



# Insights into Unmanned Aircraft Systems Accidents and Incidents (2009-2014)



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# So What?

The identification of types of anomalous events associated with accidents and incidents provide insights for consideration when developing and implementing mitigation strategies for the design, training, and operation of unmanned aircraft systems<sup>1</sup>

<sup>1</sup>Unmanned aircraft systems were considered to encompass all related definitions to include but not limited to unmanned aerial vehicles, unmanned aviation systems, remotely pilot aircraft systems, remotely operated aircraft, small unmanned aircraft systems, and remotely piloted vehicles



# Topics

- Data Source
- Methodology
- Types of Anomalous Events



# Data Source



The screenshot shows the FAA ASIAS website. At the top left is the FAA logo and the text 'Federal Aviation Administration'. To the right is the title 'FAA Aviation Safety Information Analysis and Sharing (ASIAS)'. Below this are three tabs: 'Welcome', 'Data & Information' (which is selected), and 'Studies'. A breadcrumb trail reads 'Welcome > Source Databases (P-Z)'. The main content area features a magnifying glass icon next to the heading 'FAA Preliminary UAS Accident and Incidents', followed by the subtitle 'Preliminary Reports of UAS (Unmanned Aircraft System) Accidents and Incidents'. The URL 'www.asias.faa.gov' is visible in the bottom right corner of the screenshot.

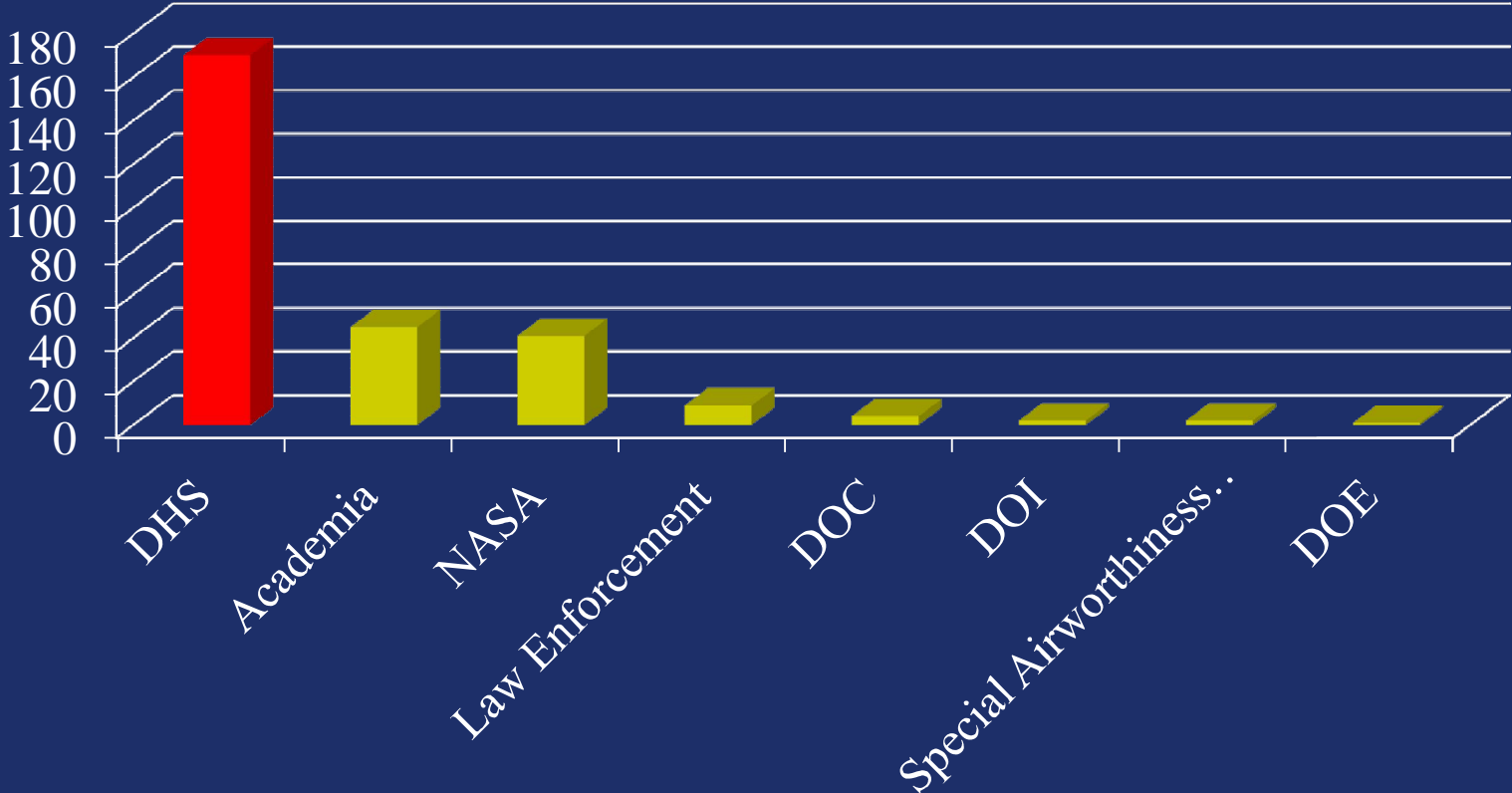
274 Accident & Incident reports submitted between **October 2009 - August 2014** in compliance with reporting requirements stated in the special provisions of UAS operator Certificates of Authorization

Date Range	2010 - 2014
Event Count	104
Freeze Date	21-AUG-14
Load Date	08-SEP-2014



# Data Source

## FAA UAS Accident & Incident Database(2009-2014)



# Methodology (Taxonomy)

Database	Event Types/Sub-types
FAA UAS A&I	5/16
ASRS	15/53

-Federal Aviation Administration Accident and Incident (FAA UAS A&I)  
-Aviation Safety Reporting System (ASRS)

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# Methodology (Event Taxonomy)

FAA UAS A&I	ASRS	
Deviations from ATC Clearance and/or Letters of Agreement/Procedures	Equipment	Track/Heading Deviation
Lost Control Link Events	Altitude Deviation	Inflight Encounter
Unusual Equipment Malfunctions	Ground Incursion	Flight Deck/Cabin
Aircraft Collisions	Airspace Violation	Procedural Deviation
All other Deviations from Provisions in Letter of Authorization	Speed Deviation	Conflict
	Ground Encounter	Ground Excursion
	ATC Issues	Other
		Undetermined



# Methodology (Event Taxonomy)

ASRS	
Equipment	Track/Heading Deviation
Altitude Deviation	Inflight Encounter
Ground Incursion	Flight Deck/Cabin*
Airspace Violation	Procedural Deviation
Speed Deviation	Conflict
Ground Encounter	Ground Excursion
ATC Issues	Other
	Undetermined

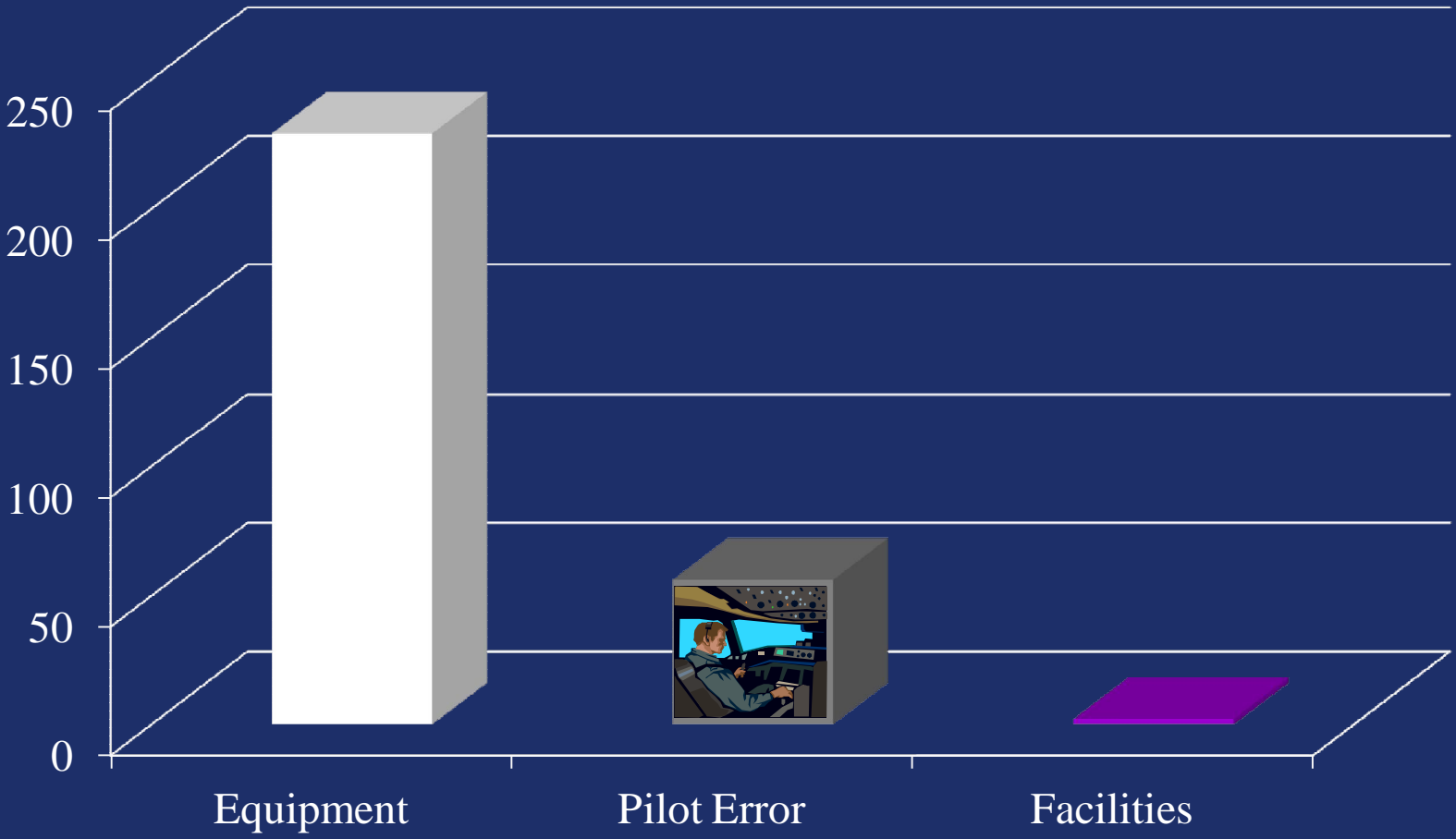
All events other than Equipment , ATC Issues, and Flight Deck/Cabin were considered Pilot Error

\*Flight Deck/Cabin were considered “Facilities Infrastructure”





# Event Types

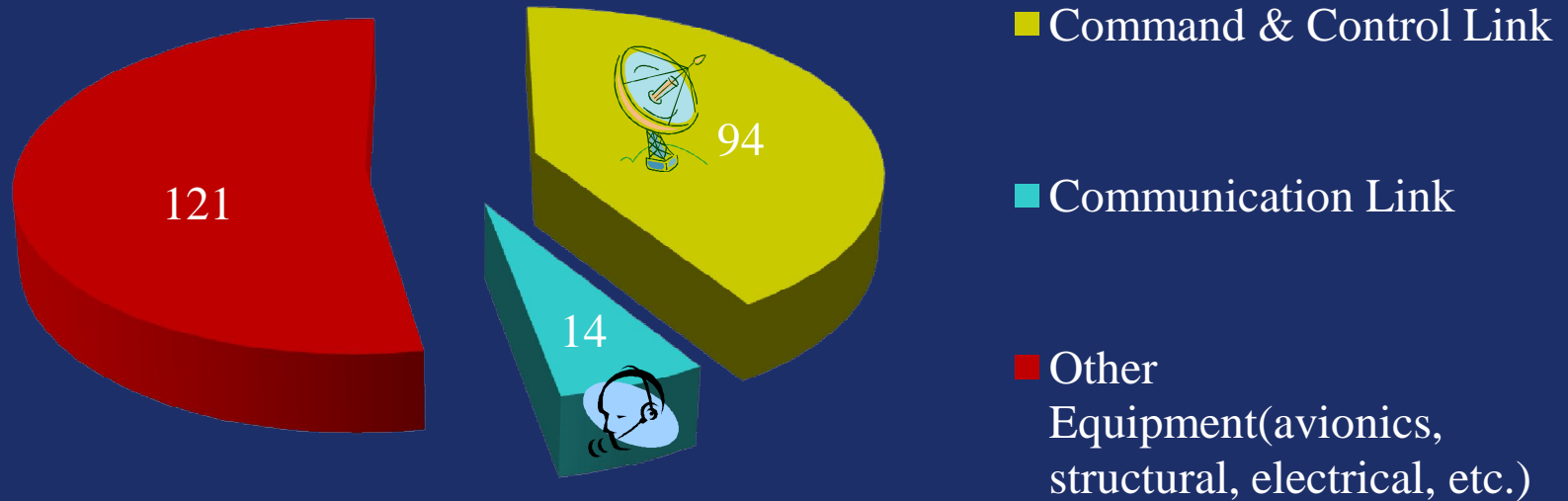


One equipment event also in NTSB database Rpt#ANC13TA072



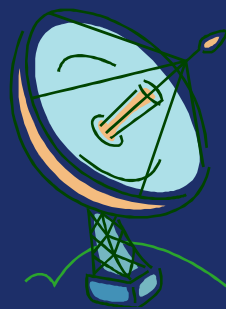
# Event Type

## Equipment Failure/Degradation



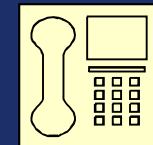
# Lost Command and Control Link

- *The crew of “XYZ” was flying in KU and experienced a lost return link (KU). The Crew ran the appropriate check-list, which directed the crew to disable the control link to the aircraft initiating autonomous flight via the emergency mission. The aircraft remained on its emergency mission and on its assigned altitude. After approximately two minutes, positive aircraft control was confirmed, and the pilot notified Center that they had been lost link, link was reestablished and the UA needed to return to base.*



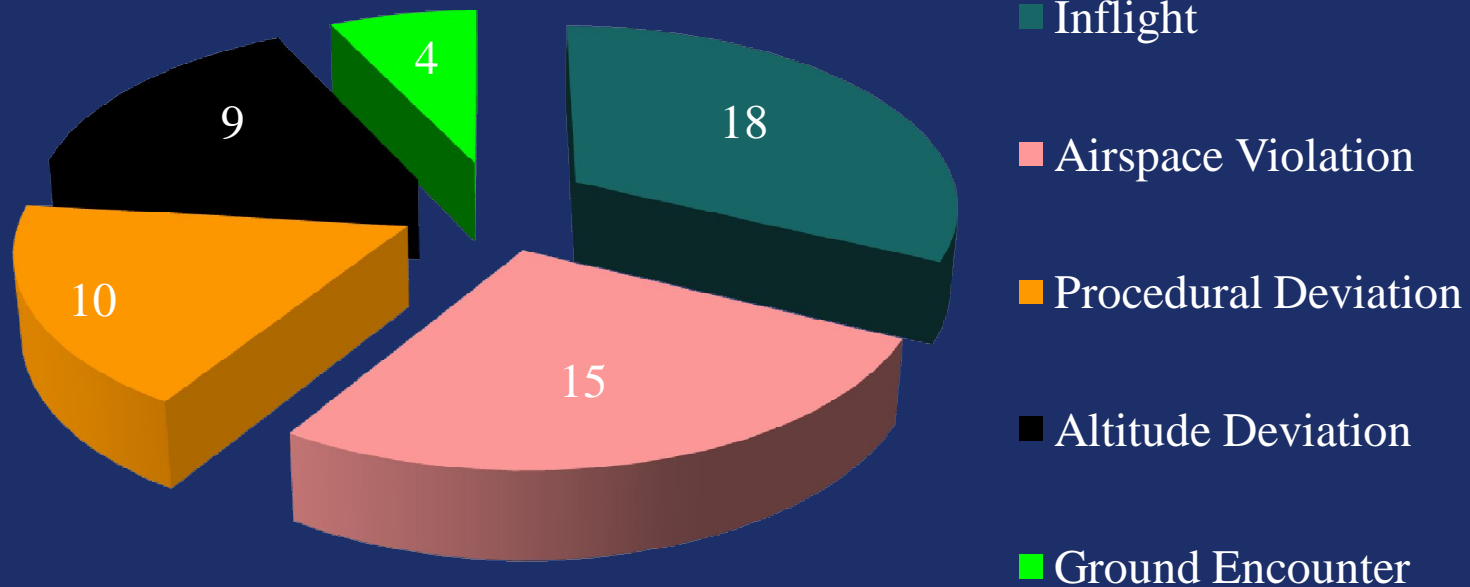
# Lost Communication Link

- *“XYZ” experienced a loss of two-way radio communications due to a Ku system component failure. The duration of communications loss was approximately sixty minutes. “The FAA ARTCC “ was contacted immediately of the failure by land-line telephone. Following three Ku system component reboot sequences with no success, the “UAS Pilot” initiated a Lost Communications Emergency with FAA ARTCC. The mission was terminated and the aircraft transited back to the “ABC” for recovery. The UAS crew maintained two-way telephone communications with ARTCC and TRACON controllers for transit and descent through the TFR. Upon entry into Class D, the UAS crew established two-way radio communications with the tower via ground-based radios located in the Ground Control Station.*



# Event Type

## Pilot Error



One altitude deviation also in ASRS database ACN 1076083



# Altitude Deviation



- *The aircraft started to climb because the **autopilot had the incorrect altitude of FL190BFL210 set from the prior altitude clearance.***
- *The pilot entered a loiter pattern but **did not input the appropriate altitude** into the altitude selector and the aircraft climbed 700’.*
- *Mission was **uploaded to the aircraft with an incorrect cruise altitude of 29,000 ft MSL.***



# Altitude Deviation



- *Unintentional altitude deviation approximately 1100 feet below its assigned altitude, due to an **incorrect command being sent to the aircraft by the PIC.***
- *Pilot entered, what he thought was 20,000' into the mission computer and initiated the auto pilot. At the same time the sensor operator advised the pilot that the aircraft was in a descent. It was determined that **2,000' versus 20,000'** had been entered into the mission computer.*



# Airspace Violation



- .... *inadvertently flew out of the northern border of XXX airspace by 1.6 NM. The pilot commanded a turn towards a surveillance target and inadvertently exited the airspace.*





# Ground Encounter

- *The pilot did not correct sufficiently to bring the aircraft over the runway and touched down just off the edge of the runway in the grass. The aircraft clipped a landing light, breaking the globe and bulb, spun around, and damaged its main and nose landing gear and right wing tip.*



# Procedural Deviation



- *The accident was due to **failure to follow the checklist** by our flight crew.*
- *However, the **pilot did not notify the XYZ Operations Coordination Center** of their activities in accordance with the Letter of Procedure.*
- *The pilot changed the C2 link to the Iridium 1 link, **but did not notice the link was not monitored**. At 1540Z, the air vehicle declared a Loss of Command and Control (C2 ) Link , although two links were functional at that time.*



# Procedural Deviation



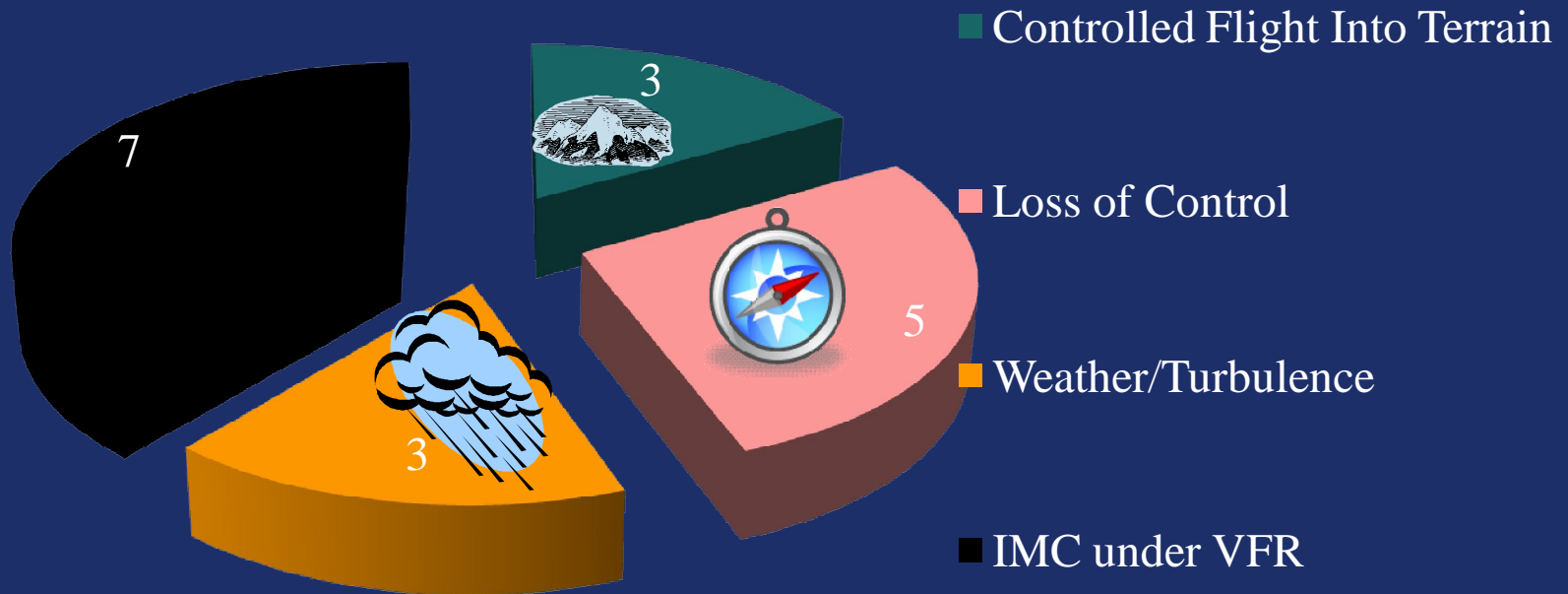
- *The XXX Checklist in the Normal section had been completed. However, the Emergency section should have been completed instead.*
- *UAS XXX declared an in-flight emergency to XYZ ARTCC in order to land at XXX without a chase aircraft.*



# Event Type

## Pilot Error

### Inflight



# Controlled Flight Into Terrain



- ....approach for landing/recovery too low for existing trees in recovery area. *Clipped top of trees.*
- ... the UAS operator determined it was necessary to decrease the “sUAS” altitude in order to avoid the J3 Cub that continued to maneuver in the “sUAS” proposed flight path. *The “sUAS” impacted trees enroute to its Home waypoint.*



# Instrument Meteorological Conditions under Visual Flight Rules



- *The UA PIC declared an emergency with the control tower, **entered a downwind and base leg in IMC conditions** and broke out on final at 900' AGL.*
- *The “UAS” **flew a downwind and base leg in IFR conditions** and broke out on final at 600 feet AGL.*
- *....the “UAS” began to **enter clouds and an area of moderate turbulence**. A 180 degree turn was executed to exit.*



# Weather/Turbulence



- ....the “UAS” began to *enter clouds and an area of moderate turbulence*. A 180 degree turn was executed to exit.



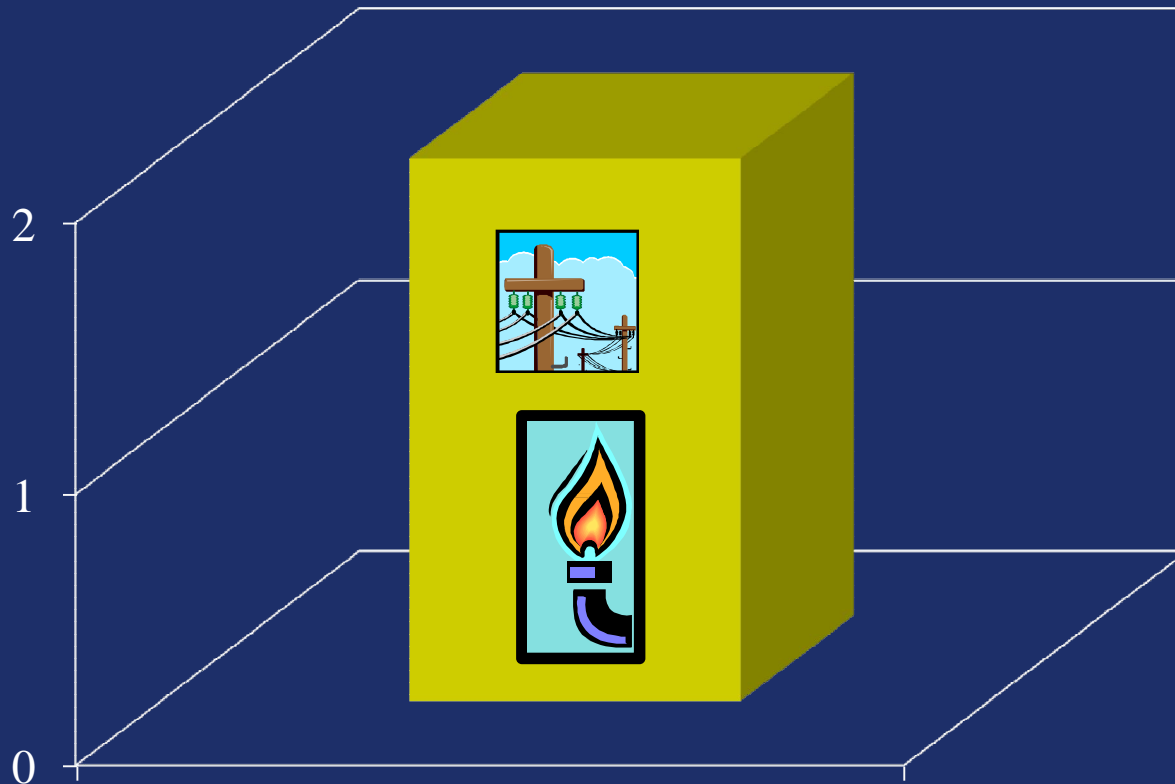
# Loss of Control-Inflight

- *The UAS was banked approx. 60 degrees, which was too great for the landing speed, causing UAS to stall and strike runway.*
- *During a normal hand launch of the aircraft, with no wind, the XXXsUAS did not reach sufficient speed to maintain altitude and impacted the ground.*
- *Pilot error led to the aircraft crash on the runway shortly after takeoff, while under manual control.*





# Event Types Facilities



# Facilities

- *...The entire “control center” was forced to evacuate today due to a gas leak. There was one “XYZ” UA airborne at the time ... about 3 +00 from home plate. ... We were out for about 40 mins.*
- *GCS lost commercial shore power due to a transformer fuse failure. Crew seamlessly transitioned to the “XYZ” battery power automatically. As designed, this power transition had no impact on the aircraft or GCS equipment. The PIC immediately declared an inflight emergency*



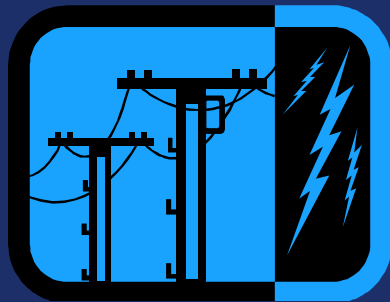
# Synopsis

- The **vast majority (84%) of the events** were related to equipment failures/degradation, specifically **command and control (C2) lost link**, distantly followed by a variety of non-equipment related events involving pilot/operator errors, such as altitude deviations, airspace violations, IMC under VFR, and procedural errors.



# Synopsis...continued

- In addition to C2 lost-link events, the study also revealed other **considerations unique to unmanned operations**, which were anomalous events from **degradation of facilities infrastructure that support UAS control stations**, and the **reliance on a telephonic system** as a back-up communication link with air-traffic control



# Aviation System Defenses

ICAO grouped hazard controls, or aviation system defenses, under the three general categories of **technology**, **training**, and **regulations** and considered the “hard mitigation” of technology as the most effective (ICAO, 2008, p. 5-ix).

- **Command and Control Link Equipment**
- **Airspace awareness**
- **Altitude awareness**
- **Weather awareness**
- **Procedural knowledge and compliance**

International Civil Aviation Organization [ICAO] (2008). Safety Management Manual (SMM). Retrieved from [http://www.icao.int/fsix/\\_Library/SMM-9859\\_1ed\\_en.pdf](http://www.icao.int/fsix/_Library/SMM-9859_1ed_en.pdf).



*“Those who cannot remember the past  
are condemned to repeat it”*

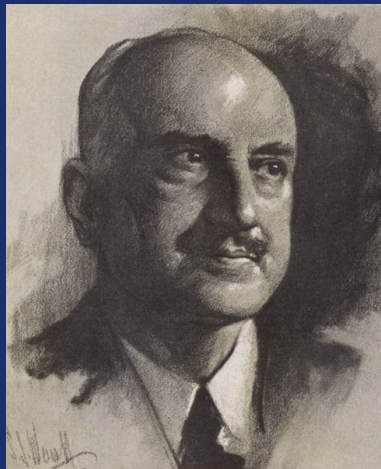


Photo: [http://en.wikipedia.org/wiki/George\\_Santayana](http://en.wikipedia.org/wiki/George_Santayana)

Ref: George Santayana (1863-1952), *The Life of Reason, Volume 1*, 1905

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