FAA UAS SYMPOSIUM

Building your Operational Risk Assessment

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Federal Aviation Administration

AUVSI

Building Your ORA

- Nicholas Flom, Executive Director, Northern Plains UAS Test Site
- Mark Blanks, Director, Virginia Tech Mid-Atlantic Aviation Partnership (MAAP)
- Alexandra Florin, Drones Project Manager – Executive Directorate, EASA
- Andy Thurling, Chief Technology Officer, Northeast UAS Airspace Integration Research (NUAIR)
- Jeremy Grogan, Aviation Safety Inspector, FAA – Part 107 Waiver Team Lead

What is an ORA and when do I need one?

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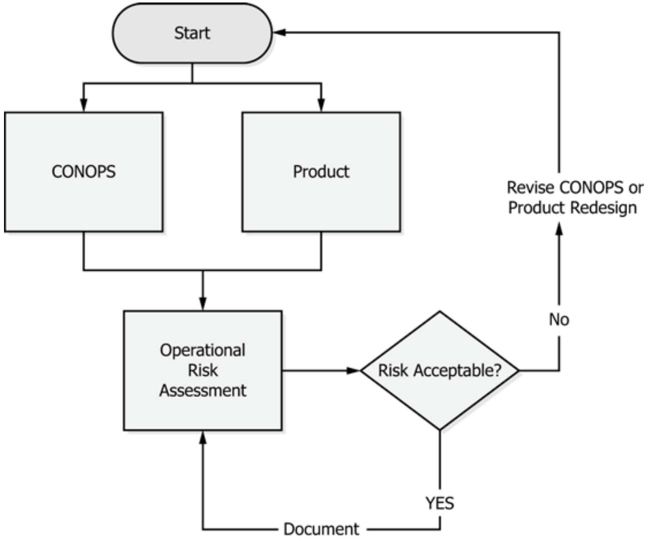


U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
CERTIFICATE OF WAIVER

Northern Plains UAS Test Site
Responsible Person: Jakee Stoltz
Waiver Number: 107W-2019-01028

4201 James Ray Dr Stop 8392
Grand Forks, ND 58202

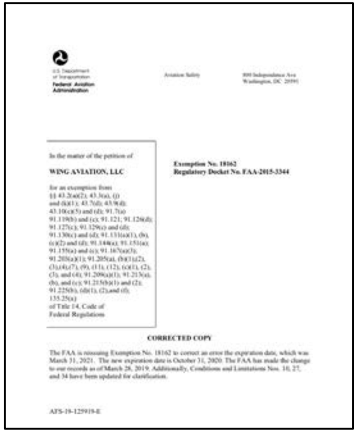
14 CFR § 107.31— Visual line of sight aircraft operation and
14 CFR § 107.33(b) and (c)(2) — Visual observer.

STANDARD PROVISIONS

SPECIAL PROVISIONS

BY DIRECTION OF THE ADMINISTRATOR
JOSEPH V FAGAN JR
General Aviation and Commercial Division, AFS-800

Waiver



WING AVIATION, LLC

Exemption No. 18162
Regulatory Docket No. FAA-2015-3344

CORRECTED COPY

Exemption

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Type Certification

NORTHERN PLAINS UAS TEST SITE

Federal Aviation Administration

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References for ORAs

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This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: F3178 – 16

Standard Practice for Operational Risk Assessment of Small Unmanned Aircraft Systems (sUAS)[1]

This standard is issued under the fixed designation F3178; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

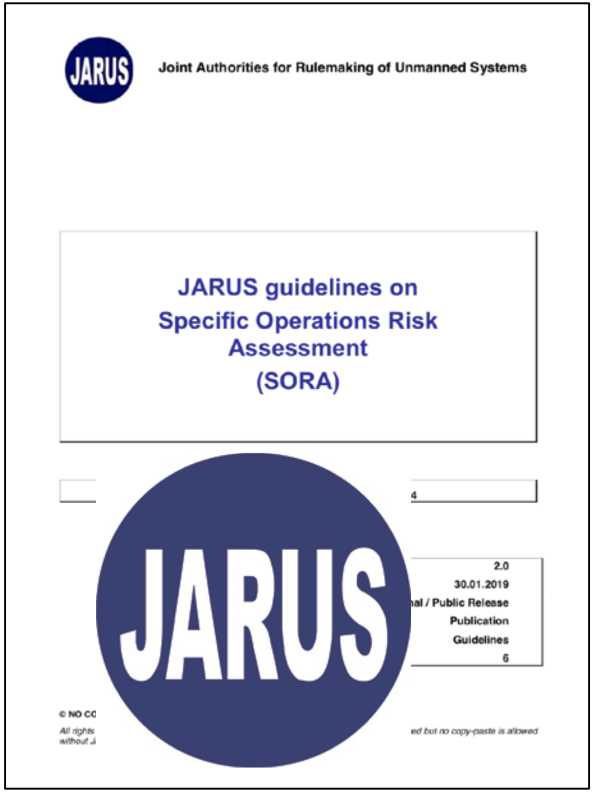
An operational risk assessment (ORA) offers to an applicant of small unmanned aircraft systems

ASTM INTERNATIONAL

1.5 This practice is intended primarily for sUAS applicants seeking approval or certification for airworthiness or operations from their respective CAA, though sUAS manufacturers may consider this practice, along with other system safety

[1] This practice is under the jurisdiction of ASTM Committee F38 on Unmanned Aircraft Systems and is the direct responsibility of Subcommittee F38.02 on Flight Operations.

Current edition approved Nov. 1, 2016. Published January 2017. DOI: 10.1520/F3178-16.



Joint Authorities for Rulemaking of Unmanned Systems

JARUS guidelines on Specific Operations Risk Assessment (SORA)

JARUS

2.0
30.01.2019
Public Release
Publication
Guidelines
6

What's in an ORA?

Hazard Category	Hazard Causes
Technical Issue with UAS	
	Propulsion System Failure
	FCS Failure
	Loss of C2 Link
	GPS receiver fails
	GCS Failure
Deterioration of external systems	
	Loss of ground radar
	RangeVue failure
	Ops van power failure
	Wide Area Network (WAN) failure
	Crew communication failure
	GPS service fails
Human Error	
	Preflight planning errors
	Maintenance errors
	Crew fatigue
	Improper communication RPIC/RPIC or RPIC/EO
Adverse Operating Conditions	
	Flight into conditions beyond aircraft limitations
Unable to See and Avoid	
	DAA system does not detect intruder

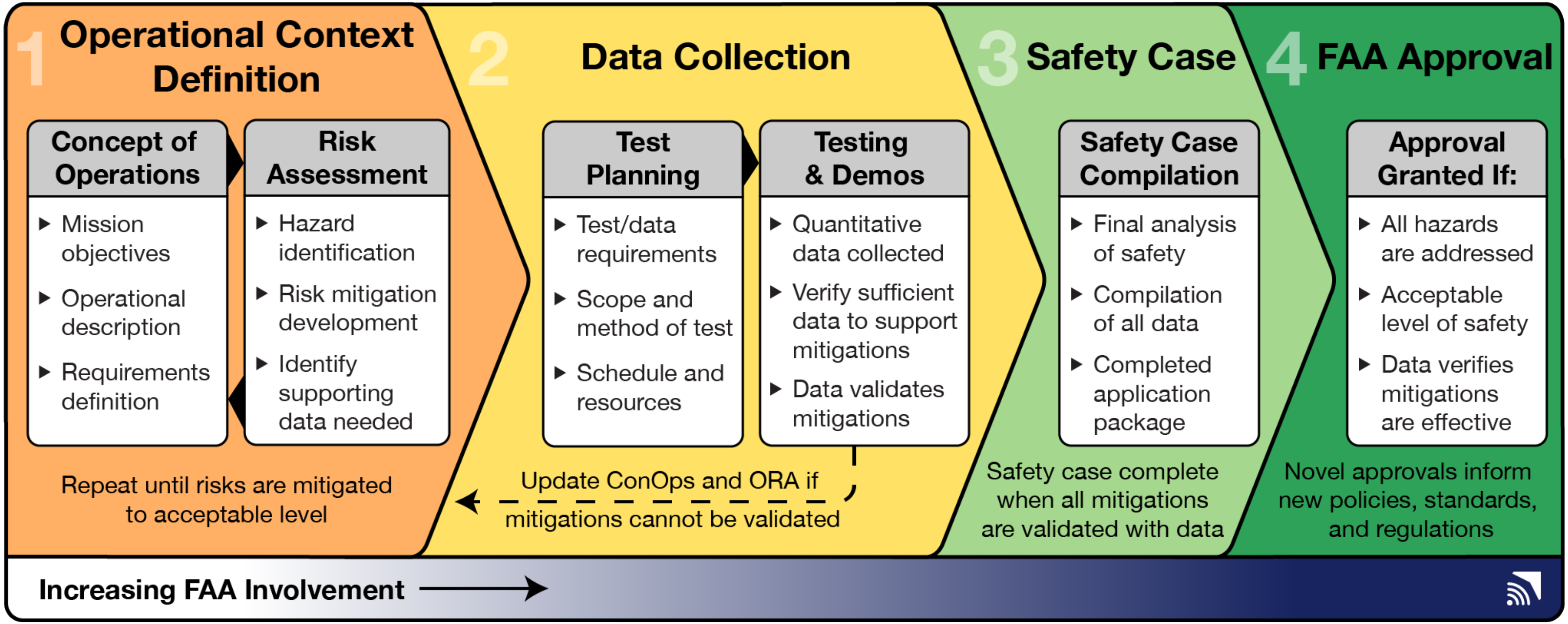
Risk Identification

Severity	Likelihood				
	Extremely Improbable (1)	Improbable (2)	Remote (3)	Occasional (4)	Frequent (5)
Catastrophic (5)	5	10	15	20	25
Hazardous (4)	4	8	12	16	20
Major (3)	3	6	9	12	15
Minor (2)	2	4	6	8	10
Negligible (1)	1	2	3	4	5

Risk Analysis

Mitigation

Risk-Based Safety Case Development



Defining the Operational Context

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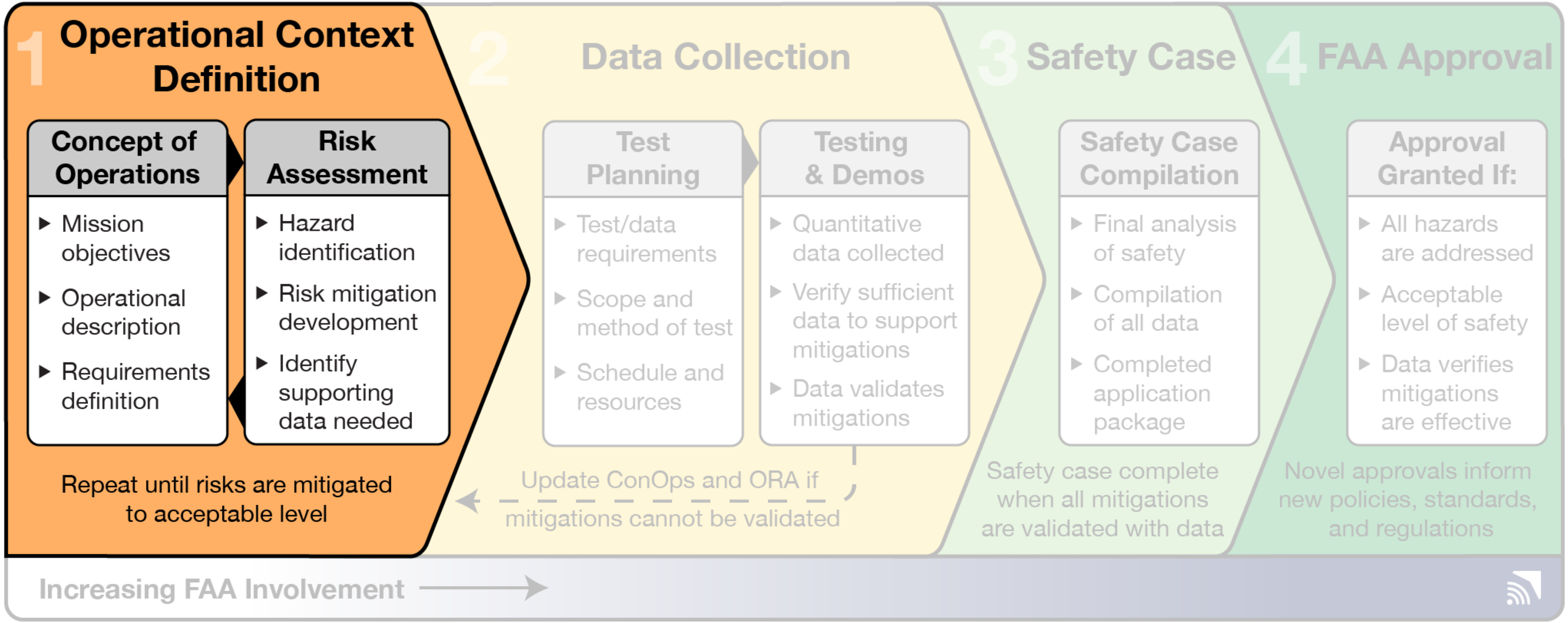

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A Familiar Risk Matrix

Severity / Likelihood	Minimal	Minor	Major	Hazardous	Catastrophic
Frequent	5	10a	15a	20a	25
Probable	4a	8a	12a	16	20b
Remote	3a	6a	9	12b	15b
Ext Remote	2a	4b	6b	8b	14 * / 10b
Improbable	1	2b	3b	4c	8c

Virginia Tech
UAS Operational Risk Matrix

High Risk 13.1-25.0
Medium Risk 7.1-13.0
Low Risk 1.0-7.0

*Single Point or Common Cause Failures = Red / 14

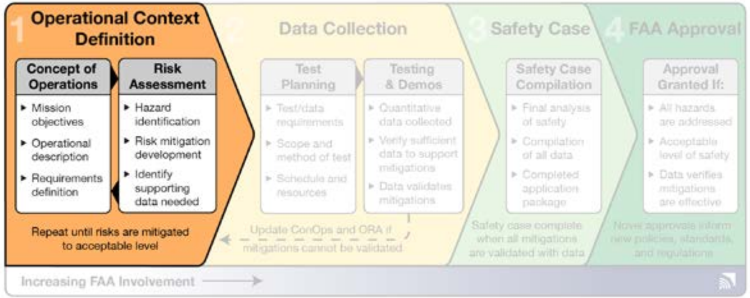
- Based on FAA's risk matrix in SRM Policy 8040.4B
- Shared by DOD, DHS
- X axis (Severity)
- Y axis (Likelihood)
- Numbering added for easy cross reference and tracking

Mitigating Risks – Casualty Example

Risk Category	Hazard ID	Hazard Description	Hazard Assessment	Hazard Assessment Description	Mitigation ID	STAAR	Mitigation Action	Post Mitigation Assessment	Data to Support	Overall Category Risk
Casualty Risk Note: this category excludes casualties that may occur from a mid air collision.	C	sUAS loss of propulsion leads to collision with person	9	Loss of propulsion due to battery power or loss of power train leads to uncontrolled descent into a person. Loss of power train may be caused by operator error with regard to preflight, battery monitoring or flight into an object that causes damage to propulsion system	C3	Reduces Severity	Limit altitude ceiling to acceptable level as determined in AIS Injury Testing. Reduces descent range to prohibit unacceptable injury risk.	6b	Acceptable injury thresholds and methods to evaluate injury risk of a specific UAS have been discussed in numerous papers and rulemaking committees and research conducted at Virginia Tech. At this time, the FAA has not accepted a standard for injury threshold or test method. However, based on two existing Part 107.39 waivers, there does appear to be acceptance that very small aircraft such as the PhotoKitePro (620 g, 1.37 lbs.) and Prox Dynamics PD-100 (18 g, 0.04 lb.) are safe for operations over people (OOP). Evaluating risk of AIS 2 and 3+ injury to the head, neck, and thorax through a series of controlled laboratory vehicle impact tests into an instrumented Hybrid III dummy.	**Low / 6**

Example: Selecting an Aircraft

- Able to perform the mission
- Needed risk reducing features:
  - Proven reliability
  - Low injury risk
  - Optimized flight behavior/logic
- Reputable manufacturer
- Readily available



Best Practices: Operational Context Definition

1. **Bound the operation**
   - "Dream" operations versus "Minimum Viable Product"
   - Prevents implementing limitations/mitigations that eliminate the business case
2. **Narrow the context**
   - Start broad and iterate to specific
   - Ensures potential risk mitigations and technology are not overlooked
3. **Prioritize risk mitigations**
   - Some risk mitigations improve safety, but are not "critical path"
   - The amount of supporting data (i.e. "robustness") likely depends on criticality

Traditional vs holistic approach

- Traditionally, manned aviation requests certification of the aircraft, approval of the operator and license of the pilot.
- Certification/approval/license provide a high level of assurance / confidence that an aircraft operation can be conducted with an acceptable level of risk.
- What is an acceptable level of risk?
  - In manned aviation, a Target Level of Safety (TLS) is the general term which designates the minimum safety objectives to be achieved expressed in terms of probability of potential fatalities on the ground or in the air.

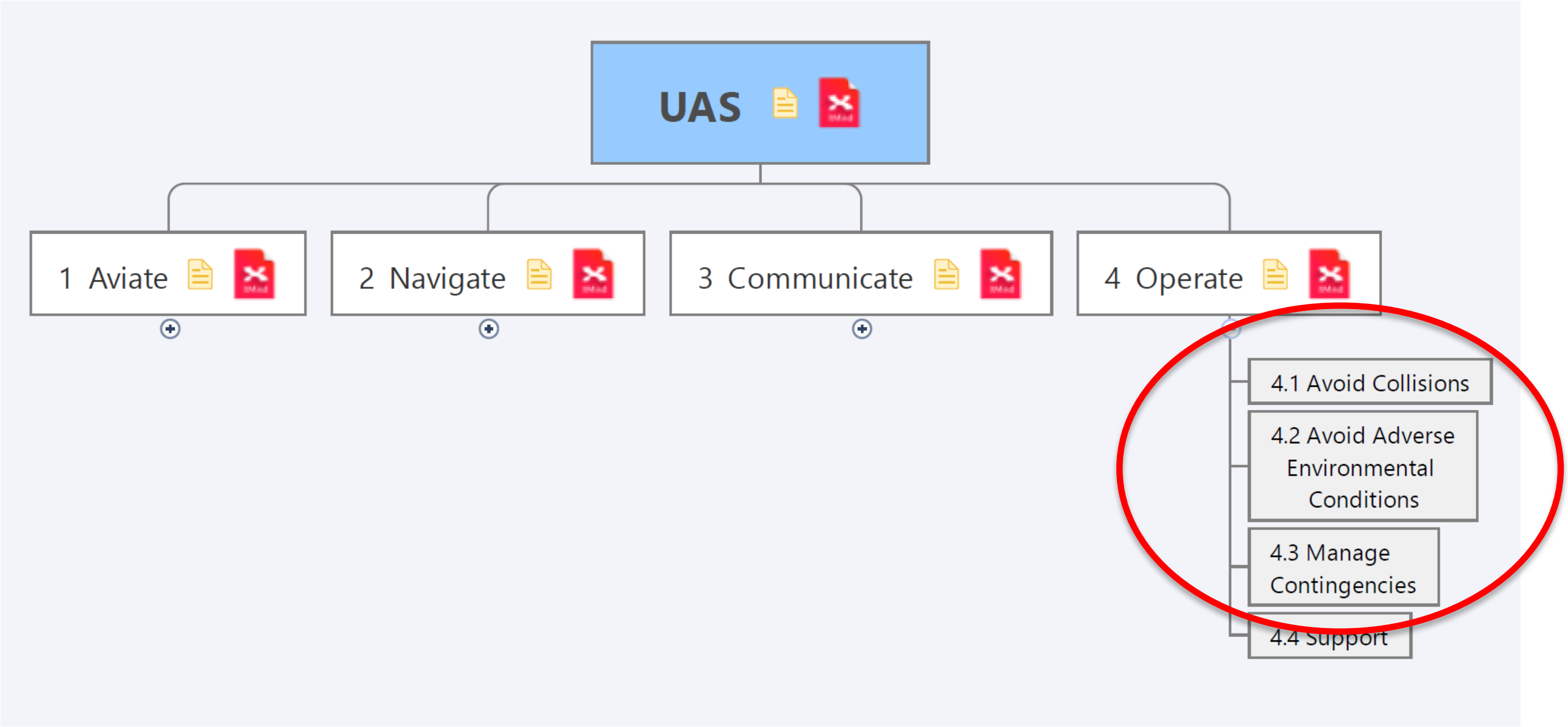
Traditional vs holistic approach

- Unmanned aircraft are expected to meet the same TLS as manned aircraft.
- Does this mean that all UAS need to be certified, operator approved and pilot licensed?
- An holistic approach allows to take credit of operational or design mitigations to demonstrate that an operation can be conducted with an acceptable level of risk, e.g.
  - VLOS vs BVLOS
  - Independent flight termination system
  - Controlled ground area.

Why a (S)ORA?

- An ORA is a way to analyze a proposed ConOps and identify if there are sufficient mitigation means to conduct an operation with an acceptable level of risk.
- The SORA developed by JARUS provides a systematic methodology to identify in an holistic way risks associated to a UAS operation.
- This is the approach used in Europe to develop an operation centric, performance based and risk based drone regulation.
  - 3 categories: open, specific and certified
  - Open (intrinsic low risk): safety is achieved by limitations, competencies of the pilot, technical requirement for the UAS
  - Certified (intrinsic high risk): like for traditional aviation
  - Specific (intrinsic medium risk): risk assessment (SORA as AMC)

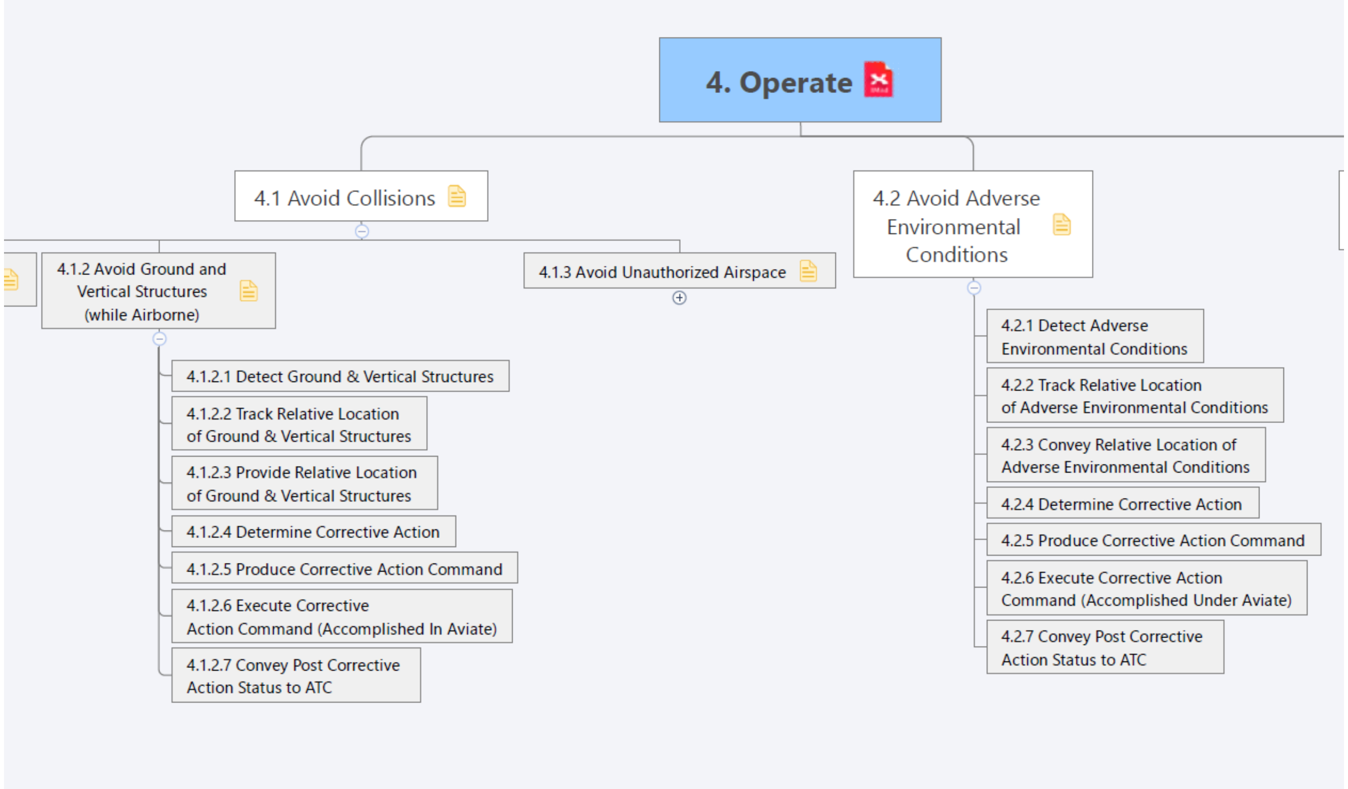
"Old School" Functional Hazard Assessments Work Too!



VLOS - Quite a Good Mitigation

- Learning Point – simply adapting a VLOS safety case to a BVLOS CONOP was much harder than I thought
  - When you give up the Mk I eyeball as a feedback mechanism, you lose your:
    - Icing sensor
    - Backup ADI
    - Obstacle detector
    - Aircraft collision detector
    - Wind Sensor
  - Hard to tell you've breached containment
  - Datalink Interference – "but I check on the spectrum analyzer"

“Old School” Functional Hazard Assessment



Weather Hazards – Hidden in Plain Sight

- Even VLOS isn't infallible!
- So, BVLOS requires considerably better information
- Where will you get it?
- Even if you had perfect information, do you know how your drone will <u>really</u> respond?

Real World Safety Incident

- Lack of wind measurements aloft
- Situation: VLOS – Loss of Control at 100 Feet AGl
- Followed the standard - hand held anemometer, TAF, METAR
- Result: Crash due to invisible threat lurking above
- Real Data Versus Inference - great deal of inference requiring knowledge of how the atmosphere works

USE CASE 1

"Land As Soon As Possible"

- Scenario – Single engine Helicopter
- Engine quits – Where are you going to land?
- You probably have about 5 seconds to decide before you lose link
- "That soccer field looked good on Google Earth, officer"
- So, all your contingencies become <u>much</u> harder to manage

Part 107 safety baseline

- Part 107 safety is based on Visual Line of Sight Flight as a primary risk mitigation

- When performing operations Beyond Visual Line of Sight, many other rule compliance issues may arise. Some examples are
  - 107.37-Operations near aircraft, right-of-way rules
  - 107.39-Operations over human beings
  - 107.51-Operating limitations for sUAS

Part 107 safety baseline

- Because of all the part 107 interdependencies on the LOS risk mitigation, waiver applications normally require a complete risk assessment of the operation for a waiver, when 107.31 is requested
  - Other rules have interdependencies including
    - 107.19
    - 107.23

Waiver experience

- 70-80% of waiver applications are disapproved for incomplete information
- The average waiver application is 1-2 sentences long
- Many applications do not address the whole risk and regulatory compliance for the proposed operation

Other Risk Tools

- FAA realizes traditional 8040 SRM process could be improved to account for sUAS operations
- Agency is actively working on augmenting the order to assist with UAS risk management
- SORA process has value in standardizing risk framework in operational applications
  - The underlying standards and support structure are not in place for SORA to be directly invoked
  - FAA is actively working on implementing SORA like methodology into the current Risk Management Framework