Final Report
ASSURE A28: Disaster Preparedness and Response Using UAS
Attachment 3 – Concept of Operations (CONOPS) for Hurricane, Tornado, and Flooding

June 1, 2022

NOTICE

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TABLE OF ACRONYMS

ACUASI	Alaska for Unmanned Aircraft Systems Integration
BVLOS	Beyond Visual Line of Sight
CONOP	Concept of Operation
DLI	Divert Land Immediately
EO	Electro-Optical
EVLOS	Extended Visual Line of Sight
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
GCS	Ground Control Station
GEOJSON	Geographic JavaScript Object Notation
HD	High definition
IFR	Instrument Flight Rules
JPEG	Joint Photographic Experts Group
KML	Keyhole Markup Language
NAS	National Airspace System
NOAA	National Oceanic and Atmospheric Administration
NOTAM	Notice to Airmen
NWS	National Weather Service
ORA	Operational Risk Assessment
PIC	Pilot in Command
RTB	Return to Base
SAR	Search and Rescue
SGI	Special Government Interest
SHP	Shape file
SOSC	System Operations Support Center
TFR	Temporary Flight Restriction
TIFF	Tag Image File Format
TIR	Thermal Infrared

UAF	University of Alaska Fairbanks
UAH	University of Alabama Huntsville
UAS	Uncrewed/Unmanned Aircraft System
VFR	Visual Flight Rules
VLOS	Visual Line of Sight
VNIR	Visible and near-infrared
VO	Visual Observer
VTOL	Vertical Take-Off and Landing

ATTACHMENT 3 - CONCEPT OF OPERATIONS (CONOPS) FOR HURRICANE, TORNADO, AND FLOODING

Lead organization will demonstrate that the CONOP has been reviewed. The CONOP will be accepted if the document contains sufficient information to proceed to an Operational Risk Assessment (ORA). *The CONOP is to be submitted by the lead organization for the mission.*

Approval by (Name/Org)	Title	Date	Approve Digital Signature

This CONOP will include all items needed to build out a successful mission. There will be sections included that are specific to each disaster response in the CONOP, such as under purpose of mission. Any specific information needed in the CONOP for a disaster response will be included before the summary section.

This CONOP document follows the "5-paragraph order" format, leveraged from the military operations world. The purpose is to allow operational team members to determine whether an applicant explicitly identifies key information that will be necessary for a subsequent **ORA**. These paragraphs spell out the acronym **S-M-E-A-C, for "Situation", "Mission", "Execution", "Administration & Logistics", "Command & Signal"**. This is known as the "SMEAC Sheet".

List of Revisions			
Revision Description	Approved by	Approve Digital Signature	Release Date (DD/MM/YY)

<u>Notes on a CONOP:</u>

The CONOP is viewed as an "evolving" document that records an analysis performed during the requirements generation process and should contain the following:

- A clear statement of the goals and objectives
- Strategies, tactics, policies, and constraints that describe how security will affect the program
- Organizations, activities, and interactions that describe who will participate and what these stakeholders do in that process
- A clear statement of the responsibilities and authority of the roles played in the process
- The specific operational processes, in overview fashion, that provide a process model in terms of when and in what order these operation processes take place, including such things as dependencies and concurrencies
- Processes for initiating the program, developing the products and components, maintaining the products, and components, and possibly for retiring the program and its products and components

CONOP:

- Narrate the processes to be followed
- Define the roles of the various stakeholders involved in the process
- Outline a methodology to realize the goals and objectives of the mission

1.1 Concept of Operation (CONOP)

Hurricane (Category 4) passes through the region and there is significant post event flooding.

<u>Operation</u>

Hurricane passing from Gulf of Mexico into Louisiana and makes landfall around New Orleans with accompanying tornadoes. Significant building damage and extensive flooding along with air support for search and rescue operations.

<u>Duration</u>

Several days

<u>Outcomes/Actionable intelligence</u>

- Large UAS successful mission and pushes data back to ground to build maps and videos of events
- Small UAS #3 successfully stays airborne and acts as a communications hub with a tethered system for power and data transfer
- Small UAS #2 feeds back real-time Electro-Optical (EO) visible and Thermal Infrared (TIR) video feeds to ground operations to perform Search and Rescue (SAR)
- Small UAS #3 feeds EO video feeds back to ground operations to evaluate buildings impacted by tornado and hurricane.
- Small UAS #2 and #3 can fly defined patterns and manually move to locations as needed by the ground team, air boss and operations center lead
- Small UAS #4 successfully produces data to build maps of flooded areas to support ground teams to evaluate water extent and impact on communities and buildings.
- Small UAS #4 real-time feeds of flooding extent and post-production of mosaicked georectified maps

<u>Metrics of success:</u>

- Large UAS streams data back to the incident center to support assessment of full extent.
- Small UAS #1 provides a long-term communications hub for ground teams where cell tower coverage is lacking.
- Small UAS #2 streams back EO data to the operations center and can move field of view based on needs for ground teams SAR.
- Small UAS #3 moves to locations needed by the operations center on the ongoing disaster and where buildings need inspection
- Small UAS #2 maps buildings as defined by ground teams.
- Small UAS #4 produced real-time needs to support operations center to assess flooding extent and where to send ground teams to minimize impact and to at-risk areas

- Small UAS #1 - #3 fly under Part 107 and Visual Line Of Sight (VLOS) to Extended Visual Line Of Sight (EVLOS) is maintained.
- Large UAS and small UAS #4 with Beyond Visual Line Of Sight (BVLOS) permissions.

1.2 CONOP Quad Chart: Hurricane passing from Gulf of Mexico into Louisiana and makes landfall around New Orleans with accompanying tornadoes. Significant building damage and extensive flooding along with air support for search and rescue operations.

1.2.1 Mission Purpose/Objectives

Purpose: Significant hurricane (category 4) passes onto land near to New Orleans with subsequent tornadoes impacting the landscape and communities and then post-event extensive flood waters that continue impact surrounding communities. Also, lack of cell-coverage requires airborne communications to support ground teams.

Goals: Large UAS providing long endurance eyes and communications over the impacted area from high altitude. Small UAS #1 will be tethered and at fixed location to provide communications hub for ground operations as well as additional EO/thermal video feed of the area. Small UAS #2 with an EO and thermal payload that can get close into buildings to support ground SAR [SAR for survivors; Short campaigns; Targeted to support ground operations]. Small UAS #3 with an EO and thermal payload that can focus on collected data on at risk buildings so that ground teams can assess if there is any risk of further damage/collapse. Small UAS #4 will have EO and visible-near infrared payload to fly around the flooded areas to assess extent of water flooding and also overtime assess the water levels as they recede.

Objectives: Large UAS with real-time data to Ground Control Station (GCS) and onto emergency management operations center that is used to provide airborne surveillance from above the disaster zone. Tethered small UAS #1 in the disaster zone gains eyes and communications on the event from a fixed location and turns on a dedicated communications hub over specific channels only for ground operations use. Small UAS #2 is flown manually, and the flight pattern adapts based on the ground team SAR needs. Small UAS #2 will take-off and land from several locations as the ground team makes requests. Small UAS #3 is flown to provide data on the at-risk infrastructure within the disaster zone. As with small UAS #2, small UAsS#3 will be flown manually with take-off and landing locations as defined by the needs of the ground team. Small UAS #4 is flown on predetermined routes based on observations that have been analyzed by the emergency management operations center and collected by the large UAS. Small UAS #4 will fly with VLOS permissions in place and also with capability to adapt flight plans based on needs of the emergency management operations center to map the water levels. Evaluate how small UAS missions can respond to large UAS operations and data analysis. Evaluate how local 107 pilots can respond to needs of State and/or City agencies. Evaluate how tethered small UAS #1 can provide eyes and communications on events as well as act as a communications hub.

1.2.2 Mission Procedures/Approach

Large UAS: Rapid response take-off from Huntsville [UAH] airport - 3 hr. flight time to disaster zone

BVLOS operations, flown from nearby runway to then have holding pattern above disaster zone

Multiple hours of flying to provide high altitude eyes and communications on disaster

Visual Flight Rules (VFR)/Instrument Flight Rules (IFR) conditions as will be BVLOS - able to fly in full range of conditions

Small UAS #1: Tethered sUAS fixed to one location within the disaster zone

VLOS operations, Part 107 waiver and Special Government Interest (SGI) waiver [might have different needs as tethered system]

Eyes and communications on infrastructure with pointable EO/thermal

Provides response only communications hub, Powered through tether so can stay airborne for extended period and/or whole event

Small UAS #2: Short pop-up flights during disaster response

Manual small UAS: Search and rescue EO/thermal to support ground teams

Flown from multiple locations at the needs of SAR teams

VLOS with Part 107 or SGI waiver

VFR conditions [IFR if event limits visual observer from keeping VLOS]

Small UAS #3: Short pop-up flights during disaster response

Manual small UAS: Building safety assessment with EO/thermal to support ground teams

Flown from multiple locations at the needs of ground teams and emergency management operations center

VLOS with Part 107 or SGI waiver

Small UAS #4: Long endurance flights to map the extent of the flooding

Pre-defined routes based on large UAS data with ability to manually fly at needs of emergency management operations center

EO with visible-near infrared sensor, VLOS operations with capability and permissions to extend to BVLOS, if needed

VFR conditions [IFR if event limits Visual Observer (VO) from keeping VLOS]

1.2.3 Mission Results

Observations: Recording of full extent of the event from a large UAS whose flight pattern aims to provide continued data collection. At least four small UAS used. Small UAS #1 is tethered to GCS and placed within the disaster area to provide a fixed location for communications and EO/thermal data with a pointable payload. Small UAS #2 is a mobile system with EO/thermal payload and flown at low altitude to support ground teams as they perform SAR. Small UAS #3 provides EO/thermal video feeds of at-risk infrastructure so that the ground teams and emergency management operations center can assess if they are safe or if further damage is possible. Small UAS #4 will provide EO and visible-near infrared observations of the flooded area whose flight pattern will be defined based on the data from the large UAS. Small UAS #4 may be flown manually, if required to map the flooded areas.

Real-time Mission Products: Large UAS - EO/thermal video feeds back to emergency management operations center. Small UAS #1: EO/thermal videos and open communication channels for others in response to use. Small UAS #2: EO/thermal videos back to emergency management operations center and SAR ground teams. Small UAS #3: EO/thermal videos back to emergency management operations center and infrastructure inspection ground teams. Small UAS #4: EO and visible-near infrared video feeds back to emergency management operations center. Data from all UAS displayed in geospatial interface to superimpose on other available data from state, federal, and local agencies.

Post-Mission [fast response] Products: Mosaicked maps of the full extent of the disaster from the large UAS; 3D constructed dataset from small UAS #2 of at-risk infrastructure with thermal infrared superimposed. Mosaicked maps of the water extent from small UAS #4 with possible visible (EO) and visible-near infrared comparisons.

1.2.4 Mission Milestones

Outcomes/Actionable Intelligence

Large UAS successful mission and pushes data back to ground to build maps and videos of events

Small UAS #3 successfully stays airborne and acts as a communications hub with tethered system for power and data transfer

Small UAS #2 feeds real-time EO and thermal infrared video feeds to ground operations to perform SAR

Small UAS #3 feeds EO video feeds back to ground operations to evaluate buildings impacted by tornado and hurricane

Small UAS #2/#3 fly defined patterns and manually move to locations needed by the ground team and emergency management lead

Small UAS #4 successfully produces data to build maps of flooded areas

Small UAS #4 supports ground teams to evaluate water extent and impact on communities and buildings

Small UAS #4 real-time feeds of flooding extent and post-production of mosaiced georectified maps

Metrics of success

Large UAS streams data back to the incident center to support assessment of full extent

Small UAS #1 provides a long-term communications hub for ground teams where cell tower coverage is lacking

Small UAS #2 streams back EO data to operations center and can move field of view on needs for ground teams SAR

Small UAS #3 moves to locations needed for the ongoing disaster and where buildings need inspection

Small UAS #2 maps buildings as defined by ground teams

Small UAS #4 produced real-time needs to assess flooding and where to send ground teams to minimize impact and to at-risk areas

Small UAS #1 - #3 fly under Part 107 and VLOS to EVLOS is maintained

Large UAS and Small UAS #4 with BVLOS permissions.

1.3 Situation

1.3.1 Overview

Purpose of the mission: Significant hurricane (CAT 4) passes onto land near to New Orleans with subsequent tornadoes impacting the landscape and communities and then post-event extensive flood waters that continue to impact surrounding communities. Also, lack of cell-coverage requires airborne communications to support ground teams.

Goals: Large UAS providing long-endurance eyes and communications over the impacted area from high altitude. Small UAS #1 will be tethered and at a fixed location to provide a communications hub for ground operations as well as additional EO/thermal video feed of the area. Small UAS #2 with an EO and thermal payload that can get close to buildings to support ground SAR (SAR for survivors; Short campaigns; Targeted to support ground operations). Small UAS #3 with an EO and thermal payload that can focus on collected data on at-risk buildings so that ground teams can assess if there is any risk of further damage/collapse. Small UAS #4 will have EO and Visible-Near Infrared (VNIR) payload to fly around the flooded areas to assess extent of water flooding and overtime assess the water levels as they recede.

UAS mission Lead: University of Alabama Huntsville (UAH) with support from University of Alaska Fairbanks (UAF) Alaska for Unmanned Aircraft Systems Integration (ACUASI).

Overall: ACUASI/large UAS team at operations center. Communicate with flight team leads

Large UAS: High altitude observations on event

- Flight team lead with crew
- Flight from Huntsville (UAH) airport as would be outside major disaster zone)

Small UAS #1: Tethered system to provide data communications hub and EO/TIR video

- Pilot In Command (PIC) with VO
- Specialist team member to relay needs to PIC to ensure communications hub

Small UAS #2: Manually operated so can move to locations where needed for SAR

- PIC with VO
- Specialist team member to relay needs of ground team to PIC
- EO and thermal video data

Small UAS #3: Manually operated to move to locations needed for infrastructure assessment

- PIC and VO
- Specialist team member to relay needs of ground team to PIC
- EO and thermal video data

Small UAS #4: React to needs of ICS to capture data over flooded areas

- PIC and VO
- Specialist team member to relay needs of ground team to PIC
- EO/VNIR payload with video feed in real-time
- Planned route with ability for manual operations

1.3.2 Location

Large UAS operations

Huntsville airport, Alabama	Latitude: 34.6403° N	Longitude: 86.7757° W
IATA: HSV	ICAO: KHSV	FAA LID: HSV

http://www.airnav.com/airport/khsv

Small UAS operations

Hurricane impact and flooding - Equivalent to Ida on August 29, 2021

Landfall location - Port Fourchon

Latitude: 29.1056° N

Longitude: 90.1944° W

All Maps in Appendix 3

1.3.3 Systems

<u>Central Operations</u>

- Coordination with flight teams. Based in Louisiana Emergency Operations Center or equivalent setup for the disaster response
- ACUASI as large UAS operator - Director Cahill or Director of Operations Adkins
- Local Emergency Management Response team, Local Airport Representatives, Air Boss, Federal Aviation Administration (FAA), and Federal Emergency Management Agency (FEMA) representatives

<u>1st flight - will take time to respond, provide large scale mapping of extent</u>

<u>Large UAS</u>

- SeaHunter/Sentry type from Huntsville (UAH) airport
- Endurance for multiple hours per flight (say up to 4 hrs.)
- Would need to return to airport, refuel and get back airborne
- Pilots and support crew for large UAS
    - External Pilot, Crew Chief, Internal Pilot, and Supplemental Pilot
    - Additional operator to manage data feed from onboard payload
- Minimum Payload
    - EO feed is sent back to GCS and onto operations center
    - Optical and thermal payload integrated for nadir viewing
- Flight pattern to stay above disaster zone and within temporary flight restriction

<u>2nd flight up to get EO/TIR eyes and communications (Tethered sUAS)</u>

<u>Small UAS #1</u>

- Vertical Takeoff and Landing (VTOL) (Endurance for all the event)
- Operations Center determines best location to tether sUAS
- Flight team
    - Part 107 PIC + VOs with Engineering support [if possible as VO]
- Minimum Payload
    - EO with thermal: Pointable with fixed nadir option
- Provide communications hub above the disaster zone for ground ops.
- Sufficient power capacity for continued stable location
- Power through tether so onboard systems stay on and working
- May need a waiver/permission to get a higher altitude, > 400 ft.

<u>3rd flight up to provide SAR needs for the ground teams</u>

<u>Small UAS #2</u>

- VTOL (Endurance for 30 - 45 mins per flight)
- Operations Center determines best location to launch small UAS

- Flight team
    - Part 107 PIC + VOs with Engineering support [if possible as VO]
- Minimum Payload
    - EO + zoom with thermal: Pointable with fixed nadir option
    - Camera has up-to-date thermal calibration documents
- Ability to move to spot locations where needed for takeoff and landing
- Manually flown so can react to needs of ground teams
- Need a waiver/permission to get a higher altitude, > 400 ft.

4th flight up to provide building inspection observations for ground teams

Small UAS #3

- VTOL (Endurance for 30 - 45 mins per flight)
- Operations Center determines best location to launch small UAS
- Flight team
    - Part 107 PIC + VOs with Engineering support [if possible as VO]
- Minimum Payload
    - EO + zoom with thermal: Pointable with fixed nadir option
    - Camera has up-to-date thermal calibration documents
- Capture sufficient data to produce 3D model after mission with video too
- Manually flown so can react to needs of ground teams
- Need a waiver/permission to get a higher altitude, > 400 ft.

5th flight up to map the flooding extent and provide EO and VNIR data

Small UAS #4

- VTOL (Endurance for 30 - 45 mins per flight)
- Operations Center determines best location to launch small UAS
- Flight team
    - Part 107 PIC + VOs with Engineering support [if possible as VO]
- Minimum Payload
    - EO + zoom with thermal: Pointable with fixed nadir option
    - VNIR payload to support mapping of landscape and flooding extent
- Manually flown so can react to needs of ground teams to map flooding
- Need a waiver/permission to get a higher altitude, > 400 ft.

1.4 Mission

Disaster:

Significant hurricane (CAT 4) passes onto land near to New Orleans with subsequent tornadoes impacting the landscape and communities and then post-event extensive flood waters that continue to impact surrounding communities. Also, lack of cell-coverage requires airborne communications to support ground teams.

Observations

Recording of full extent of the event from a large UAS whose flight pattern aims to provide continued data collection. At least four small UAS are used. Small UAS #1 is tethered to GCS and placed within the disaster area to provide a fixed location for communications and EO/thermal data with a pointable payload. Small UAS #2 is a mobile system with EO/thermal payload and flown at low altitude to support ground teams as they perform search and rescue. Small UAS #3 provides EO/thermal video feeds of at-risk infrastructure so that the ground teams and operations center can assess if they are safe or if further damage is possible. Small UAS #4 will provide EO and VNIR observations of the flooded area whose flight pattern will be defined based on the data from the large UAS. Small UAS #4 may be flown manually, if required to map the flooded areas.

Response mission:

A Category 4 hurricane has made landfall and passes through a populated area. There are reports of associated tornadoes and significant flooding. Ground teams are performing search and rescue of any trapped civilians as well as need to inspect impacted infrastructure. airborne assets can detect significant flooding and required continued analysis of the flooded areas and changes in the water levels.

Stakeholders:

Huntsville (UAH) Airport; FAA; FEMA; Local operations center. All need observations and communications on the event and ability to support ground operations.

Goals:

Get large UAS up to keep continued observations on the full extent of the disaster event and to get data to the operations center; Local small UAS Part 107 pilots can respond and provide data. Getting tethered within the disaster zone along with all permissions in place and communications hub. Demonstrate that the mobile small UAS can respond to needs of the operations center and get data on the event including SAR and infrastructure assessment data for ground teams. Small UAS #4 maps water extent and provides data feeds on the changing water levels. Show communication between the multiple UAS flight teams and that operations center/Air Boss can communicate with PICs and get tethered UAS to move field of view; get mobile small UAS to move to area of impact and where needed by the ground crews; Small UAS #4 is able to fly defined patterns and react to the need of the operations team to map the water levels; lUAS to get airborne and data feedback to the operations center.

Objectives:

Large UAS with real-time data to GCS and onto the operations center that is used to provide airborne surveillance from above the disaster zone. Tethered small UAS #1 in the disaster zone gains observations and communications on the event from a fixed location and turns on a dedicated communications hub over specific channels only for ground operations use. Small UAS #2 is flown manually, and the flight pattern adapts based on the ground team SAR needs. Small UAS #2 will take off and land from several locations as the ground team makes requests. Small UAS #3 is flown to provide data on the at-risk infrastructure within the disaster zone. As with small UAS #2, small

UAS #3 will be flown manually with takeoff and landing locations as defined by the needs of the ground team. Small UAS #4 is flown on predetermined routes based on observations that have been analyzed by the operations center and collected by the large UAS. Small UAS #4 will fly with VLOS permissions in place and with capability to adapt flight plans based on needs of the operations center to map the water levels. Evaluate how small UAS missions can respond to large UAS operations and data analysis. Evaluate how local 107 pilots can respond to needs of State and/or City agencies. Evaluate how tethered small UAS #1 can provide observations on events as well as act as a communications hub.

Real-time Mission Products:

- Large UAS - EO/thermal video feeds back to the operations center
- Small UAS #1: EO/thermal videos and open communication channels for others in response to use
- Small UAS #2: EO/thermal videos back to the operations center and SAR ground teams
- Small UAS #3: EO/thermal videos back to the operations center and infrastructure inspection ground teams
- Small UAS #4: EO and NVIR video feeds back to the operations center
- Data from all UAS displayed in geospatial interface to superimpose on other available data from state, federal, and local agencies.

Post-Mission (fast response) Products:

- Mosaicked maps of the full extent of the disaster from the large UAS
- 3D constructed dataset from small UAS#2 of at-risk infrastructure with TIR superimposed
- Mosaicked maps of the water extent from small UAS #4 with possible EO and NVIR comparisons

1.5 Execution

1.5.1 Operations Plan

Large UAS supports the event and 4 small UAS at lower altitudes, with their specific missions.

Large UAS

- Rapid response takeoff from Huntsville (UAH) airport
- 3-hour flight time to disaster zone with BVLOS operations. Keeps holding pattern
- Provide high altitude observations and communications on disaster
- VFR/IFR conditions and able to fly in full range of conditions
- Follow pre-flight, during, and post-flight checklist for lUAS like SeaHunter/Sentry

Small UAS #1

- Tethered mall sUAS fixed to one location within the disaster zone
- Part 107 waiver and SGI (might have different needs as tethered system)
- VLOS operations and hold at top of tethered extent
- Observations and communications on infrastructure with pointable EO/Thermal
- Provides response only communications hub
- Powered through tether so can stay airborne for extended period and/or whole event

- Follow pre-flight, during, and post-flight checklist for small UAS, need for VO

Small UAS #2

- Short pop-up flights during disaster response
- Manual small UAS: Search and rescue EO/thermal to support ground teams
- Flown from multiple locations at the needs of SAR teams
- VLOS with Part 107 or SGI waiver
- VFR conditions (IFR if event limits VO from keeping VLOS)
- Follow pre-flight, during, and post-flight checklist for small UAS, need for VO

Small UAS #3

- Short pop-up flights during disaster response
- Manual small UAS: Building safety assessment with EO/thermal to support ground teams
- Flown from multiple locations at the needs of ground teams and operations center
- VLOS with Part 107 or SGI waiver
- VFR conditions (BVLOS if event limits VO from keeping VLOS)
- Follow pre-flight, during, and post-flight checklist for small UAS, need for VO

Small UAS #4

- Long endurance flights to map the extent of the flooding
- Pre-defined routes based on large UAS data
- Ability to manually fly at needs of operations center
- EO with VNIR sensor, VLOS operations with capability to extend to BVLOS, if needed
- VFR conditions (BVLOS if event limits VO from keeping VLOS)
- Follow pre-flight, during, and post-flight checklist for small UAS, need for VO

1.5.2 Data collection, processing, and dissemination

Large UAS

Full extent of disaster event

- Data in flight:
    - High precision locations and time synchronization of flight
    - Flight routes and logs from crew
    - Geotagged EO visible and infrared imagery over disaster area
    - Decimeter res. visible data from High Definition (HD) multi-megapixel camera
    - Broadband thermal infrared [7 - 13 μm] data: Minimum 640 x 480 resolution
    - Optical setup supports overlay videos onto visualization tool [Full Motion Video]
    - Optical data streamed to ground station and onto operations center
    - On-board storage of data that is downloaded upon landing
- Products post flight:
    - Geotagged videos with overlaid field of view on geospatial visualization tool
    - Mosaicked maps from optical and thermal data

Small UAS #1

Tethered aircraft that hovers at set altitude

- Data in flight:
    - High precision locations and time synchronization of flight
    - Flight routes and logs from crew
    - Geotagged EO visible and infrared imagery over disaster area
    - cm-resolution visible data from HD Multi-megapixel camera
    - Broadband thermal infrared [7 - 13 μm] data: Minimum 640 x 480 resolution
    - EO visible streamed to ground station and onto operations center
    - On-board storage of data that is downloaded upon landing
    - On-board dedicated communications to support ground and air operations
- Products post flight:
    - Geotagged videos with overlaid field of view on geospatial visualization tool
    - Mosaicked maps from optical and thermal data

<u>Small UAS #2</u>

Low altitude flights; Support SAR needs of the ground teams

- Data in flight:
    - High precision locations and time synchronization of flight
    - Flight routes and logs from crew
    - Geotagged EO visible and infrared imagery over disaster area
    - cm-resolution visible data from HD Multi-megapixel camera
    - Broadband thermal infrared [7 - 13 μm] data: Minimum 640 x 480 resolution
    - EO visible streamed to ground station and onto operations center
    - On-board storage of data that is downloaded upon landing
    - On-board dedicated communications to support ground and air operations
- Products post flight:
    - Geotagged videos with overlaid field of view on geospatial visualization tool
    - Mosaicked maps from optical and thermal data

<u>Small UAS #3</u>

Low altitude flights; Support building inspection needs of the ground teams

- Data in flight:
    - High precision locations and time synchronization of flight
    - Flight routes and logs from crew
    - Geotagged EO visible and infrared imagery over disaster area
    - cm-resolution visible data from HD Multi-megapixel camera
    - Broadband thermal infrared [7 - 13 μm] data: Minimum 640 x 480 resolution
    - EO visible streamed to ground station and onto operations center
    - On-board storage of data that is downloaded upon landing

    - On-board dedicated communications to support ground and air operations
- Products post flight:
    - Geotagged videos with overlaid field of view on geospatial visualization tool
    - Mosaicked maps from optical and thermal data
    - 3D models of the buildings from EO data with superimposed TIR data

<u>Small UAS #4</u>

Low to medium altitude flights; Mapping flooding (pre-defined and manual)

- Data in flight:
    - High precision locations and time synchronization of flight
    - Flight routes and logs from crew
    - Geotagged EO visible and infrared imagery over disaster area
    - cm-resolution visible data from HD Multi-megapixel camera
    - VNIR sensor coupled with the EO visible imager
    - Broadband thermal infrared [7 - 13 μm] data: Minimum 640 x 480 resolution
    - EO visible streamed to ground station and onto operations center
    - On-board storage of data that is downloaded upon landing
    - On-board dedicated communications to support ground and air operations
- Products post flight:
    - Geotagged videos with overlaid field of view on geospatial visualization tool
    - Mosaicked maps from optical and thermal data
    - Mosaicked EO and VNIR maps of the flooding extent

<u>Post Mission Debrief</u>

- Discussion if metrics for success accomplished
- Performed at end of each day [depending on length of event]
- All flight crews with operations center leads as well as UAS lead organizations [UAH/UAF]
- Documented lessons learned and where issues occurred to limit mission success

1.5.3 Administration & Logistics

1.5.3.1 Planning and local logistics

Large UAS team will have accommodation at a hotel nearby the launching airport. This will provide overnight lodging before and after each flight day. Also, it will allow them to store no mission required equipment to optimize the equipment taken with them for the daily missions. Large UAS team will work with launching airport to acquire runway access and setup location for their ground control station. UAS mission teams will ensure that all required waivers are in place to support flight operations. Large UAS will have all permissions to fly from launching airport and within the National Airspace System (NAS) to the terrorism event. If a Temporary Flight Restriction (TFR) is in place, the flight team lead will liaise with the event air boss to ensure permissions set up to allow large UAS to fly into TFR.

Small UAS team will have accommodation near Port Fourchon. This will provide overnight lodging before and after each flight day. Also, it will allow them to store no mission required equipment to optimize the equipment taken with them for the daily missions. UAS mission teams will ensure that all required waivers are in place to support flight operations. If TFR in place, the flight team lead will liaise with the event air boss to ensure permissions set up to allow small UAS to fly into TFR.

Any required Part 107 waivers will be in place before missions start. SGI waiver will be submitted to support all small UAS missions to ensure that sufficient permissions are acquired, if needed, so that they do not need to be submitted during the missions and any time lost. Small UAS #1 will be tethered to provide a fixed location for operations. Small UAS pilot in command and UAS missions lead will liaise with the emergency operations center to define allowed locations for tethered UAS. From these site selections, the most effective location to support ground operations and acquire data of the events will be chosen.

All required communications will occur between all PICs and local air traffic control tower. All Notices to Airman (NOTAMs) will be provided to the wider aviation community.

1.5.4 Hazards/Risk

Hazard #1: Severe Weather Conditions

- Risk: This hazard is a result of atmospheric conditions that change so there is a no-go for flight operations. Possible effects are a stop in flight operations and an aircraft that must rapidly return to land or end flight and the team left waiting and unable to complete their mission.
- Mitigation: During flight, if weather conditions deteriorate suddenly, the PIC assesses if Divert Land Immediately (DLI) is required or if they can invoke Return To Base (RTB) resulting in a suspension of the onward flight path. DLI will ensure that the flight lands safely as close as possible to the original location. If the PIC can determine that flight can still operate with the RTB in place, then the UAS will follow this pattern, i.e., its launch/landing point. If this is not possible given the weather conditions, the mission will use the defined landing zones developed in the CONOP to divert land immediately. If there are multiple UAS flights at the same time and in the same airspace supporting a disaster response, then pre-mission coordination on each flight's alternative landing zones will occur to mitigate any mid-air collisions from DLI or RTB flights.

Hazard #2: Loss of time synchronization between UAS used in response

- Risk: This hazard would be caused by incorrect timing of missions [multiple aircraft] to match through centralized communications. Possible effects are aircraft taking off at the wrong time and data not comparable for evaluation of the disaster event.
- Mitigation: Before all the missions start, the flight crews will ensure that aircraft systems and GCSs are synchronized so that data can be compared. Between flights, the crew will re-assess the time synchronization of their systems and be in communications with the central team to ensure operations occur at the time specified in the CONOP.

Hazard #3: Large UAS is unable to stay airborne or takes too long to launch

- Risk: This hazard comes from the time taken to get the large UAS airborne to collect data thus limiting higher altitude observations of the event. Also, it can be caused by a need to refuel and therefore no high-altitude observations of the response. Possible effects are no higher altitude data to keep eyes on the full extent of the event and/or act as a communications hub.
- Mitigation: The large UAS team will react as quickly as they are requested to support the disaster response. They will know the available airports that they can use for their flight operations and will have their own flight checklists for flight operations. The large UAS team that assets are closest to the disaster response will be contacted first to ensure fast response. The disaster response team will know the available large UAS teams that are approved to support a disaster response. The large UAS flight crew will inform the ICS lead/air boss on their currently available fuel and time that they can stay airborne.

Hazard #4: Lack of safe landing for flight operations over water

- Risk: This hazard comes from a small UAS flying over water and crew undefining a safe landing zone and/or unable to perform a manual landing back on boat. Possible effects are the sUAS having to ditch into the water as it does not have a safe landing site or fails to land back onto the boat.
- Mitigation: Before the mission, the PIC of the small UAS will determine a range of potential landing locations if there is an issue with the aircraft as it flies over the water or if the visual observer is unable to track the aircraft. Zones on land will be defined as alternates for the boat landing site used for the oil spill analysis. All backup landing sites will be chosen to ensure safe landing and that the aircraft can land away from any water. If the only option is to land on water, the PIC and flight crew will use RTB to ensure a reusable UAS and if not possible will instigate a safe DLI procedure.

Hazard #5: Crew unable to provide visual observations for small UAS flight

- Risk: This hazard comes from a required flight time of the small UAS missions extending beyond the visual observation capabilities of the crew and there is no BVLOS plan in place. Possible effects are that a mission must end and cannot support operations or a small UAS cannot be tracked and so a RTB is required to ensure the crew can keep a visual on it and airspace.
- Mitigation: Before the mission starts, the PIC will determine the maximum distance that a VO can see to ensure VLOS operations based on the conditions at the time of flight. The VO will continue to stay in communication with the PIC to ensure that they can confirm that they can see the aircraft and the airspace around the operations. If there is a deviation of the planned flight route, then the PIC will ensure that the VO can still see the aircraft and if no onboard detect and avoid system is in place and no waiver to allow BVLOS operations then the new route will not occur, and the aircraft will stay on its course that ensure VLOS operations.

Hazard #6: Crew unable to ensure safe operations over people and/or property

- Risk: This hazard comes from the flight crew being unable to ensure safe flight operations when there are people and/or property below the flight route. Possible effects are a crash of the UAS with people/property or a need to RTB because the PIC cannot ensure safe flight operations.

- Mitigation: Before the mission starts, the PIC will define all the backup landing zones in case there is an issue with the flight operations. The VO will continue to track the aircraft and airspace and inform the PIC if they are unable to continue this role. If there is a loss of the aircraft by the VO, then the PIC will invoke a DLI or RTB depending on the location and proximity to people and property. The flight mission will have all required permissions to allow them to fly over people and the environment below the flight path.

Hazard #7: Loss of power and navigational connection to large UAS in NAS

- Risk: This hazard comes from a loss of power and control of the large UAS providing higher altitude eyes on the response. Possible effects are no higher altitude data to keep eyes on the full extent of the event and/or act as a communications hub and a RTB or uncontrolled descent of the UAS.
- Mitigation: Mitigation would include assigning ditch points for the UAS in the CONOP, so the team is prepared for safe landings, if unable to return to home. The crew member responsible for mission team safety and the ground control station will inform the PIC or mission manager on loss of power. Depending on the vehicle capabilities, it may not be possible to reach a prescribed ditch point during a power loss. However, if the vehicle can reach the ditch point, these points should be monitored for pedestrian/ground traffic to ensure safe landing is possible. VOs in place for VLOS operations will be used to support the PIC in understanding any risks on the ground below the aircraft's location when power is lost. If there are multiple UAS flights at the same time and in the same airspace supporting a disaster response, then pre-mission coordination on each flight's alternative landing zones will occur to mitigate any mid-air collisions from DLI or RTB flights.

1.5.5 Community outreach and connections

All Operations: Huntsville (UAH) Airport (Chosen as would be outside major disaster zone); Incident command team if a statewide Ops Center has been setup; Connection to FAA in area

Small UAS: Four missions. Coordination between flight teams on who will fly each mission

1.5.6 Disaster response mission specific information

- Hurricane Ida 2021 events - Synoptic History from National Oceanic and Atmospheric Administration (NOAA)
- Spot forecast for Port Fourchon region from National Weather Service (NWS). This is downloaded to the flight checklist documentation for each crew and GCS.
- Information from NOAA's National Hurricane Center on ongoing activity - https://www.nhc.noaa.gov/

1.5.7 Mission Summary

Disaster:

Significant hurricane (CAT 4) passes onto land near to New Orleans with subsequent tornadoes impacting the landscape and communities and then post-event extensive flood waters that continue impact surrounding communities. Also, lack of cell-coverage requires airborne communications to support ground teams.

Objectives:

Large UAS with real-time data to GCS and onto the operations center that is used to provide airborne surveillance from above the disaster zone. Tethered small UAS #1 in the disaster zone gains observations and communications on the event from a fixed location and turns on a dedicated communications hub over specific channels only for ground operations use. Small UAS #2 is flown manually, and the flight pattern adapts based on the ground team SAR needs. Small UAS #2 will take off and land from several locations as the ground team makes requests. Small UAS #3 is flown to provide data on the at-risk infrastructure within the disaster zone. As with small UAS #2, small UAS #3 will be flown manually with takeoff and landing locations as defined by the needs of the ground team. Small UAS #4 is flown on predetermined routes based on observations that have been analyzed by the operations center and collected by the large UAS. Small UAS #4 will fly with VLOS permissions in place and with capability to adapt flight plans based on needs of the operations center to map the water levels. Evaluate how small UAS missions can respond to large UAS operations and data analysis. Evaluate how local 107 pilots can respond to needs of State and/or City agencies. Evaluate how tethered small UAS #1 can provide observations on events as well as act as a communications hub.

Flight Missions:

Large UAS flown to provide overview of full disaster extent (Continued observations and communications that support emergency managers to determine small UAS location and observational needs). Four small UAS missions flown to: (1) provide airborne communications hub and fixed location for EO/thermal data of events; (2) manually operated small UAS to support SAR operations and is flown from multiple locations; (3) manually operated small UAS to support evaluation of infrastructure impacted by disaster to assess for safety; and (4) pre-defined mapping and manually flown operations to map extent of flood waters and monitor their progression.

Metrics of success:

- Large UAS streams data back to the incident center to support assessment of full extent.
- Small UAS #1 provides a long-term communications hub for ground teams where cell tower coverage is lacking.
- Small UAS #2 streams back EO data to the operations center and can move field of view based on needs for ground teams SAR.
- Small UAS #3 moves to locations needed by the operations center on the ongoing disaster and where buildings need inspection
- Small UAS #2 maps buildings as defined by ground teams.
- Small UAS #4 produced real-time needs to support operations center to assess flooding extent and where to send ground teams to minimize impact and to at-risk areas
- Small UAS #1 - #3 fly under Part 107 and visual line of sight (VLOS) to EVLOS is maintained.
- Large UAS and small UAS #4 with BVLOS permissions.

1.6 Command & Signal

<u>Aim:</u> *This section should provide an overview of the command and communication systems to be used. This supports anyone reviewing and evaluating the CONOP to efficiently assess those sufficient communications are in place to connect the UAS flight crew with additional organizations connected to and supporting the disaster response and/or preparedness.*

For some of the details included in this section, the plans will cross reference to the ORA, as they will be mitigation plans to ensure safe flight operations and minimize the risk of hazards that can impact flight operations.

<u>Include details on:</u>

- Type of communications tools used to connect PIC, Observer, and other crew members
- Security measures in place to protect the flight crew
- Hand-off process, where appropriate, between the PIC and visual observer(s)
- Flight team lost link and emergency procedures to ensure safe flight operations
- Communication tools use to connect the flight team and local ATC

Note: for each communication tool to be used, this section should also include signals used such as radio frequencies, flight control frequencies, etc.

1.7 Supplementary appendices to accompany CONOP

1.7.1 Appendix 1: Operational Details – One Pager

Mission and Disaster Preparedness/Response

Hurricane passing from Gulf of Mexico into Louisiana and makes landfall around New Orleans with accompanying tornadoes. Significant building damage and extensive flooding along with air support for search and rescue operations.

Mission Purpose/Objectives

Purpose : Significant hurricane (category 4) passes onto land near to New Orleans with subsequent tornadoes impacting the landscape and communities and then post-event extensive flood waters that continue impact surrounding communities. Also, lack of cell-coverage requires airborne communications to support ground teams.

Goals : Large UAS providing long endurance eyes and communications over the impacted area from high altitude. Small UAS #1 will be tethered and at fixed location to provide communications hub for ground operations as well as additional electro-optical/thermal video feed of the area. Small UAS #2 with an electro-optical and thermal payload that can get close into buildings to support ground search and rescue (SAR) [SAR for survivors; Short campaigns; Targeted to support ground operations]. Small UAS #3 with an electro-optical and thermal payload that can focus on collected data on at risk buildings so that ground teams can assess if there is any risk of further damage/collapse. Smll UAS #4 will have electro-optical and visible-near infrared payload to fly around the flooded areas to assess extent of water flooding and also overtime assess the water levels as they recede.

Objectives : Large UAS with real-time data to ground control station (GCS) and onto emergency management operations center that is used to provide airborne surveillance from above the disaster zone. Tethered small UAS #1 in the disaster zone gains eyes and communications on the event from a fixed location and turns on a dedicated communications hub over specific channels only for ground operations use. Small UAS #2 is flown manually and the flight pattern adapts based on the ground team SAR needs. Small UAS #2 will take-off and land from several locations as the ground team makes requests. Small UAS #3 is flown to provide data on the at-risk infrastructure within the disaster zone. As with small UAS #2, small UAsS#3 will be flown manually with take-off and landing locations as defined by the needs of the ground team. Small UAS #4 is flown on predetermined routes based on observations that have been analyzed by the emergency management operations center and collected by the large UAS. Small UAS #4 will fly with visual line of sight (VLOS) permissions in place and also with capability to adapt flight plans based on needs of the emergency management operations center to map the water levels. Evaluate how small UAS missions can respond to large UAS operations and data analysis. Evaluate how local 107 pilots can respond to needs of State and/or City agencies. Evaluate how tethered small UAS #1 can provide eyes and communications on events as well as act as a communications hub.

Mission Results

Observations : Recording of full extent of the event from a large UAS whose flight pattern aims to provide continued data collection. At least four small UAS used. Small UAS #1 is tethered to ground control station (GCS) and placed within the disaster area to provide a fixed location for communications and electro-optical/thermal data with a pointable payload. Small UAS #2 is a mobile system with electro-optical/thermal payload and flown at low altitude to support ground teams as they perform search and rescue (SAR). Small UAS #3 provides electro-optical/thermal video feeds of at-risk infrastructure so that the ground teams and emergency management operations center can assess if they are safe or if further damage is possible. Small UAS #4 will provide electro-optical and visible-near infrared observations of the flooded area whose flight pattern will be defined based on the data from the large UAS. Small UAS #4 may be flown manually, if required to map the flooded areas.

Real-time Mission Products : Large UAS - Electro-optical/thermal video feeds back to emergency management operations center. Small UAS #1: Electro-optical/thermal videos and open communication channels for others in response to use. Small UAS #2: Electro-optical/thermal videos back to emergency management operations center and SAR ground teams. Small UAS #3: Electro-optical/thermal videos back to emergency management operations center and infrastructure inspection ground teams. Small UAS #4: Electro-optical and visible-near infared video feeds back to emergency management operations center. Data from all UAS displayed in geospatial interface to superimpose on other available data from state, federal, and local agencies.

Post-Mission [fast response] Products: Mosaicked maps of the full extent of the disaster from the large UAS; 3D constructed dataset from small UAS #2 of at-risk infrastructure with thermal infrared superimposed. Mosaicked maps of the water extent from small UAS #4 with possible visible (electro-optical) and visible-near infrared comparisons.

Mission Procedures/Approach

Large UAS: Rapid response take-off from Huntsville [UAH] airport - 3 hr flight time to disaster zone
Beyond visual line of sight (BVLOS) operations, Flown from nearby runway to then have holding pattern above disaster zone
Multiple hours of flying to provide high altitude eyes and communications on disaster
Visual Flight Rules (VFR)/Instrument Flight Rules (IFR) conditions as will be BVLOS - able to fly in full range of conditions

Small UAS #1: Tethered sUAS fixed to one location within the disaster zone
Visual line of sight (VLOS) operations, Part 107 waiver and special governmental interest (SGI) waiver [might have different needs as tethered system]
Eyes and communications on infrastructure with pointable electro-optical/thermal
Provides response only communications hub, Powered through tether so can stay airborne for extended period and/or whole event

Small UAS #2: Short pop-up flights during disaster response
Manual small UAS: Search and rescue electro-optical/thermal to support ground teams
Flown from multiple locations at the needs of SAR teams
VLOS with Part 107 or SGI waiver
VFR conditions [IFR if event limits visual observer from keeping VLOS]

Small UAS #3: Short pop-up flights during disaster response
Manual small UAS: Building safety assessment with electro-optical/thermal to support ground teams
Flown from multiple locations at the needs of ground teams and emergency management operations center
VLOS with Part 107 or SGI waiver

Small UAS #4: Long endurance flights to map the extent of the flooding
Pre-defined routes based on large UAS data with ability to manually fly at needs of emergency management operations center
Electro-optical with visibel-near Infrared sensor. VLOS operations with capability and permissions to extend to BVLOS, If needed

Mission Milestones

Outcomes/Actionable Intelligence
Large UAS successful mission and pushes data back to ground to build maps and videos of events
Small UAS #3 successfully stays airborne and acts as a communications hub with tethered system for power and data transfer
Small UAS #2 feeds real-time electro-optical and thermal infrared video feeds to ground operations to perform SAR
Small UAS #3 feeds electro-optical video feeds back to ground operations to evaluate buildings impacted by tornado and hurricane
Small UAS #2/#3 fly defined patterns and manually move to locations needed by the ground team and emergency management lead
Small UAS #4 successfully produces data to build maps of flooded areas
Small UAS #4 supports ground teams to evaluate water extent and impact on communities and buildings
Small UAS #4 real-time feeds of flooding extent and post-production of mosiaked georectified maps

Metrics of success
Large UAS streams data back to the incident center to support assessment of full extent
Small UAS #1 provides a long-term communications hub for ground teams where cell tower coverage is lacking
Small UAS #2 streams back electro-optical data to operations cnter and can move field of view on needs for ground teams SAR
Small UAS #3 moves to locations needed for the ongoing disaster and where buildings need inspection
Small UAS #2 maps buildings as defined by ground teams
Small UAS #4 produced real-time needs to assess flooding and where to send ground teams to minimize impact and to at-risk areas
Small UAS #1 - #3 fly under Part 107 and VLOS to EVLOS is maintained
Large UAS and Small UAS #4 with BVLOS permissions.

1.7.2 Appendix 2: Flight Checklists

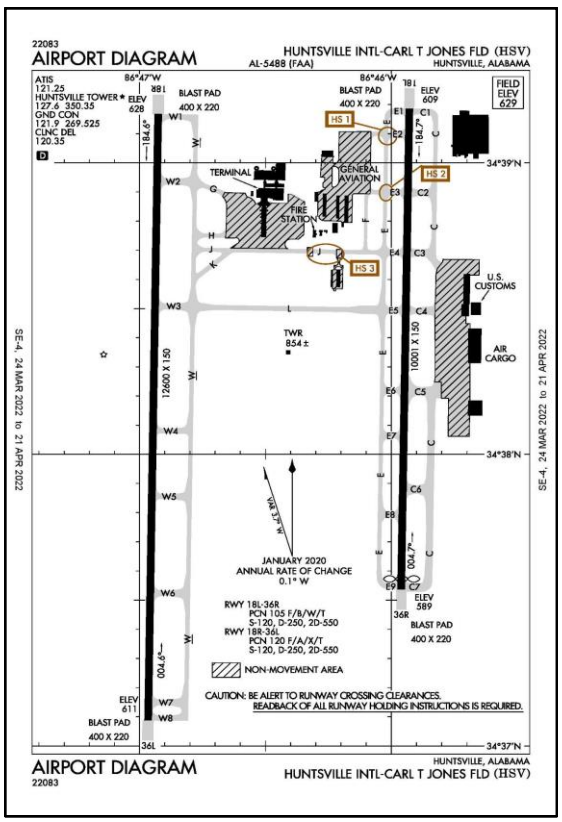
Aim: This appendix collects all flight checklists the mission team would complete pre-, during, and post-flight while at the mission location as well as pre- and post-operation before arriving and after leaving the mission location. Each flight checklist is included in a supplementary document. These checklists are to supplement the maintenance checklists that would go with the organization leading the missions for the disaster response and/or preparedness that they use to ensure the safety of their aircraft and equipment. These maintenance checklists will likely be a part of the organization's own safety assessment process.

Include details on:

- Before CONOP development: Site Survey (details on assessment of mission location)
- Before Operations: Mission checklist (complete at home for lead organization)
- Pre-deployment: Checklist to complete prior to leaving for mission site
- Deployment: Checklists for flight operations, once arrived at mission site
- Pre-flight: Checklist to follow prior to flight including example of flight readiness review
- Post-flight: Checklists to follow including log sheet
- Post-mission: Checklists to follow at the end of all flights for the mission

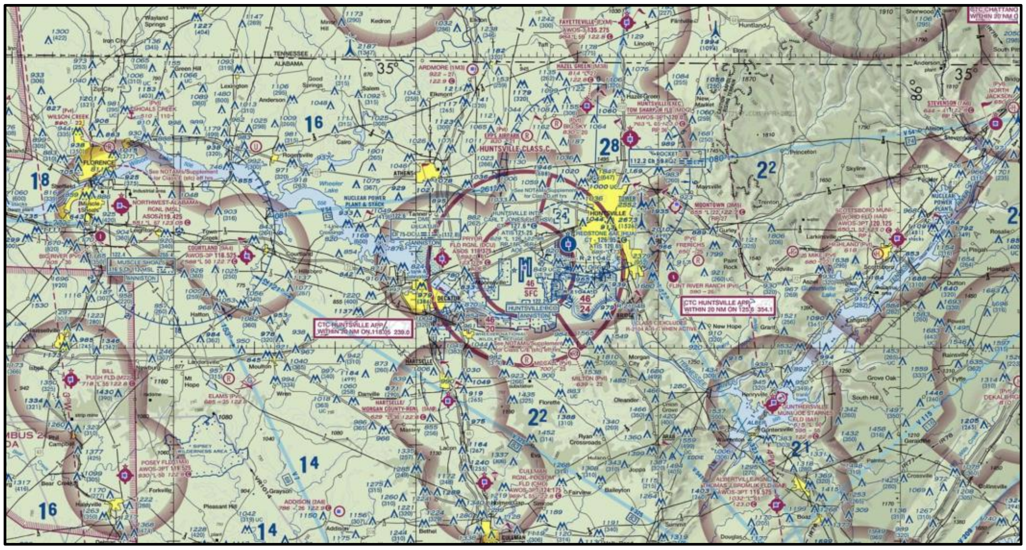
1.7.3 Appendix 3: Additional Requirements

[Huntsville airport map]

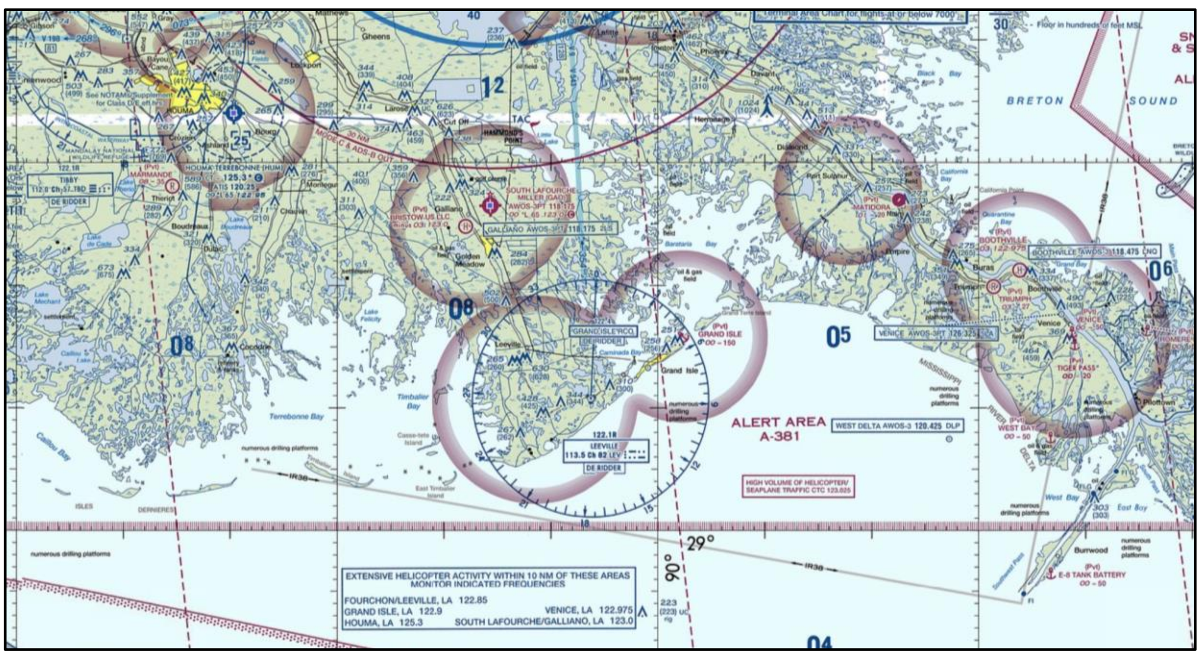


Sectional Charts

Huntsville and region

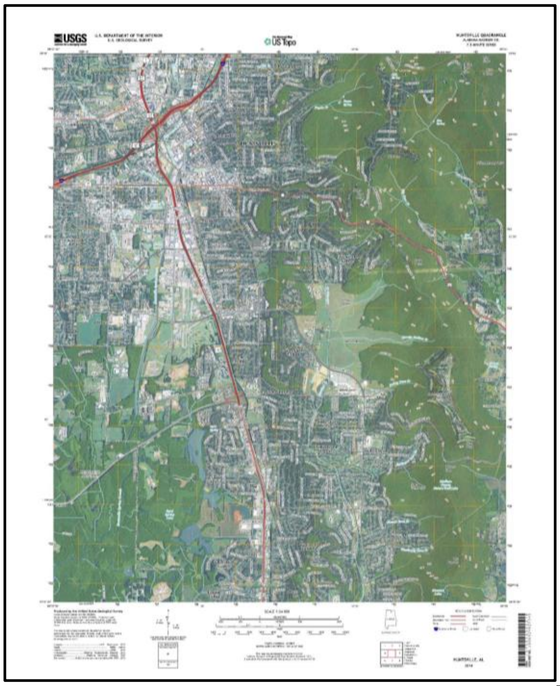


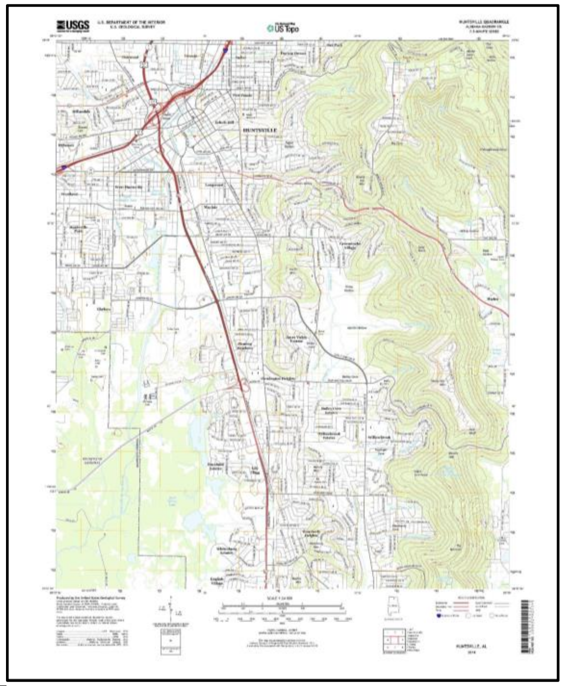
Port Fourchon and region



United States Geological Survey 7.5-minute topographic map

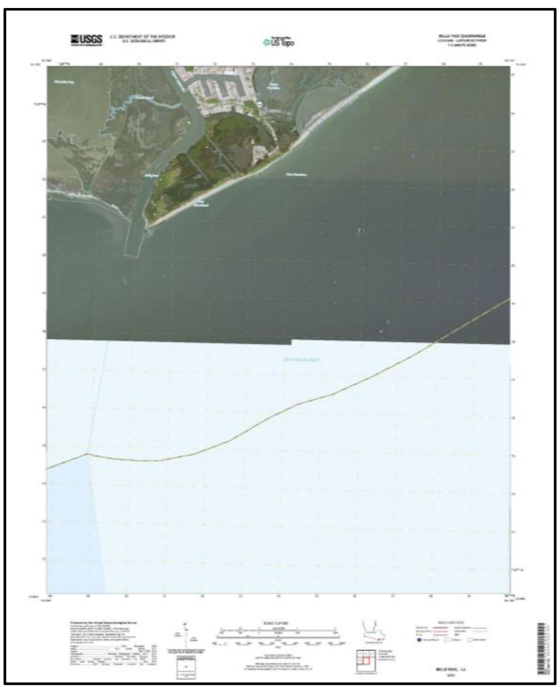
[Huntsville and region](#)





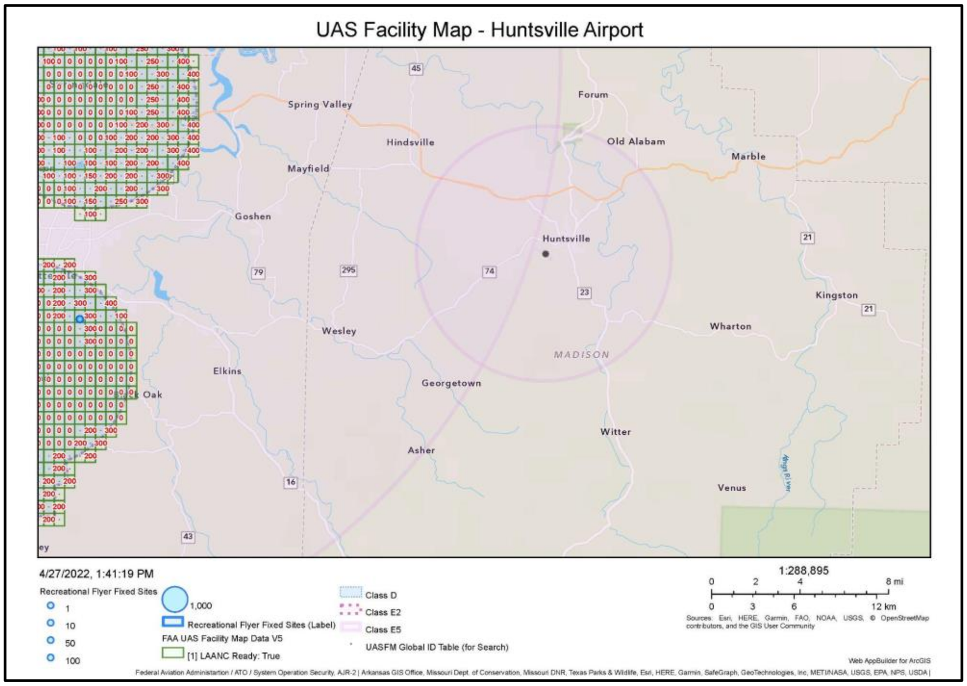
Port Fourchon and region

Leeville and Belle Pass

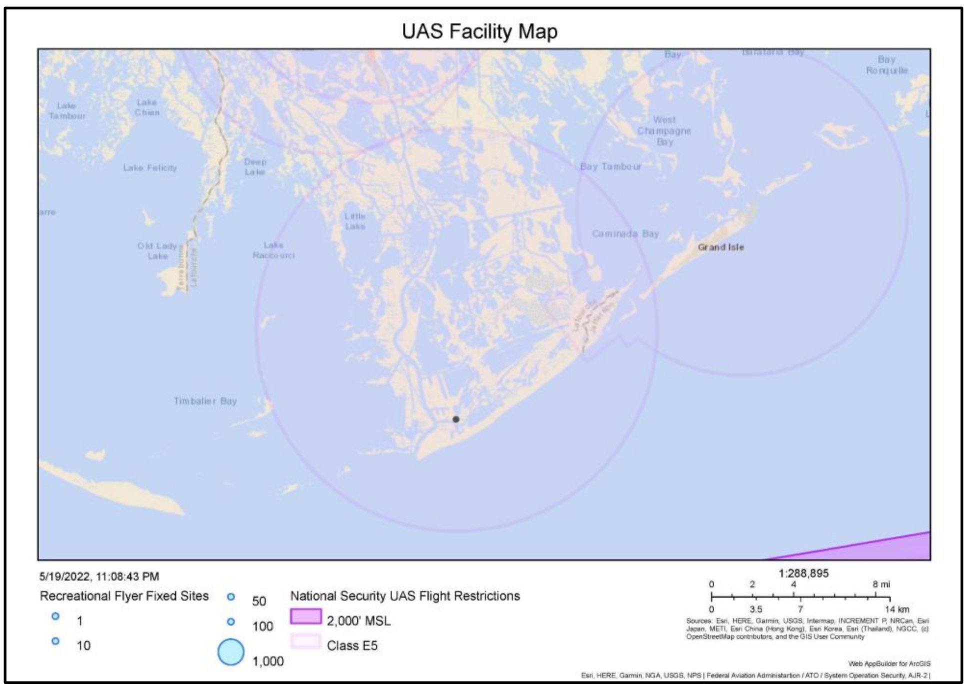


Low Altitude Authorization and Notification Capability Facility Maps

Huntsville and region



Port Fourchon and region



The FAA's Center of Excellence for UAS Research
ASSURE
Alliance for System Safety of UAS through Research Excellence

1.7.4 Appendix 4: Special Government Interests (SGI) Process Documentation

- FAA Order JO7200.23B
  Processing of UAS Requests. Effective: July 14, 2020
    - Page 16 to 19: Chapter 6. 14CFR Part 91, COA Processing
    - Page 17 – SGI information: The SGI process will be managed by Systems Operations Security as per FAA Order JO 7210.3
- FAA Order JO7210.3CC
  Facility Operation and Administration. Effective: June 17, 2021
    - Page 469: Section 21-5-4. UAS SGI Addendum Request Process and Coordination
    - System Operations Support Center (SOSC) Contact Phone Number - 202-267-8276
- FAA Request Form for Expedited SGI Waiver or Authorization for UAS Operation – Form # SOSC 2020/02/20 1125Z

1.7.5 Appendix 5: Data Archive Plan

Processing specifications

- Imagery and video collected at maximum resolution
- Sufficient overlap to support Structure from Motion processed
- Full motion video captured where possible from available payload

File formats

- Detailed descriptions: https://www.ogc.org/docs/is
- EO visible and multispectral visible - near-infrared imagery
    - Joint Photographic Experts Group (JPEG): containing lossy and compressed data
    - Tag Image File Format (TIFF): store raster graphics and image information
- Broadband thermal infrared imagery
    - Radiometric JPEG: JPEG and TIFF for thermal data
    - Stores Temperature data as well as red green blue JPEG of thermal data
- EO visible and multispectral visible - near-infrared video
    - MPEG-4 format [MP4, note MOV from EO visible on dual camera system]
    - High compression international audio-visual coding standard
- Broadband thermal infrared video
    - SEQ/FFF - Proprietary FLIR video formats that store images and thermal data
    - MOV - MPEG 4 video container file
- Point clouds – Light Detection and Ranging data
    - LAS (binary file format) or LAZ (compressed LAS file)
- Geospatial data - GEOTIFF
    - Standard file for GIS with embedded geolocation data
- Google Keyhole Markup Language (KML)
    - KML (default Google Earth geospatial format)
    - Keyhole Markup Zipped (compressed KML file format)
- Geographic JavaScript Object Notation (GEOJSON)
    - GEOJSON (coordinates as text in JavaScript Object Notation form

- Shapefile (SHP)
    - SHP (feature geometry), SHX (shape index position), DBF (attribute data)
    - PRJ (projection system metadata), XML (associated metadata)

Data archiving locations

- In-Flight:
    - Onboard storage of all data as well as through specific GCS
    - Data streamed through GCS to operations center to support secondary archive
- Post-Flight:
    - Online secure file storage per UAS and per mission [password protected]
    - Folders for raw sensor data as well as flight logs and route data
    - Folders to store post-processed data and all planning documents

1.7.6 Appendix 6: Rationale behind each section in CONOP

Situation

High level situation awareness and sufficient information to clearly define each element.

Template items

- *Organization's business (manufacturer, operator, system integrator, etc.).*
- *Geographic operating boundaries (lack of specifics implies very broad NAS access).*
- *Describe if launch/ fly/ recover only over private property with owner's permission.*
- *Define the minimum and maximum operating altitude of the vehicle.*
- *Describe if operating within or beyond Visual Line of Sight (VLOS).*
- *Define command and control link.*
- *Provide details on dimensions and materials for vehicle design.*
- *Identify the vehicle's maximum cruise speed and maximum operating gross weight.*
- *Describe Proposed Airspace Classes (A, B, C, D, E, F, etc.).*
- *Define the Proposed Operating Airspace (character aspects – regardless of class).*
- *Describe location of the control station.*

Mission:

Sufficient, clear, and concise statement of what the flight team and lead organization and/or stakeholders for the disaster response mission request want to accomplish. Provide the most important large-scale information and provide sufficient information and clearly define each element.

- *Describe the intended mission of the UAS (surveillance, response, preparedness, etc.).*

Execution:

Thoroughly state how you will "execute" the mission and provide sufficient information and clearly define each element.

- *Identify Airspace Considerations (peculiarities and congestion, special use, etc.)*
- *Give information on Launch and Recovery Details / Location(s)*

- *Identify and describe the vehicle's proximity to people, infrastructure, and surface vehicles*
- *Identify and describe the vehicle's proximity to other NAS users*
- *Identify whether you want to Flight into Known Icing (FIKI)*
- *Identify meteorological conditions you want to operate in Visual / Instrument conditions*
- *Identify the flight rules you want to operate in Visual / Instrument Flight Rules*
- *Describe whether your geographic and airspace boundaries are physically contiguous*
- *Identify Automation Level (occasional autopilot, 100% autonomous, manual control, etc.)*
- *Identify minimum crew and support personnel*
- *Identify the role(s) of the crew and support personnel*
- *Identify whether you will fly over people not involved in the operation*
- *Identify any requests for airspace be blocked off for your exclusive use*
- *Identify your operator/vehicle ratio (1:1, etc.)*
- *Identify day and/or night operations*
- *Describe your plan for safety of Operator(s) and Observer(s)*
- *Describe the training level of each team member*

Command & Signal:

Sufficiently provide information of their plans involving command and communication functions between different portions of the UAS and stakeholders. Clearly describe how you will command and signal amongst the various components of the entire system (vehicle, control station, control link, observers, etc.)

- *Describe Communication between Operator, Observer, Crew Members (visual, radio, etc.)*
- *Describe the Electronic Security of the Control Link*
- *Describe the Physical Security of the operator and control station*
- *Describe real time situational awareness features*
- *Describe the # of operators, and hand-off between control*
- *Describe Lost Link Procedures or loss of Positive Control*
- *Describe Communication Expectations with Air Traffic Control*
- *Describe Emergency Procedures*

Administration & Logistics:

Adequately provide the information or instructions pertaining to how and with whom they will coordinate to conduct the operations.

- *Details on Community Outreach (Flying / Non-Flying Public, municipalities, airports, etc.)*
- *Describe when if flight routes will be filed with Air Traffic Control (VFR / IFR)*
- *Identify Liaisons with Air Traffic Control*
- *Identify MISHAP Reporting Procedures*
- *Identify when NOTAMs will be posted*