AVS Research Strategic Guidance 2021

Introduction

This document provides guidance for the development of the 2021 Aviation Safety (AVS) Research portfolio. This Strategic Guidance identifies some hazards, risks, and safety issues based on samples of data that drive AVS research needs. While the data covers a variety of operations, it is only a subset of extensive aviation safety data that affects the Federal Aviation Administration (FAA), and specifically AVS. This Strategic Guidance provides notional direction only. It is the responsibility of each AVS Service or Office (S/O) to determine research needs within their areas of responsibility that support the AVS mission.

All Technical Community Representative Groups (TCRG) and Office of Primary Interest (OPI) Representatives should develop and update their research plans. Research plans provide an organized long-range focus on critical research requirements, thus enabling AVS to identify and coordinate long-range resource needs, increasing the likelihood that resources are available.

Communication is critical to the successful development of the annual AVS research portfolio. Direct questions and comments on AVS research issues first to the OPI representative, then the AVS S/O Research, Engineering, and Development (RED) Group Member, and then the AVS R&D Manager.

Aviation Safety Hazards and Risks for AVS-Wide Consideration

AVS is responsible for responding to today's hazards and risks, as well as preparing for potential risks associated with changes related to the Next Generation Air Transportation System (NextGen), current FAA Strategic Initiatives, and other foreseeable and unknown economic and industry trends affecting aviation safety. Ensuring that regulations and guidance materials maintain relevancy will require the continued implementation of a comprehensive approach, with reactive, proactive, and predictive components integrated into an agency-wide Safety Management System (SMS) framework. AVS Research is one of the critical tools supporting development of effective means for continued safety improvement.

The FAA Office of Accident Investigation and Prevention (AVP) analyzed data sources to identify some high priority hazards and risks facing the National Airspace System (NAS). Consideration of these hazards and risks during research requirement development will stimulate multi-disciplinary and coordinated efforts across AVS offices and TCRGs, and the development of research requirements that address these hazards and risks. Thus, AVS will be in a position to meet safety goals and responsibilities spanning the lifecycle of certification and continued operational safety.

Risks to Aviation Safety in the Current NAS

Aviation safety data provides a historical basis from which to indicate possible significant high-priority risks to safety in the current NAS. Mitigating these risks has a direct and predictable effect on the reduction of future accidents, incidents, and associated human injuries and fatalities.

In accordance with the mission of AVS, research proposals should contribute to the development and implementation of FAA guidance materials, processes, regulations, policy, and/or standards that serve to reduce, mitigate, or prevent high-priority risks. These research proposals should identify the aviation safety data they are based upon.

When developing research proposals, AVS Sponsors should consider safety risk statistics within various aviation sectors and emerging issues identified by subject-matter experts. For Commercial Aviation, the percentage of total accidents for the following events is elevated for Title 14, Code of Federal Regulations (14 CFR) Part 121 Operations, as shown in Figure 1:

- Loss of Control – In Flight
- Structural Component or Aircraft System Failures/Malfunctions (Non-powerplant)
- Runway Excursions – Landing

In comparison, as shown in Figure 2, the percentage of total accidents for General Aviation is elevated for the following events:

- Loss of Control – In Flight
- Controlled Flight Into or Toward Terrain
- Structural Component or Aircraft System Failures/Malfunctions (Powerplant)

The percentage of fatal helicopter accidents is elevated for the following events as shown in Figure 3:

- STRIKE – Obstacle and Wire Strikes
- LOC – Loss of Control
- VIS – Degraded Visibility

Risks involving unmanned aircraft spoken of in UAS community include:

- Lost Link
- Flyaway
- Unseen by manned aircraft

Carefully consider trends within aviation sectors when developing research requirement proposals. Each AVS S/O and TCRG should carefully consider these differences and trends and all other related data and activities that may influence research needs and priorities.

Emerging Risks to Aviation Safety

Historical accident data highlight hazards capable of producing severe and negative outcomes, though it is not comprehensive for forecasting future significant risks to the aviation community. Moving beyond this reactive historical data to include proactive and forecast approaches involves identifying current or emerging hazards with a high likelihood or potential to result in significant safety risks. Proactive and forecast approaches enable AVS to move forward in the research cycle to prevent accidents and manage safety with the changing composition of hazards.

Currently, the Aviation Safety Information Analysis and Sharing (ASIAS) http://www.asias.faa.gov/pls/apex/f?p=100:1: program serves as a central conduit for the exchange of safety information within the aviation community and is a national resource for the aggregation, analysis, and dissemination of aviation safety products. ASIAS is a central repository for data and analytical tools that enables aviation stakeholders to enhance their safety decision making. ASIAS provides metrics for stakeholders on areas identified as known safety risks, such as:

- Unstable Approach
- Midair Collision
- Controlled Flight Into Terrain
- Loss of Control

In addition, ASIAS conducts directed studies or in-depth assessments of safety topics of particular interest to the aviation community, on subjects such as:

- Runway Safety
- Rejected Takeoffs
- RNAV Departures
- Controller-Pilot Communications
- STAR (RNAV) Ops
- Misconfiguration

The results of systems-level modeling of safety outcomes to forecast risk are being developed and validated. This modeling incorporates planned changes associated with NextGen, as well as unplanned changes associated with market trends and fluctuations. In the interim, by reviewing government and industry reports that rely on historical data, statistical trends, and the input of subject matter experts, a short set of near-term, high-priority safety issues emerge that transcend specific implementation plans, technologies, and operational frameworks (as listed below). Each AVS S/O should refer to this set of safety issues for help in identifying relevant domain-specific future hazards and risks:[1]

- Aircraft Mixed Fleet Equipage
- Assurance of Functional Integrity for Critical Systems
- Certification Methods for Complex Systems (for example, software)
- Changing Roles for Air Traffic and Flight Deck Personnel
- Human-Automation Interaction
- Physiology and Human Performance Vulnerabilities
- Information and Systems Security
- Interoperability and System Incompatibilities
- System Safety Assessment Methods and Tools
- New types of user technologies, such as unmanned aircraft systems (UAS) and commercial space vehicles

[1] This list is not comprehensive; Issues are organized in alphabetical order – placement does not suggest priority.

The System Safety Management Transformation (SSMT) apart of AVS Safety Management System (SMS), https://my.faa.gov/org/linebusiness/avs/programs/avssms/overview.html System Man program consists of tools to collect data, identify risk, and support risk mitigation evaluation in the NAS, including surface / runway anomalies, terminal / en route anomalies, wake encounters, and NextGen Operational Improvements. Baseline risk metrics are established from multiple data sources, including ASIAS, and future risk assessments can be determined. SSMT's core product, the Integrated Safety Assessment Model (ISAM), supports NextGen and other mission deployment decisions as well as risk-informed rulemaking. In the past, SSMT has supported risk assessments of safety topics including:

- UAS (unmanned aircraft systems) operations
- Airport surface events
- Wake Vortex encounters
- Loss of control – in-flight for general aviation

Each safety issue may encompass multiple hazards and potential risks. For example, research in the area of System Safety Assessment Methods and Tools that addresses increased component and system complexity may also include methods to identify common-cause failures and the introduction of new failure modes. Multiple approaches across AVS Services/Offices (S/Os) and TCRGs that will mitigate anticipated risks are encouraged for developing responses to these issues.

AVS S/Os should consider additional sources for emerging issues and opportunities for future research and identify those sources in their requirement write-ups. For example, in fall 2014, the Research, Engineering, and Development Advisory Committee's (REDAC) Subcommittee on Aircraft Safety (SAS) developed a set of Emerging Issues and Future Opportunities to provide input on strategic aspects of the AVS research portfolio. Each year the REDAC SAS carefully reviews proposed AVS research portfolios, provides research recommendations to the FAA. The SAS has identified this current set of Emerging Issues and Future Opportunities as recommendations that AVS S/Os may consider as they determine their needs for safety-related research and anticipate future research needs:

https://redacdb.faa.gov/uploadedFiles/REDAC/Full%20Committee%20Meeting%20-%20October%209,%202014/Full%20REDAC%20Report%202014.pdf

The list below reflects the current SAS updates and clarifications from FY17

- Real-Time System-Wide Safety Assurance
    - Connect and support the joint FAA and National Aeronautics and Space Administration (NASA) Research Transition Team activities https://my.faa.gov/content/dam/myfaa/org/linebusiness/avs/activities/avs_flyer_archive/Flyer_5_19_16.pdf
- Dependability of Increasingly Complex Systems
    - Software, Automation, and Autonomy
    - Data Integrity

    - Updated Federal Aviation Regulations (FAR) and Means of Compliance
- Certification of Advanced Materials and Structural Technologies
    - Examples include research into emerging engine issues of hot corrosion, dwell fatigue and inspection techniques
- High-Density Energy Storage, Management, and Use
- Commercial Space Integration with the NAS
- General Aviation's Role in Safety Systems Development
    - Relates to the technologies converging around distributed electrical propulsion and autonomy driving drastic market changes
- Effects of Breakthrough Medical Technologies on FAA Medical Certification Standards

System-level Safety Issues

Under the Administrator's Risk-Based Decision Making Strategic Initiative, https://my.faa.gov/org/staffoffices/AOA1/Strategic_Initiatives_Group/SIGRisk.html , the FAA Lines of Business (LOBs) and appropriate organizations established an annual process for identifying, prioritizing, and tracking safety issues that cross FAA LOBs. The purpose of the process is to proactively identify emerging threats that are most effectively addressed through cross-organizational collaboration to achieve meaningful system-level outcomes. The process recognizes that organizations may already be working to resolve safety issues identified via incidents in the system, yet there may be duplication of efforts due to low visibility, or that the safety issue would be more effectively addressed through cross-organizational involvement.

Each year the process was used, the LOBs and Staff Offices worked together to update it based on lessons learned from the previous year. The most current update in 2017 involved transitioning the process from an annual, list-based schema to one that is more dynamic and data-driven. The goal is to have a system in place where aerospace system data is collected and analyzed to identify and address the most critical safety risks first. The idea is to study the system data, look for emerging trends, identify the emerging safety risk, and mitigate the risk before incidents or accidents occur. The focus is on decreasing the risk in the NAS as well as decreasing the aviation fatal accident rate, while allocating resources in priority order based on safety risk.

Through this evolving process, the FAA identifies potential safety issues through two primary methods. FAA LOBs and Services/Offices identify potential issues through data analysis, system monitoring, and subject matter expertise. Key to this activity is the capability to acquire, monitor, mine, review, and assess available information related to the aerospace system to identify potential safety issues and emerging threats in the system and determine whether the issues should be raised to the FAA SMS Committee or addressed elsewhere (e.g., managed within one LOB). Second, FAA LOBs/Staff Offices discover potential safety issues through their existing organizational processes. Potential safety issues identified by FAA LOBs/Staff Offices for

consideration by the FAA SMS Committee must meet at least one of the Aerospace System Level (ASL) criteria as published in FAA Order 8040.4B, Safety Risk Management Policy. In addition to the ASL criteria, it is expected that FAA LOBs/Staff Offices will develop their own organization-specific criteria for identifying and elevating safety issues.

The LOBs/Staff Offices and/or AVP conduct preliminary risk assessments on the safety issues so that they can be characterized in terms of risk and highlighted to decision makers based on filtering criteria. LOBs/Staff Offices and/or AVP enter the issues into the Hazard Identification Risk Management and Tracking (HIRMT), a single integrated tool that provides a consistent and standardized methodology to manage and track safety issues, https://hirmt.faa.gov/. This tool will ensure the issues are tracked, and information and decisions are documented. The FAA SMS Committee and, if necessary, the FAA SMS Executive Council determine whether cross-organizational teams will be established to conduct Safety Risk Management (SRM), https://my.faa.gov/tools_resources/safety_initiatives/sm/sms/srm.html. Depending on the issue and its scope, the team may conduct a safety risk analysis (first three steps of the SRM process), a safety risk assessment (first four steps of the SRM process), or full SRM (all five steps). Typically, cross-organizational teams addressing safety risk are managed by the Safety Collaboration Team (SCT), which is chartered by the FAA SMS Committee.

Examples of previously identified FAA-level (cross-LOB) safety issues include:

- Wrong Surface Landings
- Class B Airspace Excursions
- Uncertified Runways at part 139 Airports
- Light Emitting Diode (LED) Lighting in Aircraft Operations
- Runway Incursions
- Inflight Pilot Report (PIREP) Collection and Dissemination
- Potential of Carry-on/Checked Passenger Devices to Cause Fire/Heat/Smoke Incident

AVS Services/Offices are encouraged to consider both cross-LOB and AVS-only safety issues, as well as proposed controls and mitigation strategies in determining their research needs. AVS S/Os should identify these safety issues in their research requirement proposals. AVS S/Os are also encouraged to work within their respective S/Os for further information regarding these safety issues and their proposed controls or mitigation strategies. Furthermore, AVS S/Os are encouraged to work within their respective S/Os to evolve their capabilities for identifying, analyzing, and managing potential safety issues that may require cross-organizational (either across multiple S/Os within AVS, or across multiple LOBs).

Key Technology Areas

There are key technology areas where the FAA has provided research leadership. There are certain areas where FAA is performing research that cannot be duplicated anywhere else in the world. FAA must maintain critical research in areas that make up the backbone of its long-term FAA R&D program. In such cases, FAA has a strategic need to maintain in-house capability and competency to perform research.

Commercial Aviation Safety Team Data

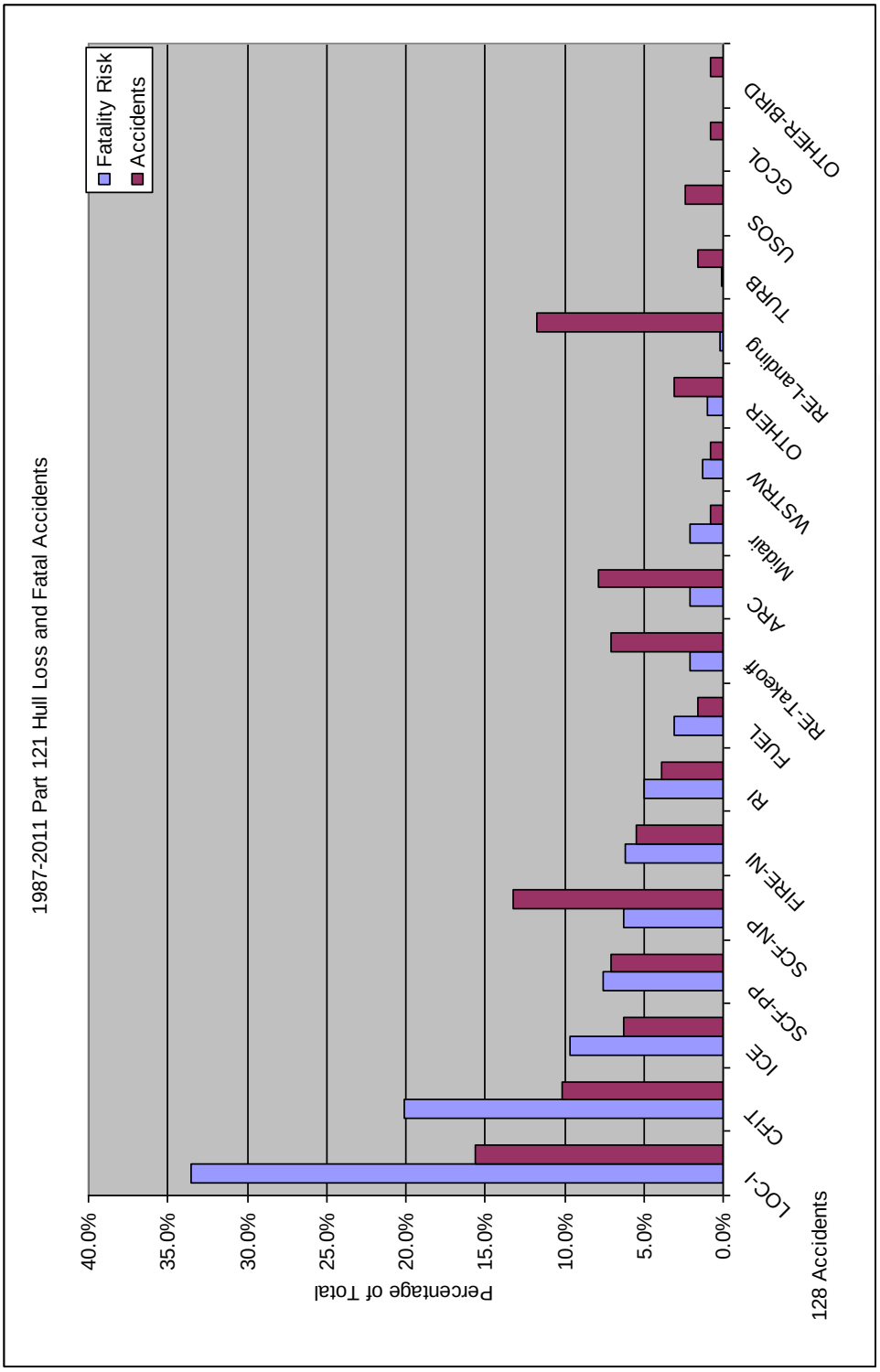

Figure 1

Source: Commercial Aviation Safety Team (CAST) – Domestic U.S. Part 121 Operations

Outcomes: Categorized according to Common CAST/ICAO Common Taxonomy Team (CICCT) – Occurrence Taxonomy

Fatality Risk: Sum of equivalent full planeloads perished per event

General Aviation Data

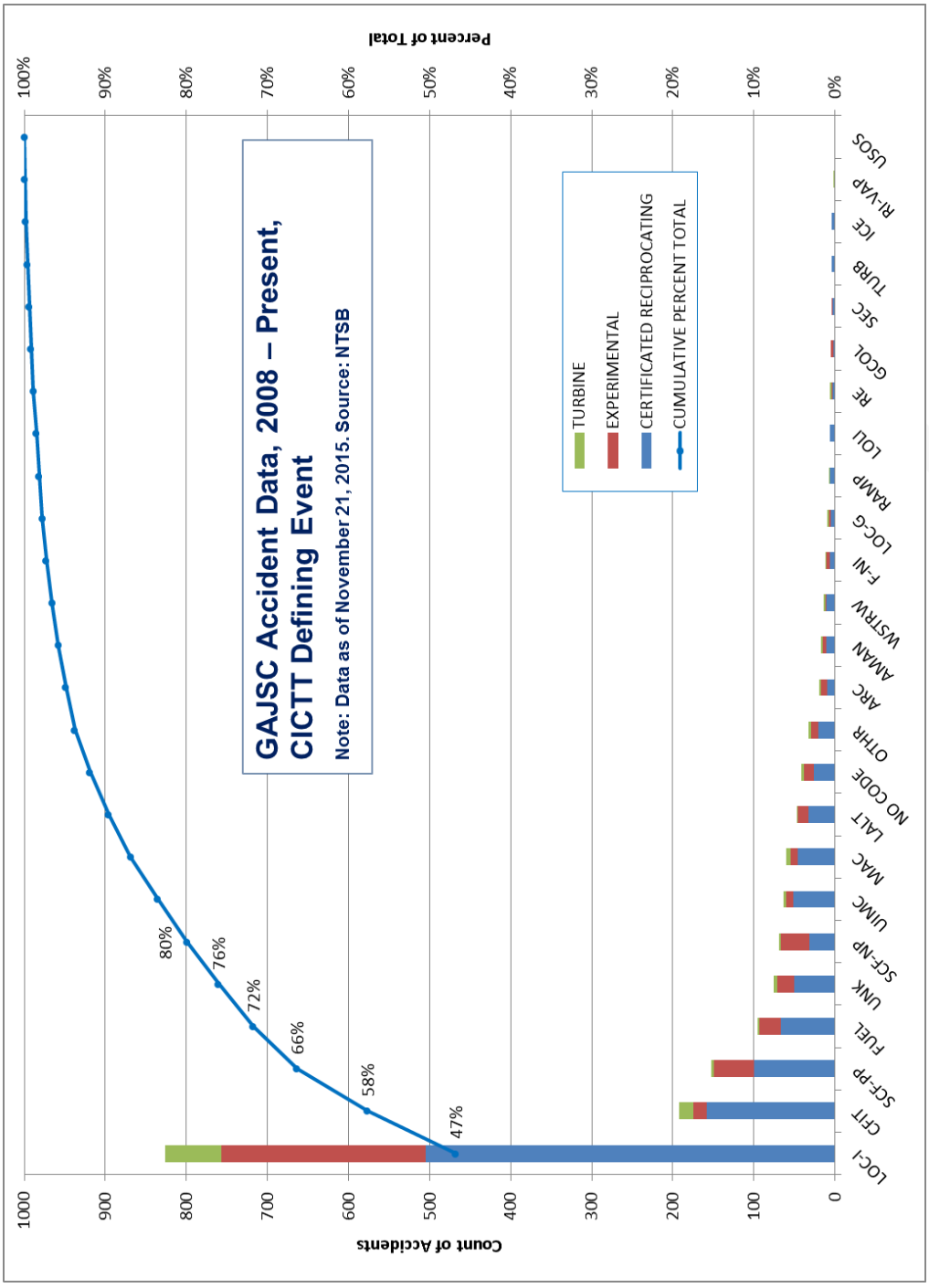

Figure 2

Source: General Aviation Joint Steering Committee (GAJSC)

Common CAST/ICAO Common Taxonomy Team (CICCT) Defining Event

Helicopter Safety Team Data

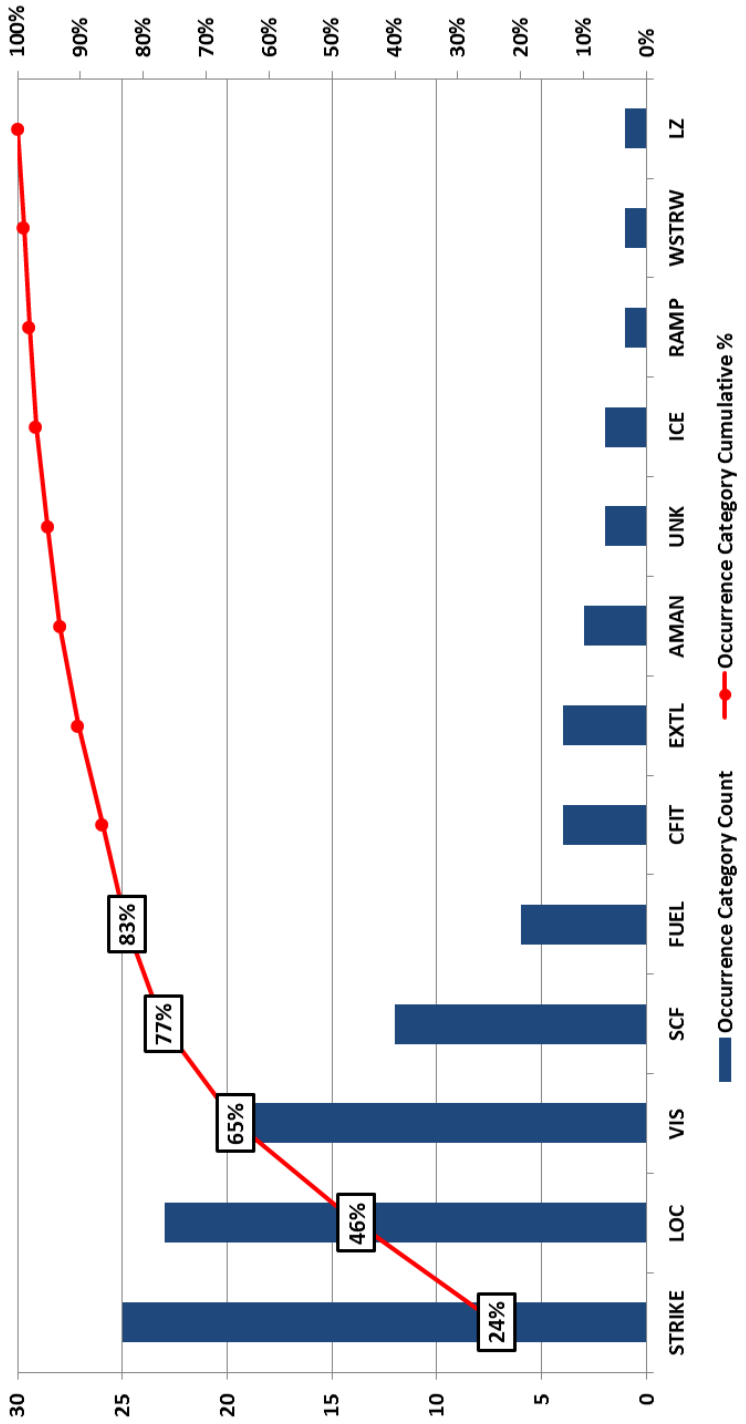

Figure 3
"Priority" Occurrence Category by JHSAT/JHIMDAT Taxonomy
2009 – 2013 (104 fatal accidents)
United States Helicopter Safety Team, March 2014

Appendix 1. Acronyms and Key Terms from CASTM GAJSC and IHST charts.

ARC: Any landing or takeoff involving abnormal runway or landing surface contact.

CFIT: Controlled Flight Into or Toward Terrain. In-flight collision or near collision with terrain, water, or obstacle without indication of loss of control.

Fire-NI: Fire/Smoke (Non-Impact). Fire or smoke in or on the aircraft, in flight or on the ground, which is not the result of impact.

Fuel: One or more powerplants experienced reduced or no power output due to fuel exhaustion, fuel starvation/mismanagement, fuel contamination/wrong fuel, or carburetor and/or induction icing.

GCOL: Ground Collision. Collision while taxiing to or from a runway in use.

ICE: Icing. Accumulation of snow, ice, freezing rain, or frost on aircraft surfaces that adversely affects aircraft control or performance.

LALT: Low Altitude Operations.

LOC: Loss of Control.

LOC-G: Loss of Control – Ground. Loss of aircraft control while the aircraft is on the ground.

LOC-I: Loss of Control – In Flight. Loss of aircraft control while or deviation from intended flight-path in-flight.

MAC: Midair/Near Midair Collision. Airprox, ACAS alerts, loss of separation, as well as near collisions or collisions between aircraft in flight.

Other: Any occurrence not covered under another category.

Other-Bird: Occurrences involving collisions / near collisions with bird(s) / wildlife

Ramp: Ground Handling. Occurrences during (or as a result of) ground handling operations.

RE-Landing: Runway Excursion Landing. A veer off or overrun off the runway surface.

RE-Takeoff: Runway Excursion Takeoff. A veer off or overrun off the runway surface.

RI: Runway Incursion: – vehicle, aircraft or person. Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and take-off of aircraft.

RNAV: Area Navigation. A method of navigation that permits aircraft operation on any desired flight path within the coverage of navigation aids

SCF-NP: System/Component Failure or Malfunction (Non-Powerplant). Failure or malfunction of an aircraft system or component – other than the powerplant.

SCF-PP: System/Component Failure or Malfunction (Powerplant). Failure or malfunction of an aircraft system or component – related to the powerplant.

STRIKE: Obstacle and wire strikes

TURB: Turbulence Encounter. In-flight turbulence encounter.

UNK: Unknown or Undetermined. Insufficient information exists to categorize the occurrence.

USOS: Undershoot/Overshoot. A touchdown off the runway/helipad/helideck surface.

VIS: Degraded Visibility.

WSTRW: Windshear or Thunderstorm. Flight into windshear or thunderstorm.