General Aviation Joint Steering Committee (GAJSC)

Controlled Flight Into Terrain (CFIT) Working Group

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CONTROLLED FLIGHT
INTO TERRAIN

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I. GAJSC Controlled Flight Into Terrain Work Group.

Background

The General Aviation Joint Steering Committee (GAJSC) is a public-private partnership focused on improving the safety of the general aviation (GA) industry. The GAJSC analyzes aviation safety data to identify emerging issues and develop mitigation strategies that address and prioritize safety issues. It was originally created in the mid-1990s as a counterpart to the Commercial Aviation Safety Team (CAST) under the Safer Skies initiative. The GAJSC had many successes through the mid-2000s, such as the creation of Federal Aviation Administration's (FAA) annual General Aviation and Air Taxi Activity Survey. This provided the FAA and industry with credible data on flight hours, from which meaningful accident rates could be calculated. After the mid-2000s, however, industry and FAA involvement abated and by 2010, the committee was inactive.

In January 2011, the GAJSC was reestablished. The impetus for this came from the Secretary of Transportation and the Future of Aviation Advisory Committee (FAAC). In its final report, the FAAC Safety Subcommittee identified the need to refocus joint FAA/industry work[1] on proactive and cooperative safety analysis to reduce the GA fatal accident rate.

The re-formed GAJSC adopted a structured, strategic process focused on making its work data-driven (see Figure 1.1 for this revised process). This ensures analytical credibility and allows the FAA and industry to plan comprehensive implementation activities.

The GA fatal accident rate is one of the metrics the FAA's Aviation Safety organization monitors. Although the FAA established a GA safety metric under the Safer Skies initiative based on the number of annual fatal accidents,[2] industry and the FAA jointly transitioned to a rate-based metric in 2007. The FAA and industry agreed to base the new metric on the three safest years in GA on record—2006–2008[3]—and plan for an annual improvement of a one percent reduction per year over ten years: no more than one fatal accident per 100,000 hours flown by 2018.[4] The preliminary GAJSC safety improvement goal for the 2020s is to continue reducing the fatal accident rate per 100,000 hours by one percent per year.

In the spring of 2011 the GAJSC tasked its analytic body, the Safety Analysis Team (SAT), with conducting a review of GA accidents to determine the GAJSC's priorities (see Figure 2). Based on this review, the

[1] FAAC, Safety Recommendation #3 "Voluntary Safety Data" and #5 "Identification of Safety Priorities."

[2] The FAA and industry jointly established a safety metric in the mid-1990s based on the number of fatal accidents in 1 year. At that time, industry and the FAA were reluctant to establish a rate-based metric because of limitations in the exposure data from GA. Through joint work under the GAJSC General Aviation Data Improvement Team, the exposure data (hours flown) was improved and currently has an accuracy of approximately 1.6 percent Standard Error, which was deemed acceptable for transitioning to a rate-based metric and goal for GA safety for 2007–2018.

[3] The 3 years with the fewest fatal accidents since World War II were 2006–2008. Converted to a rate, these years experienced 1.12 fatal accidents per 100,000 hours flown.

[4] In 2018, the GAJSC achieved its initial goal, with only 0.89 fatal GA accidents per 100,000 hours by the end of FY 2018.

GAJSC first focused on accidents identified as "Loss of Control (LOC)" according to the CAST International Civil Aviation Organization (ICAO) Common Taxonomy Team (CICTT) taxonomy. The GAJSC issued its first report on loss of control accidents in 2012, focusing on events occurring during approach or landing. After conducting an analysis in 2014 of fatal GA accidents occurring during other phases of flight, the GAJSC issued a second recommendation set aimed at mitigating LOC events.

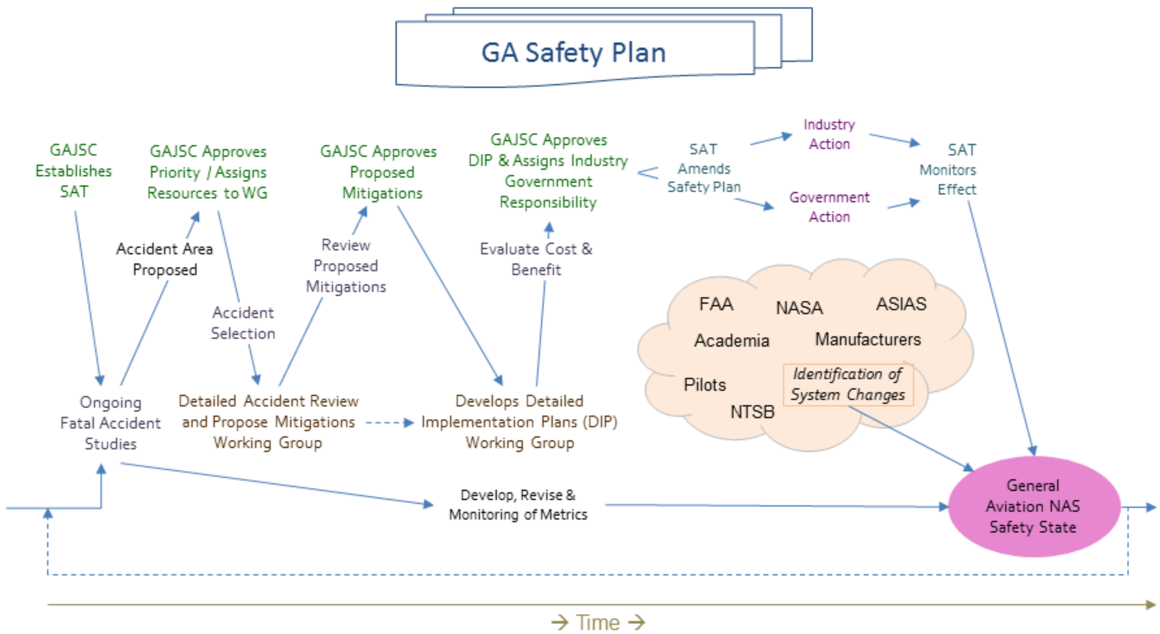

Figure 1.1 GAJSC Process Overview following 2011 Revisions

Following the LOC work, the GAJSC focused on System/Component Failure–Powerplant (SCF–PP) accidents. Although Controlled Flight into Terrain (CFIT) remained a high-risk area, the GAJSC determined because of the steady decline of CFIT accidents, the committee should focus first on SCF–PP events. A report on these was issued in 2016; subsequently, the GASJC voted to revisit CFIT.

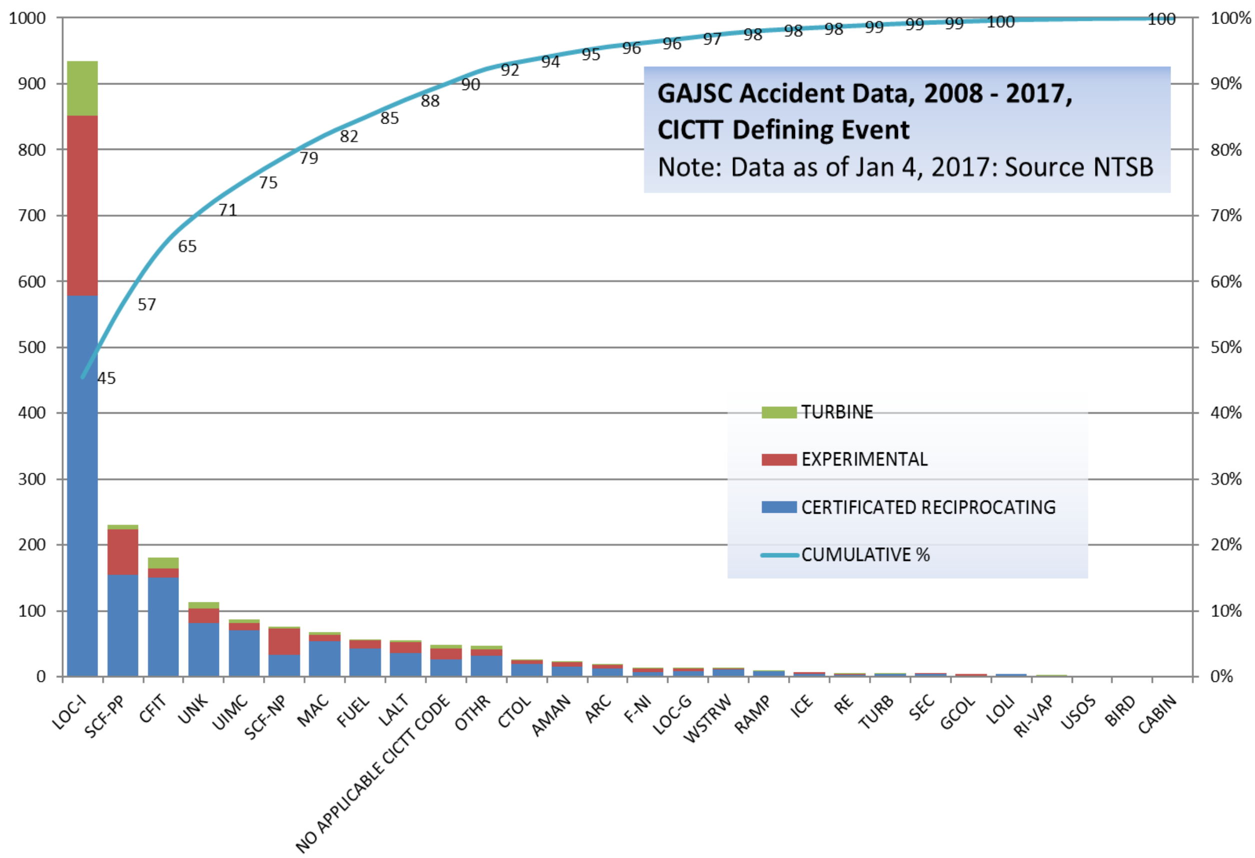

Figure 1.2 GAJSC Fatal Accident Pareto Calendar Year 2001–2011

Organization

The CFIT Working Group (CFIT WG) held its first meeting in October 2017 at NetJets' headquarters in Columbus, Ohio. The CFIT WG was co-chaired by representatives from the National Business Aviation Association (NBAA) and FAA Flight Standards (AFX), with technical support and process guidance from the FAA's Office of Accident Investigation and Prevention (AVP). All participating organizations in the GAJSC had an opportunity to nominate technical experts based on expertise identified in the CFIT WG Charter. The final membership of the working group is included in Appendix 2, and Appendix 3 contains a list of the CFIT WG's ten meetings.

The CFIT WG conducted its detailed accident analyses through two subteams based on the accident selection subsets of experimental amateur-built, certified piston engine aircraft, and turbine engine-powered aircraft.

II. Scope of This Report

This report is organized according to the following tasks contained in the CFIT WG Charter (Appendix 1 to this report):

1. The working group will conduct an in-depth analysis and review of the CFIT accidents provided by the SAT.
2. The working group will review and determine the applicability of other work done in the CFIT accident area.
3. The working group will develop and prioritize safety intervention strategies that will reduce the potential for fatal CFIT accidents. In addition to documenting its analysis results and recommended intervention strategies, the working group will also document its assumptions regarding the analysis.
4. The working group will present the prospective interventions to the GAJSC for review and approval. The report will include the analysis and rationale for how the intervention strategies were dispensed.
5. Following the GAJSC's approval of the interventions, the working group will develop a Detailed Implementation Plan (DIP) for each intervention.

   Each detailed implementation plan will contain—

   - Prioritized implementation strategies,
   - Parties responsible for actions,
   - Major implementation milestones,
   - Metrics to monitor progress in meeting these milestones, and
   - Metrics for tracking success of the interventions.

   The working group will present each DIP to the GAJSC for review and approval.

6. The working group will provide feedback to the GAJSC about what worked and what did not work with respect to this process to help assist with future working groups.

Additionally, recommendations for areas of further consideration are included at the end of the report (Section IV). The appendices contain detailed information about the CFIT WG's analysis and processes in formulating the Safety Enhancements (SE).

III. Taskings

1.0 Task 1

The working group will conduct an in-depth analysis and review of the CFIT accidents provided to it by the SAT. The SAT has established a statistically acceptable process to reduce the 162 CFIT accidents that occurred between 2008–2017 into a data set that can, within the timeframe provided, be practically reviewed by the working group.

The number of GA accidents within the proposed 2008–2017 timeframe made a detailed review of all fatal accidents, including all CFIT accidents, prohibitive from a time and resource perspective. To address data volume during the initial LOC–I studies, the SAT asked the GAJSC participants from the Center for Excellence in General Aviation Research (CGAR) to develop a method to select representative accidents to be used by the LOC–I Working Group in their analysis. This same process has been used to refine the accidents sets for the SCF–PP and CFIT Working Groups.

The GAJSC SAT randomly selected 67 accidents for turbine, certified piston aircraft, and experimental amateur-built aircraft, and the accidents were analyzed in detail. The complete process for accident selection is included in Appendix 4. The GAJSC SAT provided the accident selections to the CFIT WG before its first meeting. The National Transportation Safety Board (NTSB) assisted by compiling the accident dockets containing additional information about the accident sequence and pilot data, including medical examination's post-mortem information, to facilitate the root-cause analysis.

2.0 Task 2

The working group will review and determine the applicability level of other work done in the CFIT accidents area. The CFIT WG benefitted from its individual members' expertise and invited subject matter experts (SME). The SMEs provided briefings about relevant technical information; a list of these is included in Appendix 6.

The CFIT WG considered the solutions on existing work conducted in the CFIT accidents area offered during the briefings. When applicable to the risks identified in this study, the CFIT WG incorporated these fixes into the final recommendations and SEs.

3.0 Task 3

The working group will develop and prioritize safety intervention strategies that will reduce the potential for fatal CFIT accidents. In addition to documenting its analysis results and recommended intervention strategies, the working group will also document its assumptions regarding the analysis.

3.1 Methodology

Two subteams of the CFIT WG membership halved a set of 67 accident reports for analysis. Each subteam developed an event sequence spreadsheet (see Appendix 13). Each spreadsheet included the events necessary to aid in understanding the accident sequence's nature. The subteams then evaluated the events to determine if they represented a "problem" involving hardware/software failure or human execution errors, decisions, or procedural non-compliance.

If the members considered an event contributory to the accident, they developed a statement describing why. They identified the specific nature of the problem associated with an event in the sequence, along with the factors that could have triggered the problem. These contributing factors were then restated in more general terms as Standard Problem Statements (SPS) to make them relevant beyond the specific accident.

The subteams rated the SPSs as described below, and they developed potential interventions to address each. Appendix 11 contains a list of potential interventions, and Appendix 9 lists the SPSs the CFIT WG used.

3.2 "Standard Problem Statement" Rating System

Ratings.

The subteams used the following rating factors to prioritize the interventions: power (P), confidence (C), and applicability (A). They then determined the overall effectiveness (OE) using the scores assigned to "P," "C," and "A."

Power indicates how important a problem was to an accident and the degree to which an intervention could have resolved it and broken the chain of events. There was confusion in previous CAST Joint Safety Analysis Teams (JSAT) about the practical meaning of power. In practice, "P" was sometimes scored to indicate the relative power of the targeted problem in the accident; at other times, it indicated an intervention's power to resolve a specific problem and, thereby, break the chain of events. Consequently, "P" often failed to integrate the two concepts and instead scored one side of the concept and excluded the other.

Recognizing this confusion, the process changed following the Approach and Landing JSAT. The two factors outlined above were partitioned into "P1" and "P2" so each could be rated separately.

- P1 indicates the importance of the problem or contributing factor as a causal link in the accident.
- P2 indicates the ability of the rated intervention to mitigate the problem or contributing factor.

The 0–6 rating scales used to evaluate P1 and P2 were similar to ones for previous ratings. The two scores were combined arithmetically to produce a single power rating, explicitly addressing the past confusion and yielding a single power score conceptually equivalent to the power rating used by previous JSATs.

The CFIT WG incorporated the change into revised process guidelines: P1 focuses on the problem or contributing factor, and P2 focuses on the intervention.

Confidence indicates how strongly the subteam believed everyone and everything would perform as expected if the interventions were implemented. The confidence factor assesses the real world, in which interventions are seldom 100 percent effective.

Applicability indicates how frequently the problems addressed by the specific intervention recur. Applicability provides a bridge from the specifics of the accident to future operations.

Overall Effectiveness.

To support prioritization of the proposed interventions, the subteams ranked each intervention by its overall effectiveness. To do this, it was necessary to reduce the P/C/A ratings to a single value that roughly approximated OE. The intent was for the OE score to provide the first sort of the interventions.

The following algorithm is used to convert P/C/A to OE:

OE = P x C/6 x A/6 = P x C x A/36

Appendix 10 lists the interventions ranked by OE.

3.3 Assigning Feasibility

The feasibility assessment was accomplished by assigning a numerical value to each intervention for each of the following six elements:

1. Technical
2. Financial
3. Operational
4. Schedule
5. Regulatory
6. Sociological

Feasibility values of 1, 2, or 3 were assigned to each element and are described as follows:

Technical feasibility is the ability of the project to take advantage of the current state of technology in pursuing further development.

3—Off-the-shelf technology, no development required.

2—Some development required, not currently in public use.

1—Major technology development effort required.

Financial feasibility should consider the implementation's total cost, including the planning process. It also involves the capability of the participating organizations (FAA, manufacturers, air carriers, and operators) to provide the appropriate funding needed to implement the project.

3—Less than $100 million to implement.

2—Between $100 million and $250 million to implement.

1—Greater than $250 million to implement.

Operational feasibility involves the practicality of the project within the context of the operating environment, including areas such as the National Airspace System (NAS), ground operations, maintenance, and inspection. It also considers which organizations within the aviation system are affected and the degree of the impact.

3—Minimal change to entities within the operating environment.

2—Modest change to operating environment.

1—Major change to operating environment.

Schedule feasibility addresses whether the project can contribute to achieving the goal in a selected timeframe. It must consider implementation schedule by project.

3—Less than 2 years to full implementation.

2—Full implementation in 2–5 years.

1—Longer than 5 years to full implementation.

Regulatory feasibility should be evaluated against current rules and certification processes—a long approval process could be a deterrent.

3—No policy change.

2—Guidance change only (orders, handbooks, policy).

1—Rule change.

Sociological feasibility requires an evaluation of the project goals' compatibility with the prevailing goals of the political system—worthy projects may face heavy opposition because of political factors.

3—Positive push from political system.

2—Neutral.

1—Negative.

Once each subteam completed all the feasibility evaluations, they collated their numbers and added the value for each feasibility element and the average value for that project into the spreadsheet. To build consensus and ensure the values were defendable, the CFIT WG reviewed the numerical assessments for each element after the subteams entered all the values. Once complete, the CFIT WG combined the interventions into a single spreadsheet.

3.4 Generate Color-coded Spreadsheets.

The initial step in generating color-coded spreadsheets was to numerically sort the interventions by overall effectiveness and feasibility ratings. This sorting identified clusters in the data where colors could be assigned. The CFIT WG set break points for effectiveness and feasibility wherever naturally occurring breaks appeared. These breakpoints will be different for future working groups.

With the Overall Effectiveness and Average Feasibility columns populated, the spreadsheet was ready for use with an Excel feature called Conditional Formatting. This is a method of applying criteria to a set of numerical values and highlighting these in color. The condition format can be applied to the whole spreadsheet or one section, and the specific criteria may vary depending upon where the natural breakpoints occur in the ratings.

Colors for the CFIT WG were assigned as follows:

	Overall Effectiveness	Feasibility
Red	0 to 2	0 to 2
Yellow	2 to 3	2 to 2.6
Green	3 to 5	2.6 to 3

Figure 3.1 SE Effectiveness Score

Assigning red, yellow, and green colors permitted the working group to present interventions in instructive visual displays; for example, interventions with effectiveness “greens” could be clustered together, or they could be clustered together with feasibility “greens.” The combination of numerical sorting and color conditioning is a very powerful tool—the visually coded numerical values give a strong sense of priority and order, and they help to visually segregate the data.

3.5 Prioritize Interventions.

The CFIT WG’s next step was to determine the product of the overall effectiveness and feasibility ratings. The CFIT WG multiplied OE—the already determined overall effectiveness value—by F—the feasibility value determined by the subteams—to generate a rating used to determine priorities of interventions. This resultant product, OE x F, was captured in the spreadsheet and shown in a separate column, and the interventions should be sorted based on this product value to aid in their prioritization. This sort will show how the color codes for effectiveness and feasibility compare (green/green, green/yellow, etc.). Figure 3.1 is an example from the CFIT WG.

Based upon the resulting sort of OE x F, a cutoff value for OE x F was determined to identify the interventions most effective at reducing accident rates. The cutoff value for OE x F will vary between working groups.

For each intervention contained in this OE x F “product value set,” the associated intervention buckets were identified. These buckets and their remaining interventions were determined to be the high-priority project areas.

A new spreadsheet was generated based on a resorting of the data by intervention bucket and the product (OE x F). This provided the team with a visual representation of the high-priority project areas, their associated interventions, and the color-coded relationships for all of the interventions within each specific project area.

3.6 Establish SEs.

The high-priority project areas were reassigned to the subteams, and the first task of the subteams was to organize the interventions in their respective buckets into SEs. An SE is a plan containing one or more intervention strategies to prevent or mitigate a problem associated with an accident’s cause.

The teams identified the agencies and organizations potentially affected by the outputs or actions of their specific SE. One or more individuals from each of these agencies and organizations should be identified and their assistance solicited to act as working group members during the DIP drafting and planning phase. It is important to note the team may require the GAJSC’s assistance in identifying individuals of various agencies and organizations and obtaining approval for participation of the working group members.

4.0 Task 4

The working group will present the prospective interventions identified for implementation to the GAJSC for review and approval. The analysis and rationale for how all the intervention strategies were dispensed will be included in the report.

4.1 Developed SEs.

The CFIT WG originally developed 12 draft SEs. After discussions with the GAJSC and the SAT, a total of seven SEs were drafted for GAJSC consideration. The SAT undertook an effectiveness assessment of the SEs to present to the GAJSC during their consideration of the SEs prior to voting. The scores developed during this assessment were used as an additional tool for the GAJSC's decision-making process for which SEs would be assigned resources for implementation as part of the GAJSC Safety Plan.

4.2 Accident Analysis Methodology Compared to CAST

Unlike CAST's process, because of the large number of accidents the SAT did not score the SE effectiveness against all CFIT accidents or the full set of fatal accidents from 2008–2017. As a result, the effectiveness scores and analysis are intended to be a decision tool, as opposed to a comprehensive analysis of the aggregate effectiveness.

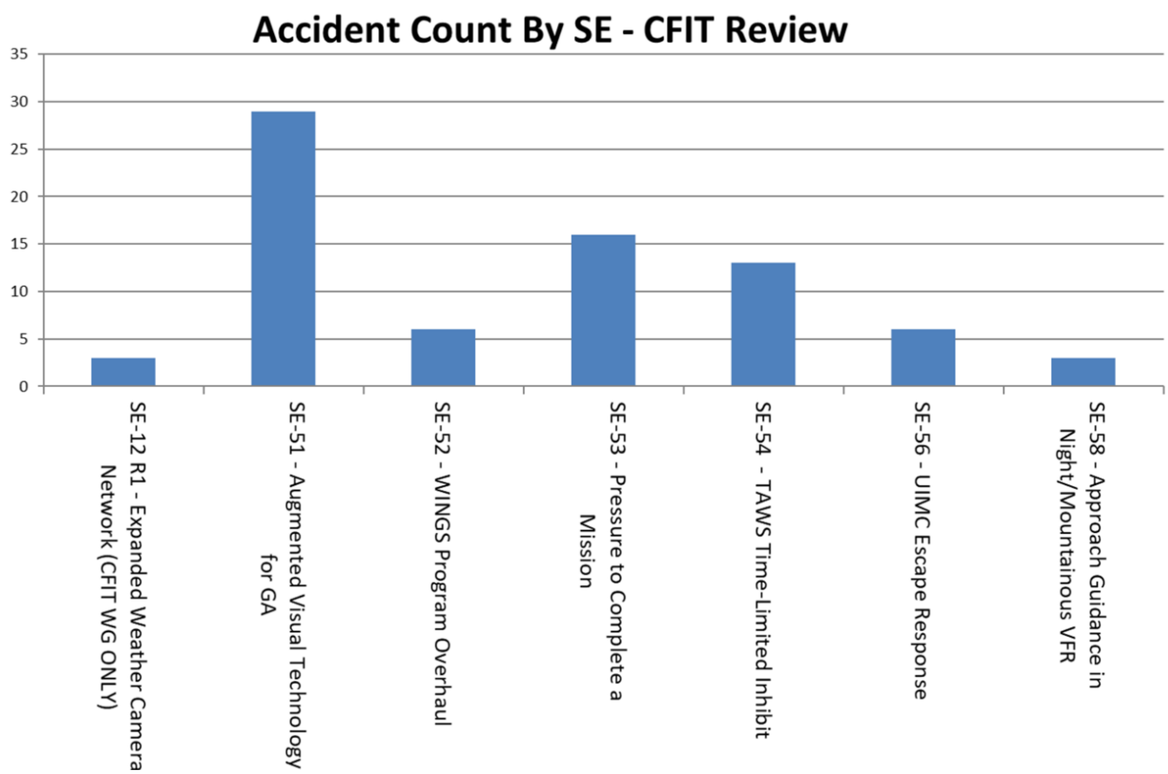

Figure 4.1 SE Accident "Count" Against 30 Randomly Selected CFIT Accidents

4.4 GAJSC Presented the Effectiveness Ratings of the SAT

The SEs were presented to the GAJSC several weeks before its August 2019 meeting to provide adequate review time. The SAT presented the results of its effectiveness analysis at that meeting.

4.5 GAJSC Approved List of SEs

The GAJSC approved seven individual SEs with the lead Implementers identified (see Table 4.1). Appendix 7 contains a list of the approved SEs.

SE	Title	Implementer
SE 12, R1	Expanded Weather Camera Network	FAA and aviation community/industry (NASAO, NATA, AAAE)
SE 51	Augmented Visual Technology for GA	SAT and pilot associations
SE 52	WINGS Program Overhaul	FAA AFS–850 (FAASTeam), AFS–630 and AFS–640, WIAC, NAFI, SAFE, EAA–IMC/VMC Clubs, AOPA, training providers
SE 53	Pressure to Complete a Mission	FAA, academia, AOPA, EAA, NBAA
SE 54	TAWS for GA, Addressing Time-Limited Inhibit, and Future Auto Ground Collision Avoidance	FAA AIR–600, AIR–700, AFS–400; AFS–250, NASA; avionics manufacturers
SE 56	UIMC Escape Response	FAA, GAJSC, new UIMC Task Force, FAASTeam, AOPA, EAA, NBAA, SAFE, NAFI
SE 58	Approach Guidance in Night/Mountainous VFR	FAA, pilot associations, training providers, 14 CFR part 141 flight schools, and FIRC and e-FIRC providers

Table 4.1 GAJSC Approved CFIT SEs

5.0 Task 5

Following the GAJSC's approval of the interventions, the CFIT WG developed a DIP for each intervention. In some cases, multiple interventions were combined into one DIP because of their relation.

5.1 Scope of this Section

This section contains a synopsis of the actions for each recommended SE's DIP, and the methodology used in DIP development. The entire DIP for each SE is in Appendix 6.

5.2 Methodology—Development of DIPs

The DIPs contain the following elements: the SE description, implementers and supporting organizations, the Statement of Work (SOW), financial resources, relation to other initiatives, performance indicators, milestones, obstacles, related notes, an applicable CICTT code, Outputs, and actions.

A description of the elements follows.

1. The SE description is a brief synopsis of the activity to prevent or mitigate a problem associated with an accident's cause.
2. The CFIT WG was responsible for identifying the Implementers, which may consist of Lead and Supporting organizations, the roles and responsibilities of which include—
    - Overseeing the completion of necessary outputs (critical path elements, progress against the plan),
    - Conducting program-status checks at predetermined implementation process milestones to verify performance against plan and task completion,

- Ensuring detailed plans are in place to achieve the project outputs,
- Identifying and communicating resource needs to the GAJSC, and
- Reporting the progress against the plan and the completion of tasks to the SAT.

3. The SOW is a brief, clear, and unambiguous text, including a description of the project's objective, a brief statement of the approach, and the outcome(s).
4. Resource requirements apply to organizational effect and financial or material requirements to complete the SE.
5. Relationship to Current Aviation Community Initiatives are ongoing programs directly related to a specific SE or Output.
6. Performance Goals and Indicators for SEs are defined as the target levels of performance expressed as a tangible, measurable objective against which actual performance can be compared within specified timeframes, including goals as quantitative standards, values, or rates. Performance goals may be applied to processes, Outputs, and outcomes, and can be characterized as the expected benefit of the projects in accidents prevented. Performance indicators are measures applied to a process, Output, or SE to ascertain the extent to which performance goals are met. This will be characterized as the methodology to measure the effectiveness of the intervention.
7. Milestones are listed by total months to complete an Output, thus providing an estimated timeline for SE completion. This does not include the time for an SE to be established within the community.
8. Potential Obstacles are items that my affect an SE's implementation or effectiveness.
9. Notes contain additional background or supplementary material important to understanding the resultant SE.
10. The CICTT code is the applicable Occurrence Category (in other words, risk area) the SE intends to mitigate.
11. Outputs are defined as the products and services produced and delivered or implemented in support of the stated SE. Actions consist of one or more Subactions.

The CFIT WG's minimum requirement for DIPs is that they contain strategies for implementing the interventions in the selected projects above the selected OE x F cutoff value. Whenever possible, the lower-ranked interventions should be included in the plans unless the inclusion would result in activities requiring excessive resources or implementation time.

5.3 Safety Enhancements

SE 12: Revision 1: Expanded Weather Camera Network

Deploy cost-effective technologies providing real-time weather information (including actual conditions as viewed through a remote camera) at remote airports.

SE 51: Augmented Visual Technology for GA

Encourage GA pilots and operators to equip and utilize Enhanced Vision System (EVS)/Synthetic Vision System (SVS) technology to enhance situational awareness with respect to surrounding terrain.

SE 52: WINGS Program Overhaul

FAA to overhaul and develop a plan for continual improvement of the FAA Pilot Proficiency Program (WINGS) to make it more user-friendly and dynamic. Aspects of the current WINGS program's automation are not user-friendly, especially for tablet and smartphone users. To encourage greater use of the program and reach more pilots, the CFIT working group recommends refreshing the program's automation so that it is more user-friendly and will work easily on all user devices. In addition, the working group recommends reviewing/updating the program's training content to ensure it is all up-to-date and includes CFIT-specific information from the CFIT Working Group's efforts.

SE 53: Pressure to Complete a Mission

To identify opportunities for improving awareness of the need to mitigate mission completion pressure on piloting, including sources and types of pressures, and the impact on decision-making.
External pressures, while difficult to anticipate, can influence a pilot's aeronautical decision-making, causing distraction and potential deviation from SOPs. The SE recommends conducting a review of existing measures intended to address pressure to complete a flight, and identifying new opportunities for improved education and outreach to the flying community on the importance of managing pressure.

SE 54: TAWS for GA, Addressing Time-Limited Inhibit, and Future Auto Ground Collision Avoidance

Improve TAWS capabilities and algorithms to better protect pilots operating in areas with challenging terrain, and develop additional safety protections to prevent the permanent inhibition of nuisance TAWS alerts during a terrain-critical flight.

SE 56: UIMC Escape Response

FAA and Industry to form a UIMC Escape Response Task Force which will look at past LOC analysis (LOC–1 and LOC–2 data) as well as ASRS reports involving UIMC. The group will make recommendations on revisiting how we teach and train the UIMC escape response maneuver to include an initial climb before any heading change, should the data support such a change.

SE 58: Approach Guidance in Night/Mountainous VFR

To further prevent controlled flight into terrain (CFIT) accidents, the FAA along with pilot organizations, flight instructor refresher course (FIRC) providers, and training providers should conduct an education campaign and/or develop learning modules educating the instrument-current pilot community of the safety benefits of backing up a nighttime VFR approach with lateral and vertical navigation guidance, particularly in mountainous terrain.

6.0 Task 6

The working group will provide feedback to the GAJSC about what worked and what did not with respect to this process to help assist with future working groups.

The CFIT WG leveraged the experiences of those who participated in the previous GAJSC working groups.

To be efficient, the many participants allowed the work to be divided into two subteams. Although synergies existed and a few participants divided time between the two, an unintended consequence occurred from the labor division. The participants in separate subteams would organically score the intervention strategies (IS) based on the discussions unique to each respective team. When combining the two teams' ISs and scores into one Excel spreadsheet, a majority of one team's ISs fell below the Mendoza line. This was rectified by finding commonalities between the ISs above the line with those that scored high but still fell below the line. Future working groups are encouraged to consistently rotate participants if they are using subteams to accomplish the work.

The proclivity of participants to create new SPSs by adding one or two specifics to existing SPS is also a lesson learned. To prevent the SPS list becoming unwieldly, future working groups are encouraged to use the master SPS list to the extent practical, and note any specific details as a comment.

Similar to the recommendation of LOC–I WG 2.0, it is highly encouraged to use shared workspaces, such as SharePoint, to help with version control and easy access to the most up-to-date documents.

IV. Areas of Focus for Further Study and Technical Studies

Scope of this Section

The following areas did not produce an SE; however, the CFIT WG identified several areas that may warrant further monitoring based on the analysis.

Air Traffic Control

As documented above, the CFIT WG took a holistic approach to the accident analysis. To that extent, the working group acknowledges the importance of air traffic control specialists (ATCS) in accident prevention.

The CFIT WG toured the Anchorage Terminal Radar Approach Control (A11) and had meaningful discussions with A11 facility management and the labor organization. Additionally, the team's FAA Air Traffic Organization (ATO) representative provided a presentation explaining a Minimum Vectoring Altitude and a Minimum Safe Altitude Warning.

Five accidents in the data set had at least one safety problem statement attributed to air traffic control: ANC13FA030, ERA09FA078, WPR10FA107, CEN11FA110, and ERA15FA326. It should be noted the NTSB determined the ATCS were contributory in the probable cause of two of the five accidents: ANC13FA030 and WPR10FA107.

During the SE development stage, the CFIT WG initially focused its analysis on expectation bias vis-à-vis controller-pilot communication breakdowns surrounding altitude clearances; for example, a pilot's understanding of a higher "as-published" altitude after being assigned a lower altitude by an ATCS. The events documented in ANC13FA030 are an example of this situation.

Upon further analysis, the recognition and issuance of a safety alert (with emphasis regarding VFR flight following aircraft) was a common thread. The issuance of a safety alert is one of the first duty priorities for an ATCS, and FAA Order JO 7110.65 lists the applicable requirements.

The FAA ATO is the United States' Air Navigation Service Provider, and it relies on numerous programs to execute its Safety Management System. The "Top 5" is one of those programs: a data-driven list of trending safety issues on which FAA ATO focuses its resources, takes corrective action, and monitors results. "Traffic Advisories/Safety Alerts (TA/SA)," specifically the lack of issuance of traffic advisories and/or safety alerts where required, has been a Top 5 issue since 2013. Additionally, "Altitude Compliance," specifically aircraft operating at an unexpected or unintended altitude, has been a Top 5 issue since 2012. Previously, FAA ATO identified new Top 5 issues every year; however, in fiscal year (FY) 18, FAA ATO established a continuous Top 5, so each Top 5 issue is retained until the risk is mitigated enough to no longer have Top 5 safety priority. Though another topic may replace a mitigated issue in the Top 5 program, FAA ATO continues risk-monitoring activities to ensure the risk does not rise to a level to be included in the Top 5 again.

Since 2018, both TA/SA and altitude compliance have been included in that continuous Top 5. To address these issues, FAA ATO establishes a government/industry workgroup that includes controller and pilot representatives who analyze pertinent reports from the Air Traffic Safety Action Program (ATSAP), Confidential Information Sharing Program (CISP), Mandatory Occurrence Reports (MOR), and other safety data, and develop corrective actions to mitigate associated safety risks. Though some actions may be long-term, the workgroups establish new Corrective Action Plans (CAP) each year to mitigate further the risks. These Top 5 CAPs have included reviews and changes to equipment/software, procedures, training, and outreach, made after the accidents occurred (between 2009 and 2015) the CFIT workgroup analyzed.

Government and industry representatives developed the current Top 5 CAPs, which include 17 TA/SA activities and six altitude compliance activities. The current TA/SA strategies are:

1. Emphasize the importance of, and improve controller issuance of, traffic advisories and safety alerts through promotional materials/campaigns and training; focus on tracking retention and comprehension of such content for future monitoring.
2. Enhance/provide clarification on policy and procedures for controller judgment as it applies to traffic advisory and/or safety alert provisions.
3. Develop more efficient designs of airspace to de-conflict VFR aircraft by incorporating VFR routes/corridors in congested airspace.

The current altitude compliance strategies are:

1. Improve pilot-controller communication with regard to altitude clearances.
2. Engage pilot community for training and awareness of altitude conformance.

New Top 5 FY21 CAPs will be developed for TA/SA and altitude compliance. Considering this, the CFIT WG decided not to pursue an SE involving safety alerts and/or communication breakdowns surrounding altitude clearances.

GAJSC CFIT Fatigue

A recurring theme in the Title 14, Code of Federal Regulations (14 CFR) part 135 CFIT accidents the workgroup analyzed was fatigue and a company culture of an elevated level of accepted risk. This was especially prevalent in Alaska and Hawaii operators.

The FAA regulates crew rest for commercial operations through its Federal Aviation Regulations (FAR) 135 and 121. Crew rest, as defined by the FARs, is any time a crewmember is free from all duties and responsibilities, including flying and administrative work. The FAA places strict limitations on minimum crewmember rest periods. Despite mandatory rest periods, pilots still find it difficult to get eight hours of uninterrupted sleep during the 24/7 schedules that often define today's flight operations. In some of these accidents, those limits were routinely exceeded, as an accepted company practice.

Fatigue can manifest itself in many ways. Signs of fatigue include:

- Degraded performance: making multiple mistakes or taking an unusually long time to perform a normal task.
- Reduced attention time or memory loss: not remembering if a flight received clearance to land.
- Loss of situational awareness: often leads to errors in judgment and increased reaction time. Another crewmember may recognize this situation before the affected pilot notices it.

While fatigue may not have been causal, it was at least contributory in these accidents. The working group discussed possible mitigating strategies, including a "pilot Fitbit," which tracks sleep patterns, and educational outreach. The consensus was for the FAASTeam to provide educational tools to the Flight Standards District Office (FSDO) Inspectors for their operators emphasizing fatigue awareness for part 135 operators and to ensure this was adequately reflected in the company's initial and recurrent training programs; this should include how to operate effectively and safely. It is vital for pilots to not only understand the physiological processes of sleep and fatigue, but also to employ effective coping strategies.

Appendix I — CFIT WG Charter

CHARTER

GA JSC Risk Reduction Working Group

Controlled Flight Into Terrain (CFIT)

April 12, 2017

A. Background

The General Aviation Joint Steering Committee (GAJSC) chartered a Safety Analysis Team (SAT) to conduct a review of fatal general aviation accidents for 2008 through 2016. The SAT reviewed 162 fatal general aviation accidents based on CAST/ICAO Common Taxonomy Team (CICTT) categories and Controlled Flight into Terrain (CFIT) accidents as the second most prevalent accident.

Industry and Government agreed to conduct a data-driven approach to identifying high priority safety initiatives for general aviation and jointly agree to work toward the mitigation of accident causes. The GAJSC has now chartered three separate and successful working groups to examine causes and determine targeted mitigations; LOC–Approach and Landing, LOC–Takeoff and Enroute, and System/Component Failure–Powerplant (SCF–PP). Originally, CFIT accidents appeared to be decreasing, and SCF–PP fatal accident numbers appeared to be stagnant. For this reason, the GAJSC determined that the next working group would analyze SCF–PP accidents. The GAJSC has now determined that it is appropriate to revisit CFIT accidents.

B. Tasks

1. The working group will conduct an in-depth analysis and review of the CFIT accidents provided to the working group by the SAT. The SAT has established a statistically acceptable process to reduce the 162 CFIT accidents that occurred during 2008 through 2016 into a data set that can be practically reviewed by the working group within the timeframe provided. This resulted in 62 CFIT accidents assigned to the work group.

2. The working group will review and determine the level of applicability of other work done in the CFIT area.

3. The working group will develop and prioritize safety intervention strategies that will reduce the potential for CFIT fatal accidents. In addition to documenting its results of the analysis and recommended intervention strategies, the working group will also document its assumptions regarding the analysis.

4. The working group, with help from the SAT, will present the prospective interventions identified for implementation to the GAJSC for review and

approval. The analysis and rationale for how all the intervention strategies were dispensed will be included in the final report.

5. Following the approval of the GAJSC of the interventions, the working group will develop a Safety Enhancement (SE) for each intervention.

   5.1. Each SE will contain:

   - Prioritized implementation strategies,
   - Parties responsible for action,
   - Major implementation milestones,
   - Metrics to monitor progress in meeting these milestones, and
   - Metrics for tracking success of the interventions after they are implemented.

   5.2. The working group, with help from the SAT, will present each SE to the GAJSC for review and approval.

6. The working group will provide feedback to the GAJSC about what worked and what did not work with respect to this process to aid future working groups.

C. Products

The working group will deliver the following to the GAJSC:

- Progress reports,
- A report documenting analysis and recommendations on mitigation strategies,
- An implementation plan for review and approval, and
- Safety enhancements, including metrics for monitoring effectiveness of mitigation strategies.

D. Membership

The working group will include representatives with the appropriate technical background provided by industry and government including several members from the SAT who can further assist with the data analysis.

E. Resources

The GAJSC participating organizations agree to provide appropriate financial, logistical, and personnel resources necessary to carry out this charter and approved implementation strategies. The working group will use conference calls as needed, but will primarily meet face-to-face at the discretion of the working group government/industry co-chairs.

F. Schedule

The working group is expected to exist for nine months, but can be extended at the discretion of the GAJSC. The working group is requested to target its deliverables as follows:

- November 2017: Report documenting analysis and recommendations for mitigations.
- March 2018: An implementation plan including metrics for monitoring effectiveness of mitigations.

G. Specific Resources

The organizations providing personnel resources to this project are asked for discretion in possible changes in the need for resources. However, based on an initial assessment, it is expected that the working group consist of two co-chairs and approximately 30 members, each contributing on average 3 days every month and a half. The skill sets needed include:

Industry Co-Chair	1	FAA Co-Chair	1
Pilots (light, instructors, turbine)		2	
Manufacturers		2	
Training Providers		2	
Analysis Support (AVP, Universities)		6	
Government (Policy & Technical)		10	

H. CFIT Working Group Chartered Membership

- National Business Aviation Association (NBAA) (Industry Co-Chair)
- Federal Aviation Administration (FAA) (Government Co-Chair)
- Aircraft Electronics Association
- Aircraft Owners and Pilots Association (AOPA)
- AvMet
- Experimental Aircraft Association (EAA)
- Embry-Riddle Aeronautical University (ERAU)
- ESI
- FAA AVP–100, AVP–200, AFS, ANG, ATO, AIR, FAA Weather in the Cockpit (WITC)
- FAA William J. Hughes Technical Center
- General Aviation Manufacturers Association (GAMA)
- Garmin International, Inc.
- Honeywell

- Jeppesen
- Lancair Owners and Builders Organization (LOBO)
- National Transportation Safety Board (NTSB)
- Partnership to Enhance General Aviation Safety, Accessibility and Sustainability (PEGASAS)
- Society of Aviation Flight Educators (SAFE)
- Textron Aviation
- University of North Dakota (UND)

I. Approved

This charter was approved by the GAJSC on April 12, 2017.

Industry Co-Chair Government Co-Chair

Appendix 2 — Participants

Adler, Richard	FAA
Allen, Jim	Honeywell
Barkowski, Justin	AOPA
Bracken, Joseph	AvMet
Brewer, Chad	FAA
Champion, Robert	Honeywell
Charpentier, Tom	EAA
Collins, John	AOPA
Crossley, William	Purdue
Edwards, Jeff	LOBO
Foster, Lowell	FAA
Fraser, Kate	FAA
Haertlein, Lauren	GAMA
Halloran, Michael	FAA
Hempen, Pat	FAA
Hennig, Jens	GAMA
Huhn, Michael	NTSB
Ishihara, Yasuo	Honeywell
Johnson, Ian	FAA
Kenny, David	AOPA
King, Ryan	FAA
Knoll, Barry	FAA
Korns, Peter	NBAA
LeBaron, Tim	NTSB
Malcolm, Toon	ForeFlight
Martellotti, Bob	Piper
McGuire, Bob	FAA
Miller, Brad	Cirrus
Moore, Ann	FAA
O’Farrell, Kieran	FAA
Peri, Ric	AEA
Plumleigh, Martin	Jeppesen
Pollack, Matthew	MITRE
Pruchnicki, Shawn	OSU
Ramey, Rob	Textron Aviation
Reese, Scott	ERAU
Serur, Steven	FAA
Stephens, Corey	FAA
Stewart, Doug	SAFE
Thigpen, Neil	FAA
Walton, Andrew	Liberty
Welch, Buck	Textron Aviation
Winn, Bob	Engsys

Appendix 3 — CFIT WG Meetings

GAJSC CFIT MEETINGS	MEETING HOST
OCTOBER 3–5, 2017 – COLUMBUS, OHIO	NetJets
DECEMBER 12–14, 2017 – PHOENIX, ARIZONA	Honeywell Learning Center
JANUARY 23–25, 2018 – FT. LAUDERDALE, FLORIDA	Embraer Aircraft
MARCH 13–16, 2018 – ENGLEWOOD, COLORADO	Jeppesen
APRIL 17–19, 2018 – RENTON, WASHINGTON	Boeing
JUNE 12–14, 2018 – OSHKOSH, WISCONSIN	EAA
AUGUST 28–30, 2018 – ANCHORAGE, ALASKA	University of Alaska – Anchorage
DECEMBER 4–6, 2018 – BOSTON, MASSACHUSETTS	Signature Aviation
APRIL 9–11, 2019 – DAYTONA BEACH, FLORIDA	Embry-Riddle Aeronautical University
MAY 13–17, 2019 –FREDERICK, MARYLAND	AOPA

Appendix 4 — Accident Selection Process

Proposed Methodology for JSC SAT Accident Selection

To provide a quantitative framework for the investigation of selected focal areas, the Safety Analysis Team (SAT) will use appropriate and empirically-based vetting protocols, which will endeavor to provide a meaningful foundation for the team's subsequent analyses. The methodology's underlying foundation will use the following principles: (1) preprocessing of the search criteria will be as exhaustive as practical; (2) random selection (each resultant accident report will have an equal selection probability) will be used; and (3) during the post-analytical process, pruning and/or outlier removal will only occur when there is a substantial lack of information contained in the report not readily apparent in the preprocessing tasks, when an accident report was inaccurately and obviously misclassified, or when there is a justifiable basis to believe the report will not materially contribute to the focal area.

Preprocessing

The National Transportation Safety Board's (NTSB) aviation accident database and its associated interactive search capability will be used in the selection of accidents needed for further inquiry. Unless otherwise directed by the GAJSC or by most of the SAT, all accident selections will use the following criteria:

Investigation Type:	Accident
Injury Severity:	Fatal (with Non-Fatal augmentation; see below)
Category:	Airplane
Operation:	All General Aviation*
Report Status:	Probable Cause

*The SAT may decide to include 135 reposition and other non-revenue flights.

If desired by a majority vote of the SAT, further narrowing of selection criteria can be used with the following parameters:

- Amateur-built (may be used as an additional sample; see below)
- Engine Type
- Purpose of Flight
- Broad Phase of Flight

Further preprocessing activities will use a word string phrase or phrases agreed upon by the majority vote of the SAT and congruent with the selected focal areas. Once agreed upon, all records used for a focal area must use the same criteria and word string phrase or phrases.

Random Selection

If the resultant search query from the NTSB's database exceeds thirty (30) separate accident reports, a random sample of the available reports will be collected. The random sample shall include a minimum of thirty (30) samples. If thirty (30) reports are not available, Non-Fatal accidents may be used to bring the total sample size to thirty (30). In addition, the SAT may decide a separate and additional sample involving Amateur-built aircraft be used.

A software tool, such as Microsoft's Excel or IBM's SPSS, will be used to randomize and select the sample. The randomizing shall only use the NTSB report number and, once run, shall constitute the master list of accident reports used for analysis. Further information within the accident report will be accessed only after the master list is compiled.

Post-Analysis

Each report will be assigned to at least two members of the subgroup tasked with the focal area. Each member will review the report and make an initial judgment about the suitability of the report as it relates to the task at hand. When making this judgment, the subgroup member must be able to answer Question 1 in the affirmative and Question 2 in the negative.

1. Does the report have adequate information available to form an appropriate qualitative assessment?
2. Has the accident outlined in the report been obviously misclassified, or does the report contain an error that would render any conclusion drawn therein not relevant to the focal area?

If most subgroup members assigned to the specific accident report are in agreement the answer to Question 1 is in the affirmative or Question 2 is in the negative, then the next available accident from the randomized master list shall be selected for analysis. The process would then repeat.

Once a report has passed this initial check, the subgroup members assigned to a report will conduct a preliminary analysis of the accident report.

If, after completing the analysis, the members of the subgroup tasked with the analysis of the accident report unanimously conclude that the accident in question will not materially contribute to the analysis of the focal area, the report will be excluded. In making the decision to exclude any accident report, the following question should be answered in the negative:

3. Will the accident report materially contribute to the analysis of the considered focal area?

If there is doubt as to the answer, the question should be answered in the positive, and the report should be included for further analysis.

Working Group

When the subgroup compiles a sample list of accidents per the above methodology, they shall forward the list to the assigned working group. In addition, the subgroup will also forward an additional list of reports, known as the reserve dataset, to be used in the event the working group concludes a particular accident report is not suitable for further analysis given the focal area. If no accident report remains in the reserve data set, the subgroup shall reconvene to generate additional reports drawn from the master list and processed in accordance with the post-analysis procedures listed above.

Appendix 5 — Accident Set Reviewed by the CFIT WG

WPR10FA107 Piper PA 32–300	CEN10MA367 Cessna 421B
CEN12FA522 Cessna T337G	ERA11LA424 Air Tractor AT–602
ERA11FA055 Mooney M20F	WPR14FA188 Mooney M20C
ERA13MA139 Beech 390	ERA09FA060 Piper PA–38–112
ERA11FA218 Cessna 310R	CEN11FA263 Piper PA–32R–300
WPR10FA305 Hawker Beechcraft A36	CEN11FA663 Thorp T–18
WPR12FA098 Cessna 210	WPR11FA391 Beech A36
WPR13FA073 Beech B100	ERA09FA381 Beech A36
ERA11FA467 Cessna 172M	ERA15FA326 Piper PA–44
CEN12FA517 Bellanca 7GCBC	ERA11FA070 Piper PA–46–350P
ERA09FA078 Rockwell International 690B	ERA11FA219 Beech 58
ERA09LA371 Layson Stanley B Steen Sky Bolt	WPR13FA095 Cessna 140
ERA12FA327 Mooney M20J	DEN08FA162 Pilatus PC–12/47E
CEN10FA230 Bellanca 17–30A	WPR12FA105 Cessna 172S
WPR13FA017 Cessna 182P	WPR09FA385 Cessna 182S
CEN15FA187 Aircraft MFG & DVLPMT CH601XL	ERA12FA483 Cessna 172P
WPR14LA007 Piper PA 32–300	ERA11FA480 Piper PA–28–181
NYC08FA138 Cirrus Design Corp SR22	WPR14FA124 Piper PA–31
ERA15FA204 Cessna 182	ERA11FA085 Diamond Aircraft Ind DA–40
SEA08FA108 Cirrus Design Corp SR22	CEN11LA307 Cessna 320
ANC09FA052 Harden RV–7	MIA08FA115 Cessna T206H
CEN11FA110 Beech B60	CEN12FA639 Mooney M20J
ERA14FA359 Piper PA–46–310P	ERA13FA064 Piper PA–28–180
CEN12FA311 Cessna T210L	ERA14FA044 Focke-Wulf FWP 149D
ERA14LA409 Cessna A188B	CEN09FA083 Cessna 206H
ERA09LA123 Piper PA–28–151	WPR09FA320 Piper PA–46–350P
ANC13FA030 Beech 1900C	WPR10FA116 Cessna 340
ERA09FA039 Partenavia Spa P.68C	WPR15FA212 Beech A35
EPR12FA255 Piper PA–32–300	ERA10FA088 Piper PA–30
WPR15FA166 Cessna 210F	WPR11FA319 Piper PA–22–135
ANC15MA041 Dehavilland DHC–3	WPR12FA136 Cessna 150L