The FAA's Center of Excellence for UAS Research

ASSURE

Alliance for System Safety of UAS through Research Excellence

Final Report
ASSURE A28: Disaster Preparedness and Response Using UAS
Attachment 4 – Concept of Operations (CONOPS) for Oil Spill

June 1, 2022

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TABLE OF ACRONYMS

ARTCC	Air Route Traffic Control Center
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
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
ORA	Operational Risk Assessment
PIC	Pilot in Command
RTB	Return to Base
SAR	Search And Rescue
SfM	Structure from Motion
SGI	Special Government Interest
SHP	Shape file
SOSC	System Operations Support Center
TFR	Temporary Flight Restriction
TIFF	Tag Image File Format
UAF	University of Alaska Fairbanks
UAS	Uncrewed/Unmanned Aircraft System
USGS	United States Geological Survey
VFR	Visual Flight Rules
VLOS	Visual Line of Sight
VNIR	Visible and near-infrared
VO	Visual Observer

VTOL	Vertical Take-Off and Landing

ATTACHMENT 4 - CONCEPT OF OPERATIONS (CONOPS) FOR OIL SPILL

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 ***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)

Notes on a CONOP:

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)

Oil terminal at Valdez, Alaska has significant spill

Oil impact to local landscape, infrastructure, and Valdez Bay and community

Operation:

Oil Spill from terminal onto land and ocean

Duration:

1 day (Large uncrewed/unmanned aircraft system, UAS, provides high altitude data and needs to get to Valdez from Anchorage; small UAS #1 would be local approved operator that could reach terminal; small UAS #2 is approved operator and would also need to find local in Valdez with access to boat)

Outcomes/Actionable intelligence

- Large UAS real-time streamed back to operations or post-processed and displayed in visualization tool
- Large UAS operations to get data of full extent of disaster to operations to determine locations for small UAS #1 and #2
- Small UAS #1 multispectral data maps terminal area and produces orthomosaic map of landscape around terminal to determine if any spillage.
- Small UAS #1 flight to build three-dimensional model of the terminal area; Displayed in visualization tool to support ground ops team
- sUAS #2 (Option 1: Mapping) produces orthomosaic that shows any evidence of oil on ocean surface and coastline
- sUAS #2 (Option 2: Ignite oil insitu) placement of repellent on oil surface
- sUAS #2 (Option 2: Ignite oil insitu) ignite of oil on ocean surface
- sUAS #2 (Option 2: Ignite oil insitu) Electro-Optical (EO) visible data review of oil removal

Metrics of success:

- Large UAS streams data back to the incident center to support assessment of full extent.
- Small UAS #1 streams back data to support those on ground to mitigate terminal hazards.
- Small UAS #2 maps extent of oil with routes adapted to find spread in oceanic environment
- Small UAS #2 pilot in command respond to commands from the incident center on where obs. are needed.
- Small UAS #2, Option 2, places retardant onto oil and performs insitu burning of oil
- Safe flight operations with two small UAS operating in close vicinity with data streaming back.
- Both small UAS flew under Part 107 and so Visual Line Of Sight (VLOS) is maintained.
- Small UAS #2 takeoffs and land on a boat in Valdez Bay and return to continue missions.

1.2 CONOP Quad Chart: Oil Spill from terminal onto land and ocean.

1.2.1 Mission Purpose/Objectives

Purpose: Oil Spill from Valdez Terminal onto local land and across into Port of Valdez Harbor.

Goals: Record the spill from terminal with EO videos and where possible multispectral images. Small UAS mission at lower altitude over terminal. Small UAS mission off boat to assess spill extent over the ocean and Port of Valdez. Large UAS at higher altitudes to assess full extent and if possible, Search And Rescue (SAR) data to detect spill on ocean surface.

Objectives: Large UAS with real-time data and possible machine learning from search and rescue data. Small UAS at terminal to feed optical video to emergency command center and multispectral images. Second small UAS off boat to analyze extent over ocean and feed data back to the emergency command center. Evaluate how to work with two small UAS in the same airspace. One will have focused analysis at the terminal, while the second will be moving based on the oil extent and finding the edge of the oil. Also, may be using repellent to burn off oil in-situ from remote systems on UAS.

1.2.2 Mission Procedures/Approach

Large UAS: Beyond Visual Line Of Sight (BVLOS) operations over disaster

Early morning take-off from Anchorage or Kenai

Flown from runway to the traverse up Port of Valdez Bay towards terminal

Day of flying to reach site and provide high altitude eyes on disaster

Visual Flight Rules (VFR)/Instrument Flight Rules (IFR) conditions as will be BVLOS and traveled from airport to Valdez

Small UAS #1: Terminal mapping

Part 107 waiver and Special Government Interest (SGI) waiver

Option 1: May need to fly across Bay from Valdez - if so then BVLOS or Extended Visual Line Of Sight (EVLOS)

Option 2: Flown from near terminal and so would be VLOS

Flown in the Temporary Flight Restriction (TFR) region - match when large UAS overhead and small UAS over ocean

VFR conditions

Map the extent of impact to terminal and multispectral spill over land

Small UAS #2: Flown from boat in the Port of Valdez Bay

Routine pattern or defined by emergency team to map extent of oil drifting in ocean

Option 1: EO and multispectral to map oil spill extent

[Note video will be used over ocean and Structure from Motion (SfM) mapping near coastlines where stitching techniques have improved performance]

Option 2: Carry repellant to burn off oil in-situ

Time of flights to match large UAS observations

VLOS with Part 107 waiver if needed based on time of day/location/altitude

VFR conditions

1.2.3 Mission Results

Observations: Recording any continued spillage from the terminal; understanding of the extent of the land-based spillage and required clean up. Extent of the spill into the harbor: include where it is heading, clean up area of focus, and if extents across to coast on other side of bay and into City off Valdez. Small UAS will have EO and multispectral sensors. Large UAS will collect EO, thermal and if possible, SAR. Potential for small UAS to place repellent onto oil and then be able to burn it off in-situ from UAS.

Products: Small UAS #1: EO videos of terminal and multispectral images of oil extent on land. Orthomosaics in optical wavelengths of terminal once spill ends as well as 3D models where structure from motion is possible to assess damage to the terminal. Small UAS #2: EO videos of ocean extent of oil spill and where possible multispectral or thermal data. Large UAS: EO videos of the full extent of the disaster and where possible SAR maps of the oil on the ocean and land to compare to optical data.

1.2.4 Mission Milestones

Outcomes/Actionable Intelligence

Large UAS: EO data from higher altitude

Real-time streamed back to operations center or post-processed and displayed in visualization tool

Large UAS operations to get data of full extent of disaster to operations center to determine locations for small UAS #1 and #2

Small UAS #1: True Color and near-infrared with EO video data to map terminal area and produce orthomosaic map of landscape around terminal to determine if any spillage.

Small UAS #1 flight to build 3D model of the terminal area; Displayed in visualization tool to support ground ops team

Small UAS #2 [Option 1: Mapping]

Ship launch and recovery to fly small UAS over impacted area seen in large UAS data

Production of orthomosaic that shows any evidence of oil on ocean surface and coastline

Small UAS #2 [Option 2: Ignite oil in situ]

Ship launch and recovery to fly small UAS over impacted area seen in large UAS data

Placement of repellent on oil surface and ignite of oil on ocean surface

EO data review of oil removal

Metrics of success

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

Small UAS #1 streams back data to support those on ground to mitigate terminal hazards.

Small UAS #2 maps extent of oil with routes adapted to find spread in oceanic environment

Small UAS #2 pilot in command responds to commands from the incident center on where observations are needed.

Small UAS #2, Option 2, places retardant onto oil and performs in situ burning of oil

Safe flight operations with two small UAS operating in close vicinity with data streaming back.

Both small UAS flew under Part 107 and so VLOS are maintained.

Small UAS #2 takeoffs and land on a boat in Valdez Bay and return to continue missions.

1.3 Situation

1.3.1 Overview

Purpose of the mission: Mapping oil spill from Valdez terminal onto land and into ocean and local harbor. To provide data and observations of the ongoing hazard to support ground teams and decision support systems.

Goals: Large UAS flown at higher altitudes to support long endurance observations of the oil spill events. Small UAS #1 and its flight crew placed near the terminal, in a safe location, to provide data on any impact to the vegetation and terminal infrastructure. Small UAS #2 and crew to be flying UAS from boat in Port Valdez Bay to map the oil spill on the ocean and with Option 2 operations ignite the oil in-place and use repellant to mitigate the subsequent fire once most of the oil has been burned off.

UAS mission lead: University of Alaska Fairbanks (UAF) Alaska Center for Unmanned Aircraft Systems Integration team with large UAS working with support from DDEC and Alyeska pipeline service company (owners of the oil terminal).

Large UAS: High altitude observations of the event

- Flight team with crew
- Flight from Anchorage International Airport
- EO visible and thermal sensors onboard
- Stays at higher altitudes throughout the event

Small UAS #1: Terminal mapping of oil spill products and surrounding landscape

- Pilot in command and Visual Observer (VO)
- EO visible and thermal sensors along with visible-near infrared sensor
- Data feeds through ground control station to operations center/Valdez on-the-ground teams

Small UAS #2: Ocean mapping of oil spill and/or insitu burning of oil on water

- Pilot in command and VO
- Specialist team member to operate the ignition and repellant equipment
- EO visible sensor along with visible-near infrared sensor to provide observations of surrounding area

1.3.2 Location

Ted Stevens Anchorage International Airport, Alaska

Latitude: 61.1740847° N Longitude: 149.9981375° W

IATA: ANC ICAO: PANC FAA LID: ANC

https://www.airnav.com/airport/PANC

All maps in Appendix 3

1.3.3 Systems

Central Operations

- Coordination of flight teams: Anchorage/Alaska emergency operations center or airport
- UAF lead points of contact for large UAS operations
- Alyeska Pipeline Service Company representatives as owners of the Valdez Oil Terminal and for access to support mapping from small UAS #1
- City of Valdez representatives as impacted community and to support locations for boat launch for small UAS #2
- Operations: Air Boss along with Federal Aviation Administration (FAA) and Federal Emergency Management Agency representatives

1st flight: Assess issue at Valdez terminal from Oil Spill

- Small UAS #1
    - Vertical takeoff and landing (VTOL) from harborside in City of Valdez
    - Endurance for 45 minutes per flight
    - Flight team
        - Pilot in Command (PIC) and multiple VOs including sensor engineering support
        - Approved local Part 107 operator with aircraft for rapid response

        - 5 km from take-off to Terminal so need BVLOS operations or VO's tracking at terminal and radio to PIC
    - Minimum payload
        - Integrated multispectral sensor: Nadir viewing with pointable system
        - Optimized for techniques to detect oil through advanced data analysis
    - Sufficient battery capacity for multiple flights or ½ of operations
    - If limited to VLOS, will need take-off and landing from the same side as terminal

2nd flight: Assess oil extent spillage into ocean

- Small UAS #2
    - VTOL from boat in Port of Valdez and local harbor
    - Endurance for 45 minutes per flight
    - Manual operations to map edge of oil spill depending on other data
    - Flight team
        - PIC and VOs including sensor engineering support
        - Approved local Part 107 operator with aircraft for rapid response
        - Engineering support at Valdez so can come back for fix between flights
    - Minimum payload
        - Integrated multispectral sensor: Nadir viewing with pointable system
        - Optimized for techniques to detect oil through advanced data analysis
    - Sufficient battery capacity for multiple flights or ½ of operations

3rd flight: Large scale mapping of extent, will take time to respond

- Large UAS
    - SeaHunter/Sentry type
    - Ted Stevens Anchorage International Airport, Alaska (PANC)
    - Endurance for multiple hours per flight, up to 4 hours per mission
    - 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 Ground Control Station (GCS) and onto operations center
        - Multispectral and thermal payload integrated for nadir viewing
    - Products: Classification of full extent of spill

1.4 Mission

Disaster:

Oil Spill from Valdez Terminal onto local land and across into Port of Valdez Harbor. Need to map spill from terminal, assess impact to local vegetation and landscape, assess oil spill into ocean and if need to insitu burn, and provide higher altitude observations of the full extent of the event.

Observations:

Recording any continued spillage from the terminal. Providing data to understand the extent of the land-based spillage and any required clean up. Collect data to support teams to assess the extent of the spill into the harbor: include where it is heading, clean up area of focus, and if it extends across to coast on other side of bay and into City of Valdez. Both small UAS will have optical and multispectral sensors while the large UAS will collect optical, thermal and if possible, visible-near infrared. Potential for small UAS #2 to place repellent onto oil and be able to burn it off in-situ from UAS.

Response mission:

Alyeska Pipeline Service Company is the owner of the oil terminal at Valdez, the southern end of the trans-Alaska pipeline system. There is a reported significant oil spill from the terminal, and it is declared a major disaster and a need for airborne support to the ground assessment of the extent of the event. Two small UAS provide proximal observations of the spill site at the terminal as well as the extent of the spread of the oil over land and ocean. A large UAS responds to provide higher altitude observations of the full extent and support those to assess where to send the boat based small UAS team.

Stakeholders:

Alyeska Pipeline Service Company as owners of the terminal to assess if the spill is still ongoing. State Decision Support teams to understand impact to landscape, wildlife, local habitats, National Oceanic and Atmospheric Administration (NOAA) on the ocean impact and those partners responsible for the clean-up. The City of Valdez for community impact from the spillage and as a support team to gain access to the harbor for boat launch.

Goals:

Small UAS #1 provides airborne observations over the terminal and manually flies to locations of interest for the emergency operations team. Small UAS #1 provides broadband thermal, multi-channel Visible-Near Infrared (VNIR) and EO visible observations of the local landscape around the terminal as well as the terminal in real-time as well as orthomosaic maps as post mission products. Small UAS #2 is flown from a boat in the Port of Valdez and provides manually flown observations of the extent of the oil spill on the sea surface. If required, small UAS #2 flight team has capability to ignite the oil in-situ as well as use repellant when needed to put out any fire. Large UAS keeps continued observations of the oil spill event and surrounding area to get data to the operations center and to support small UAS flight crews on optimum locations for data collection.

Objectives:

Small UAS #1 at the terminal will feed EO visible videos to the emergency command center along multispectral (VNIR and broadband thermal) images. Small UAS #1 flown off a boat in the Port of Valdez to analyze extent over ocean and feed data back to the emergency command center. Evaluate how to work with two small UAS in the same airspace. One small UAS focused analysis at the terminal, while the second manually operated based on the oil extent and finding the edge

of the oil. Also, can be used with a repellent to burn off oil in-situ from remote systems on UAS. Both small UAS flew under Part 107 waivers and so VLOS is maintained. Small UAS #2 takeoff and landing from a boat. Demonstrate how a small UAS flight crew can rapidly respond, move location at the needs of an emergency management team, and apply their flight protocols. Large UAS flies from Anchorage International Airport in the National Airspace System and into and out of TFR area over and around the oil spill. Large UAS streams data back to the incident center to support assessment of full extent as well as ensuring real-time streams allow small UAS teams to select locations for optimal data collection in consultation with central operations. Large UAS has multispectral real-time data and with the potential for classification of the oil on land and water through advanced data analytics techniques.

Real-time Mission Product:

- Small UAS #1: EO and thermal video with VNIR images of terminal and landscape.
- Small UAS #2: EO and thermal video with VNIR images of the Port of Valdez and the surrounding coastline.
- Large UAS: EO and thermal 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:

- Orthomosaics in optical, VNIR, and thermal wavelengths from all UAS
- Summit three-dimensional models through SfM of oil terminal

1.5 Execution

1.5.1 Operations Plan

Large UAS supports the event and 2 small UAS at lower altitudes, with their specific missions. One at the oil terminal and surrounding land and one flown over the Port of Valdez and local area, with location defined by emergency operations and/or oil spill recovery needs.

Small UAS #1

- This is to map the Valdez Terminal: Map the extent of impact to terminal and multispectral spill over land
- Operations will have Part 107 and SGI waiver to support operations in restricted areas like TFR
- Take-off Option 1: Fly across Bay from Valdez - if so, BVLOS or EVLOS
- Take-off Option 2: Fly from near terminal and VLOS; need access to terminal site
- Flown in the TFR region - match when large UAS overhead and sUAS over ocean
- VFR conditions
- Follow pre-flight, during, and post-flight checklist for small UAS, need for VO

Small UAS #2

- Flown from boat in the Port of Valdez Bay

- Flown as routine pattern with ability to be flown manual as defined by emergency team to map extent of oil drifting in ocean
- Payload Option 1: Optical and multi spectral to map oil spill extent, Video feed over sea, and SfM mapping near coastlines
- Payload Option 2: Carry repellant to burn off oil in-situ and payload to ignite
- Time of flights to match large UAS observations
- VLOS with Part 107 waiver if needed based on time of day/location/altitude
- VFR conditions
- Follow pre-flight, during, and post-flight checklist for small UAS, need for VO

Large UAS

- BVLOS operations over disaster
- Rapid response take-off from Ted Stevens Anchorage International Airport, Alaska (PANC)
- Mission will be flown under BVLOS operations
- Flown from runway to the traverse up Port of Valdez Bay towards terminal
- Day of flying to reach site and provide high altitude eyes on disaster
- Fly under instrument flight rules conditions
- Support operations under a full range of atmospheric conditions
- Follow pre-flight, during, and post-flight checklist for large UAS

1.5.2 Data collection, processing, and dissemination

Small UAS #1

Terminal and land spill extent

- Data in flight:
    - High Precision locations and time synchronization of flight
    - Flight routes and logs from crew
    - Geotagged optical and thermal infrared imagery over terminal and landscape
    - Decimeter res. visible data from High Definition (HD) multi-megapixel camera
    - Broadband thermal infrared (7 - 13 μm) data: Minimum 640 x 480 resolution
    - Geotagged multispectral imagery of spill extent over land
    - Optical setup supports overlay videos onto visualization tool (Full Motion Video)
    - Optical and thermal setup to support SfM processing from data
    - Optical data streamed to GCS
    - On-board storage of data, downloaded upon landing and processed
- Products post flight:
    - Geotagged videos with overlaid field of view on geospatial visualization tool
    - Mosaicked maps from optical, VNIR, and thermal data

Small UAS #2

Ocean spill extent

- Data in flight:
    - Both Options: High Precision locations and time synchronization of flight
    - Both Options: Flight routes and logs from crew
    - Option 1: Imagery and video
        - Geotagged optical and multispectral infrared imagery of extent over water and coastline impact
        - Optical data streamed to PIC and onto GCS
        - Assess routes to evaluate full extent
    - Option 2: Repellant and burn oil in-situ
        - First flight carries ignition source to place on top of oil
        - Second flight carry equipment to light oil in-situ
        - Optical data streamed to PIC and onto GCS
        - Geotagged optical and multispectral infrared imagery of oil extent
    - Both Options: On-board storage of data, downloaded and processed
- Products post flight: TBD
    - Geotagged videos with overlaid field of view on geospatial visualization tool
    - Mosaicked maps from optical, VNIR, and thermal data

Large UAS

Full extent of oil disaster

- Data in flight:
    - High Precision locations and time synchronization of flight
    - Flight routes and logs from crew
    - Geotagged optical and thermal infrared imagery over terminal, Port of Valdez, City of Valdez, and landscape
    - Decimeter res. visible data from 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 and thermal setup to support SfM processing from data
    - Optical data streamed to GCS
    - On-board storage of data, downloaded upon landing and processed
- Products post flight:
    - Geotagged videos with overlaid field of view on geospatial visualization tool
    - Mosaicked maps from optical and thermal data

Post Mission Debrief

- 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 (UAF)
- Documented lessons learned and where issues occurred to limit mission success

1.6 Administration & Logistics

1.6.1 Planning and local logistics

Large UAS team will have accommodation at a hotel nearby to 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 the launching airport to acquire runway access and set up 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 TFR 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.

For small UAS, 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 fly over the oil terminal. If BVLOS or EVLOS operations are not possible then the flight crew and its organization will work with Alyeska Pipeline Service Company to gain closer access to the terminal so that VLOS observations can be supported. Small UAS #1 flight crew will need overnight accommodation in Valdez to support continued operations if the disaster event extends beyond one day.

Small UAS #2 flight team will obtain access to a local boat that could launch from and land on during their flight operations. This boat will be moored in Valdez Harbor and will support the flight crew to move their location for data collection to those sites needed to assess the impact of the oil on the sea surface and surrounding cost line. Small UAS #2 flight crew will need overnight accommodation in Valdez to support continued operations if the disaster event extends beyond one day.

1.6.2 Hazards/Risk

The following information provides specific hazards that may occur from supporting the emergency response to the oil spill event.

Hazard 1: Large UAS flies from National Airspace System to temporary airspace restriction zone.

- Risk: Large UAS will start off at Anchorage airport and fly in the U.S. NAS and the specific airspace at and surrounding this airport. It will then fly from the NAS, where there could be other crewed and uncrewed systems, into a TFR setup over the oil spill site. Flight team does not have permissions setup with the operations center and will be unable to enter TFR.
- Mitigation: Flight crew and PIC coordinate with the operations center and air boss for emergency response so that they are aware at all times of the location of the large UAS. PIC and flight mission lead will set up all permissions before any missions starts to ensure that the large UAS can respond to all needs and enter and leave the TFR when needed.

Hazard #2: Small UAS are mobile and pushing the limits of VLOS. VO may lose sight of UAS.

- Risk: Manually flown UAS will provide observations of oil spill over land as well as water and flying under VLOS operations with a visual observer. The mission may require flying to the maximum extent of observers view and as such would be close to flying outside VLOS. This would mean that the flight crew does not have a sight on UAS or the airspace around it.
- Mitigation: PIC and visual observer will be in constant contact to ensure that there is always a visual sighting on UAS and airspace. VO will inform the PIC if the flight route is reaching the extent of their visibility of the aircraft and airspace. PIC will inform operations to see if necessary to push beyond VLOS operations. If so, then extended VLOS will be assessed if possible. If BVLOS is needed, flight crew will determine if UAS has BVLOS capacity and request through SGI on a BVLOS waiver to continue operations.

Hazard #3: Small UAS flight 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 including those in the City of Valdez, the Oil Terminal, and emergency response ground teams. Possible effects are a crash of the UAS with people/property or a need to Return to Base (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 Divert Land Immediately (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 #4: Lack of safe landing for small UAS #1 flight operations over water

- Risk: This hazard comes from a small UAS flying over the Port of Valdez and surrounding bay and crew undefining a safe landing zone and/or unable to perform a manual landing back on boat. Possible effects are the small UAS 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. 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: Large UAS 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. This would lead to no higher altitude data to keep observations on the full extent of the oil spill event and a RTB or uncontrolled descent of the UAS.
- Mitigation: PIC for large UAS would assign ditch points 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. If one of the small UAS flights is in the vicinity of a ditch location and in the same airspace, 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 #6: Toxic ash and gasses concentrations along flight routes

- Risk: This hazard caused by oil spill fire concentrations impacting the aircraft and visibility leads to IFR only conditions. Possible effects resulting from this hazard are a loss of aircraft performance and ability to continue mission.
- Mitigation: PIC will perform controlled flight operations to move the aircraft away from the toxic levels. The PIC will assess if the levels in the atmosphere limit the ability of the UAS to operate and the crew to continue to operate. The PIC will determine if a RTB or return to land is required or if the aircraft can continue its operations. The mission PIC will invoke a Divert Land Immediately, which suspends the onward flight path and commands the UAS to land at a designated landing zone, in a controlled manner at the maximum safe descent rate.

Hazard #7: Lack of timing precision between missions prevents data from being compared.

- Risk: There will be one large UAS being flown for the ground support as well as two small UAS teams. Each will be acquiring imagery and videos of the events as well as recording their flight logs and GPS locations of their flights. To cross-compare the data feeds and evaluate the data, each of these systems needs to be time-synchronized. If not, the data will not be able to be compared and prevent cross analysis of the UAS data.
- Mitigation: The PICs and flight crew for each UAS will synchronize their flight clocks and sensor clocks with the same coordinating universal time timing system. This will be continuously monitored throughout the missions and rechecked and recalibrated after each flight. This will ensure that there are minimal time differences between the clocks of all the aircraft and sensors and support like data comparison.

1.6.3 Community outreach and connections

All Operations: City of Valdez , Alyeska Pipeline Service Company, Incident command team if a statewide operations center has been set up, FAA Anchorage Air Route Traffic Control Center (ARTCC), education to local community on dangers of recreational UAS operations during response.

Large UAS: Communications with launching airport for large UAS (Anchorage International airport) and Department of Defense Joint-Base Elmendorf-Richardson given routes around Anchorage and their potential airspace.

Small UAS #1: Alyeska Pipeline Service Company and City of Valdez to set up the necessary access for the takeoff and landing site.

Small UAS #2: Boat operators in Valdez to acquire a vessel to land and launch the second small UAS. This can be done through the City of Valdez.

1.6.4 Disaster response mission specific information

Details on the Exxon Valdez Oil Spill from 1989

- https://darrp.noaa.gov/oil-spills/exxon-valdez

NOAA tides and currents for Valdez

- https://tidesandcurrents.noaa.gov/noaacurrents/Stations?q=valdez
- https://tidesandcurrents.noaa.gov/noaatidepredictions.html?id=9454240
- https://tidesandcurrents.noaa.gov/map/index.html?id=9454240

1.6.5 Mission Summary

Disaster:

Alyeska Pipeline Service Company reports an oil spill from their terminal at the end of the trans-Alaska pipeline system. City of Valdes and Alyeska require airborne observations of the spill, analysis of the impact to the terminal and surrounding landscape, extent of the spill into the Port of Valdez, and a need to burn the oil insitu on the sea surface.

Objectives:

Small UAS #1 at the terminal will feed EO visible videos to the emergency command center along multispectral (VNIR and broadband thermal) images. Small UAS #1 flown off a boat in the Port of Valdez to analyze extent over ocean and feed data back to the emergency command center. Evaluate how to work with two small UAS in the same airspace. One small UAS focused analysis at the terminal, while the second manually operated based on the oil extent and finding the edge of the oil. Also, can be used with a repellent to burn off oil in-situ from remote systems on UAS. Both small UAS flew under Part 107 waivers and so VLOS is maintained. Small UAS #2 takeoff and landing from a boat. Demonstrate how a small UAS flight crew can rapidly respond, move location at the needs of an emergency management team, and apply their flight protocols. Large UAS flies from Anchorage International Airport in the National Airspace System and into and out of the TFR area around the oil spill. Large UAS streams data back to the incident center to support assessment of full extent as well as ensuring real-time streams allow small UAS teams to select locations for optimal data collection in consultation with central operations. Large UAS has multispectral real-time data and with the potential for classification of the oil on land and water through advanced data analytics techniques.

Flight Missions:

Large UAS is flown to provide an overview of the full disaster extent. Two small UAS are flown to: (1) collect data over the terminal infrastructure and any spill onto local land; and (2) collect data on the spill into the oceanic environment of Port of Valdez Harbor. Small UAS #1 provides

airborne observations over the terminal and manually flies to locations of interest for the emergency operations team. Small UAS #1 provides broadband thermal, multi-channel VNIR and EO visible observations of the local landscape around the terminal as well as the terminal in real-time as well as orthomosaic maps as post mission products. Small UAS #2 is flown from a boat in the Port of Valdez and provides manually flown observations of the extent of the oil spill on the sea surface. If required, small UAS #2 flight team has capability to ignite the oil in-situ as well as use repellant when needed to put out any fire. Large UAS keeps continued observations of the oil spill event and surrounding area to get data to the operations center and to support small UAS flight crews on optimum locations for data collection.

Metrics of success:

- Large UAS streams data back to the incident center to support assessment of full extent.
- Small UAS #1 streams back data to support those on ground to mitigate terminal hazards.
- Small UAS #2 maps extent of oil with routes adapted to find spread in oceanic environment
- Small UAS #2 PIC responds to commands from the incident center on where obs. are needed.
- Small UAS #2, Option 2, places retardant onto oil and performs insitu burning of oil
- Safe flight operations with two sUAS operating in close vicinity with data streaming back.
- Both small UAS flew under Part 107 and so VLOS is maintained.
- Small UAS #2 takeoffs and land on a boat in Valdez Bay and return to continue missions.

1.7 Command & Signal

Aim: 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.

Include details on:

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

1.8 Supplementary appendices to accompany CONOP

1.8.1 Appendix 1: Operational Details – One Pager

Mission and Disaster Preparedness/Response

Oil Spill from terminal onto land and ocean.

Mission Purpose/Objectives

Purpose : Oil Spill from Valdez Terminal onto local land and across into Port of Valdez Harbor.

Goals : Record the spill from terminal with electro-optical videos and where possible multispectral images. Small UAS mission at lower altitude over terminal. Small UAS mission off boat to assess spill extent over the ocean and Port of Valdez. Large UAS at higher altitudes to assess full extent and if possible, search and rescue (SAR) data to detect spill on ocean surface.

Objectives : Large UAS with real-time data and possible machine learning from search and rescue data. Small UAS at terminal to feed optical video to emergency command center and multispectral images. Second small UAS off boat to analyze extent over ocean and feed data back to the emergency command center. Evaluate how to work with two small UAS in the same airspace. One will have focused analysis at the terminal, while the second will be moving based on the oil extent and finding the edge of the oil. Also, may be using repellent to burn off oil in-situ from remote systems on UAS.

Mission Results

Observations : Recording any continued spillage from the terminal; understanding of the extent of the land-based spillage and required clean up. Extent of the spill into the harbor: include where it is heading, clean up area of focus, and if extents across to coast on other side of bay and into City off Valdez. Small UAS will have electro-optical and multispectral sensors. Large UAS will collect -electro-optical, thermal and if possible, SAR. Potential for small UAS to place repellent onto oil and then be able to burn it off in-situ from UAS.

Products : Small UAS #1: Electro-optical videos of terminal and multispectral images of oil extent on land. Orthomosaics in optical wavelengths of terminal once spill ends as well as 3D models where structure from motion is possible to assess damage to the terminal. Small UAS #2: Electro-optical videos of ocean extent of oil spill and where possible multispectral or thermal data. Large UAS: Electro-optical videos of the full extent of the disaster and where possible SAR maps of the oil on the ocean and land to compare to optical data.

Mission Procedures/Approach

Large UAS : beyond line of sight (BVLOS) operations over disaster
Early morning take-off from Anchorage or Kenai
Flown from runway to the traverse up Port of Valdez Bay towards terminal
Day of flying to reach site and provide high altitude eyes on disaster
Visual Flight Rules (VFR)/Instrument Flight Rules (IFR) conditions as will be BVLOS and traveled from airport to Valdez

Small UAS #1: Terminal mapping
Part 107 waiver and special governmental interest (SGI) waiver
Option 1: May need to fly across Bay from Valdez - if so then BVLOS or extended line of sight (EVLOS)
Option 2: Flown from near terminal and so would be visual line of sight (VLOS)
Flown in the temporary flight restriction (TFR) region - match when large UAS overhead and small UAS over ocean
VFR conditions
Map the extent of impact to terminal and multispectral spill over land

Small UAS #2 : Flown from boat in the Port of Valdez Bay
Routine pattern or defined by emergency team to map extent of oil drifting in ocean
Option 1: Electro-optical and multispectral to map oil spill extent
[Note video will be used over ocean and SfM mapping near coastlines where stitching techniques have improved performance]
Option 2: Carry repellant to burn off oil in-situ
Time of flights to match large UAS observations
VLOS with Part 107 waiver if needed based on time of day/location/altitude
VFR conditions

Mission Milestones

Outcomes/Actionable Intelligence
Large UAS: Electro-optical data from higher altitude
Real-time streamed back to operations center or post-processed and displayed in visualization tool
Large UAS operations to get data of full extent of disaster to operations center to determine locations for small UAS #1 and #2
Small UAS #1: True Color and near-infrared with electro-optical video data to map terminal area and produce orthomosaic map of landscape around terminal to determine if any spillage.
Small UAS #1 flight to build 3D model of the terminal area; Displayed in visualization tool to support ground ops team

Small UAS #2 [Option 1: Mapping]
Ship launch and recovery to fly small UAS over impacted area seen in large UAS data
Production of orthomosaic that shows any evidence of oil on ocean surface and coastline

Small UAS #2 [Option 2: Ignite oil insitu]
Ship launch and recovery to fly small UAS over impacted area seen in large UAS data
Placement of repellent on oil surface and ignite of oil on ocean surface
Electro-optical data review of oil removal

Metrics of success
Large UAS streams data back to the incident center to support assessment of full extent.
Small UAS #1 streams back data to support those on ground to mitigate terminal hazards.
Small UAS #2 maps extent of oil with routes adapted to find spread in oceanic environment
Small UAS #2 pilot in command responds to commands from the incident center on where observations are needed.
Small UAS #2, Option 2, places retardant onto oil and performs insitu burning of oil
Safe flight operations with two small UAS operating in close vicinity with data streaming back.
Both small UAS flew under Part 107 and so VLOS are maintained.
Small UAS #2 takeoffs and land on a boat in Valdez Bay and return to continue missions.

1.8.2 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

1.8.3 Appendix 3: Additional Requirements

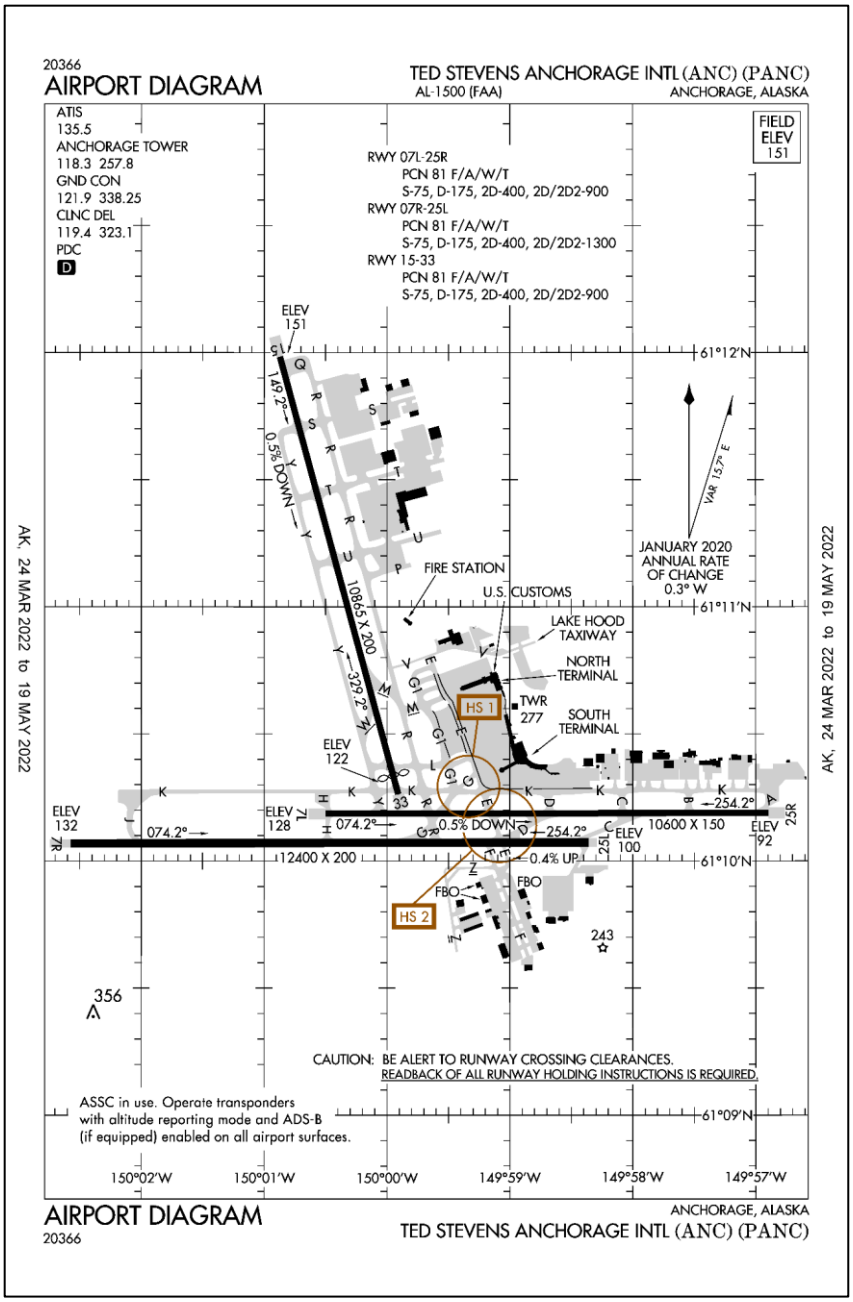
Ted Stevens Anchorage International Airport, Alaska

Latitude: 61.1740847° N Longitude: 149.9981375° W

IATA: ANC ICAO: PANC FAA LID: ANC

https://www.airnav.com/airport/PANC

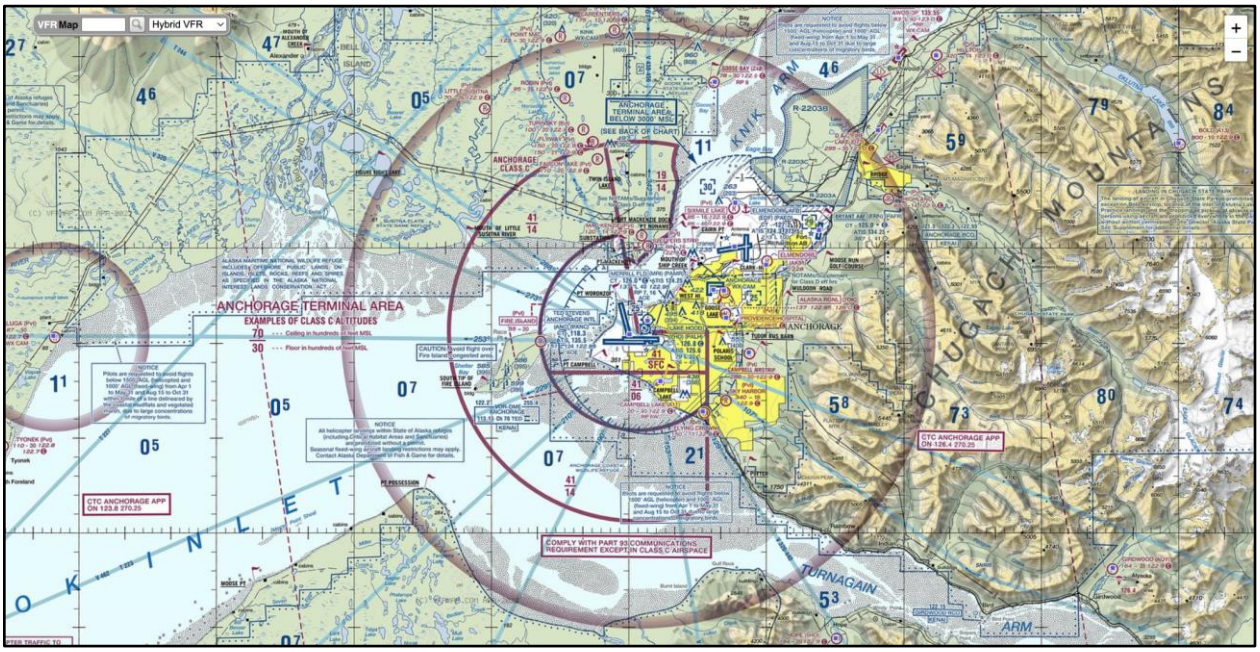
Anchorage airport map



Sectional Charts

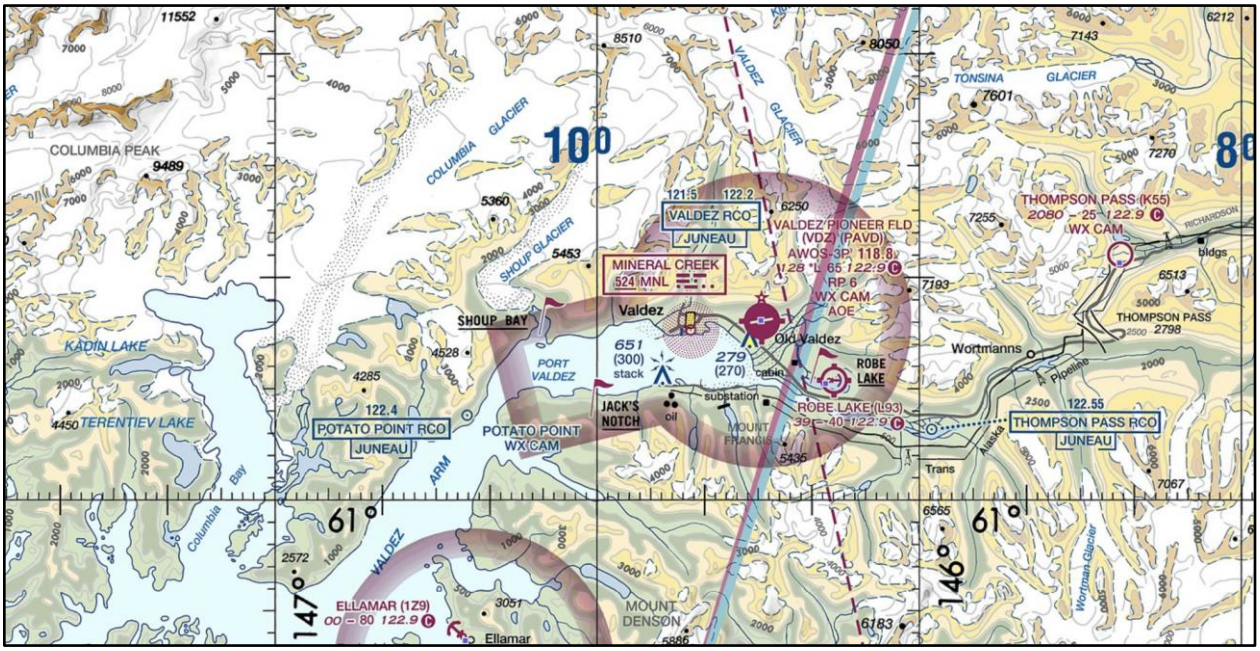
Anchorage Airport and vicinity

http://vfrmap.com/?type=vfrc&lat=61.174&lon=-149.998&zoom=10&api_key=763xxE1MJHyhr48DlAP2qQ



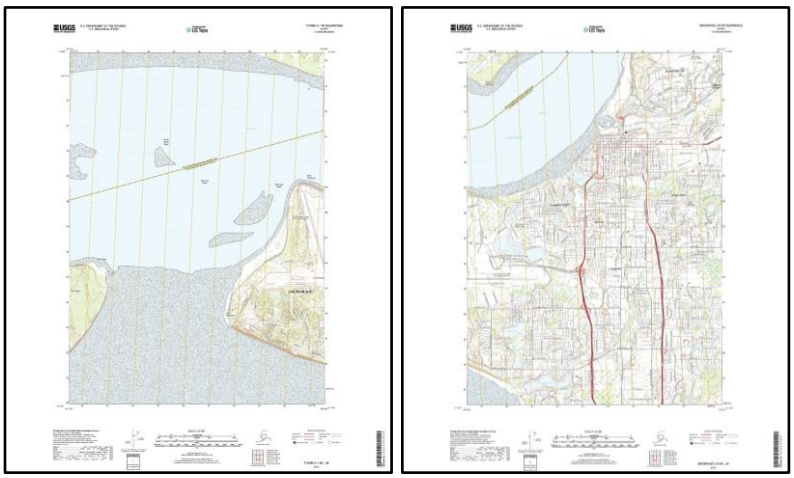
Valdez and vicinity

http://vfrmap.com/?type=vfrc&lat=61.174&lon=-149.998&zoom=10&api_key=763xxE1MJHyhr48DlAP2qQ

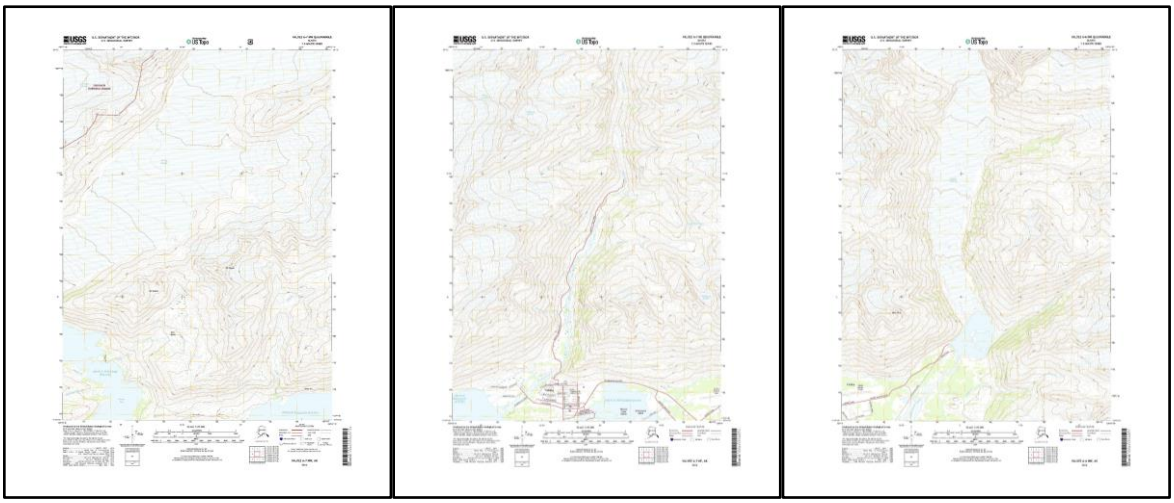


United States Geological Survey (USGS) 7.5-minute topographic map

Anchorage airport and its vicinity

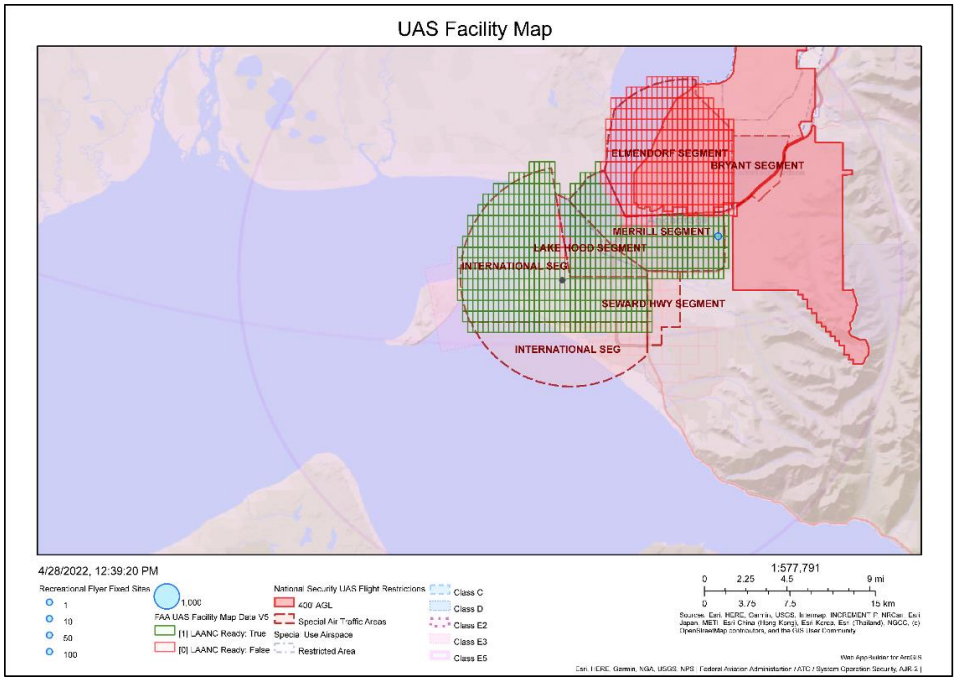


Valdez and vicinity

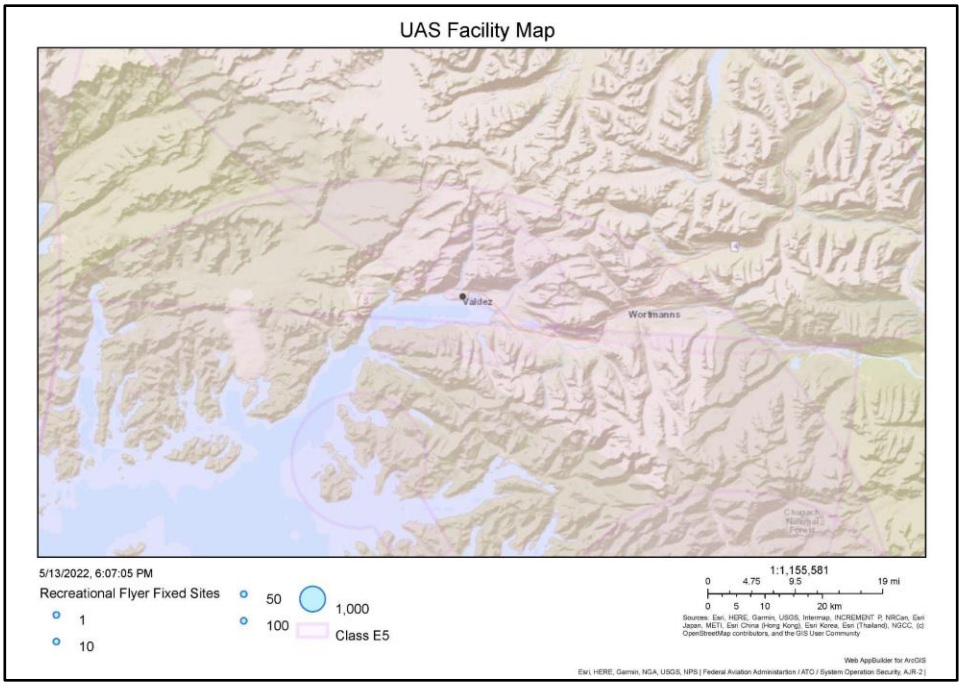


[Low Altitude Authorization and Notification Capability Facility Maps]

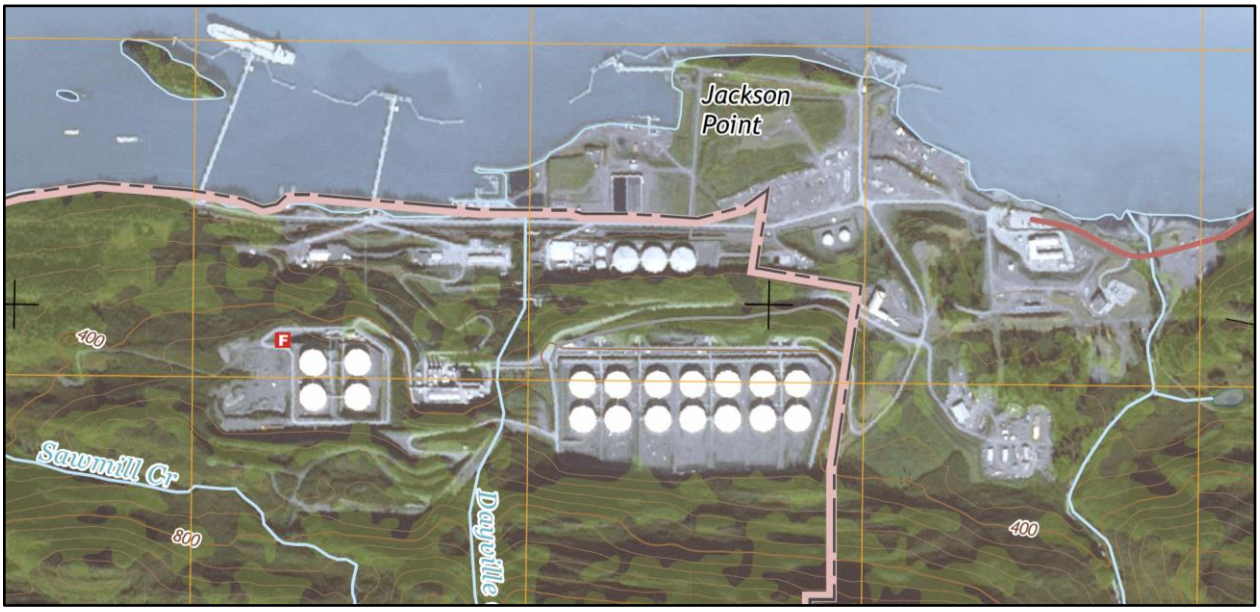
Anchorage Airport and vicinity



Valdez and vicinity



Alyeska map of the oil terminal



Developed from USGS 7.5-minute topographic map: AK_Valdez_A-7_SE_20160815_TM_geo.pdf

1.8.4 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

1.8.5 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

1.8.6 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 BVLOS.*
- *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*

1.9 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 Notices to Airmen will be posted*