FAA ROTORCRAFT SAFETY RATING CONCEPT FOR DESIGN AND EQUIPMENT

Abstract

The FAA has observed that the U.S. rotorcraft community has been unable to sustain a long term reduction in the fatal accident rate. The FAA considers rotorcraft design and equipment among the key factors that may contribute to changing this trend. The FAA proposes a government/industry partnership for a rotorcraft rating system concept. The intended outcomes are: 1) inform and educate the full spectrum of rotorcraft stakeholders of available design and equipment safety enhancements and increase their awareness of the benefits, 2) promote voluntary equipage to higher levels of safety, and 3) reduce U.S. rotorcraft fatal accidents/fatalities.

AIR-616, Strategic Policy Rotorcraft Section (FAA)
December 15, 2020
Contents

Introduction ................................................................. 2
Background ....................................................................... 2
Discussion of Occupant Protection Categories ......................... 3
Discussion of Accident Avoidance Categories ......................... 5
Discussion of How the Safety Rating Concept Could Be Used by Various Stakeholders .......... 9
Conclusion .................................................................... 11
Appendix A: Crash Resistant Seats and Structure Ratings Descriptions .................. 12
Appendix B: Crash Resistant Fuel System Ratings Descriptions ............................ 13
Appendix C: Bird Strike Protection/Mitigation Ratings Descriptions ....................... 14
Appendix D: Loss of Control Prevention/Recovery Systems Ratings Descriptions ........... 15
Appendix E: Low Altitude Operations Ground and Obstruction Awareness, Warning, and Avoidance Systems Ratings Descriptions ........................................... 16
Appendix F: In-flight Aircraft Collision Avoidance Systems Ratings Descriptions ......... 17
Appendix G: FAA Contributors ........................................... 18
Introduction

This white paper introduces a safety rating concept for rotorcraft design and equipment and is intended to encourage the following outcomes.

**INFORM & EDUCATE** the full spectrum of rotorcraft stakeholders of available design and equipment safety enhancements and increase their awareness of the benefits.

**PROMOTE** voluntary equipage to higher levels of safety.

**REDUCE** U.S. rotorcraft fatal accidents/fatalities.

Background

The FAA has observed that the U.S. rotorcraft community has been unable to sustain a long-term reduction in the fatal accident rate. Exploring solutions to this problem has been the focus of both government and industry safety teams, such as the U.S. Helicopter Safety Team (USHST). The FAA considers rotorcraft design and equipment among the key factors that can contribute to changing this trend. The FAA identified two general safety focus areas of design and equipment intended to improve safety.

**Occupant Protection**: Intended to increase the protection to occupants and thus reduce the likelihood of a fatal injury if an accident occurs.

**Accident Avoidance**: Intended to reduce the likelihood of an accident occurring in the first place.

The FAA formed a team of rotorcraft engineers, a safety data analyst, and flight test specialists to establish an initial framework for the following six safety rating categories under the two general safety focus areas:

**Occupant Protection**
1. Crash Resistant Seats and Structure (CRSS)
2. Crash Resistant Fuel System (CRFS)
3. Bird Strike Protection/Mitigation

**Note**: Bird Strike Protection/Mitigation addresses some aspects of both occupant protection and accident avoidance.

**Accident Avoidance**
1. Loss of Control Prevention/Recovery Systems
2. Low Altitude Operations: Ground and Obstruction Awareness, Warning, and Avoidance Systems
3. In-flight Aircraft Collision Avoidance Systems

The FAA envisions the number of design and equipment categories could expand beyond six. The industry’s participation and advocacy is critical to provide suggestions on how to improve the proposed six categories, expand the rotorcraft safety rating concept, and use the concept for effective safety promotion.
Discussion of Occupant Protection Categories

Occupant protection attributes for design and equipment have been defined through a number of sources, including requirements in Title 14 of the Code of Federal Regulations (14 CFR), Part 27 and Part 29. Other recommendations are included in the work of the Aviation Rulemaking Advisory Committee’s (ARAC’s) Rotorcraft Occupant Protection Working Group (ROPWG) and the Rotorcraft Bird Strike Working Group (RBSWG). Both the ROPWG and RBSWG were comprised of rotorcraft industry subject matter experts representing rotorcraft manufacturers, suppliers, operators, industry trade organizations, pilots, aircrew, academia, and helicopter crash survivor advocates. They also included an advisory member from the FAA. A summary of the recommendations from each working group has been presented by both government and industry at public rotorcraft safety forums. The full reports from the ROPWG and RBSWG are publicly available at: https://www.faa.gov/regulations_policies/rulemaking/committees/documents/index.cfm/search/searchResults.

1. **Crash Resistant Seats and Structure (CRSS)**
   Blunt force trauma was the cause of death in 92% of the 97 fatal U.S. rotorcraft accidents from 2008-2013 studied by the FAA’s former Rotorcraft Directorate and the Civil Aerospace Medical Institute (CAMI). CRSS increases survivability in the event of a crash by reducing blunt force trauma injuries. It increases the protection to occupants from excessive vertical and longitudinal impact loads, addresses the occupant’s secondary impact with the rotorcraft’s structure, addresses items of mass that may become loose on impact, and has seat designs that use energy management or dissipation and proper occupant restraint.

2. **Crash Resistant Fuel System (CRFS)**
   A post-crash fire occurred in 40% of the 97 fatal U.S. rotorcraft accidents from 2008-2013 studied by the FAA’s former Rotorcraft Directorate and CAMI. A CRFS increases safety in the event of a survivable crash by either decreasing the likelihood or delaying the onset of post-crash fires. A CRFS minimizes crash-induced fuel leaks and their contact with potential fuel ignition sources during and after a crash and increases the time occupants have to egress before a post-crash fire becomes critical.

3. **Bird Strike Protection/Mitigation**
   The FAA has observed a long-term upward trend in reported bird strikes to rotorcraft through the FAA’s wildlife strike database (https://wildlife.faa.gov/home). In the RBSWG’s 2017 report to the Aviation Rulemaking Advisory Committee (ARAC), they cited research that more than 90% of bird strikes occur below 3,500 feet AGL. They went on to note that the likelihood of a damaging bird strike increases below 2,500 feet AGL. Most rotorcraft spend the entirety of every flight below 2,500 feet AGL. Each rotorcraft bird strike event has the potential to cause injury to occupants or disrupt a critical system component. The RBSWG’s 2017 report to the ARAC also reported that approximately 85% of bird strikes occurred forward of the main rotor mast on the windshield, main rotor, nose, and fuselage, with the windshield alone accounting for 40% to 47% of cases. Reports of windshield strikes resulting in bird penetration into the cockpit are not uncommon. If the pilot is incapacitated due to bird penetration into the cockpit, or if damage to a critical system component is severe, loss of control of the rotorcraft is possible. The RBSWG report concluded that “the current [Part 29] regulation has been effective
in preventing fatalities and significant injuries including some events with larger than specified bird species (e.g., > 2.2 lb).” However, the regulation mentioned by the RBSWG is only mandatory for new designs of Part 29 (Transport Category) rotorcraft. Most rotorcraft are not covered by a comparable regulatory requirement. For these cases, varying levels of protection/mitigation are available as optional safety enhancements. This alternative would apply to any Part 27 rotorcraft or to the models of Part 29 rotorcraft that were not required to meet the Part 29 bird strike regulation.
Discussion of Accident Avoidance Categories

The U.S. Helicopter Safety Team (USHST) regularly completes in-depth, data driven analysis of fatal rotorcraft accidents. The USHST is comprised of both government and industry stakeholders. The vision of the USHST is a civil U.S. registered helicopter community with zero fatal accidents, and the FAA considers their analysis and recommendations a well vetted source for identifying the occurrence categories most likely to result in a fatal accident. The findings from the USHST’s work led to selection of two of the three accident avoidance categories. The third category selected was not based on the USHST’s work, but attempted to be predictive of future risk based on emerging trends within the vertical lift industry. This category considered the projected increase in the population of vehicles operating in the low altitude infrastructure and the need to ensure safety by keeping those various vehicles safely separated.

1. Loss of Control Prevention/Recovery Systems

Loss of control during flight was one of the three highest occurrence categories contributing to U.S. fatal rotorcraft accidents from 2009-2018, according to the USHST. About 20% of the approximately 200 fatal accidents the USHST analyzed were categorized as loss of control during flight. The percentage increased to 35% if the 15% of unintended flight into IMC (UIMC) fatal accidents are included. UIMC is a separate occurrence category. However, once UIMC occurs, the typical sequence in accidents is that loss of control occurs shortly thereafter, often leading to a fatal outcome. Stability systems that either prevent loss of control or initiate recovery when loss of control is deemed imminent may have a substantial impact in fatal accident reduction.

2. Low Altitude Operations: Ground and Obstruction Awareness, Warning, and Avoidance Systems

The unique capabilities of rotorcraft and the industries they support result in a high exposure to the low altitude operating environment. The operational environment is saturated with obstructions, whether naturally occurring or man-made. The most frequent obstruction struck by rotorcraft is power lines. In-flight contact with obstructions seriously degrades the rotorcraft’s performance and controllability. At low altitudes, there is little time to initiate emergency action in these situations before ground impact occurs. The USHST’s data showed that striking an object at low altitude was one of the three highest occurrence categories contributing to U.S. fatal rotorcraft accidents from 2009-2018. It was observed in approximately 15% of fatal events analyzed by the USHST. Controlled Flight into Terrain (CFIT) is a separate occurrence category from striking an object at low altitude. Although CFIT accounted for a much lower percentage of fatal accidents according to the USHST’s work (5% of fatal events), CFIT events also have the potential to be reduced by awareness, warning, and avoidance systems.

3. In-flight Aircraft Collision Avoidance Systems

In-flight aircraft collision avoidance systems address air proximity issues, to include loss of separation. Midair collisions have a low frequency of occurrence for rotorcraft. However, when they do occur, most result in a fatal event for one or both of the aircraft involved. Midair collision avoidance is an area of increasing importance with the projected increases in rotorcraft operations in urban environments. The higher volume of air traffic within a more densely confined space increases the opportunities for reduced separation between traffic.
Discussion of Safety Rating Concept’s Intent: Inform & Educate, Promote, and Reduce

INFORM & EDUCATE the FULL SPECTRUM of rotorcraft stakeholders of available design and equipment safety enhancements and increase their awareness of the benefits.

The full spectrum of rotorcraft stakeholders spans from the manufacturers staffed with rotorcraft certification experts on one extreme, to the first-time rotorcraft passenger who does not have any knowledge of rotorcraft certification regulations on the other extreme. For someone who is not well versed in rotorcraft certification and the multitude of associated regulations, the process of determining whether a particular category of design or equipment on one rotorcraft has a higher level of safety when compared to that same category on another rotorcraft may be a difficult task. Framed another way, we can consider owners/operators, pilots/aircrew, and passengers from the flying public as three types of consumers within the rotorcraft stakeholder population. The current situation does not make it easy for these consumers to be well informed. This can be rectified by establishing a simpler process for a consumer to compare designs and equipment within a particular safety category. A rating scale, such as the star system, offers this solution.

The star system is not a new concept for informing consumers of transportation safety. The U.S. government has supported the National Highway Transportation Safety Administration’s (NHTSA’s) highly regarded five-star safety ratings system for automobiles since 1993. NHTSA’s five-star safety rating system has been key to creating a consumer demand for automotive safety. By informing and educating the consumer on safety in coordination with promoting automotive designs and features that improve safety, the safety features on automobiles have increased at an unprecedented pace. Some aspects of the successful star system model are easily adapted to aviation.

The ROPWG observed the pervasive lack of understanding of safety enhancing technology and equipment among rotorcraft stakeholders. One aspect of this is the lack of understanding related to the different levels of safety in the FAA’s rotorcraft certification regulations tied to different amendment levels to those same regulations. The ROPWG suggested that a safety rating system was a method to better promote the benefit of safety enhancing features. In Task 6 of their report delivered to the ARAC in 2018, one of the ROPWG’s recommendations for near-term implementation by the FAA was, “The FAA and/or insurance industry should establish a standardized rating system for rotorcraft and rotorcraft components (e.g. Seat Systems, Fuel Systems) similar to that being used by NHTSA and IIHS for automobiles.”

PROMOTE VOLUNTARY equipage to HIGHER levels of safety.

The FAA’s initial concept is for the industry to consider a four star rating system that applies to each of the six previously described design and equipment categories of the rotorcraft. To be clear, there would not be an overall star rating assigned to a particular rotorcraft model. The star rating would only apply to each of the six individual categories that encompass features of the rotorcraft’s design or equipment. It is possible for two rotorcraft that are the same model to have different ratings in some of the six categories if there is different equipment installed on each rotorcraft as related to a particular rating category. The FAA envisions that the star
system would serve as a reference for any rotorcraft stakeholder who voluntarily chooses to research and understand the level of safety features associated with a rotorcraft of interest to them.

For each of the six design and equipment categories, the focus for each level of the star rating was the attributes of the system. The star ratings apply only to systems installed on the rotorcraft. They were not developed to assess carry-on equipment and its potential effects.

The following are the four proposed levels of the star rating and their corresponding meaning suggested in the FAA’s initial concept:

1-star: Safe
2-star: Improved Safety
3-star: Superior Safety
4-star: Highest Tier Safety

The attributes that define each level of the four star rating for each of the six categories are listed in Appendices A through F.

A rotorcraft design that receives a type certificate from the FAA is safe, because the design met the minimum level of safety required by regulation when it was originally certified. Over time, new regulations or amendments to existing regulations have resulted in increased levels of safety. The requirements of these later regulations must be incorporated into new designs for new type certified rotorcraft, but they are not required for previous type certificated rotorcraft. However, the older designs could also benefit from these increased levels of safety if retrofit options were made available.

The star rating concept provides an intuitive method to determine the level of safety enhancement that has been incorporated into the rotorcraft design. Safety enhancements for the three occupant protection categories were typically not required for all newly manufactured rotorcraft or for rotorcraft already in-service. As a result, older designs that did not incorporate the later safety enhancements are likely to receive a 1-star rating to represent meeting the minimum level of safety at the time of certification. If older designs incorporated some or all of the features of a safety enhancement, they would receive a higher star rating. A new design certified to the most recent regulatory standards would be more likely to have a 4-star rating in each of the six categories.

For the three occupant protection ratings categories, rotorcraft with designs or equipment that are above a 1-star rating have a reduced probability of fatalities or serious injuries when a survivable accident occurs. For the three accident avoidance ratings categories, rotorcraft with designs or equipment that are above a 1-star rating have a reduced probability of being involved in those particular types of accidents.

The FAA expects the concept of the rotorcraft star rating system to evolve, because levels of safety in designs and equipment will continue to improve. As innovation brings safety to levels that are beyond the existing rating system framework, the FAA envisions updates to the rating system to recognize the continued safety advancements in the industry.
REDUCE U.S. rotorcraft fatal accidents/fatalities.

Many in the U.S. rotorcraft community know the story of the 2015 Frisco, CO helicopter air ambulance crash where pilot Patrick Mahany lost his life and flight nurse Dave Repsher survived after experiencing burns over 90% of his body (NTSB Number: CEN15MA290). The rotorcraft in the accident met the minimum level of safety required based on the date of the design’s original certification. However, there is a significant likelihood that the fatality and serious injuries from the accident would have been avoided if certain features of the rotorcraft’s design and equipment were at a higher level of safety. As part of their ongoing and persistent advocacy to improve rotorcraft safety, Patrick’s wife Karen, Dave Repsher, and Dave’s wife Amanda spoke at the FAA’s 2020 International Rotorcraft Safety Conference. Amanda Repsher described her idea of a “three legged stool” model for helicopter safety that consisted of regulation, incentive, and consumer demand. The industry can effectively use the rotorcraft safety rating concept as a voluntary means to strengthen the incentive and consumer demand legs of the three legged stool that Amanda described. Through this strengthening, the industry can sustain reductions in U.S. rotorcraft fatal accidents/fatalities.

The safety rating concept would establish a level playing field by setting objective criteria that acknowledges that there are higher levels of safety enhancement available for each of the six aforementioned rotorcraft design and equipment categories. Rather than safety promotion being tied to potentially subjective marketing, it would be tied to a transparent rating system that could be readily understood and applied across the rotorcraft industry. The concept allows the opportunity for fully informed stakeholders at all levels, whether that be the manufacturer who has built rotorcraft for decades, or a passenger who is about to take his or her first helicopter flight. As observed in other industry sectors, when there is an informed consumer with an increased understanding of the value and benefit to safety, the consumer’s expectations for safety increase. The informed consumer who demands higher levels of safety in rotorcraft design and equipment incentivizes the industry as whole to pursue higher levels of safety in rotorcraft design and equipment. Increased safety, observed through decreased fatal accidents and fatalities, is good for the consumer and good for the industry as a whole.

Since use of the rotorcraft safety rating concept would be voluntary, individuals or organizations could choose to accept the current level of safety on their helicopter, regardless of whether the rating was low in each of the six categories. The important point is that the individual or organization is making an informed risk decision regarding the level of safety of their design and equipment. To reiterate, a rotorcraft with a 1-star rating across all six categories is considered safe, because it meets the minimum level of safety required by regulation when it was originally certified. The FAA expects there will be differences in the risk tolerances of different owners and operators and those tolerances may be based in part on the particular operation the rotorcraft will be used for in the industry. These differences in risk tolerances will lead to different decisions on the level of safety an organization or individual sees as necessary regarding the rotorcraft design and equipment.
Discussion of How the Safety Rating Concept Could Be Used by Various Stakeholders

The rotorcraft rating system concept is intended to assist stakeholders in making an informed risk-based decision. If a stakeholder is not familiar with some of the terms used to describe the ratings for the six categories of the safety rating concept, the FAA recommends the following as actions to help them to determine the rating of a particular rotorcraft.

For those considering owning or leasing a rotorcraft:
Refer to the safety ratings categories and ask the rotorcraft manufacturer what rating their product meets for each of the six categories. Rotorcraft manufacturers can also provide stakeholders with information on available FAA approved design modifications that will allow their product to meet higher ratings for the six categories.

For current owners and operators:
Refer to the safety ratings categories and ask the local Flight Standards District Office (FSDO) what rating the product that is owned or operated meets for each of the six categories. The FSDO may also connect the stakeholder to an Aircraft Certification Office (ACO) to assist in answering this question. Rotorcraft manufacturers can also provide the stakeholder information on available FAA approved design modifications that will allow their product to meet higher ratings for the six categories.

For pilots and aircrew:
Refer to the safety ratings categories and ask the operator what rating their rotorcraft meets for each of the six categories.

For passengers:
Refer to the safety ratings categories and ask the operator what rating their rotorcraft meets for each of the six categories.

For rotorcraft manufacturers and modifiers:
Refer to the safety rating categories and contact an Aircraft Certification Office (ACO) if you want to pursue FAA approval of design modifications that will allow your product to meet higher safety ratings for the three categories.

The stakeholders listed above could generally be grouped into two sets: suppliers or consumers. As the rotorcraft safety rating concept matures, both sets of stakeholders would benefit from a public, actively maintained list. Such a list could further simplify the ability to share information by showing the rating for each particular category of design and equipment on the each of the various rotorcraft products. There is past precedent that future development of a consolidated public list would be worthwhile. The previously released FAA lists of rotorcraft TCs and STCs that were published in association with Special Airworthiness Information Bulletins (SAIBs) SW-17-31 (addressing CRFS) and SAIB SW-19-15 (addressing CRSS) were well received by many stakeholders. They are mentioned in some of the FAA’s proposed descriptions associated with various star levels for some of the ratings categories. The issuance of the SAIBs resulted in an increase in manufacturers voluntarily developing retrofits for older rotorcraft designs that are in operation.
There would be challenges to maintaining a public list. One challenge would be designating an entity to constantly keep the list current to reflect the latest design and equipment developments and innovations. A second challenge, mentioned earlier in the white paper, is that the same model of rotorcraft may have a different rating for a particular category of design and equipment because different equipment may be installed on two rotorcraft that are the same model. However, the potential complexity of maintaining a public list should not be a deterrent from pursuing the overall rotorcraft rating concept. A public list is not necessary to begin implementing the concept, it is only a possible future step for industry to consider to further the goal of ensuring fully informed consumers across the full spectrum of rotorcraft stakeholders.
Conclusion

The U.S. rotorcraft industry has shown its durability over the years in facing tough challenges and surviving. The COVID-19 global pandemic of 2020 was the latest example. When aviation was largely shut down in March 2020, rotorcraft was among the first aviation industries to bounce back. By early June, levels of flight operations for many rotorcraft industry sectors met or exceeded pre-pandemic activity. In spite of the irrepressible tenacity of the industry, rotorcraft still have a perception problem with segments of the flying public who consider them unsafe. This perception is in part due to high profile fatal accidents and an inability to achieve sustained fatal accident reductions over time.

The safety rating concept for rotorcraft offers a great opportunity to leverage safety information, education, and promotion to change public perception by improving the U.S. rotorcraft fatal accident safety record through a voluntary, industry led measure. The U.S. rotorcraft industry has a window of time to take an active role in shaping and developing this potentially powerful tool. If the industry chooses to defer leading the effort and the struggles continue with sustaining fatal accident reduction in the U.S., the likelihood of directed measures from other entities increases, with less time and opportunity for industry to shape and develop the solution.

Consider for a moment that to a certain extent the safety rating concept for rotorcraft has already begun, and it was not led by either the FAA or by the U.S. rotorcraft industry. It was led by the U.S. Congress. The FAA’s Reauthorization Act of 2018 resulted in public law 49 USC 44737: Helicopter Fuel System Safety. The law mandated that newly manufactured rotorcraft operating in the U.S. must comply with a subset of existing crash resistant fuel system requirements by April 5, 2020 (18 months from enactment of the law). This action effectively established the first rating system for rotorcraft fuel systems: 1) systems with full compliance to the existing crashworthiness regulations, 2) systems that meet a subset of the crashworthiness regulations (Congressional mandate), and 3) everything else. The U.S. rotorcraft industry does not have to wait for Congressional action on other design and equipment categories that it knows are important to improving safety. Those areas can be communicated and promoted by the industry through choosing to voluntarily develop a safety rating concept for rotorcraft.

The FAA and the rotorcraft industry know and appreciate the value of rotorcraft in the U.S. In his remarks during an interview with Helicopter Association International’s President and CEO Jim Viola on December 10, 2020, FAA Administrator Steve Dickson stated, “Whether for police, EMS, utilities, corporate shuttles, or literally hundreds of other purposes—rotorcraft are essential. No other flying machine can do the same thing.” By the industry choosing to pursue a safety rating concept for rotorcraft as a means to sustain fatal accident rate reductions, the improved safety record of the rotorcraft will help convince the skeptics. They will come to appreciate the value of rotorcraft in the same way that the FAA and the rotorcraft industry does. Improvements in safety are good for everyone across the full spectrum of rotorcraft stakeholders, and increased public confidence in rotorcraft safety will help inspire continued growth within the industry.
## Crash Resistant Seats and Structure Ratings Descriptions

<table>
<thead>
<tr>
<th>Star Rating</th>
<th>Star Rating Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe ★</td>
<td>Rotorcraft that is type certificated in accordance with 14 CFR 21.21(b) or 21.29.</td>
</tr>
<tr>
<td>Improved Safety ★★★</td>
<td>Seat is equipped with a shoulder harness AND at least one of the following:</td>
</tr>
<tr>
<td></td>
<td>1. Inflatable shoulder harness</td>
</tr>
<tr>
<td></td>
<td>2. Inertia reels</td>
</tr>
<tr>
<td>Superior Safety ★★★★</td>
<td>Seat meets one of the following two options.</td>
</tr>
<tr>
<td></td>
<td>1. Stroking seat consistent with the reduced energy level recommended by the Rotorcraft Occupant Protection Working Group (ROPWG). As described in the ROPWG’s 2018 reports to the Aviation Rulemaking Advisory Committee (ARAC), the seat would successfully meet a dynamic seat test with a vertical velocity component of at least 21.7 feet/second. FAA certification credit was neither requested nor received.</td>
</tr>
<tr>
<td></td>
<td>2. Fully TSO-C127 compliant energy absorbing seat, although the seat does not comply with the installation requirements in the latest safety amendments to 14 CFR Part 27 or Part 29 (as applicable) for sections .561, .562, and .785. FAA certification credit was neither requested nor received.</td>
</tr>
<tr>
<td>Highest Tier Safety ★★★★★</td>
<td>Entire rotorcraft complies with all aspects of the latest FAA regulatory requirements for occupant protection to reduce spinal and blunt force trauma injuries.</td>
</tr>
<tr>
<td></td>
<td>For a normal category rotorcraft (Part 27) to meet the 4 star level, the certification basis would include Amendment 27-25 or later of 14 CFR Part 27 (sections 27.561, 27.562, and 27.785).</td>
</tr>
<tr>
<td></td>
<td>For a transport category rotorcraft (Part 29) to meet the 4 star level, the certification basis would include Amendment 29-29 or later of 14 CFR Part 29 (sections 29.561, 29.562, and 29.785).</td>
</tr>
<tr>
<td></td>
<td>Note: Designs meeting the 4 star rating are in Table 1 of the FAA’s list associated with the latest revision to SAIB SW-19-15.</td>
</tr>
</tbody>
</table>
## Appendix B: Crash Resistant Fuel System Ratings Descriptions

### Part 27 and Part 29 Rotorcraft Designs & Equipment

### Crash Resistant Fuel System (CRFS)

<table>
<thead>
<tr>
<th>Star Rating</th>
<th>Star Rating Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Safe ★</strong></td>
<td>Rotorcraft that is type certificated in accordance with 14 CFR 21.21(b) or 21.29.</td>
</tr>
<tr>
<td><strong>Improved Safety ★★</strong></td>
<td>Fuel tank installed that meets the drop test requirements described in 14 CFR Part 27/29.952(a), except the tank may be drop tested either in or out of rotorcraft structure. FAA certification credit was neither requested nor received.</td>
</tr>
</tbody>
</table>
| **Superior Safety ★★★** | Fuel system complies with the entire sub-set of regulations in the congressional mandate codified in 49 USC 44737, “Helicopter fuel system safety”. The requirements include a subset of paragraphs from 14 CFR Parts 27 or 29 (as applicable), sections .952, .963, and .975.  

**Note**: Designs meeting the 3 star rating are in Table 2 of the FAA’s list associated with the latest revision to SAIB SW-17-31. |
| **Highest Tier Safety ★★★★★** | Rotorcraft complies with all aspects of the latest FAA regulatory requirements to minimize the likelihood or delay the onset of a post-crash fire.  

**For a normal category rotorcraft (Part 27)** to meet the 4 star level, the Part 27 certification basis would include Amendment 27-30 or later for 14 CFR Part 27 (sections 27.952, 27.963, 27.967, 27.973, and 27.975).  

**For a transport category rotorcraft (Part 29)** to meet the 4 star level, the Part 29 certification basis would include Amendment 29-35 or later for 14 CFR Part 27 (sections 27.952, 27.963, 27.967, 27.973, and 27.975).  

**Note**: Designs meeting the 4 star rating are in Table 1 of the FAA’s list associated with the latest revision to SAIB SW-17-31. |
<table>
<thead>
<tr>
<th>Star Rating</th>
<th>Star Rating Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe ★</td>
<td>Rotorcraft that is type certificated in accordance with 14 CFR 21.21(b) or 21.29.</td>
</tr>
</tbody>
</table>
| Improved Safety ★★ | For a normal category rotorcraft (Part 27): Meets at least 1 of the following:  
1. Windshield material is bird strike resistant (e.g., polycarbonate)  
2. Bird strike deterrents installed (e.g., lights, audio, high visibility main rotor blades)  
3. Rotorcraft Flight Manual (RFM) limits the indicated airspeed to 80 knots  

For a transport category rotorcraft (Part 29): The rotorcraft’s windshield was tested and the manufacturer determined it met the requirements described in 14 CFR 29.631. FAA certification credit was neither requested nor received.  

Note: The transport category rating description was developed with reference to one of the Rotocraft Bird Strike Working Group’s (RBSWG’s) recommendations for the existing Part 29 fleet with a maximum occupancy of 10 to 15 (crew plus passengers). However, within the context of the rotorcraft rating system, it applies to all Part 29 rotorcraft regardless of maximum occupancy. |
| Superior Safety ★★★ | For a normal category rotorcraft (Part 27): The rotorcraft’s windshield was tested and the manufacturer determined it met the requirements described in 14 CFR 29.631. FAA certification credit was neither requested nor received.  

Note: The RBSWG proposed the existing Part 29.631 test requirements as a baseline for Part 27.  

For a transport category rotorcraft (Part 29): The rotorcraft’s windshield and “flight critical components” forward of the main rotor mast were tested and the manufacturer determined it met the requirements described in 14 CFR 29.631. The “flight critical components” forward of the main rotor mast may be determined on a case by case basis with the FAA. For both the windshield and “flight critical components” forward of the mast, FAA certification credit was neither requested nor received.  

Note: The transport category rating description was developed with reference to one of the original RBSWG recommendations for the existing Part 29 fleet with a maximum occupancy of 16 or more (crew plus passengers). Within the context of the rotorcraft rating system, it applies to all Part 29 rotorcraft regardless of maximum occupancy. |
| Highest Tier Safety ★★★★ | Entire rotorcraft complies with the bird strike requirements of 14 CFR 29.631.  
Effective as of August 8, 1996 per Amendment 29-40 of 14 CFR Part 29, all newly certified Part 29 rotorcraft must already comply with section 29.631. However, the 4 star description implies that all other Part 27 rotorcraft and all existing/newly manufactured Part 29 rotorcraft can also meet the same level of safety described in 14 CFR 29.631 and receive a 4 star rating. |
<table>
<thead>
<tr>
<th>Star Rating</th>
<th>Star Rating Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Safe</strong></td>
<td>Rotorcraft that is type certificated in accordance with 14 CFR 21.21(b) or 21.29.</td>
</tr>
<tr>
<td>Improved Safety</td>
<td>Rotorcraft is equipped with either of the following:</td>
</tr>
<tr>
<td></td>
<td>1. Stability Augmentation System (SAS)</td>
</tr>
<tr>
<td></td>
<td>2. Stability and Control Augmentation System (SCAS)</td>
</tr>
<tr>
<td>Superior Safety</td>
<td>Rotorcraft is equipped with a system that contains <strong>ALL</strong> of the following capabilities, as a <strong>minimum</strong>:</td>
</tr>
<tr>
<td></td>
<td>1. 2 axis autopilot (pitch and roll)</td>
</tr>
<tr>
<td></td>
<td>2. Attitude hold capability</td>
</tr>
<tr>
<td>Highest Tier Safety</td>
<td>Rotorcraft is equipped with a system that contains <strong>ALL</strong> of the following capabilities, as a <strong>minimum</strong>:</td>
</tr>
<tr>
<td></td>
<td>1. 3 axis autopilot (pitch, roll, and yaw)</td>
</tr>
<tr>
<td></td>
<td>2. Attitude and altitude hold capability</td>
</tr>
</tbody>
</table>
### Star Rating Descriptions

#### Part 27 and Part 29 Rotorcraft Designs & Equipment

<table>
<thead>
<tr>
<th>Star Rating</th>
<th>Star Rating Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe ★</td>
<td>Rotorcraft that is type certificated in accordance with 14 CFR 21.21(b) or 21.29.</td>
</tr>
<tr>
<td>Improved Safety ★★★</td>
<td>Rotorcraft is equipped with a system that contains <strong>ALL</strong> of the following capabilities, as a <strong>minimum</strong>:&lt;br&gt;1. Capability to &quot;look ahead&quot; of rotorcraft for ground and obstructions.&lt;br&gt;2. An aural alert to provide awareness and alerting of ground and/or obstruction.</td>
</tr>
<tr>
<td>Superior Safety ★★★★★</td>
<td>Rotorcraft is equipped with a system that contains <strong>ALL</strong> of the following capabilities, as a <strong>minimum</strong>:&lt;br&gt;1. Capability to &quot;look ahead&quot; of rotorcraft for ground and obstructions.&lt;br&gt;2. <strong>Both</strong> aural alert and a display of the hazard's location relative to the rotorcraft</td>
</tr>
<tr>
<td>Highest Tier Safety ★★★★★★</td>
<td>TSO-C194 (HTAWS) compliant system, installed in accordance with FAA Advisory Circular (AC) 27-1b or 29-2c, MG-18.</td>
</tr>
</tbody>
</table>
## Appendix F: In-flight Aircraft Collision Avoidance Systems Ratings Descriptions

<table>
<thead>
<tr>
<th>Star Rating</th>
<th>Star Rating Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe ★</td>
<td>Rotorcraft that is type certificated in accordance with 14 CFR 21.21(b) or 21.29.</td>
</tr>
</tbody>
</table>
| Improved Safety ★★ | Rotorcraft is equipped with a system that contains **ALL** of the following capabilities, as a **minimum**:

**Both** aural alert and **limited visual alert of potential aircraft collision threat** (e.g., Traffic Alert System [TAS] or Traffic Information System [TIS]).

**Note:** A general example of a limited visual alert is a textual description or arrow toward a particular quadrant. |
| Superior Safety ★★★ | Rotorcraft is equipped with a system that contains **ALL** of the following capabilities, as a **minimum**:

**Both** aural alert and a **display of the potential aircraft collision threat relative to the rotorcraft**. The display **must include** a “pop-up” alert depicted in a plan view (e.g., ADS-B In, TCAS I). |
| Highest Tier Safety ★★★★ | Rotorcraft is equipped with a system that contains **ALL** of the following capabilities, as a **minimum**:

**Both** aural alert and a **display of the potential aircraft collision threat relative to the rotorcraft with associated resolution advisories** (e.g., TCAS II). |
Appendix G: FAA Contributors

Managers:
Jorge Castillo, Strategic Policy Rotorcraft Section (AIR-616)
Michael Linegang, Operational Safety Branch (AIR-720)
Stephen Barbini, General Aviation and Rotorcraft Unit (AIR-721B)

Staff:
Martin Crane (Structures Engineer)
Clark Davenport (Human Factors/Flight Test)
Scott Franke (Structures Engineer)
Jon Jordan (Flight Test Pilot)
Lee Roskop (Operations Research Analyst)
George Schwab (Electrical/Avionics/System & Equipment Engineer)
Andy Shaw (Electrical/Avionics/System & Equipment Engineer)
Sandy Shelley (Structures Engineer)