
2. Geo-fence containment boundary is confirmed during pre-flight checklists by UAC to be adequately within authorized airspace.
3. Individual in-flight UA identification can be performed visually, by sending control inputs to observe UA motions for confirmation.

WARNING

AVO situational awareness is reduced during multi-vehicle operations. There is an increased risk of loss of control, mid-air collisions, and/or loss of UAs which may result in injury to personnel and damage to property. AVO procedures, software, and hardware capabilities for multi-vehicle operations have not been validated by NAVAIR.

Note

UAS datalinks may be impaired by operation of multiple UAS within their respective RF ranges.

9.4 SWARMING OPERATIONS

Swarm UAS missions consist of simultaneously flying UAs in autonomous coordinated flight modes, such as waypoint following and/or sensor-based navigation. The UAs can communicate wirelessly with each other, subject to constraints of LOS and range, to share information (e.g., telemetry, sensor data) to facilitate use of coordination algorithms (such as flocking, leader-followers, or formation flying). Compact telemetry data are provided to the CS for situational awareness of all aircraft (typically including current position and previous tracks and/or intended trajectories) using unique identifiers and pairings between the CS and UAs.

General Operating Procedures:

1. Prior to takeoff, the swarming UAC and supporting AVOs will confirm swarm settings for each UA participating in the swarm to ensure deconfliction (i.e., altitude and/or lateral separation) of all swarming UA.

2. Prior to takeoff, each swarming UA will be checked to ensure the swarming payload can be disengaged to allow for UA deselection from the swarm.
3. Prior to takeoff, Geo-fence containment boundary for each swarming UA and for the entire swarm is confirmed during pre-flight checklists by UAC to be adequately within authorized airspace.
4. Individual in-flight UA identification can be performed visually, including sending manual control inputs to observe UA motions for confirmation.
5. Specific T/M/S swarming operations will be identified in the governing IFC.

9.5 LASER OPERATIONS

9.5.1 Configuration

The configuration of each LSRB approved laser is provided in the LSRB letter. The ARC shall ensure they have an LSRB approval for the specific UAS configuration prior to laser operations.

9.5.2 Limitations

Laser wavelengths, laser hazard classification, nominal ocular hazard distances (NOHDs), diffused NOHDs, required laser eye protection (LEP) optical density (OD), and nominal skin hazard distances (NSHDs) are provided in the LSRB letter for each approved laser per UAS configuration.

9.5.3 Procedures and Warnings

The following procedures, and warnings apply to all approved lasers. Additional procedures, limitations, warnings cautions and notes specific to each approved laser are provided in the LSRB Letter for each approved laser per UAS configuration.

1. Lasers shall only be operated while the UA is in an approved laser operating/firing area.
2. Lasers shall not be fired upwards, at a reflective surface, into dry grass, or at any unprotected personnel during maintenance or preflight verification.
3. All lasers shall be put into a safe state during launch and recovery operations, except when the laser is required and LSRB-approved to support those phases of flight (e.g. laser altimeters, or other lasers used in support of guidance and control functions).
4. When the UA is on the ground, LEP with the required OD for the specific laser wavelength shall be worn at all times by personnel within the appropriate NOHD of the laser, except when the laser is in a safe (off/unpowered) state.
5. Laser Operations shall be a briefing item prior to laser operations. UAS operators, maintainers and ground personnel shall be trained in laser hazards and control measures to prevent injury during maintenance, ground and flight operations.
6. Personnel shall treat all lasers as if they were in the on state after landing and during retrieval until they are confirmed in a safe state.

WARNING

- Improper use of laser systems may cause permanent eye injury to personnel on the ground or in other aircraft.
- Personnel within NOHD without LEP can incur permanent eye damage. Personnel within the NSHD can experience severe skin damage.

9.6 ELECTRICALLY POWERED TETHERED UAS ELECTRICAL SHOCK MITIGATION

Electrically Powered Tethered UAS provide continuous high voltage direct current that is powering the UA during flight. This high voltage direct current requires special considerations during flight operations. As with all UAS Operations positive control of the UA throughout flight shall be maintained. It is highly advisable to cordon off the area surrounding the UA Tethered Base Station to prevent personnel from inadvertently entering the SHKOZ. The following procedure is only applicable to shore based operations only and shall be conducted whenever personnel are in the SHKOZ for Flight during Electrically Powered Tethered UA Operations. Shipboard operations of Electrically Powered Tether UA is beyond the scope of this manual and shall be addressed in an IFC.

1. Minimum crew: 1 AVO and at least 1 Safety Observer.
2. Preflight inspection: Inspect the tether to UA connection for any visible damage before each flight.
3. Safety Observers, external to the CS enclosure, shall maintain continuous direct verbal communication with the AVO (e.g., radio, etc) and shall maintain VLOS contact with the UA and tether.
4. The Safety Observer shall be capable of initiating a secure power call to the AVO via immediate direct communication.
5. The AVO shall be in continuous direct verbal communication with the Safety Observer and be prepared to receive a secure power call from the Safety Observer. Operations shall be conducted per the OEM manuals and any associated SOPs.
6. Post Flight Inspection: Inspect the tether to UA connection for any visible damage after each flight.

WARNING

A severed electrical tether may result in death, injury, and/or damage to property or ship.

CHAPTER 10

Emergency Procedures

10.1 INTRODUCTION

Emergency situations are unpredictable by nature. However, proper mission planning, detailed mission briefings, adherence to checklist procedures and established standards, systems knowledge, and situational awareness will minimize the impact of UAS emergencies on operations and personnel.

UAS operator manuals and checklists shall contain system specific emergency procedures to include general warnings, cautions, and notes. AVOs and all flight personnel engaged in the UAS operation shall familiarize themselves with these procedures and be prepared to take appropriate action should an emergency arise.

The emergency situations and procedures in this chapter cover the common types of emergencies encountered. However, the procedures used during an actual emergency shall result from careful consideration of the complete situation. Compound emergencies, adverse weather, and other unusual conditions may require modification of the emergency procedures in order to recover the UA safely. The AVO shall use all available information, knowledge, and experience to deal with each situation.

10.2 CONVENTIONS

10.2.1 Critical Steps/Immediate Actions

Critical steps are those steps in a procedure that the AVO shall commit to memory and execute without delay or reference to a written checklist. After executing a procedure's critical steps, the AVO shall utilize the written checklist to complete any remaining steps.

10.3 CREW RESPONSIBILITIES IN AN EMERGENCY

10.3.1 Standard Aviation Sequence

Aviate, navigate, and communicate is a workload management flow used by AVOs to prioritize duties. These prioritized actions apply to all phases of flight. However, they are especially important to follow during emergency situations when the stress level and workload is high.

Aviate, navigate, and communicate are defined as follows:

1. Aviate: The first priority is always to maintain control of the UA before any other action is taken.
2. Navigate: The second priority is to orient the UA. Ensure UA heading and altitude are appropriate for the terrain and in compliance with airspace restrictions. Ensure UA track is appropriate in order to reduce to possibility of injury/death to personnel on the ground in the event of ground impact.
3. Communicate: The third priority is to communicate. As necessary, communicate UA status and/or airspace request to the airspace management authority, as appropriate. Always communicate briefly and concisely.

10.3.2 General Responsibilities

UA control is always the first priority. Once control is achieved, analyze the situation, take the appropriate corrective action, and perform a recovery as required. Other general responsibilities include:

1. Maintain awareness.
2. Act quickly when a problem develops.

3. Manage the UA during the span of time when the problem is known but has not yet been diagnosed.
4. Diagnose problems.
5. Perform the applicable emergency procedure or take action appropriate for the problem. If at any time a condition is corrected, stop execution of the emergency procedure.

10.3.3 AVO Responsibilities

1. Maintain control of the UA.
2. Perform all immediate action items.
3. Communicate the emergency situation and intentions to external agencies, as required.
4. Utilize the checklist to complete all non-immediate action items.
5. Troubleshoot, as required.
6. Determine landing criteria and land as required.

10.3.4 Unmanned Aircraft System Aircraft Crewmember (UASC) Responsibilities

1. Assist in ensuring the continued safe flight of the UA.
2. Assist the AVO in performance of emergency action items, as directed by the AVO.
3. Assist the AVO in communicating the emergency situation and intentions to external agencies, as required.
4. Assist the AVO in troubleshooting.

10.4 GENERAL EMERGENCY PROCEDURES

(SEE OEM operating manual and T/M/S flight clearance for detailed emergency procedures.)

10.4.1 Critical System Failure

In the event the UA unintentionally departs the UAS operating area or safe-for-flight box proceed as follows:

1. Ensure UA is in a safe state.
2. Attempt to return UA to safe-for-flight box.
3. If unable to return UA to safe-for-flight box, land as soon as possible or terminate flight over a preselected point.
4. Notify local ATC/range control authority.

WARNING

A critical system failure can leave the UA in an uncontrolled state while operating within established limitations. Such a failure may result in the UA unintentionally departing the UAS operating area or safe-for-flight box. A critical system failure may result in the loss of UA, injury or death to personnel, and/or damage to property either inside or outside of the operating area or safe for flight box.

Note

- If possible to make the pre-selected point, every effort shall be made to visually inspect the probable impact area prior to executing the flight termination procedure.
- A secondary method of terminating/controlling the vehicle may exist. The UAS may be equipped with an independent flight termination systems.

10.4.2 Flight Termination

Flight termination may be necessary if the vehicle cannot otherwise be safely recovered. The ground areas directly beneath, and in the near vicinity of, the UA during flight termination should be clear of personnel and property. The size and location of the cleared ground/surface area should be based on the altitude at which flight termination was executed along with the UA's maximum anticipated airspeed, glide ratio, and the prevailing winds. The area should also account for any other relevant geographical/environmental factors. After flight termination, the AVO shall record the last known location of the UA's position for potential recovery of equipment.

WARNING

Flight termination may result in uncontrolled flight, resulting in injury or death to personnel, or damage to property. Terminating at lower altitudes will minimize the hazard area underneath the termination point.

10.4.3 Degraded GPS

If GPS jamming is suspected, the AVO should command the UA to a safe altitude and exit the area of suspected jamming to minimize the possibility of unexpected navigation errors. If applicable, the AVO should consider taking manual control of the UAS to further mitigate an active GPS jamming environment.

Note

- The effect of GPS jamming on the UA navigation system has not been fully characterized. It is possible that GPS altitude and navigation reference can be in error.
- Flight operations without GPS, or with degraded GPS data, increases AVO workload and increases the uncertainty in reported UA position. Without a functioning GPS, it will be necessary to rely on alternate navigation techniques.

10.5 IN-FLIGHT EMERGENCIES

(SEE OEM operating manual and T/M/S flight clearance for detailed emergency procedures.)

10.5.1 Emergency Landing Site Selection

Ensure landing area is as follows:

1. Clear of people and property.
2. Clear of obstructions and rough terrain.
3. Near the launch and recovery equipment, or other safe retrieval location.

10.5.2 Lost or Degraded Command and Control Link

During times of lost or degraded link (downlink or uplink), follow OEM procedures and notify ATC, airspace approval authority, or SUA using agency and provide the following information:

1. UAS type/size.

2. Last known location and time of lost link Loss Link.
3. Heading, altitude, and estimated flight time remaining.
4. Pre-programmed lost link flight instructions.

WARNING

The inability to accurately predict UA behavior due to a degraded or lost link reduces AVO situational awareness and may result in flight outside the safe-for-flight box or engine kill radius, resulting in loss of UA injury or death to personnel and/or damage to property.

Note

If unable to restore downlink promptly, any delay in commanding lost link procedures through functional uplink increases uncertainty of UA position and flight status.

10.5.3 Loss of GPS

1. Assume manual control of the UA.
2. Utilize alternate navigation techniques (if available).
3. If behavior persists, land as soon as practicable.

10.5.4 Unexpected Autonomous Behavior

1. Neutralize CS or RC mode inputs.
2. Assume manual control of the UA.
3. If behavior persists, land as soon as possible or terminate flight if the UA poses impending risk to personnel or property.

10.5.5 Departure from Assigned Airspace

1. Command UA to RTH, RTL or Land (if applicable).
2. Notify ATC, airspace approval authority, or SUA using agency and provide pertinent information.
3. If UAS is not recoverable, provide information on last known location, direction of travel, altitude and expected UAS behavior.

10.5.6 Inadvertent Flight In Icing Conditions

Airframe icing increases drag, reduces lift, and increases weight of the UA. Indicators of increased drag or weight and reduced lift include erratic flight and/or changes in engine or motor power requirements due to increased weight.

In the event of inadvertent flight in icing conditions, exit the area immediately. Descend to warmer air, climb or descend to avoid clouds (get into drier air and get out of visible moisture), and turn away from area. With a temperature inversion, it may be necessary to climb to increase temperature.

10.5.7 Loss of VLOS (If VLOS is Required by Airspace Approval Authority)

If VLOS is lost:

1. Regain VLOS as soon as possible.

If VLOS cannot be regained:

1. Follow OEM/airspace approval authority procedures for loss of VLOS.

If VLOS is still not regained:

1. Enter hover mode, return home mode, or land UA immediately.

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CHAPTER 11

Extreme Weather

(SEE OEM operating manual and T/M/S flight clearance for detailed procedures and limitations.)

11.1 ICING

Icing may occur at outside air temperatures as high as 41 °F or 5 °C. The standard atmosphere lapse rate is -3.6 °F or -2 °C per 1,000 ft (305 m). This rate can be used to predict the temperature at a given altitude from a known altitude and temperature. Consider this rate during planning avoid potential icing conditions.

Note

Airframe icing increases drag, reduces lift, and increases weight of the UA.

11.2 COLD WEATHER

Refer to OEM manuals for cold weather operations.

11.2.1 Ground Operation

The UA, CS, and/or launch or recovery equipment may require preheating prior to flight operations.

11.2.2 In-Flight Operation

Refer to OEM manuals for cold weather operations.

11.3 HOT WEATHER

During hot weather operations, monitoring of UA, CS and/or launch or recovery equipment temperatures may be required. Refer to OEM manuals for hot weather operations.

11.3.1 Ground Operation

Operation of specific T/M/S equipment on the ground may require engine or motor cooling air, or external cooling air. Extended ground operation in hot weather may overheat electronic components.

11.3.2 In-Flight Operatons

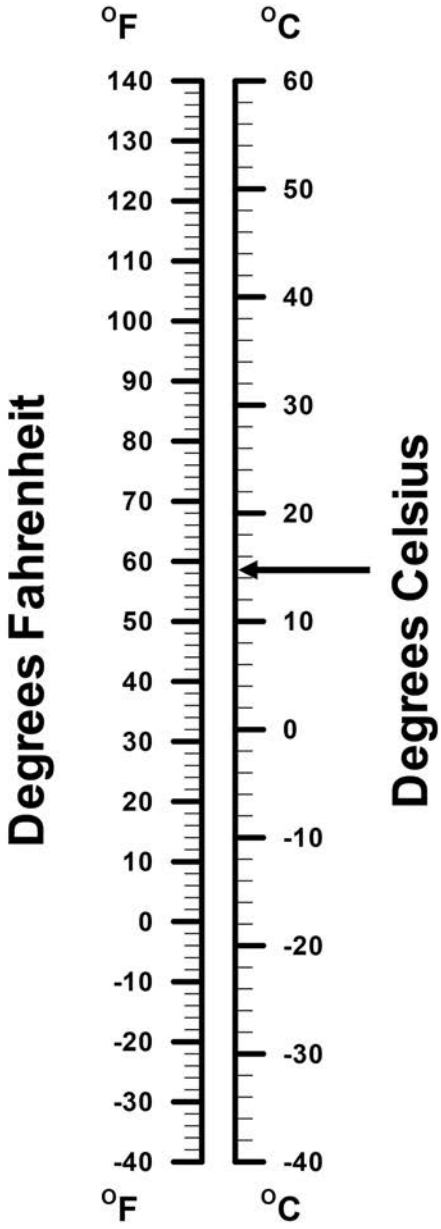
Hot weather raises DA. As a result, UA performance can be significantly reduced during hot weather operations. Warm air is less dense than cool air. The higher the temperature the higher the density altitude. For example, with an outside air temperature (OAT) of 95 °F (35 °C) at 1,000 ft MSL, the UA performs as if it is at 3,500 ft MSL. Density Altitude can be calculated using Figure 11-2.

Figure 11-1. Temperature Conversion Chart

Conversion formulas: °F = (°C x 1.8) + 32 °C = (°F - 32) / 1.8

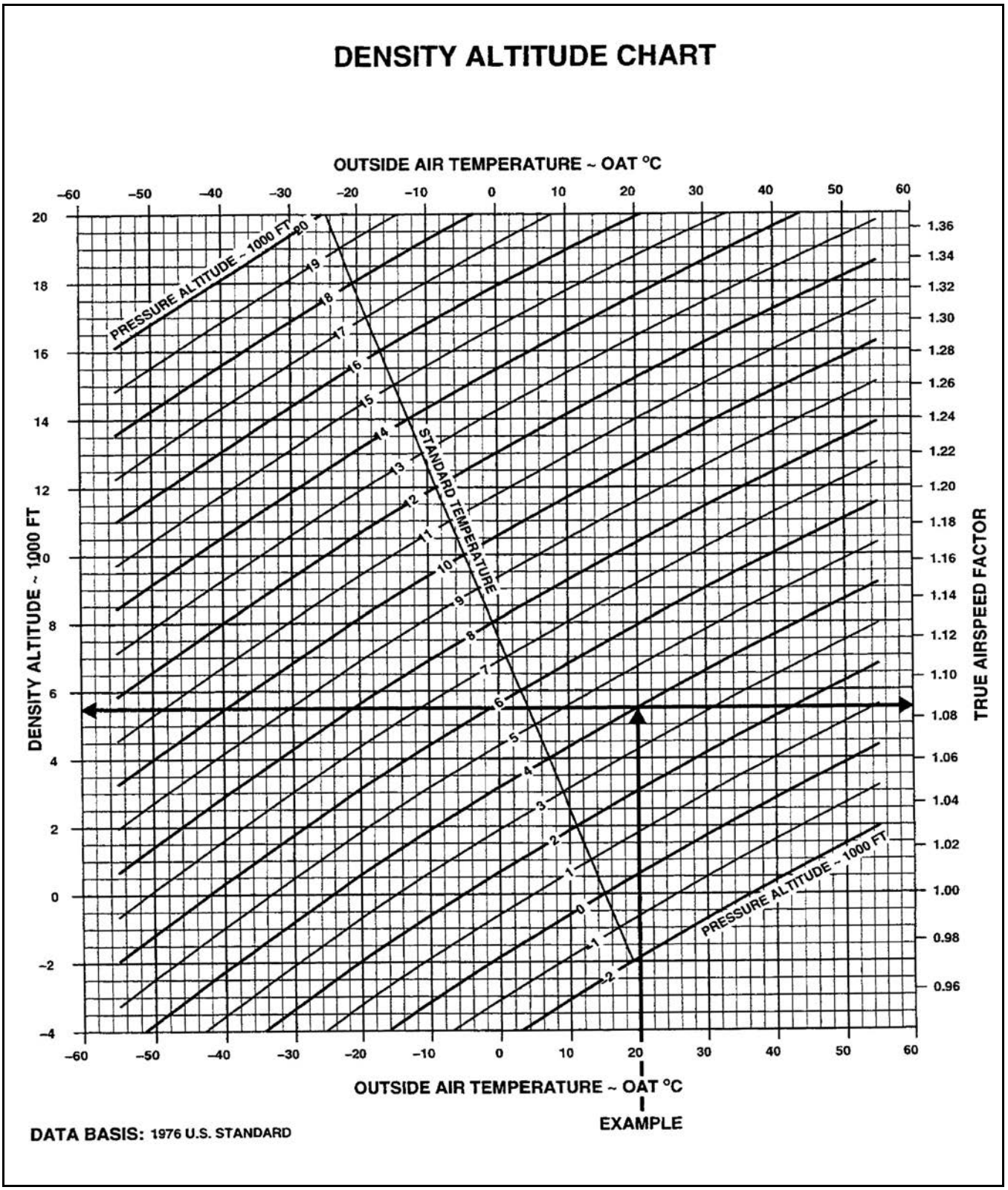
For interpolation: 1°C = 1.8°F

Use the chart below to convert temperatures.



Example:
15°C = 59°F (Std Day, Sea Level)

Figure 11-2. Density Altitude Chart



11.4 DESERT AND DRY WEATHER

Operation in a dusty environment may cause pitot tube or other orifices of the UA to clog. It is recommended to visually inspect UA after exposure to a dust environment.

Dust or dirt on the UA may impair aerodynamic performance. The UA should be cleaned before launch.

Take additional precautions to prevent damage associated with dust, sand, and high temperature. Certain components and systems (engine, fuel, oil, pitot-static, and CS connections) are susceptible to contamination, malfunction, or damage from sand and dust.

Close and seal UA hatches as required when sand and dust are blown. When the UA is not in use, cover or close all openings and store the UA in its storage box.

For short-term storage, store the UA in an environment similar to the temperature and humidity in which the UA operates. When the UA is stored in air-conditioned environment and then introduced to high temperature and humidity, condensation may form inside UA compartments.

11.5 WIND SHEAR, GUSTS, AND TURBULENCE

Wind shear is caused by sudden change in wind speed or direction over a short distance. A micro-burst is a sudden downward blast of air usually associated with convective activity.

Operating the UA in turbulence greater than moderate is not advised, but if the UA enters turbulence, limit exposure to turbulent conditions as much as practical.

Operation of the UA near the ground may be adversely affected by wind shears, micro-burst, and turbulence. During launch and recovery, maintain alertness when the weather changes rapidly and there are thunderstorms, passing storm fronts, and high wind gusts.

Check available forecasts, Airmen's Meteorological Information (AIRMET), and Significant Meteorological Information (SIGMET) advisories for convective or low-level wind shear turbulence.

11.6 THUNDERSTORMS AND LIGHTNING

Adverse or severe weather poses a significant threat to CS, ground personnel and GSE. AVOs shall use all available weather information to minimize potential loss of life and damage to equipment. Store and secure CS, and GSE as mission dictates.

11.7 VISIBLE PRECIPITATION

Environmental factors can change unexpectedly and the UA may be exposed to visible precipitation. If a UA incapable of safe flight in precipitation inadvertently enters into visible precipitation, consider environmental effects on UA. As required climb or descend to avoid clouds and/or turn away from the area to avoid precipitation.

The DAA/ARC shall establish specific operating guidelines for each T/M/S considering the effects of precipitation and its effects on the UAS during flight operations. Factors to be considered when developing operating guidelines include:

1. Effects of high humidity on UA, internal and external payloads, CS, launch and recovery equipment.
2. Effects of precipitation on UA, payloads, batteries, electronics, CS, launch and recovery equipment.
3. Availability of real time weather observations and or forecast.

Note

- Visible moisture includes rain and airborne moisture (humidity) that reduces visibility below 1 SM.
- If available, pitot heat should be used for flight in visible moisture.

CHAPTER 12

Weaponized UAS

12.1 UAS WEAPONIZATION

Category 3 UAS are prohibited from carriage and/or employment of live ordnance except when approved by a governing flight clearance.

See governing flight clearance for configuration, limitations and/or warnings, cautions, and notes.

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CHAPTER 13

Cybersecurity Safety/Cybersecurity

13.1 CYBERSECURITY

Cybersecurity is outside the scope of this manual. ARCs shall ensure compliance with DON Cyber Security Policies in regards to acquisition and operations of UAS.

Note

Unencrypted Command and Control and Sensor Data links are not secure and may be susceptible to exploitation. Images, video and/or flight records (including position information) may be uploaded to unsecure servers in other countries if air vehicle, ground station, E-Device, remote controller or laptop computers are connected to the internet.

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CHAPTER 14

Operational Risk Management

14.1 GENERAL

Risk is inherent in all tasks, training, missions, operations, and in personal activities no matter how routine. A frequent contributing cause in task degradation or mission failure is human error, specifically the inability to consistently manage risk. ORM reduces or offsets risks by systematically identifying hazards and assessing and controlling the associated risks, allowing decisions to be made that weigh risks against mission or task benefits while assessing their potential impact on operations. As professionals, Navy personnel are responsible for managing risk in all tasks while leaders at all levels are responsible for ensuring proper procedures are in place and that appropriate resources are available for their personnel to perform assigned tasks.

14.2 OPERATIONAL RISK MANAGEMENT (ORM)

ORM is a risk identification and mitigation tool, using a continuous loop process that identifies hazards, aims at implementing controls to mitigate the associated risks, and monitors the effects of the specific controls measures. The use of an ORM assessment is normally done during the preflight mission analysis (MA) stage.

ORM follows a five-step sequence:

1. Identify hazards (e.g., a weather brief, mission area/flight routes).
2. Assess hazards. Assessing hazards is done normally when completing mission planning and assessing the effects of weather, terrain, risks to people on the ground, and other aircraft, etc.
3. Make risk decision. Making risk decisions is done normally when determining the route, such as navigating around populated areas or selecting an altitude to avoid terrain.
4. Implement controls. Implementing controls comes in the form of SOPs, briefs, and rehearsals.
5. Supervise and watch for change.

14.3 THREE LEVELS OF APPLICATION

There are three application levels of ORM:

1. Time critical. In time critical ORM, very little time is available for assessment. Situational awareness and adaptability/flexibility are required to perform the five-step sequence.
2. Deliberate. In deliberate ORM, time is not an issue. Normal planning time is available to perform MA than in time critical ORM.
3. In-depth. In in-depth ORM, advanced planning time is allocated, so the integration into MA is easily accomplished.

14.4 FOUR PRINCIPLES OF APPLICATION

The four principles of applying ORM share a commonality with decision making, MA, and situational awareness.

1. Accept risk when benefit outweighs risk.
2. Accept no unnecessary risk.
3. Anticipate and manage risks by planning.
4. Make risk decisions at the right level.

During every mission, the decision must be made to either accept or decline the risks. Risks must provide a justifiable return for the effort. During the MA (planning) phase of the flight, risks are addressed using control measures and proper briefing techniques. The UAS crew, using good situational awareness, must identify those risks and deal with in-flight challenges as they occur appropriately.

14.5 UAS MISSION RISK ASSESSMENT

Refer to Appendix D for sample UAS Mission Risk Assessment.

APPENDIX A

BUQ Levels

A.1 PURPOSE

Appendix A establishes UAS training standards, Basic UAS Qualification (BUQs), for UASCs. Appendix A presents the knowledge requirements and knowledge-based skills required for each BUQ level.

A.2 BUQ LEVELS I-IV TRAINING

Each training level is inclusive of the previous levels (e.g., BUQ IV includes BUQ-I, II, and III tasks).

BUQ I and BUQ II training may be found online at the SUASMAN website via https://suasman.sofapps.net/Default.aspx. Utilize the "training" tab and navigate to the appropriate BUQ level training course. ARCs may approve locally created training programs which satisfy the required topics.

1. BUQ Level I: Knowledge and knowledge-based skills required to fly in VFR conditions in Class E, G, and Restricted/combat airspace <1200´AGL. BUQ-I is the minimum recommended training for UASC who perform duties other than UAC/AVO. Figure A-1 contains the required areas of knowledge for BUQ Level I.

Figure A-1. BUQ Level I

BUQ LEVEL I	
MISSION PREPARATION	
Aviation Weather	Aircraft Performance Data and Limitations
Crew Resource Management and Communications	Publications
Emergency Equip/In Flight Emergency Procedures	Departure and Arrival Planning
Flight Checklists and Use	Computerized Flight Planning Systems
Charts – Sectional, Tactical, and Global	Mission Route Selection & Analysis
International Civil Aviation Organization (ICAO)/Flight Information Publications Procedures	
COMMUNICATIONS	
Communication Planning and Management	Data Links
Knowledge of Airborne Communication Systems	
AIRCRAFT OPERATIONS	
Weather Hazards	Basic Manual Navigation
General Flight Rules	Low Level Flying
Fuel Planning	Aircraft System and Directives
Integrated Navigation Systems	Emergency Procedures
Aviation Principles	Manual Flight Control Skills
Time & Course Control	Air Tasking Order (ATO)
(1) BEFORE FLIGHT CATEGORY	
VFR Mission Planning	Exterior Inspection Checks
Weather Data for Mission Planning	Appropriate Communication Procedures
Operational Data for Mission Planning	Starting Engines Checks

Figure A-1. BUQ Level I (cont.)

(1) BEFORE FLIGHT CATEGORY (CONT.)	
Mission Briefing	
Map Preparation for use During Flight	Verbal Communication/Radio Procedures
Route Planning to Destination & Alternates	GPS Position Checks
En Route Altitudes IAW Flip	Pre-flight Clearances
Pre-flight Checks	Ground Control Station (GCS) Instrument Checks
Maintenance Logs	Before Takeoff Checks
(2) CONTACT CATEGORY	
Recognize departure and recovery procedures	
Appropriate climb airspeed	Controlling Rate of Descent
Establishing and maintaining altitude	Use of local area map for orientation
Applicable in-flight checks	
Turns, climbs, descents, as required	
Level-off checks	Approach to field checks
Basic area orientation	Basic AERO maneuvers
Current wind conditions	Before descent checks
	Automatic approach and landing
Go-around on final approach turn	Approach to landing
Airspeed change, straight-and level as required	Landing & rollout procedures
Go-ahead from final approach/flare	Go-around/missed approach checks
GCS Safety procedures	Post landing checks & procedures
Normal traffic pattern	Flight line and air discipline
Traffic pattern deconfliction	Final approach procedures
	Takeoff, initial climb & associated checks
Clearing airspace in direction of turn	Maneuvering within assigned airspace
Air configuration: Pre-landing checks	Airmanship, judgment & decision-making in aircraft (situational awareness)
	Stalls and recovery procedures
	Altitude/attitude control throughout flight
(3) INSTRUMENT CATEGORY — NO TASKS	
(4) NAVIGATION CATEGORY	
Visual navigation	Correlation of aircraft position with map
Map reading	Calculation of actual fuel consumption
Using visual landmarks in flight planning	In-flight navigation planning
Calculation/compensation for inflight winds	Time and fuel management
Calculation of new Estimated Time of Arrival (ETA)	Lost communication/Command and Control (C2) link procedures
(5) EMERGENCY CATEGORY	
Emergency conditions	Analyzing current situation, including systems for possible emergency
Aircraft control during emergency conditions	Recognition of applicable Emergency procedures
Communication/declaration of an emergency (if required)	Recognition and proper response to unplanned lost C2 link events

Figure A-1. BUQ Level I (cont.)

Land as soon as conditions permit	Unusual Attitudes and Recovery Techniques
(6) AFTER FLIGHT CATEGORY	
After landing checks	Completion of flight time logs
Engine shutdown checks	Completion of maintenance logs
All safety procedures for securing aircraft	Post landing procedures

2. BUQ Level II: Aviation knowledge and UAS knowledge–based skills required to fly in VFR conditions in Class D, E, G and Restricted/combat airspace <18,000´ MSL. BUQ Level II meets or exceeds the knowledge requirements of 14 CFR Sub-part J 61.309 and 61.311 for a FAA sport pilot license. Figure A-2 contains the required areas of knowledge for BUQ Level II. As stated above, tailoring of BUQ requirements toward individual UAS, and BUQ Levels are cumulative in nature.

Figure A-2. BUQ Level II

BUQ LEVEL II	
PREREQUISITES — ALL BUQ LEVEL I TASKS	
MISSION PREPARATION — NO NEW TASKS	
COMMUNICATIONS — NO NEW TASKS	
AIRCRAFT OPERATIONS	
Radio Aid Navigation	RADAR Navigation/Fixing
(1) BEFORE FLIGHT CATEGORY	
Compute takeoff and landing data	Clearance to taxi
Local VFR flight clearance	Clearance to takeoff
ICE-T/Ground speed	Taxing to runway
Filing DD 175/ICAO 1801 (Flight Plan)	Taxing into takeoff position
Interior inspection check	Line-up checks, Engine start checks
Before taxi checks	Operation of navigation radios
(2) CONTACT CATEGORY	
Appropriate climb per manuals	Requesting and receiving landing clearance
Basic departure procedures	Local breakout procedures
Leveling off from TECH order climb	Closed patter
(3) INSTRUMENT CATEGORY — NO NEW TASKS	
(4) NAVIGATION CATEGORY	
Position reporting	Usage of Pilot to Metro Service (PMSV) and Air Traffic Information Service (ATIS), and Pilot Report (PIREP)
In-flight clearance	Interpretation of radio weather condition report
Dead reckoning navigation	Navigation Diversions based on weather reports
Actual and planned rate of fuel consumption	Comparing actual and planned groundspeeds
(5) EMERGENCY CATEGORY — NO NEW TASKS	
(6) AFTER FLIGHT CATEGORY	
Taxing clear of runway	Closing a flight plan with ATC
Taxing to parking	

3. BUQ Level III: Knowledge and knowledge-based skills required to fly in VFR conditions in airspace below 18,000′ MSL. BUQ Level III meets or exceeds the knowledge requirements of 14 CFR Sub-part E 61.105 and 61.107 for FAA private pilot license. Figure A-3 contains the required areas of knowledge for BUQ Level III. As stated above, tailoring of BUQ requirements toward individual UAS, and BUQ Levels are cumulative in nature.

Figure A-3. BUQ Level III

BUQ LEVEL III	
PREREQUISITES — ALL BUQ LEVEL I AND II TASKS	
MISSION PREPARATION — NO NEW TASKS	
COMMUNICATIONS — NO NEW TASKS	
AIRCRAFT OPERATIONS	
Basic Instrument Flight	Instrument Flight Procedures
(1) BEFORE FLIGHT CATEGORY	
Instrument Flight Rules (IFR) mission planning	
Operation of Air Traffic Surveillance Equipment (Identification, Friend or Foe/Selective identification Feature/Traffic Collision Avoidance System/Sense and Avoid Sensors)	
(2) CONTACT CATEGORY	
Normal Overhead pattern	
(3) INSTRUMENT CATEGORY	
Partial panel instrument flight	Aircraft maneuvers under instrument conditions
Recognition of improper nose low condition	Course intercept
Rate of intercept	Angle of intercept
Recognition and recovery from unusual attitudes under instrument conditions	Operation of aircraft instruments and navigation equipment
Hazardous/adverse weather conditions in flight	Weather phenomena which affect flight
Establishing and maintaining constant altitude, airspeed, and heading during instrument flight	
(4) NAVIGATION CATEGORY	
Unfamiliar field departure procedures	Low level navigation
Unfamiliar field visual and instrument approach procedures	
(5) EMERGENCY CATEGORY — NO NEW TASKS	
(6) AFTER FLIGHT CATEGORY — NO NEW TASKS	

4. BUQ Level IV: Knowledge and knowledge-based skills required to fly VFR/IFR in all weather conditions in airspace up to FL600. BUQ Level IV meets or exceeds the knowledge requirements of 14 CFR Sub-part F 61.125 and 61.127 for an FAA commercial pilot license with instrument rating. Figure A-4 contains the required areas of knowledge for BUQ Level IV. As stated above, tailoring of BUQ requirements toward individual UAS, and BUQ Levels are cumulative in nature.

Figure A-4. BUQ Level IV

BUQ LEVEL IV	
PREREQUISITES — ALL BUQ LEVEL I, II AND III TASKS	
MISSION PREPARATION	
Global Flight Ops Knowledge	
COMMUNICATIONS	
Satellite Communications (SATCOM)	
AIRCRAFT OPERATIONS	
Global Navigation Procedures	
AIR OPERATIONS	
Search and Rescue (SAR)	
(1) BEFORE FLIGHT CATEGORY — NO NEW TASKS	
(2) CONTACT CATEGORY — NO NEW TASKS	
(3) INSTRUMENT CATEGORY	
Auto/instrument takeoff, climb, and departure procedures	Departing a holding pattern
Instrument cross check	Procedure turns
Intercepting a heading at a predetermined angle	Transitioning from Minimum Descent Altitude (MDA) to runway
Establishing and maintaining appropriate heading	ATC/approach control clearances
Determination of lead point	Standard instrument approach Plate procedures
Course interception	Procedure turn airspace
IFR Navigation	En Route descents
Fix-to-fix navigation	Appropriate Landing Configuration
Maintaining selected course with wind correction	Descent gradients
Knowledge of establishing Arc	Instrument Meteorological Condition (IMC) penetration
Arc interception	ATC clearances
Arc maintenance	ATC procedures
Radial interception from Arc	Remaining within cleared airspace
Holding/loitering	Controlling Rate of Descent
Understanding holding instructions	Instrument approach procedures
Holding pattern entry	RADAR patterns
Maintaining position within holding pattern airspace	Following Ground Controlled Approach (GCA) controller's directions
Wing analysis in holding pattern airspace	Turning to directed headings
Maintaining directed altitudes	Glide slope control
Maintaining proper airspace	Course control
Establishing proper holding configuration	Transitioning from instruments to visual references
(3) INSTRUMENT CATEGORY (CONT.)	

Figure A-4. BUQ Level IV (cont.)

Precision RADAR approach	Visual Descent Point (VDP)
Non-precision RADAR approach	Circling approach procedures
Gyro-out instrument pattern	Missed approach procedures
Half-standard rate turns on final	ATC missed approach clearances
Gyro-out precision RADAR approach	Missed approach checks
Corrections to aircraft heading	Transitioning from glide path to runway
In-flight IFR Clearance	
(4) NAVIGATION CATEGORY — NO NEW TASKS	
(5) EMERGENCY CATEGORY — NO NEW TASKS	
(6) AFTER FLIGHT CATEGORY — NO NEW TASKS	

APPENDIX B

Operating Locations, Right of Way Rules, and Airspace Operations

B.1 OPERATING LOCATIONS

To the maximum extent practicable, DON Group 1-2 UAS operations should be conducted on military-controlled property and within military-delegated airspace. Unless mission requirements dictate, operations on civil-controlled property and within civil-controlled airspace will be avoided.

B.2 RIGHT OF WAY RULES

B.2.1 Background

Right of way rules contained in 14 CFR part 91.113 shall be understood and followed by all aircraft. Additionally, DON Group 1-2 UA right of way rules contained in Paragraph B.2.2 are derived from DON Group 1-5 UA right of way rules established for operations within U.S. civil airspace.

B.2.2 DON Group 1-2 UA Right-of Way Rules

Regardless of the airspace, the right of way rules contained herein will be followed unless otherwise directed by the applicable airspace approval authority. DON Group 1-2 UA must yield right of way to manned aircraft. AVOs should take action early to prevent a potential conflict from developing into an unsafe situation. DON Group 1-2 UA will also yield right of way to Group 3-5 UA. In the event of a conflict between two Group 1-2 UA, both AVOs are responsible for maneuvering their UA as to avoid a potential collision.

B.3 AIRSPACE OPERATIONS

B.3.1 Flight Operations in U.S. National Airspace System (NAS) Outside of Active Restricted Areas and Warning Areas

B.3.1.1 Background

DON UAS flight operations in U.S. NAS outside of active Restricted Areas and Warning Areas shall be IAW the OPNAV Requirements and Guidance for Access to and Operations within United States Civil Airspace by Department of the Navy Unmanned Aircraft Systems and, to the extent capable, 14 CFR Part 91. Since UAS are unable to comply with all aspects of Part 91, an Alternate Means of Compliance (AMOC) must be authorized via an FAA COA or DON AAA for any portion of Part 91 that the UAS cannot follow. Any deviations from Part 91 rules must be authorized in the FAA COA or DON AAA.

B.3.1.2 Statement of Airworthiness

A NAVAIRSYSCOM issued Statement of Airworthiness is required for DON UAS operations in U.S. NAS outside of active Restricted Areas and Warning Areas. A Statement of Airworthiness in the form of an IFC or a NAVAIRSYSCOM issued Memorandum for Record may contain a Statement of Airworthiness for DON UAS operations in U.S. NAS outside of active Restricted Areas and Warning Areas. Each platform's IFCs are unique and requests for FAA COA and/or DON AAA shall not be submitted for operations restricted by the IFC.

B.3.1.3 U.S. NAS Airspace Operating Limitations under an FAA COA or DON AAA

The FAA COA and DON AAA establish mandatory operating provisions to ensure the level of safety for DON UAS flight operations in the NAS meets or exceeds that of manned aircraft. They may be unique to the intended mission, and specify the time period, circumstances, and operating conditions under which the UAS must be operated. Operating limitations specified in the FAA COA or DON AAA will be derived from those contained in "Requirements and Guidance for Access to and Operations within United States Civil Airspace by DON UAS".

For UAS operations that are not locally based, and will occur within an installations' CFR 99.7 Special Security Instruction (SSI)/National Defense Airspace, approval for operations must be obtained from the cognizant installation Base Commanding Officer. Verification is required that missions within the SSI meet the authorized list of exceptions within the FAA/DoW Joint Standard Operating Procedures (JSOP) for UAS Specific SSI. An authorization memorandum or Letter of Agreement from the Installation Commanding Officer must be submitted with the COA/AAA request.

B.3.2 Flight Operations in Active Restricted Areas and Warning Areas

Flight operations in active restricted areas and warning areas shall be IAW applicable scheduling and operating procedures as provided by Using or Scheduling Agency. Furthermore, flight operations in active warning area airspace in international airspace shall be IAW DoDI 4540.01 Due Regard procedures.

1. Intentional flight over non-participating personnel, congested areas, vessels, open air assemblies of people, or heavily trafficked roads is prohibited.

B.3.3 Flight Operations in Prohibited Areas

Flight operations within prohibited area airspace require a separate approval from FAA Systems Operations Security offices. These requests are submitted via the Regional FAA NAVREP.

B.3.4 Flight Operations in International Airspace

Flight operations in international airspace outside of active warning area airspace shall be IAW ICAO flight procedures or DoDI 4540.01 Due Regard procedures.

Flight operations shall be planned/conducted to avoid overflight of personnel, populated ground areas, and to minimize exposure to manned aircraft. When mission requirements dictate the need to operate over personnel, populated or congested areas, deliberate and/or time critical operational risk management shall be conducted with due consideration of the population density and hazards to personnel on the ground.

Note

The AVO is responsible for ensuring that there is a safe operating distance between manned aircraft and the UA.

B.3.5 Flight Operations in Foreign National Airspace

Foreign national airspace operations shall be IAW foreign national operating and flight rules, and applicable host nation agreements.

B.3.6 Flight Operations in Joint Operating Areas, Combat and Contingency Airspace

Flight operations in joint operating areas, combat and contingency airspace shall be IAW the U.S. recognized airspace authority. For joint doctrine, see Joint Publication 3-30 "Command and Control for Joint Air Operations" and Joint Publication 3-52 "Joint Airspace Control". For employment guidance, see MCRP 3-20.5 "UAS Operations" or NTTP 3-55.14 "Multi-Service Tactics, Techniques, and Procedures for UAS".

APPENDIX C

UAS Groups

C.1 EXPLANATION OF UAS GROUPS

All current and currently planned DOD UAS fall into one of the five UAS groups depicted in Figure C-1.

Figure C-1. Unmanned Aircraft Systems Categorization Chart

UA CATEGORY	MAXIMUM GROSS TAKEOFF WEIGHT (LBS)	NORMAL OPERATING ALTITUDE (FT)	SPEED (KIAS)
Group 1	0-20	<1,200 AGL	100
Group 2	21-55	<3,500 AGL	<250
Group 3	<1320	<18,000 MSL	<250
Group 4	>1320	<18,000 MSL	Any Airspeed
Group 5	>1320	>18,000 MSL	Any Airspeed

Figure C-2. UAS Operating Parameter Legend

Legend:			
AGL	above ground level	ft	feet
KIAS	knots indicated airspeed	kts	knots
MSL	mean sea level	lbs	pounds
UA	unmanned aircraft		

These groups are based on UA gross weight, normal operating altitude and airspeed, and are independent of tasking authority, echelon of command and control authority, and type of payload. For example, a UA that weighs 10 pounds and is normally operated below 1,200 ft. AGL at speeds less than 100 knots, is categorized a Group 1 UAS. A UA possessing one attribute of the next higher numbered group is categorized in the higher numbered group. For example, a UA that weighs less than 20 pounds, and is normally operated above 1,200 ft. AGL at speeds less than 250 knots is a Group 2 UAS.

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APPENDIX D

Sample Operational Risk Management Matrix

D.1 UAS MISSION RISK ASSESSMENT

Figure D-1. UAS Mission Risk Assessment

UAS MISSION RISK ASSESSMENT					
Flight Event #:	Date:		Assessment Completed By:		
Risk Level	**0**	**+1**	**+2**	**High Risk (Automatic ARC Approval)**	**Item Risk**
Winds	Variable	0 - 13 Knots	14 - 19 Knots	>20 Knots	
Sea State	0 - 1 ft	1 - 3 ft	3 - 4 ft	>4 ft	
Ceiling	>1,500 ft	1,000 - 1,500 ft	500 - 1,000 ft	<500 ft	
Visibility/Night Ops	>3 SM	2 SM - 3 SM	1/2 SM - 2 SM	<1/2 SM	
Turbulence	None	Light	Moderate	Severe/Extreme	
Precipitation	None	Light	Moderate	Heavy	
Temperature	32 °F - 90 °F	91 °F - 104 °F	105 °F - 119 °F	>120 °F	
Operator Experience (AVO)	>100 Hours	50 - 100 Hours	10 - 50 Hours	<10 Hours	
Days Since Last Flight	<30 Days	30 - 45 Days	45 - 60 Days	>60 Days	
Operator Rest	>8 Hours	6 - 8 Hours	4 - 6 Hours	<4 Hours	
Mission	Routine	Unusual	Complex	Unconventional	
			Total ORM score		
Mitigations for High Risk level scores:					

Low Risk (AVO Approval)	Moderate Risk (AVO & VO Approval)	High Risk (ARC Approval)
0 - 10	10 - 18	>18
Air Vehicle Operator (AVO)	Name: Signature:	Date:
Visual Observer (VO)	Name: Signature:	Date:
Aircraft Reporting Custodian (ARC)	Name: Signature:	Date:

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APPENDIX E

Sample Mission Briefing Guide

E.1 UAS MISSION BRIEFING GUIDE CHECKLIST

Figure E-1. Sample Mission Briefing Guide

PRE-BRIEF ITEMS
☐COA ☐ NOTAMS
☐ Weather
☐ Laser Operations

ROLL CALL
☐ All Parties Present

MISSION OBJECTIVES
☐ Primary Objective
_____
☐ Secondary Objective
_____
☐ Mission Overview
☐ Mission Plan Validated

MISSION TIMES
☐ Walk Time _____
☐ Start/Check-in _____
☐ Takeoff _____
☐ Op Area _____
☐ Land _____

FLIGHT LINEUP
☐ AVO and Call Sign
_____/_____
☐ Additional Players
_____
☐ Responsibilities

RANGES
☐ Airspace Scheduled
☐ Airspace Conflicts
☐ Tower Coordination

CONFIGURATION REVIEW
☐ Weight & C.G.
☐ Software Configuration
☐ Hardware Configuration
☐ Recent Maintenance & Gripes
☐ Battery Status

Limitations & Procedures
☐ Pertinent Limitations
☐ Go/No Go Criteria/Parameters
☐ Special Preflight Procedures
☐ Knock-it-off Criteria
☐ Expected Results
☐ Emergency Procedures

STANDARD CALL OUTS
☐ Knock-it-Off/Abort/Terminate Calls
☐ Unique Calls
☐ Comms Responsibilities
☐ VO Responsibilities

Operational Risk Management (ORM)
☐ ORM Review
☐ Qualitative Risk Level

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APPENDIX F

Sample EMC SOFT Checklist

F.1 EMC SOFT SAMPLE CHECKLIST

Figure F-1. EMC Soft Checklist

BuNo:	Installation:
Date:	Conducted by:
Location	Signature:

SOF Equipment	System Check	Baseline Check	EMI Check
Comm/Nav			
Crew Comm Radios	Check for normal ops around aircraft		
Primary Link	Ensure normal link indications		
Secondary Link (if equipped)			
Payload/Video Link	Ensure normal operation of each		
IFF (if equipped)	Check for power, normal operations		
SAASM GPS (if equipped)	Check GPS status		
Primary GPS	Check GPS status		
Secondary GPS (if equipped)	Check GPS status		
Flight Instruments/Controls	Monitor instruments/indicators for erroneous readings		
Autopilot	Check for normal operations		
Magnetometer (if equipped)	Check for normal operations		
Servos	Check for commanded movements only		
Control Surfaces	Check flt controls free and clear		
Engines	Monitor instruments/indicators for erroneous readings		
Ignition System	Ensure smooth running engine		
Lighting (if equipped)			
Strobe lights	Check for normal operation		
Navigation/Position lights	Check for normal operation		
Launcher (if equipped)			
Launcher Remote Console	Check for normal operation		
ECIM	Check for normal operation		
Mission Equipment (Non-SOF)			
GCS/Hand Controller Video downlink	Normal link indications – good video		
Remote Video Terminal downlink	Normal link indications – good video		
Additional systems	Check for normal operation		

Note

- The EMC SOFT should be executed (EMI Check column) for each potential source of EMI individually and then one final test with all known emitters operating simultaneously.
- This guide is not all encompassing. Individual UAS may have more or less systems that shall be checked for EMI.

APPENDIX G

Safety Management and Safety Reporting

G.1 PURPOSE

OPNAV M-3750.6 Naval Aviation Safety Management System (SMS) establishes UAS mishap reporting requirements. Unit commanding officers are responsible for establishing a safety program and complying with applicable safety policies, provisions and mishap reporting requirements provided in OPNAV M-3750.6. All personnel, from UAS operators to the commanding officer, share the responsibility to conduct UAS operations in a safe manner. Because of their size, weight, and operating altitudes, improperly handled Group 1 and 2 UAS can present serious (and potentially catastrophic) hazards to low flying aircraft, in addition to personnel on the ground. Conducting operations in a safe manner ensures the preservation of a critical war fighting capability through the prevention of UAS related mishaps, injuries or fatalities. ARCs/unit commanders shall ensure that the unit establishes UAS safety procedures addressing standard operating, preventive, emergency, and reporting procedures; moreover, UAS personnel shall be aware of unique operational challenges and shall adhere to all safety requirements to minimize the potential risks. When these risks are not identified beforehand, the risk of a mishap greatly increases.

G.2 INCIDENTS, HAZARDS, AND AVIATION MISHAPS

G.2.1 Incidents

OPNAV M-3750.6 defines an incident as "the loss or impairment of effectiveness or utility of an item that has occurred solely because of normal and customary use of the item for its intended purpose" with total damage costs of less than $25,000.

OPNAVINST F3100.6 provides the procedures for submitting Special Incident Reports (OPREP-3, Navy Blue and Unit SITREP). Do not construe the requirement for submitting a Special Incident Report with those of a Mishap Report.

G.2.2 Hazards

OPNAV M-3750.6 defines hazards as, “any real or potential condition that can cause injury, illness, or death to personnel; damage to or loss of a system, equipment or property; or damage to the environment.” A near miss is an undesired event that, under slightly different circumstances, would have resulted in personal harm, property damage, or undesired loss of resources. The goal of the Naval Aviation SMS is to identify and eliminate hazards and identify near misses before they result in mishaps. The medium for highlighting hazards before they contribute to a naval aviation mishap is the HAZREP. Submit HAZREPs whenever the potential for damage or injury exists.

G.2.3 Aviation Mishaps

The term “aviation mishap” is a sub-category of mishaps. Under the category of aviation mishap, manned aircraft and UAs use the same investigation and reporting processes, but are usually considered separately for statistical purposes. OPNAV M-3750.6 provides the methodology for determining reporting thresholds and Mishap Reporting Categories. The current minimum threshold for reporting a mishap occurs when the total cost of damage to DoW or non-DoW property, aircraft or UAs is $25,000 or more; or a recordable injury (greater than first aid) or illness results.

Note

A Hazard Report does not meet the mishap threshold. HAZREPs include near misses and reportable safety incidents for community awareness.

G.2.4 Mishap and Hazard Reporting

If a mishap involves Naval UAS, the unit involved shall report the mishap and will conduct the mishap investigation. In all cases, units shall complete mishap reporting via Risk Management Information — Streamlined Incident Reporting (RMI-SIR), located at http://afsas.safety.af.mil/my.policy. A unit safety officer is highly encouraged to prepare this wherever practical.

G.2.5 Web-Based Safety System

The Naval Safety Center worked with the USAF and developed RMI-SIR to allow units to submit recordable/reportable mishaps by electronic means. This method of reporting alleviates administrative burden, eases routing, and provides timely access to data reports. RMI-SIR provides data fields matching the information required in the sensitive information report (SIREP) format, for the applicable mishap types. To allow for local management of access to RMI-SIR mishap reporting and data retrieval, each UAS command or activity will designate an individual(s) to serve as their RMI account holder. This is typically the safety manager, safety officer, executive officer, regional safety manager, etc., who manages RMI-SIR mishap reporting for one or more commands or activities. This individual will need to request a RMI-SIR account.

For additional information regarding safety reporting requirements: Mr. Adam Hyams, Deputy Director Aviation Safety Programs, Naval Safety Center, (757) 444-3520 x7226, adam.e.hyams@navy.mil.

G.2.6 Systems Logs and Recordings

To facilitate incident and mishap reporting, UAS flights should be recorded using the ground control station's recording capability if applicable. Recordings and system logs should be preserved, under the authority of the unit commanding officer, following an incident or mishap to assist with reviews or investigations. Handling and retention of UAS flight recordings shall be IAW OPNAV M-3750.6 as this data may be considered either privileged or non-privileged information depending on the content. Instructions for downloading system logs files may be found in the applicable UAS OEM manual if the capability is included.

G.3 UA RECOVERY AFTER MISHAP

While not disposable, Group 1 and 2 UAS are designed to be expendable in support of operations. If a UA is lost during training every reasonable effort shall be made to recover it. If a UA is lost during combat operations a recovery may be attempted, if it is tactically prudent and the environment is permissive enough to execute a recovery without undue risk to personnel. Specific requirements for recovering downed UA may be addressed by theater or higher headquarters directives.

G.3.1 External Tracking Devices

An external tracking device may be used when required by Range Commander or unit CO policy for UAS testing or training flights in order to maximize the chance of recovering a downed UA. Additional Cyber Security requirements may apply.

APPENDIX H

Establishment of a Flying Activity

H.1 MINIMUM REQUIREMENTS FOR PURSUIT OF AN IFC AUTHORIZING THE OPERATION OF A SPECIFIC UAS

Note

The ACC or DAA may establish additional requirements.

1. Identify ACC or DAA (If none in chain of command coordinate with 1st level flag or general officer to declare DAA).
2. Designation letter from ACC or DAA authorizing the establishment of the Group 1 & 2 UAS ARC. See Figure H-2.
3. Higher Probability of Loss (HPOL) Letter for each UAS operated by the unit. See Figure H-3.
4. Seek COTS Waiver, see Chapter 13 Cyber Safety/Cyber Security.

H.2 ACC OR DAA RESPONSIBILITY CHECKLIST

1. ACC or DAA appoint a POC to provide initial and recurring annual inspections (oversight) of designated ARCs.
2. Endorse all Cyber Policy Documents.
3. Ensure Inventory Management and reporting as required. See Figure H-4.
4. Designate in writing UAS ARCs under their cognizance. See Figure H-5.
5. Delegate ARC UAS Crewmember designation authority.

H.3 ARC RESPONSIBILITY CHECKLIST

1. Train and Designate UASC in writing. See Figure H-6.
2. Draft and route all required Cyber Policy Documents via the ACC or DAA.
3. Comply with Naval Lithium Battery Certification Policy.
4. Ensure Radio Frequency Spectrum approval per OPNAVINST 2400.20.
5. Ensure assigned UAS AVOs are trained on, and comply with, Domestic Use policy contained in SECNAV Instruction 3700.2.
6. Establish a safety program and comply with applicable safety policies, provisions and mishap reporting requirements in OPNAV M-3750.6.
7. Establishment of a Unit UAS SOP to address the minimum requirements of this manual. See Paragraph H.4 for a basic requirements listing.
8. Laser Safety Review Board approvals for Laser operations when applicable.
9. Designate a POC for FAA and DON Airspace Access Authorization Account Access. See Figure H-6.
10. Establish inventory management and reporting process IAW DAA requirements.
11. Establish an UAS identification marking system.

12. Obtain IFCs from COMNAVAIRSYSCOM.
13. Ensure that takeoff and landing procedures are in place to ensure standardization during critical phases of flight Designate Detachment Unit Commanders as required.
14. ARC awareness of a Contract for which an GFR has been assigned or a Contract for which an GFR should be assigned. See Paragraph 1.4.

H.4 UNIT SOP CHECKLIST

ARC shall establish an SOP to address the following requirements as they apply to the unit.

Figure H-1. Unit Standard Operating Procedures Checklist

☐	UASC Positions. See paragraphs 1.2.2, 2.2, and Chapter 5.
☐	UASC Training requirements. See Paragraph 1.2.3 and Chapter 5.
☐	ATC Communication Procedures.
☐	UASC Training Documentation.
☐	UAS CS to CS handoff procedures.
☐	Hand Launch procedures.
☐	Swarming and Multi-vehicle operation procedures.
☐	Mission Briefing.
☐	Flight Time Limits. See Paragraph 5.4.1.1.
☐	UASC Flight Records for currency and proficiency tracking.
☐	UAS Inventory management.
☐	Lithium Battery Storage. See Paragraph 2.4.1.1.1 and Chapter 3.
☐	Safety. See Paragraph 1.2.4.
☐	Establish procedures to address security; e.g., physical security of UAS, classified material and equipment, etc. See Paragraph 1.2.1.
☐	Mishap Reporting Procedures. See Paragraph 6.1.5.3.
☐	Procedure to report Flight Deviations.
☐	Flight Authorization process. (Daily, Weekly or Duration of Unit Operation) See Paragraph 1.2.1.1.
☐	DON AAA/FAA COA process.
☐	Transfer of UAS responsibilities during flight to include UASC briefing requirements. (Applies to long endurance UAS such as Tethered UAS).
☐	Maintenance procedures and documentation.

Figure H-2. DAA Self Designation Letter

LETTERHEAD

MEMORANDUM FOR THE RECORD

Subj: ASSUMPTION OF DESIGNATED APPROVAL AUTHORITY FOR GROUP 1 AND 2 UNMANNED AIRCRAFT SYSTEMS OPERATIONS AT ORGANIZATION

Ref: (a) CNAF M–3710.9

1. In response to reference (a), ORGANIZATION TITLE (0-7 or SES), NAME herewith assumes the authorities and responsibilities of the Designated Approval Authority (DAA) for Unmanned Aerial Systems (UAS) operations at ORGANIZATION.

2. The DAA is the flag or general officer or SES equivalent who assumes Aircraft Controlling Custodian (ACC) authorities and responsibilities when an ACC is not designated. Duties found in reference (a) include, but are not limited to:

   a. Exercising administrative control of assignment, employment, and logistic support of UAS under their cognizance.

   b. Designating in writing UAS Aircraft Reporting Custodian(s) (ARC).

   c. Provide the necessary oversight to ensure the ARC is maintaining the requisite personnel, training, equipment, and infrastructure to support safe UAS flight operations in compliance with DON policies, and instructions.

   d. Maintaining a single inventory of all UAS in subordinate commands/units, their configuration/status, and the ARC responsible for their operations.

3. The DAA point of contact for ORGANIZATION is NAME, PHONE, EMAIL.

4. The DAA authority assumed is effective the date of this memorandum and will remain in effect unless accepted by another individual or upon departure from ORGANIZATION.

X. X. XXXXXX
DAA TITLE

Copy to:
CNAF (N45)
NAVAIR ACO
NAWCAD AIRWorks

Figure H-3. Higher Probability of Loss (HPOL) Letter

LETTERHEAD

MEMORANDUM (Date)

From: *(fill in Command/Organization)*

To: Director, Airworthiness and CYBERSAFE Directorate, Naval Air Systems Command, Patuxent River (ATTN: PEO (U&W) Division)

Ref: (a) NAVAIR Instruction 13034.1 (Series), Airworthiness Policy

Subj: ACKNOWLEDGEMENT OF HIGHER PROBABILITY OF LOSS FOR *(fill in Command/Organization) (fill in UAS name, or leave blank if multiple UAS)* CATEGORY 3 UNMANNED AIRCRAFT SYSTEM (UAS)

1. Per Ref (a), Category 3 UAS flight clearances are issued for UAS that are not designed to meet accepted engineering standards and/or where there is insufficient engineering data to assess compliance with competency established airworthiness criteria or standards (Category 3 UAS and Category 3 UAS flight clearance may be used interchangeably). As such, this letter provides *(fill in Command/Organization)* acknowledgement of higher probability of loss and acceptance of risk of material loss for Unmanned Aircraft systems in support of NAVAIR Category 3 Interim Flight Clearances issued to *(Command/organization)*.

2. Higher probability of loss is acknowledged by *(fill in Command/Organization)* for Unmanned Aircraft systems.

3. Acknowledgement of higher probability of loss does not alleviate Owner/Sponsor/Aircraft Reporting Custodian from OPNAV M-3750.6 Naval Aviation Safety Management System reporting requirements.

4. *This paragraph optional– expiration date not required:* This acknowledgement of higher probability of loss expires DD MMM YYYY).

X. X. XXXXXX
DAA TITLE

Copy to:
ARC
NAVAIR ACO
NAWCAD AIRWorks or PMA responsible

Figure H-4. Inventory Data Requirements Example

UAS Owning Unit Information					
DoN Owning Unit	Owning Unit Location	Location UAS Stored		Location UAS Used	
Unmanned Air System (UAS) Information					
Make	Model	Version Number	Quantity	UAS Country of Origin	Current Exemption (Waiver) Expiration Date MM/DD/YYYY
Control Station (CS) Information					
Make	Model	Version Number	SW Version	Quantity	CS Country of Origin

Figure H-5. ARC Designation Letter

LETTERHEAD

MEMORANDUM FOR THE RECORD

Subj: DESIGNATION OF *(ARC title)* AS *(Organization)* AIRCRAFT REPORTING CUSTODIAN FOR NON-PROGRAM OF RECORD UNMANNED AERIAL SYSTEMS OPERATIONS BY *(Organization)*

Ref: (a) CNAF M-3710.9
(b) CNAF M-3710.7
(c) COMNAVAIRFORINST 4790.2 (Series)
(d) OPNAV M-3750.6

1. IAW reference (a), as the *(Organization)* Designated Approval Authority (DAA), I hereby designate *(ARC title)* as a Group 1 and 2 Unmanned Aerial System (UAS) Aircraft Reporting Custodian (ARC). UAS policy is documented in references (a) through (d). Your duties as ARC include, but are not limited to:

   a. Carrying out your responsibilities as an ARC IAW references (a) through (d).

   b. Maintaining the requisite personnel, training, equipment, and infrastructure to support safe flight operations in compliance with Department of Navy policies and instructions.

   c. Maintaining and reporting on single inventory of all UAS in subordinate commands/units and their configuration/status to the DAA IAW reference (c).

   d. Reporting Mishaps IAW reference (d).

2. As an ARC, you are hereby delegated the authority to approve UAS crewmember qualifications and certifications. You shall ensure that each UAS crewmember has completed the requisite training for the applicable crewmember classification. UAS crewmember classifications are provided in reference (a). You shall issue a written designation letter to each qualified individual upon their designation. Copies of each designation letter must be retained in the individual crewmember's training jacket.
3. I hereby delegate you the authority to submit Category 3 flight clearance requests to NAVAIR for *(Organization)* Group 1 and 2 UAS on behalf of the DAA.

4. This ARC delegation is effective the date of this memorandum and will remain in effect unless otherwise directed or upon your departure from *(Organization)*.

X. X. XXXXXX
DAA TITLE

Copy to:
ARC
CNAF (N45)
NAVAIR ACO
NAWCAD AIRWorks

Figure H-6. UASC Designation Letter

LETTERHEAD

MEMORANDUM FOR THE RECORD

From: *(Organization)* AIRCRAFT REPORTING CUSTODIAN

To: *(Title)*

Subj: DESIGNATION AS UNMANNED AIRCRAFT SYSTEM AIR VEHICLE OPERATOR

Ref: (a) MEMORANDUM OF ARC DESIGNATION

1. After a complete audit of your UAS training record and under the authority granted to me by the *(Organization)* DAA in reference (a), you are hereby designated as an Air Vehicle Operator (AVO) for any *(Organization)* owned and operated *(Vehicle(s))*.

2. In addition to understanding the policies and procedures upon which your initial qualification training was based, hence forth you shall comply with all applicable unit-level policies and procedures regarding operational readiness and training.

3. This designation is effective the date of this memorandum and will remain in effect unless otherwise directed upon your departure from this unit.

X. X. XXXXXX
ARC TITLE

Copy to:
Training Jacket

Figure H-7. UAS Airspace Access Applicant Designation Letter

LETTERHEAD

From: Aircraft Reporting Custodian *(Command/Unit)*

To: *(Rank First Name Middle Initial Last Name)*

Subj: DON UNMANNED AIRCRAFT SYSTEM (UAS) AIRSPACE ACCESS APPLICANT DESIGNATION

Ref: (a) OPNAV memo 3700 Ser N98/19U1421228 of 16 Oct 19

1. In accordance with reference (a), you are hereby designated as UAS Airspace Access Applicant for *(Command/Unit Name)*.

2. You shall understand and comply with all policies and procedures set forth in the reference that pertains to the role and responsibilities of a UAS Airspace Access Applicant.

3. This designation is effective immediately and will remain in effect until your departure from this unit or until otherwise directed.

(Name of CO)

Copy to:
OPNAV N98A (For USN)
HQMC AVN (For USMC)
Navy Representative, Federal Aviation Administration

Figure H-8. Procurement to Flight Checklist

Procurement to Flight Checklist

1. Check approved UA Platform list on command inventory.
2. ARCs shall ensure compliance with DON Cyber Security Policies in regards to acquisition and operations of UAS.
3. Check airspace for operational use. Make Airspace request through for project operating area. Get FAA, Base/Command, ship approval.
4. Are you using Contractors?
5. Check if new platform is within Battery Cert. If not within limits, start new Certification.
6. Start Operating Training / Certification for AVO/SO.
7. Ensure new project/mission is within Interim Flight Clearance limits.
8. Check Environmental sensitivities of planned operation area.
9. Check RF emissions. Obtain spectrum approval.
10. Ensure Communication plan is created for project location of flight ops.
11. Ensure Incident / Mishap plan is available for flight ops.
12. Review Nominal site set up
13. If shipboard flight ops are possible, review the shipboard procedures, get approval from Ship CO.
14. Make flight request to ARC and ensure you are on Center Master inventory list, and are on the weekly flight schedule.
15. Post Flight: Ensure flight time is logged, Range/Airspace authority is notified of completed flight.

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APPENDIX I

Crew Resource Management (CRM)

I.1 GENERAL

The objective of the Crew Resource Management (CRM) Program is to integrate the instruction of specifically defined behavioral skills throughout Navy and Marine Corps aviation training, and to integrate the effective application of these behavioral skills into operational aviation procedures wherever appropriate. CRM training will increase mission effectiveness, minimize crew preventable error, maximize aircrew coordination, and optimize risk management.

I.2 CRITICAL BEHAVIORAL SKILLS

The critical behavioral skills that form the basis of CRM training are:

1. Decision making. The ability to choose a course of action using logical and sound judgment based on available information. Effective decision making requires:
   a. Assessing the situation.
   b. Verifying information.
   c. Identifying solutions.
   d. Anticipating decision consequences.
   e. Making the decision.
   f. Telling others of the decision and rationale.
   g. Evaluating the decision.
2. Assertiveness. An individual's willingness to actively participate, state, and maintain a position, until convinced by the facts that other options are better. Assertiveness is respectful and professional, used to resolve problems appropriately, and to improve mission effectiveness and safety.
3. Mission Analysis. The ability to develop short-term, long-term, and contingency plans and to coordinate, allocate, and monitor crew and aircraft resources. Effective planning leads to flight conduct that removes uncertainty, increases mission effectiveness, and enhances safety.
4. Communication. The ability to clearly and accurately send and acknowledge information, instructions, or commands, and provide useful feedback. Effective communication is vital to ensure that all crewmembers understand aircraft and mission status.
5. Leadership. The ability to direct and coordinate the activities of other crewmembers or wingmen, and to encourage the crew to work together as a team. There are two types of leadership:
   a. Designated Leadership — Leadership by authority, crew position, rank, or title. This is the normal mode of leadership.
   b. Functional Leadership — Leadership by knowledge or expertise. Functional leadership is temporary and allows the most qualified individual to take charge of the situation.
6. Adaptability/Flexibility. The ability to alter a course of action based on new information, maintain constructive behavior under pressure, and adapt to internal and external environmental changes. The success of a mission depends upon the crew's ability to alter behavior and dynamically manage crew resources to meet situational demands.

7. Situational Awareness. The degree of accuracy by which one's perception of the current environment mirrors reality. Maintaining a high level of situational awareness will better prepare crews to respond to unexpected situations.

I.3 CRM TRAINING

Optimal CRM training is integrated, research-based, and skill-oriented, incorporating the Information, Demonstration, Practice, and Feedback Instructional Methodology. The success or failure of Crew Resource Management rests ultimately with each individual performing UAS crewmember duties. UASCs shall exhibit thorough knowledge of self, aircraft, team, environment, the seven critical skills, and risk to employ sound and logical judgement in the prevention of human errors. Human error is the leading causal factor in aviation mishaps. Additional human error-based training should complement CRM training. For CRM academic and flight, currency requirements and documentation see COMNAVAIRFORINST 1542.7 series.

INDEX

Page No.

A

ACC OR DAA RESPONSIBILITY CHECKLIST H-1
ACC OR DAA RESPONSIBILITY CHECKLISTACC OR DAA RESPONSIBILITY CHECKLIST H-1
AEROBATIC FLIGHT MANEUVERS 4-7
AEROBATIC FLIGHT MANEUVERSAEROBATIC FLIGHT MANEUVERS 4-7
AEROMEDICAL REQUIREMENTS 5-3
AEROMEDICAL REQUIREMENTSAEROMEDICAL REQUIREMENTS 5-3
Aircraft:
- Unmanned Aircraft System Aircraft Crewmember (UASC) Responsibilities 10-2
- Unmanned Aircraft System Aircraft Crewmember (UASC) ResponsibilitiesAircraft:Unmanned Aircraft System Aircraft Crewmember (UASC) ResponsibilitiesCrewmember:Unmanned Aircraft System Aircraft Crewmember (UASC) ResponsibilitiesResponsibilities:Unmanned Aircraft System Aircraft Crewmember (UASC) ResponsibilitiesSystem:Unmanned Aircraft System Aircraft Crewmember (UASC) Responsibilities 10-2

Airspace Coordination and Deconfliction 6-2
Airspace Coordination and DeconflictionAirspace Coordination and Deconfliction 6-2
AIRSPACE OPERATIONS B-1
AIRSPACE OPERATIONSAIRSPACE OPERATIONS B-1
ALTITUDE LIMITATIONS 4-1
ALTITUDE LIMITATIONSALTITUDE LIMITATIONS 4-1
ARC RESPONSIBILITY CHECKLIST H-1
ARC RESPONSIBILITY CHECKLISTARC RESPONSIBILITY CHECKLIST H-1
Areas:
- Flight Operations in Active Restricted Areas and Warning AreasOperations:Flight Operations in Active Restricted Areas and Warning Areas B-2
- Flight Operations in Prohibited AreasOperations:Flight Operations in Prohibited Areas B-2
- Flight Operations in U.S. National Airspace System (NAS) Outside of Active Restricted Areas and Warning AreasOperations:Flight Operations in U.S. National Airspace System (NAS) Outside of Active Restricted Areas and Warning AreasSystem:Flight Operations in U.S. National Airspace System (NAS) Outside of Active Restricted Areas and Warning Areas B-1
- Range Operations within Restricted and Warning AreasOperations:Range Operations within Restricted and Warning Areas 6-2

Armed UAS 2-2, 4-6
Armed UASArmed UAS 2-2, 4-6
ASSEMBLY AND PREFLIGHT 7-3
ASSEMBLY AND PREFLIGHTASSEMBLY AND PREFLIGHT 7-3
Assembly:
- UA Assembly 7-3
- UA AssemblyAssembly:UA Assembly 7-3

Authority:
- UAS Crewmember Designation AuthorityCrewmember:UAS Crewmember Designation Authority 1-1

Authorization:
- Requirement for Flight AuthorizationRequirement:Requirement for Flight Authorization 1-2

Autonomous Flight 7-7
Autonomous FlightAutonomous Flight 7-7

B

Background B-1
BackgroundBackground B-1
Batteries 2-2
BatteriesBatteries 2-2
Battery Fail-Safe 7-4
Battery Fail-SafeBattery Fail-Safe 7-4
Blood Donation 5-4
Blood DonationBlood Donation 5-4
Box:
- Safe-For-Flight Box 7-2
- Safe-For-Flight BoxBox:Safe-For-Flight Box 7-2

Briefing:
- Preflight Briefing 6-5
- Preflight BriefingBriefing:Preflight BriefingPreflight:Preflight Briefing 6-5
- UAS Mission Briefing Guide Checklist E-1
- UAS Mission Briefing Guide ChecklistBriefing:UAS Mission Briefing Guide ChecklistChecklist:UAS Mission Briefing Guide ChecklistGuide:UAS Mission Briefing Guide ChecklistMission:UAS Mission Briefing Guide Checklist E-1

Page No.
BUQ LEVELS I-IV TRAINING A-1
BUQ LEVELS I-IV TRAININGBUQ LEVELS I-IV TRAINING A-1

C

Capabilities:
Fuel Range and Battery Endurance CapabilitiesFuel:Fuel Range and Battery Endurance Capabilities 6-3
Charging 3-2
ChargingCharging 3-2
Checklist:
UAS Mission Briefing Guide Checklist E-1
UAS Mission Briefing Guide ChecklistBriefing:UAS Mission Briefing Guide ChecklistChecklist:UAS Mission Briefing Guide ChecklistGuide:UAS Mission Briefing Guide ChecklistMission:UAS Mission Briefing Guide Checklist E-1
COLD WEATHER 11-1
COLD WEATHERCOLD WEATHER 11-1
Command:
Command and Control Lost Link Avoidance 7-7
Command and Control Lost Link AvoidanceCommand:Command and Control Lost Link AvoidanceControl:Command and Control Lost Link Avoidance 7-7
Degraded or Lost Command and Control Link 7-8
Degraded or Lost Command and Control LinkCommand:Degraded or Lost Command and Control LinkControl:Degraded or Lost Command and Control Link 7-8
Lost or Degraded Command and Control Link 10-3
Lost or Degraded Command and Control LinkCommand:Lost or Degraded Command and Control LinkControl:Lost or Degraded Command and Control Link 10-3
Configuration 9-3
ConfigurationConfiguration 9-3
Considerations:
Mission Planning ConsiderationsMission:Mission Planning ConsiderationsPlanning:Mission Planning Considerations 6-1
Ship-Based Environmental ConsiderationsShip-Based Environmental Considerations 8-1
Contract Performance for CAS COCO 1-4
Contract Performance for CAS COCOContract Performance for CAS COCO 1-4
Contracting for Contracted Air Services (CAS) Deemed State or PAO (COCO) 1-3
Contracting for Contracted Air Services (CAS) Deemed State or PAO (COCO)Contracting for Contracted Air Services (CAS) Deemed State or PAO (COCO) 1-3
CONTRACTOR OPERATIONS 1-3
CONTRACTOR OPERATIONSCONTRACTOR OPERATIONS 1-3
CONTROL STATION (CS) 2-2
CONTROL STATION (CS)CONTROL STATION (CS) 2-2
Control:
Command and Control Lost Link Avoidance 7-7
Command and Control Lost Link AvoidanceCommand:Command and Control Lost Link AvoidanceControl:Command and Control Lost Link Avoidance 7-7
Degraded or Lost Command and Control Link 7-8
Degraded or Lost Command and Control LinkCommand:Degraded or Lost Command and Control LinkControl:Degraded or Lost Command and Control Link 7-8
Lost or Degraded Command and Control Link 10-3
Lost or Degraded Command and Control LinkCommand:Lost or Degraded Command and Control LinkControl:Lost or Degraded Command and Control Link 10-3
Radio Control and Control Station (CS) Setup 7-3
Radio Control and Control Station (CS) SetupControl:Radio Control and Control Station (CS) SetupRadio:Radio Control and Control Station (CS) SetupSetup:Radio Control and Control Station (CS) SetupStation:Radio Control and Control Station (CS) Setup 7-3
Unmanned Lighter Than Air UAs Capable of Propulsion and Control 2-1
Unmanned Lighter Than Air UAs Capable of Propulsion and ControlControl:Unmanned Lighter Than Air UAs Capable of Propulsion and ControlPropulsion:Unmanned Lighter Than Air UAs Capable of Propulsion and ControlPropulsion:Unmanned Lighter Than Air UAs Capable of Propulsion and Control 2-1
CONVENTIONS 10-1
CONVENTIONSCONVENTIONS 10-1
COUNTER-UAS (C-UAS) OPERATIONS 7-9
COUNTER-UAS (C-UAS) OPERATIONSCOUNTER-UAS (C-UAS) OPERATIONS 7-9
CREW REQUIREMENT 5-4
CREW REQUIREMENTCREW REQUIREMENT 5-4

Page No.

CREW RESPONSIBILITIES IN AN EMERGENCY 10-1
CREW RESPONSIBILITIES IN AN EMERGENCYCREW RESPONSIBILITIES IN AN EMERGENCY 10-1
Crew:
- Crew Coordination 7-5
- Crew CoordinationCrew:Crew Coordination 7-5
- Crew Replacement Briefings 6-5
- Crew Replacement BriefingsCrew:Crew Replacement Briefings 6-5
- Recommended Crew Requirements 7-5
- Recommended Crew RequirementsCrew:Recommended Crew RequirementsRequirements:Recommended Crew Requirements 7-5

Crewmember:
- UAS Crewmember Designation Authority 1-1
- UAS Crewmember Designation AuthorityCrewmember:UAS Crewmember Designation Authority 1-1
- UAS Crewmember Designations 1-2
- UAS Crewmember DesignationsCrewmember:UAS Crewmember Designations 1-2
- UAS Crewmember Training and Qualifications 1-2
- UAS Crewmember Training and QualificationsCrewmember:UAS Crewmember Training and QualificationsTraining:UAS Crewmember Training and Qualifications 1-2
- Unmanned Aircraft System Aircraft Crewmember (UASC) Responsibilities 10-2
- Unmanned Aircraft System Aircraft Crewmember (UASC) ResponsibilitiesAircraft:Unmanned Aircraft System Aircraft Crewmember (UASC) ResponsibilitiesCrewmember:Unmanned Aircraft System Aircraft Crewmember (UASC) ResponsibilitiesResponsibilities:Unmanned Aircraft System Aircraft Crewmember (UASC) ResponsibilitiesSystem:Unmanned Aircraft System Aircraft Crewmember (UASC) Responsibilities 10-2

CRITICAL BEHAVIORAL SKILLS I-1
CRITICAL BEHAVIORAL SKILLSCRITICAL BEHAVIORAL SKILLS I-1
Critical Steps/Immediate Actions 10-1
Critical Steps/Immediate ActionsCritical Steps/Immediate Actions 10-1
CRM TRAINING I-2
CRM TRAININGCRM TRAINING I-2
CYBERSECURITY 13-1
CYBERSECURITYCYBERSECURITY 13-1

Page No.

D

Debriefing:
- General Debriefing 6-5
- General DebriefingDebriefing:General Debriefing 6-5

Departure from Assigned Airspace 10-4
Departure from Assigned AirspaceDeparture from Assigned Airspace 10-4
DESERT AND DRY WEATHER 11-4
DESERT AND DRY WEATHERDESERT AND DRY WEATHER 11-4
Designation 5-2
DesignationDesignation 5-2
DISPERSAL OF PESTICIDES 4-7
DISPERSAL OF PESTICIDESDISPERSAL OF PESTICIDES 4-7
Disposal 3-5
DisposalDisposal 3-5

E

Electrical Power:
- Electrical Power 2-2

Electrical:
- Electrical Power 2-2
- Electrical PowerElectrical:Electrical PowerElectrical Power:Electrical PowerPower:Electrical Power 2-2

ELECTRICALLY POWERED TETHERED UAS ELECTRICAL SHOCK MITIGATION 9-4
ELECTRICALLY POWERED TETHERED UAS ELECTRICAL SHOCK MITIGATIONELECTRICALLY POWERED TETHERED UAS ELECTRICAL SHOCK MITIGATION 9-4
Electrolyte Contact Exposure 3-5
Electrolyte Contact ExposureElectrolyte Contact Exposure 3-5
ELECTROMAGNETIC COMPATIBILITY (EMC) SAFETY-OF-FLIGHT TEST (SOFT) 9-1
ELECTROMAGNETIC COMPATIBILITY (EMC) SAFETY-OF-FLIGHT TEST (SOFT)ELECTROMAGNETIC COMPATIBILITY (EMC) SAFETY-OF-FLIGHT TEST (SOFT) 9-1
Electromagnetic Interference 8-2
Electromagnetic InterferenceElectromagnetic Interference 8-2
EMC SOFT SAMPLE CHECKLIST F-1
EMC SOFT SAMPLE CHECKLISTEMC SOFT SAMPLE CHECKLIST F-1
Emergency:
- Emergency Landing Site Selection 10-3
- Emergency Landing Site SelectionEmergency:Emergency Landing Site

Page No.

SelectionLanding:Emergency Landing Site SelectionSelection:Emergency Landing Site Selection ... 10-3
Engine:
Engine Driven Generator(s) ... 2-3
Engine Driven Generator(s)Engine:Engine Driven Generator(s) ... 2-3
Equipment:
Hazards to Personnel and Equipment ... 8-1
Hazards to Personnel and EquipmentEquipment:Hazards to Personnel and EquipmentHazards:Hazards to Personnel and EquipmentPersonnel:Hazards to Personnel and Equipment ... 8-1
Personal Protective Equipment ... 7-5
Personal Protective EquipmentEquipment:Personal Protective Equipment ... 7-5
Personnel Protective Equipment ... 7-1
Personnel Protective EquipmentEquipment:Personnel Protective EquipmentPersonnel:Personnel Protective Equipment ... 7-1
Exceeding Established Flight Time Standards ... 5-3
Exceeding Established Flight Time StandardsExceeding Established Flight Time Standards ... 5-3
EXPLANATION OF UAS GROUPS ... C-1
EXPLANATION OF UAS GROUPSEXPLANATION OF UAS GROUPS ... C-1
External Tracking Devices ... G-2
External Tracking DevicesExternal Tracking Devices ... G-2

F

Failure:
Critical System Failure ... 10-2
Critical System FailureFailure:Critical System FailureSystem:Critical System Failure ... 10-2
Fire:
Fire ... 3-4
FireFire:Fire ... 3-4
Flight ... 3-4
FLIGHT ... 7-6
FLIGHT OPERATIONS ... 8-2
FLIGHT OPERATIONSFLIGHT OPERATIONS ... 8-2
Flight Termination ... 10-3
Flight TerminationFlight Termination ... 10-3
FlightFlight ... 3-4
FLIGHTFLIGHT ... 7-6
FOUR PRINCIPLES OF APPLICATION ... 14-1

Page No.

FOUR PRINCIPLES OF APPLICATIONFOUR PRINCIPLES OF APPLICATION ... 14-1
Frequency Approval ... 6-4
Frequency ApprovalFrequency Approval ... 6-4
Frequency Coordination ... 6-4
Frequency CoordinationFrequency Coordination ... 6-4
Freshwater Exposure ... 3-4
Freshwater ExposureFreshwater Exposure ... 3-4
Fuel:
Fuel Cells ... 2-3
Fuel CellsFuel:Fuel Cells ... 2-3
Fuel Leak Checks ... 4-6
Fuel Leak ChecksFuel:Fuel Leak Checks ... 4-6
Fuel Range and Battery Endurance Capabilities ... 6-3
Fuel Range and Battery Endurance CapabilitiesFuel:Fuel Range and Battery Endurance Capabilities ... 6-3

G

General ... 2-1
GENERAL ... 4-1, 5-1, 14-1, I-1
GENERAL EMERGENCY PROCEDURES ... 10-2
GENERAL EMERGENCY PROCEDURESGENERAL EMERGENCY PROCEDURES ... 10-2
General UASC Positions ... 5-2
General UASC PositionsGeneral UASC Positions ... 5-2
GeneralGeneral ... 2-1
GENERALGENERAL ... 4-1, 5-1, 14-1, I-1
Geo-Fencing Fail-Safe ... 7-4
Geo-Fencing Fail-SafeGeo-Fencing Fail-Safe ... 7-4
GPS:
Degraded GPS ... 10-3
Degraded GPSGPS:Degraded GPS ... 10-3
Loss of GPS ... 10-4
Loss of GPSGPS:Loss of GPS ... 10-4
Ground:
Ground Operation ... 11-1
Ground OperationGround:Ground OperationOperation:Ground Operation ... 11-1
SHKOZs For Launch, Recovery and Ground Operations ... 4-2
SHKOZs For Launch, Recovery and Ground OperationsGround:SHKOZs For Launch, Recovery and Ground OperationsOperations:SHKOZs For Launch, Recovery and Ground OperationsRecovery:SHKOZs For Launch, Recovery and Ground Operations ... 4-2

Page No.

Unmanned Ground Vehicles (UGV), Unmanned Surface Vehicles (USV) and Unmanned Underwater Vehicles (UUV) 2-2
Unmanned Ground Vehicles (UGV), Unmanned Surface Vehicles (USV) and Unmanned Underwater Vehicles (UUV)Ground:Unmanned Ground Vehicles (UGV), Unmanned Surface Vehicles (USV) and Unmanned Underwater Vehicles (UUV)Vehicles:Unmanned Ground Vehicles (UGV), Unmanned Surface Vehicles (USV) and Unmanned Underwater Vehicles (UUV) 2-2
GROUP 1 AND 2 UAS PROGRAM RESPONSIBILITIES 1-1
GROUP 1 AND 2 UAS PROGRAM RESPONSIBILITIESGROUP 1 AND 2 UAS PROGRAM RESPONSIBILITIES 1-1
Guide:
UAS Mission Briefing Guide Checklist E-1
UAS Mission Briefing Guide ChecklistBriefing:UAS Mission Briefing Guide ChecklistChecklist:UAS Mission Briefing Guide ChecklistGuide:UAS Mission Briefing Guide ChecklistMission:UAS Mission Briefing Guide Checklist E-1

H

Hazard:
Mishap and Hazard Reporting G-2
Mishap and Hazard ReportingHazard:Mishap and Hazard ReportingMishap:Mishap and Hazard ReportingReporting:Mishap and Hazard Reporting G-2
Hazards:
Hazards G-1
Hazards to Personnel and Equipment 8-1
Hazards to Personnel and EquipmentEquipment:Hazards to Personnel and EquipmentHazards:Hazards to Personnel and EquipmentPersonnel:Hazards to Personnel and Equipment 8-1
HazardsHazards:Hazards G-1
HERO, HERF AND HERP STANDOFF DISTANCES 4-6
HERO, HERF AND HERP STANDOFF DISTANCESHERO, HERF AND HERP STANDOFF DISTANCES 4-6
HOT WEATHER 11-1
HOT WEATHERHOT WEATHER 11-1
Hypobaric and Hyperbaric Exposure 5-4
Hypobaric and Hyperbaric ExposureHypobaric and Hyperbaric Exposure 5-4

Page No.

I

ICING 11-1
ICINGICING 11-1
Immunizations and Injections 5-4
Immunizations and InjectionsImmunizations and Injections 5-4
IN-FLIGHT EMERGENCIES 10-3
IN-FLIGHT EMERGENCIESIN-FLIGHT EMERGENCIES 10-3
In-Flight:
In-Flight Operation 11-1
In-Flight OperationIn-Flight:In-Flight OperationOperation:In-Flight Operation 11-1
In-Flight Operatons 11-1
In-Flight OperatonsIn-Flight:In-Flight Operatons 11-1
Inadvertent Flight In Icing Conditions 10-4
Inadvertent Flight In Icing ConditionsInadvertent Flight In Icing Conditions 10-4
Incidents G-1
INCIDENTS, HAZARDS, AND AVIATION MISHAPS G-1
INCIDENTS, HAZARDS, AND AVIATION MISHAPSINCIDENTS, HAZARDS, AND AVIATION MISHAPS G-1
IncidentsIncidents G-1
INTERMEDIATE COMMANDS — AUTHORITIES AND RESPONSIBILITIES 1-3
INTERMEDIATE COMMANDS — AUTHORITIES AND RESPONSIBILITIESINTERMEDIATE COMMANDS — AUTHORITIES AND RESPONSIBILITIES 1-3
INTRODUCTION 10-1
INTRODUCTIONINTRODUCTION 10-1

L

Landing:
Emergency Landing Site Selection 10-3
Emergency Landing Site SelectionEmergency:Emergency Landing Site SelectionLanding:Emergency Landing Site SelectionSelection:Emergency Landing Site Selection 10-3
LASER EYE PROTECTION AND HAZARD DISTANCES 4-7
LASER EYE PROTECTION AND HAZARD DISTANCESLASER EYE PROTECTION AND HAZARD DISTANCES 4-7
LASER OPERATIONS 9-3
LASER OPERATIONSLASER OPERATIONS 9-3
LASER REQUIREMENTS 2-3
LASER REQUIREMENTSLASER REQUIREMENTS 2-3

Page No.

LAUNCH 7-5
LAUNCH AND RECOVERY SYSTEMS 2-3
LAUNCH AND RECOVERY SYSTEMSLAUNCH AND RECOVERY SYSTEMS 2-3
Launch:
- Hand Launch 7-6
- Hand LaunchLaunch:Hand Launch 7-6
- Launch and Recovery 8-3
- Launch and Recovery from a Moving Vehicle ... 7-6
- Launch and Recovery from a Moving VehicleLaunch:Launch and Recovery from a Moving VehicleRecovery:Launch and Recovery from a Moving VehicleVehicle:Launch and Recovery from a Moving Vehicle 7-6
- Launch and Recovery Procedures 8-3
- Launch and Recovery ProceduresLaunch:Launch and Recovery ProceduresProcedures:Launch and Recovery ProceduresRecovery:Launch and Recovery Procedures 8-3
- Launch and RecoveryLaunch:Launch and RecoveryRecovery:Launch and Recovery 8-3
- Multi-rotor Hand Launch and Recovery Procedures 7-5
- Multi-rotor Hand Launch and Recovery ProceduresLaunch:Multi-rotor Hand Launch and Recovery ProceduresProcedures:Multi-rotor Hand Launch and Recovery ProceduresRecovery:Multi-rotor Hand Launch and Recovery Procedures 7-5

LAUNCHLAUNCH 7-5
Level of Interoperability (LOI) 2-2
Level of Interoperability (LOI)Level of Interoperability (LOI) 2-2
Limitations:
- Limitations 9-3
- Operating Limitations 6-3
- Operating LimitationsLimitations:Operating Limitations 6-3
- U.S. NAS Airspace Operating Limitations under an FAA COA or DON AAA B-2
- U.S. NAS Airspace Operating Limitations under an FAA COA or DON AAALimitations:U.S. NAS Airspace Operating Limitations under an FAA COA or DON AAA B-2

LimitationsLimitations:Limitations 9-3
Limits:
- Flight Time Limits 5-3
- Flight Time LimitsLimits:Flight Time Limits ... 5-3

LITHIUM BATTERY USAGE, CHARGING, HANDLING AND STORAGE 3-1
LITHIUM BATTERY USAGE, CHARGING, HANDLING AND STORAGELITHIUM BATTERY USAGE, CHARGING, HANDLING AND STORAGE 3-1
Loss of VLOS (If VLOS is Required by Airspace Approval Authority) 10-4
Loss of VLOS (If VLOS is Required by Airspace Approval Authority)Loss of VLOS (If VLOS is Required by Airspace Approval Authority) 10-4
Lost Link Fail-Safe 7-4
Lost Link Fail-SafeLost Link Fail-Safe 7-4

M

Manual Flight 7-7
Manual FlightManual Flight 7-7
Mid-Air Collision Avoidance 7-8
Mid-Air Collision AvoidanceMid-Air Collision Avoidance 7-8
MINIMUM REQUIREMENTS FOR PURSUIT OF AN IFC AUTHORIZING THE OPERATION OF A SPECIFIC UAS H-1
MINIMUM REQUIREMENTS FOR PURSUIT OF AN IFC AUTHORIZING THE OPERATION OF A SPECIFIC UASMINIMUM REQUIREMENTS FOR PURSUIT OF AN IFC AUTHORIZING THE OPERATION OF A SPECIFIC UAS H-1
Mishap:
- Mishap and Hazard Reporting G-2
- Mishap and Hazard ReportingHazard:Mishap and Hazard ReportingMishap:Mishap and Hazard ReportingReporting:Mishap and Hazard Reporting G-2
- Mishap Procedures 6-3
- Mishap ProceduresMishap:Mishap ProceduresProcedures:Mishap Procedures 6-3

Mishaps:
- Aviation Mishaps G-1
- Aviation MishapsMishaps:Aviation Mishaps ... G-1

MISSION BRIEFING 6-5
MISSION BRIEFINGMISSION BRIEFING 6-5
MISSION DEBRIEFING 6-5
MISSION DEBRIEFINGMISSION DEBRIEFING 6-5
MISSION PLANNING DESCRIPTION 6-1
MISSION PLANNING DESCRIPTIONMISSION PLANNING DESCRIPTION 6-1
Mission:
- Mission Endurance Requirements 6-3
- Mission Endurance RequirementsMission:Mission Endurance RequirementsRequirements:Mission Endurance Requirements 6-3
- Mission Payload Operator (MPO) 5-3
- Mission Payload Operator (MPO)Mission:Mission Payload Operator (MPO) 5-3
- Mission Planning Considerations 6-1

Page No.

Mission Planning ConsiderationsMission:Mission Planning ConsiderationsPlanning:Mission Planning Considerations 6-1
Mission Planning Documents 6-1
Mission Planning DocumentsMission:Mission Planning DocumentsPlanning:Mission Planning Documents 6-1
UAS Mission Briefing Guide Checklist E-1
UAS Mission Briefing Guide ChecklistBriefing:UAS Mission Briefing Guide ChecklistChecklist:UAS Mission Briefing Guide ChecklistGuide:UAS Mission Briefing Guide ChecklistMission:UAS Mission Briefing Guide Checklist.....E-1
UAS Mission Commander (UMC) 5-3
UAS Mission Commander (UMC)Mission:UAS Mission Commander (UMC) 5-3
UAS Mission risk assessment..... 14-2
UAS Mission risk assessmentMission:UAS Mission risk assessment..... 14-2
Modes:
Fail-Safe Modes 7-3
Fail-Safe ModesModes:Fail-Safe Modes 7-3
Multi-rotor UAS.....2-1, 4-3
Multi-rotor UASMulti-rotor UAS.....2-1, 4-3
MULTI-VEHICLE OPERATIONS AT THE OPERATING AREA 9-1
MULTI-VEHICLE OPERATIONS AT THE OPERATING AREAMULTI-VEHICLE OPERATIONS AT THE OPERATING AREA ... 9-1
MULTI-VEHICLE OPERATIONS BY A SINGLE UAC/AVO..... 9-2
MULTI-VEHICLE OPERATIONS BY A SINGLE UAC/AVOMULTI-VEHICLE OPERATIONS BY A SINGLE UAC/AVO..... 9-2

N

NATOPS Advisory Group 1-1
NATOPS Advisory GroupNATOPS Advisory Group 1-1
Night:
Night Operations..... 6-4
Night OperationsNight:Night OperationsOperations:Night Operations..... 6-4
Notice to Airmen..... 6-5
Notice to AirmenNotice to Airmen..... 6-5

O

OPERATING LOCATIONS B-1
OPERATING LOCATIONSOPERATING LOCATIONS B-1
Operation:
Ground Operation 11-1

Page No.

Ground OperationGround:Ground OperationOperation:Ground Operation 11-1
In-Flight Operation 11-1
In-Flight OperationIn-Flight:In-Flight OperationOperation:In-Flight Operation 11-1
Operational Risk Management (ORM)..... 6-3
OPERATIONAL RISK MANAGEMENT (ORM)..... 14-1
Operational Risk Management (ORM)Operational Risk Management (ORM)..... 6-3
OPERATIONAL RISK MANAGEMENT (ORM)OPERATIONAL RISK MANAGEMENT (ORM)..... 14-1
Operational Use 3-4
Operational UseOperational Use 3-4
Operations:
Airspace Operations..... 6-2
Airspace Operations Procedures Training 5-3
Airspace Operations Procedures TrainingOperations:Airspace Operations Procedures TrainingProcedures:Airspace Operations Procedures TrainingTraining:Airspace Operations Procedures Training..... 5-3
Airspace OperationsOperations:Airspace Operations 6-2
Contractor Operations of Government Owned UAS (GOCO)..... 1-3
Contractor Operations of Government Owned UAS (GOCO)Operations:Contractor Operations of Government Owned UAS (GOCO) 1-3
Flight Operations 6-2
Flight Operations in Active Restricted Areas and Warning Areas B-2
Flight Operations in Active Restricted Areas and Warning AreasOperations:Flight Operations in Active Restricted Areas and Warning Areas....B-2
Flight Operations in Foreign National Airspace B-2
Flight Operations in Foreign National AirspaceOperations:Flight Operations in Foreign National Airspace.....B-2
Flight Operations in International Airspace.....B-2
Flight Operations in International AirspaceOperations:Flight Operations in International Airspace.....B-2
Flight Operations in Joint Operating Areas, Combat and Contingency Airspace B-2
Flight Operations in Joint Operating Areas, Combat and Contingency AirspaceOperations:Flight Operations in Joint Operating Areas, Combat and Contingency Airspace.....B-2
Flight Operations in Prohibited Areas B-2

Page No.

Flight Operations in Prohibited Areas Operations:Flight Operations in Prohibited Areas B-2
Flight Operations in U.S. National Airspace System (NAS) Outside of Active Restricted Areas and Warning Areas B-1
Flight Operations in U.S. National Airspace System (NAS) Outside of Active Restricted Areas and Warning Areas Operations:Flight Operations in U.S. National Airspace System (NAS) Outside of Active Restricted Areas and Warning Areas System:Flight Operations in U.S. National Airspace System (NAS) Outside of Active Restricted Areas and Warning Areas.... B-1
Flight Operations Operations:Flight Operations 6-2
Multiple UA and Swarming Operations 6-5
Multiple UA and Swarming Operations Operations:Multiple UA and Swarming Operations 6-5
Night Operations 6-4
Night Operations Night:Night Operations Operations:Night Operations 6-4
Range Operations within Restricted and Warning Areas 6-2
Range Operations within Restricted and Warning Areas Operations:Range Operations within Restricted and Warning Areas 6-2
Ship-Based Operations 6-4
Ship-Based Operations Operations:Ship-Based Operations 6-4
SHKOZs For Launch, Recovery and Ground Operations 4-2
SHKOZs For Launch, Recovery and Ground Operations Ground:SHKOZs For Launch, Recovery and Ground Operations Operations:SHKOZs For Launch, Recovery and Ground Operations Recovery:SHKOZs For Launch, Recovery and Ground Operations 4-2
Visual Line of Sight (VLOS) Operations 7-2
Visual Line of Sight (VLOS) Operations Operations:Visual Line of Sight (VLOS) Operations 7-2

P

PAYLOADS 2-3
PAYLOADS PAYLOADS 2-3
Personnel:
Hazards to Personnel and Equipment 8-1
Hazards to Personnel and Equipment Equipment:Hazards to Personnel and Equipment Hazards:Hazards to Personnel and Equipment Personnel:Hazards to Personnel and Equipment 8-1
Human Performance and Aeromedical Qualification for Flight and Flight Support Personnel 5-3
Human Performance and Aeromedical Qualification for Flight and Flight Support Personnel Personnel:Human Performance and Aeromedical Qualification for Flight and Flight Support Personnel Qualification:Human Performance and Aeromedical Qualification for Flight and Flight Support Personnel 5-3
Personnel Protective Equipment 7-1
Personnel Protective Equipment Equipment:Personnel Protective Equipment Personnel:Personnel Protective Equipment 7-1
Planning:
Mission Planning Considerations 6-1
Mission Planning Considerations Mission:Mission Planning Considerations Planning:Mission Planning Considerations 6-1
Mission Planning Documents 6-1
Mission Planning Documents Mission:Mission Planning Documents Planning:Mission Planning Documents 6-1
Policies:
Naval Aviation Safety Policies 1-3
Naval Aviation Safety Policies Policies:Naval Aviation Safety Policies 1-3
Postflight 3-4
Postflight Postflight 3-4
POWER AND PROPULSION SYSTEMS 2-2
POWER AND PROPULSION SYSTEMS POWER AND PROPULSION SYSTEMS 2-2
Power:
Electrical Power 2-2
Electrical Power Electrical:Electrical Power Electrical Power:Electrical Power Power:Electrical Power 2-2
External Power Sources 2-3
External Power Sources Power:External Power Sources 2-3
Preflight:
GNSS Preflight 7-4
GNSS Preflight Preflight:GNSS Preflight 7-4
Preflight 3-4, 7-3
Preflight Briefing 6-5
Preflight Briefing Briefing:Preflight Briefing Preflight:Preflight Briefing 6-5
Preflight Procedures 8-2
Preflight Procedures Preflight:Preflight Procedures Procedures:Preflight Procedures 8-2

Page No.

PreflightPreflight:Preflight 3-4, 7-3
Pregnancy 5-3
PregnancyPregnancy 5-3
Procedures:
Airspace Operations Procedures Training 5-3
Airspace Operations Procedures TrainingOperations:Airspace Operations Procedures TrainingProcedures:Airspace Operations Procedures TrainingTraining:Airspace Operations Procedures Training 5-3
Crash Procedures 3-5
Crash ProceduresProcedures:Crash Procedures 3-5
Launch and Recovery Procedures 8-3
Launch and Recovery ProceduresLaunch:Launch and Recovery ProceduresProcedures:Launch and Recovery ProceduresRecovery:Launch and Recovery Procedures 8-3
Mishap Procedures 6-3
Mishap ProceduresMishap:Mishap ProceduresProcedures:Mishap Procedures 6-3
Multi-rotor Hand Launch and Recovery Procedures 7-5
Multi-rotor Hand Launch and Recovery ProceduresLaunch:Multi-rotor Hand Launch and Recovery ProceduresProcedures:Multi-rotor Hand Launch and Recovery ProceduresRecovery:Multi-rotor Hand Launch and Recovery Procedures 7-5
Preflight Procedures 8-2
Preflight ProceduresPreflight:Preflight ProceduresProcedures:Preflight Procedures 8-2
Procedures and Warnings 9-3
Procedures and WarningsProcedures:Procedures and Warnings 9-3
UA Handoff Procedures 7-8
UA Handoff ProceduresProcedures:UA Handoff Procedures 7-8
Programs:
UAS Programs Establishment 1-1
UAS Programs EstablishmentPrograms:UAS Programs Establishment 1-1
Propulsion:
Unmanned Lighter Than Air UAs Capable of Propulsion and Control 2-1
Unmanned Lighter Than Air UAs Capable of Propulsion and ControlControl:Unmanned Lighter Than Air UAs Capable of Propulsion and ControlPropulsion:Unmanned Lighter Than Air UAs Capable of Propulsion and ControlPropulsion:Unmanned Lighter Than Air UAs Capable of Propulsion and Control 2-1
PUBLIC FLIGHT DEMONSTRATIONS 4-7

Page No.

PUBLIC FLIGHT DEMONSTRATIONS PUBLIC FLIGHT DEMONSTRATIONS 4-7
PURPOSE A-1, G-1
PURPOSEPURPOSE A-1, G-1

Q

Qualification:
Basic UAS Qualification (BUQ) Levels 5-1
Basic UAS Qualification (BUQ) LevelsQualification:Basic UAS Qualification (BUQ) Levels 5-1
Human Performance and Aeromedical Qualification for Flight and Flight Support Personnel 5-3
Human Performance and Aeromedical Qualification for Flight and Flight Support PersonnelPersonnel:Human Performance and Aeromedical Qualification for Flight and Flight Support PersonnelQualification:Human Performance and Aeromedical Qualification for Flight and Flight Support Personnel 5-3
UAS AVO Qualification Standards 5-3
UAS AVO Qualification StandardsQualification:UAS AVO Qualification Standards 5-3

R

RADIO FREQUENCY (RF) STAND OFF DISTANCES 4-7
RADIO FREQUENCY (RF) STAND OFF DISTANCESRADIO FREQUENCY (RF) STAND OFF DISTANCES 4-7
Radio:
Radio Control and Control Station (CS) Setup 7-3
Radio Control and Control Station (CS) SetupControl:Radio Control and Control Station (CS) SetupRadio:Radio Control and Control Station (CS) SetupSetup:Radio Control and Control Station (CS) SetupStation:Radio Control and Control Station (CS) Setup 7-3
RECOVERY 7-8
Recovery:
Hand Recovery 7-6
Hand RecoveryRecovery:Hand Recovery 7-6
Launch and Recovery 8-3
Launch and Recovery from a Moving Vehicle 7-6
Launch and Recovery from a Moving VehicleLaunch:Launch and Recovery from a Moving VehicleRecovery:Launch and Recovery from a Moving VehicleVehicle:Launch and Recovery from a Moving Vehicle 7-6
Launch and Recovery Procedures 8-3

Page No.

Launch and Recovery ProceduresLaunch:Launch and Recovery ProceduresProcedures:Launch and Recovery ProceduresRecovery:Launch and Recovery Procedures 8-3
Launch and RecoveryLaunch:Launch and RecoveryRecovery:Launch and Recovery..... 8-3
Multi-rotor Hand Launch and Recovery Procedures..... 7-5
Multi-rotor Hand Launch and Recovery ProceduresLaunch:Multi-rotor Hand Launch and Recovery ProceduresProcedures:Multi-rotor Hand Launch and Recovery ProceduresRecovery:Multi-rotor Hand Launch and Recovery Procedures..... 7-5
Recovery Parameter Checks 7-4
Recovery Parameter ChecksRecovery:Recovery Parameter Checks..... 7-4
SHKOZs For Launch, Recovery and Ground Operations 4-2
SHKOZs For Launch, Recovery and Ground OperationsGround:SHKOZs For Launch, Recovery and Ground OperationsOperations:SHKOZs For Launch, Recovery and Ground OperationsRecovery:SHKOZs For Launch, Recovery and Ground Operations..... 4-2
RECOVERYRECOVERY 7-8
Reporting:
Mishap and Hazard Reporting G-2
Mishap and Hazard ReportingHazard:Mishap and Hazard ReportingMishap:Mishap and Hazard ReportingReporting:Mishap and Hazard Reporting..... G-2
Requirement:
Requirement for Flight Authorization 1-2
Requirement for Flight AuthorizationRequirement:Requirement for Flight Authorization..... 1-2
Requirements:
Facilities and Installations Requirements 3-1
Facilities and Installations RequirementsRequirements:Facilities and Installations Requirements..... 3-1
Mission Endurance Requirements 6-3
Mission Endurance RequirementsMission:Mission Endurance RequirementsRequirements:Mission Endurance Requirements 6-3
Recommended Crew Requirements..... 7-5
Recommended Crew RequirementsCrew:Recommended Crew RequirementsRequirements:Recommended Crew Requirements 7-5
Responsibilities:

Page No.

ACC/DAA Responsibilities 1-1
ACC/DAA ResponsibilitiesResponsibilities:ACC/DAA Responsibilities 1-1
ARC Responsibilities..... 1-2
ARC ResponsibilitiesResponsibilities:ARC Responsibilities 1-2
AVO Responsibilities..... 10-2
AVO ResponsibilitiesResponsibilities:AVO Responsibilities 10-2
General Responsibilities 10-1
General ResponsibilitiesResponsibilities:General Responsibilities 10-1
Inventory Responsibilities 1-1
Inventory ResponsibilitiesResponsibilities:Inventory Responsibilities 1-1
Unmanned Aircraft System Aircraft Crewmember (UASC) Responsibilities..... 10-2
Unmanned Aircraft System Aircraft Crewmember (UASC) ResponsibilitiesAircraft:Unmanned Aircraft System Aircraft Crewmember (UASC) ResponsibilitiesCrewmember:Unmanned Aircraft System Aircraft Crewmember (UASC) ResponsibilitiesResponsibilities:Unmanned Aircraft System Aircraft Crewmember (UASC) ResponsibilitiesSystem:Unmanned Aircraft System Aircraft Crewmember (UASC) Responsibilities 10-2
RIGHT OF WAY RULES.....B-1
RIGHT OF WAY RULESRIGHT OF WAY RULES.....B-1
Rotor:
Single Main Rotor UAS.....2-1, 4-5
Single Main Rotor UASRotor:Single Main Rotor UAS 2-1, 4-5
Rules:
DON Group 1-2 UA Right-of Way Rules.....B-1
DON Group 1-2 UA Right-of Way RulesRules:DON Group 1-2 UA Right-of Way Rules B-1

S

Safety 3-4
SAFETY HAZARD KEEP OUT ZONES..... 4-2
SAFETY HAZARD KEEP OUT ZONESSAFETY HAZARD KEEP OUT ZONES..... 4-2
Safety Observer.....5-2, 7-1
Safety ObserverSafety Observer.....5-2, 7-1
SafetySafety 3-4
Saltwater Exposure 3-4
Saltwater ExposureSaltwater Exposure 3-4
Selection:

Page No.

Emergency Landing Site Selection 10-3
Emergency Landing Site SelectionEmergency:Emergency Landing Site SelectionLanding:Emergency Landing Site SelectionSelection:Emergency Landing Site Selection 10-3
Setup:
Radio Control and Control Station (CS) Setup ... 7-3
Radio Control and Control Station (CS) SetupControl:Radio Control and Control Station (CS) SetupRadio:Radio Control and Control Station (CS) SetupSetup:Radio Control and Control Station (CS) SetupStation:Radio Control and Control Station (CS) Setup 7-3
Ship Obstructions 8-1
Ship ObstructionsShip Obstructions 8-1
Ship Site Survey 8-2
Ship Site SurveyShip Site Survey 8-2
Ship-Based Environmental Considerations 8-1
SHIP-BASED OPERATIONS INTRODUCTION 8-1
SHIP-BASED OPERATIONS INTRODUCTIONSHIP-BASED OPERATIONS INTRODUCTION 8-1
SHIPBOARD EMERGENCY CONSIDERATIONS 8-3
SHIPBOARD EMERGENCY CONSIDERATIONSSHIPBOARD EMERGENCY CONSIDERATIONS 8-3
SHIPBOARD-RELATIVE ROUTES AND AREA SPILLAGE 8-4
SHIPBOARD-RELATIVE ROUTES AND AREA SPILLAGESHIPBOARD-RELATIVE ROUTES AND AREA SPILLAGE 8-4
SHKOZs For Flight 4-2
SHKOZs For FlightSHKOZs For Flight 4-2
SHORE-BASED OPERATIONS INTRODUCTION 7-1
SHORE-BASED OPERATIONS INTRODUCTIONSHORE-BASED OPERATIONS INTRODUCTION 7-1
Shutdown/Post-Flight 7-9
Shutdown/Post-FlightShutdown/Post-Flight 7-9
Standard Aviation Sequence 10-1
Standard Aviation SequenceStandard Aviation Sequence 10-1
Statement of Airworthiness B-1
Statement of AirworthinessStatement of Airworthiness B-1
Station:
Radio Control and Control Station (CS) Setup ... 7-3
Radio Control and Control Station (CS) SetupControl:Radio Control and Control Station (CS) SetupRadio:Radio Control and Control Station (CS) SetupSetup:Radio Control and Control Station (CS) SetupStation:Radio Control and Control Station (CS) Setup 7-3
Storage 3-3
StorageStorage 3-3
SWARMING OPERATIONS 9-2
SWARMING OPERATIONSSWARMING OPERATIONS 9-2
SYSTEM 2-1
System:
Critical System Failure 10-2
Critical System FailureFailure:Critical System FailureSystem:Critical System Failure 10-2
Flight Operations in U.S. National Airspace System (NAS) Outside of Active Restricted Areas and Warning Areas B-1
Flight Operations in U.S. National Airspace System (NAS) Outside of Active Restricted Areas and Warning AreasOperations:Flight Operations in U.S. National Airspace System (NAS) Outside of Active Restricted Areas and Warning AreasSystem:Flight Operations in U.S. National Airspace System (NAS) Outside of Active Restricted Areas and Warning Areas B-1
Unmanned Aircraft System Aircraft Crewmember (UASC) Responsibilities 10-2
Unmanned Aircraft System Aircraft Crewmember (UASC) ResponsibilitiesAircraft:Unmanned Aircraft System Aircraft Crewmember (UASC) ResponsibilitiesCrewmember:Unmanned Aircraft System Aircraft Crewmember (UASC) ResponsibilitiesResponsibilities:Unmanned Aircraft System Aircraft Crewmember (UASC) ResponsibilitiesSystem:Unmanned Aircraft System Aircraft Crewmember (UASC) Responsibilities 10-2
Web-Based Safety System G-2
Web-Based Safety SystemSystem:Web-Based Safety System G-2
Systems:
Systems Logs and Recordings G-2
Systems Logs and RecordingsSystems:Systems Logs and Recordings G-2
SYSTEMSYSTEM 2-1

T

Tethered UAS 2-1, 4-6, 8-2
Tethered UASTethered UAS 2-1, 4-6, 8-2
THREE LEVELS OF APPLICATION 14-1
THREE LEVELS OF APPLICATIONTHREE LEVELS OF APPLICATION 14-1
THUNDERSTORMS AND LIGHTNING 11-4

Page No.

THUNDERSTORMS AND LIGHTNINGTHUNDERSTORMS AND LIGHTNING 11-4
TRAINING SYLLABUS 5-1
TRAINING SYLLABUSTRAINING SYLLABUS 5-1
Training:
Airspace Operations Procedures Training 5-3
Airspace Operations Procedures TrainingOperations:Airspace Operations Procedures TrainingProcedures:Airspace Operations Procedures TrainingTraining:Airspace Operations Procedures Training 5-3
UAS Crewmember Training and Qualifications 1-2
UAS Crewmember Training and QualificationsCrewmember:UAS Crewmember Training and QualificationsTraining:UAS Crewmember Training and Qualifications 1-2
Unit Training 5-1
Unit TrainingTraining:Unit TrainingUnit:Unit Training 5-1
Transportation 3-2
TransportationTransportation 3-2
Types of Group 1 and 2 UAS 2-1
Types of Group 1 and 2 UASTypes of Group 1 and 2 UAS 2-1

U

UA GROSS WEIGHT LIMITATION 4-1
UA GROSS WEIGHT LIMITATIONUA GROSS WEIGHT LIMITATION 4-1
UA RECOVERY AFTER MISHAP G-2
UA RECOVERY AFTER MISHAPUA RECOVERY AFTER MISHAP G-2
UAS Commander (UAC) 5-2
UAS Commander (UAC)UAS Commander (UAC) 5-2
UAS CREW CLASSIFICATIONS, DESIGNATION OF UAS CREW PERSONNEL AND DESIGNATING AUTHORITY 5-2
UAS CREW CLASSIFICATIONS, DESIGNATION OF UAS CREW PERSONNEL AND DESIGNATING AUTHORITYUAS CREW CLASSIFICATIONS, DESIGNATION OF UAS CREW PERSONNEL AND DESIGNATING AUTHORITY 5-2
UAS Flown Indoors or Within Other Enclosures 2-2
UAS Flown Indoors or Within Other EnclosuresUAS Flown Indoors or Within Other Enclosures 2-2
UAS MISSION RISK ASSESSMENT D-1
UAS MISSION RISK ASSESSMENTUAS MISSION RISK ASSESSMENT D-1

Page No.

UAS PROFICIENCY REQUIREMENTS 5-4
UAS PROFICIENCY REQUIREMENTSUAS PROFICIENCY REQUIREMENTS 5-4
UAS WEAPONIZATION 12-1
UAS WEAPONIZATIONUAS WEAPONIZATION 12-1
Unexpected Autonomous Behavior 10-4
Unexpected Autonomous BehaviorUnexpected Autonomous Behavior 10-4
UNIT SOP CHECKLIST H-2
UNIT SOP CHECKLISTUNIT SOP CHECKLIST H-2
Unit:
Unit Training 5-1
Unit TrainingTraining:Unit TrainingUnit:Unit Training 5-1
UNIT/COMMAND-LEVEL AIRCRAFT REPORTING CUSTODIAN AUTHORITIES AND RESPONSIBILITIES 1-2
UNIT/COMMAND-LEVEL AIRCRAFT REPORTING CUSTODIAN AUTHORITIES AND RESPONSIBILITIESUNIT/COMMAND-LEVEL AIRCRAFT REPORTING CUSTODIAN AUTHORITIES AND RESPONSIBILITIES 1-2
UNMANNED AIRCRAFT 2-1
UNMANNED AIRCRAFTUNMANNED AIRCRAFT 2-1

V

Vehicle:
Air Vehicle Operator (AVO) 5-2
Air Vehicle Operator (AVO)Vehicle:Air Vehicle Operator (AVO) 5-2
Launch and Recovery from a Moving Vehicle 7-6
Launch and Recovery from a Moving VehicleLaunch:Launch and Recovery from a Moving VehicleRecovery:Launch and Recovery from a Moving VehicleVehicle:Launch and Recovery from a Moving Vehicle 7-6
Vehicles:
Unmanned Ground Vehicles (UGV), Unmanned Surface Vehicles (USV) and Unmanned Underwater Vehicles (UUV) 2-2
Unmanned Ground Vehicles (UGV), Unmanned Surface Vehicles (USV) and Unmanned Underwater Vehicles (UUV)Ground:Unmanned Ground Vehicles (UGV), Unmanned Surface Vehicles (USV) and Unmanned Underwater Vehicles (UUV)Vehicles:Unmanned Ground Vehicles (UGV), Unmanned Surface Vehicles (USV) and Unmanned Underwater Vehicles (UUV) 2-2
VISIBLE PRECIPITATION 11-4

Page No.

VISIBLE PRECIPITATIONVISIBLE PRECIPITATION 11-4
Visual Observer (VO) 5-2
Visual Observer (VO)Visual Observer (VO) 5-2

W

WEATHER 4-2
WEATHERWEATHER 4-2
WIND LIMITATIONS 4-1
WIND LIMITATIONSWIND LIMITATIONS 4-1
WIND SHEAR, GUSTS, AND TURBULENCE 11-4
WIND SHEAR, GUSTS, AND TURBULENCEWIND SHEAR, GUSTS, AND TURBULENCE 11-4
Wing:
Fixed Wing UAS 2-1, 4-4
Fixed Wing UASWing:Fixed Wing UAS 2-1, 4-4