time segments does not create an undue burden on competition, rather, it provides the Market Maker with clarity as to the manner in which the System counts quotes and orders and thereby provides NOM Market Makers with an increased ability to monitor transactions.

Rounding

The Exchange's amendment to add that if the Issue Percentage, rounded to the nearest integer, equals or exceeds the Specified Percentage, the System automatically removes a Market Maker's quotes and orders in all series of an underlying security does not create an undue burden on competition because this amendment also provides the Market Maker with clarity as to the manner in which the System will remove quotes and orders and thereby provides NOM Market Makers with an increased ability to monitor transactions and set risk limits.

Reset

The amendment to the rule text concerning resetting does not create an undue burden on competition. The Exchange proposes to amend the manner in which a Market Maker may re-enter the System after a removal of quotes and orders. This amendment provides information to NOM Market Makers as to the procedure to re-enter the System after a trigger. This information is intended to provide NOM Market Makers with access to the market.

C. Self-Regulatory Organization's Statement on Comments on the Proposed Rule Change Received From Members, Participants, or Others

No written comments were either solicited or received.

III. Date of Effectiveness of the Proposed Rule Change and Timing for Commission Action

Because the foregoing proposed rule change does not: (i) Significantly affect the protection of investors or the public interest; (ii) impose any significant burden on competition; and (iii) become operative for 30 days from the date on which it was filed, or such shorter time as the Commission may designate, it has become effective pursuant to Section 19(b)(3)(A)(iii) of the Act [28] and subparagraph (f)(6) of Rule 19b–4 thereunder.[29]

At any time within 60 days of the filing of the proposed rule change, the Commission summarily may temporarily suspend such rule change if it appears to the Commission that such action is: (i) Necessary or appropriate in the public interest; (ii) for the protection of investors; or (iii) otherwise in furtherance of the purposes of the Act. If the Commission takes such action, the Commission shall institute proceedings to determine whether the proposed rule should be approved or disapproved. The Exchange has provided the Commission written notice of its intent to file the proposed rule change, along with a brief description and text of the proposed rule change, at least five business days prior to the date of filing of the proposed rule change.

IV. Solicitation of Comments

Interested persons are invited to submit written data, views, and arguments concerning the foregoing, including whether the proposed rule change is consistent with the Act. Comments may be submitted by any of the following methods:

Electronic Comments

- Use the Commission's Internet comment form (*http://www.sec.gov/rules/sro.shtml);* or
- Send an email to *rule-comments@sec.gov. Please include File Number SR–NASDAQ–2015–122 on the subject line.*

Paper Comments

- Send paper comments in triplicate to Brent J. Fields, Secretary, Securities and Exchange Commission, 100 F Street NE., Washington, DC 20549–1090.

All submissions should refer to File Number *SR–NASDAQ–2015–122.* This file number should be included on the subject line if email is used. To help the Commission process and review your comments more efficiently, please use only one method. The Commission will post all comments on the Commission's Internet Web site (*http://www.sec.gov/rules/sro.shtml).* Copies of the submission, all subsequent amendments, all written statements with respect to the proposed rule change that are filed with the Commission, and all written communications relating to the proposed rule change between the Commission and any person, other than those that may be withheld from the public in accordance with the provisions of 5 U.S.C. 552, will be available for Web site viewing and printing in the Commission's Public Reference Room, 100 F Street NE., Washington, DC 20549, on official business days between the hours of 10:00 a.m. and 3:00 p.m. Copies of the filing also will be available for inspection and copying at the principal office of the Exchange. All comments received will be posted without change; the Commission does not edit personal identifying information from submissions. You should submit only information that you wish to make available publicly. All submissions should refer to File Number *SR–NASDAQ–2015–122* and should be submitted on or before November 27, 2015.

For the Commission, by the Division of Trading and Markets, pursuant to delegated authority.[30]

Jill M. Peterson,

Assistant Secretary.

[FR Doc. 2015–28143 Filed 11–4–15; 8:45 am]

BILLING CODE 8011–01–P

[28] 15 U.S.C. 78s(b)(3)(a)(iii).

[29] 17 CFR 240.19b–4(f)(6).

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Aviation Rulemaking Advisory Committee—New Task

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of a new task assignment for the Aviation Rulemaking Advisory Committee.

SUMMARY: The FAA assigned the Aviation Rulemaking Advisory Committee (ARAC) a new task to provide recommendations regarding occupant protection rulemaking in normal and transport category rotorcraft for older certification basis type designs that are still in production. The FAA amended regulations to incorporate occupant protection rules, including those for emergency landing conditions and fuel system crash resistance, for new type designs in the 1980s and 1990s. These rule changes do not apply to newly manufactured rotorcraft with older type designs or to derivative type designs that keep the certification basis of the original type design. This approach has resulted in a very low incorporation rate of occupant protection features into the rotorcraft fleet, and fatal accidents remain unacceptably high. At the end of 2014, only 16% of U.S. fleet had complied with the crash resistant fuel system requirements effective 20 years earlier, and only 10% had complied with the emergency landing requirements effective 25 years earlier. A recent fatal accident study has shown these measures would have been effective in saving lives.

This notice informs the public of the new ARAC activity and solicits

[30] 17 CFR 200.30–3(a)(12).

membership for the new Rotorcraft Occupant Protection Working Group.

FOR FURTHER INFORMATION CONTACT: Martin R. Crane, Federal Aviation Administration, 10101 Hillwood Parkway, Fort Worth, Texas 76177, *Martin.R.Crane@faa.gov,* phone number 817–222–5110, facsimile number 817–222–5961.

SUPPLEMENTARY INFORMATION:

ARAC Acceptance of Task

As a result of the September 17, 2015, ARAC meeting, the FAA assigned and ARAC accepted this task establishing the Rotorcraft Occupant Protection Working Group. The Rotorcraft Occupant Protection Working Group will serve as staff to the ARAC and provide advice and recommendations on the assigned task. The ARAC will review and accept the recommendation report and will submit it to the FAA.

Background

The FAA established the ARAC to provide information, advice, and recommendations on aviation-related issues that could result in rulemaking to the FAA Administrator, through the Associate Administrator of Aviation Safety.

The Rotorcraft Occupant Protection Working Group will provide advice and recommendations to the ARAC on occupant protection rulemaking, including both initial certification and continued airworthiness. The basic concept of occupant protection is to give all occupants the greatest possible chance to egress an aircraft without serious injury after a survivable emergency landing or accident. While the number of U.S. helicopter accidents and the corresponding accident rate over the past 10 years have steadily decreased, during that same time period data associated with fatal helicopter accidents and fatalities remains virtually unchanged. A number of regulations were promulgated in the 1980s and 1990s to address and greatly improve occupant protection in a survivable emergency landing or accident. These occupant protection improvements involve seat systems that reduce the likelihood of fatal injuries to the occupant in a crash (14 CFR 27.562, 27.785, 29.562, and 29.785); structural requirements that maintain a survivable volume and restrain large items of mass above and behind the occupant (14 CFR 27.561 and 29.561); and fuel systems that reduce the likelihood of an immediate post-crash fire (14 CFR 27.952 and 29.952). If the occupant protection improvement rules are not incorporated in new production helicopters, there will be no meaningful reduction in the number of fatalities in helicopter accidents.

Following a series of accidents involving post-crash fires, the Australian Civil Aviation Safety Authority asked the FAA for assistance in determining the airworthiness of certain helicopters. This request resulted in a collaborative post-crash fire/blunt force trauma study performed by the FAA's Rotorcraft Directorate and Civil Aerospace Medical Institute (CAMI). The data consisted of 97 fatal accidents involving U.S. registered, type-certificated helicopters in a five-year timeframe from 2008 to 2013. Part 27 rotorcraft comprised the largest mass of data (87 of 97 fatal accidents, 90% of the total) in the study. The post-crash fire portion of the study found that post-crash fires occurred in 30 of 76 (39%) of fatal accidents involving part 27 helicopters without fuel systems that meet the full crash resistance requirements of 14 CFR 27.952. The post-crash fire contributed to a fatality in 20% of these fatal accidents. While the data set for part 29 rotorcraft was much smaller (10 of 97 fatal accidents, 10% of the total), the results were comparable. Through the course of the study, the Rotorcraft Directorate further discovered that there were only about 16% of U.S. registered, type-certificated rotorcraft that fully complied with the fuel system crash resistance provisions in §§ 27.952 and 29.952, despite those rules having been in effect for 20 years at the time of the study.

In the time since increased rotorcraft occupant protection standards became effective as federal regulations, research efforts have studied injury patterns in fatal rotorcraft accidents. In April 2003, *Aviation, Space, and Environmental Medicine* published Narinder Taneja and Douglas A. Wiegmann's ''Analysis of Injuries Among Pilots Killed in Fatal Helicopter Accidents.'' Using autopsy data from 1993 to 1999, Taneja and Wiegmann analyzed the pattern of specific bony injuries (ribs, skull, and pelvis) and organ/visceral injuries (brain, lung, and heart) documented in 74 fatal rotorcraft accidents. They found blunt trauma as the cause of death in 88% of the cases, with the highest percentages of injuries to the head and core body regions. Among the implications cited in their study was, ''Protection of the occupants exposed to a crash is a realistic objective that can be achieved if crashworthiness becomes a primary element of initial helicopter design and future upgrade programs.''

The second component of the Rotorcraft Directorate/CAMI study involved blunt force trauma. Blunt force trauma accounted for cause of death in 92% of the 2008–2013 fatal accident data. In addition, blunt force trauma also was the cause of death in 80% of the part 27 fatal rotorcraft accidents where a post-crash fire occurred. The Rotorcraft Directorate and CAMI built their study using the framework and methodology previously established by Taneja and Wiegmann's 2003 study. Further, they used the percentages of bony injuries and organ/visceral injuries documented in Taneja and Wiegmann's study as a baseline for comparison. The intent was to see if a statistically significant change occurred in blunt force trauma injury patterns in fatal rotorcraft accidents in the 10 years since the previous study. They concluded there was no statistically significant difference across most categories of bony injuries and across all categories of organ/visceral injuries. The Rotorcraft Directorate further discovered that only 10% of U.S. registered, type-certificated rotorcraft complied with increased occupant protection measures related to blunt force trauma mandated in the §§ 27.562 and 29.562 rules, despite the rules being in effect for 25 years at the time of the study. The provisions of §§ 27.562 and 29.562 were specifically designed for increased protection of the head and core body regions, the same regions documented with the highest levels of injury in the fatal accident studies conducted by Taneja and Wiegmann and the Rotorcraft Directorate/CAMI.

Additional research found that about 9,000 occupants had been involved in U.S. helicopter accidents in the 25 years since §§ 27.562 and 29.562 became effective. Only 2% of helicopters in those accidents were compliant with §§ 27.562 and 29.562. Over 1,300 occupants were killed in accidents involving the 98% of helicopters that were not compliant with §§ 27.562 and 29.562.

The Task

The Rotorcraft Occupant Protection Working Group is tasked to:

1. Perform a cost-benefit analysis for incorporating the existing occupant protection standards 14 CFR 27.561, 27.562, 27.785, 27.952, 29.561, 29.562, 29.785, and 29.952 via §§ 27.2 and 29.2 for newly manufactured rotorcraft that addresses the following:

a. Estimate what the regulated parties would do differently as a result of the proposed regulation and how much it would cost.

b. Estimate the improvement in survivability of future accidents.

c. Estimate any other benefits (*e.g.,* reduced administrative burden) or costs

that would result from implementation of the occupant protection standards identified above.

2. Develop a cost-benefit analysis report containing the information explained in task 1 above.

3. After the FAA accepts and considers the cost benefit analysis report, the FAA will task the Rotorcraft Occupant Protection Working Group either to make specific written recommendations on how all or part of the existing occupant protection standards 14 CFR 27.561, 27.562, 27.785, 27.952, 29.561, 29.562, 29.785, and 29.952 should be made effective via §§ 27.2 and 29.2 for newly manufactured rotorcraft, or to propose new alternative performance-based occupant protection safety regulations for newly manufactured rotorcraft that will be effective via §§ 27.2 and 29.2.

4. If new alternative performance-based occupant protection safety regulations effective via §§ 27.2 and 29.2 are proposed, perform a cost-benefit analysis that addresses the following:

a. Estimate what the regulated parties would do differently as a result of the proposed regulation and how much it would cost.

b. Estimate the improvement in survivability of future accidents from the proposed recommendations.

c. Estimate any other benefits (*e.g.,* reduced administrative burden) or costs that would result from implementation of the recommendations.

5. Develop an initial report containing recommendations on the findings and results of the tasks explained above.

a. The initial recommendation report should document both majority and dissenting positions on the findings and the rationale for each position.

b. Any disagreements should be documented, including the rationale for each position and the reasons for the disagreement.

6. Complete the following after the FAA accepts the initial recommendation report identified in task 5:

a. Specifically advise and make written recommendations on incorporating rotorcraft occupant protection improvements and standards into the existing rotorcraft fleet. Occupant protection standards include either all or part of 14 CFR 27.561, 27.562, 27.785, 27.952, 29.561, 29.562, 29.785, and 29.952, or new alternative proposed performance-based regulations.

b. Develop an addendum report containing recommendations on the findings and results of the tasks explained above.

c. Document both majority and dissenting positions on the findings and the rationale for each position.

d. Any disagreements should be documented, including the rationale for each position and the reasons for the disagreement.

7. The working group may be reinstated to assist the ARAC in responding to the FAA's questions or concerns after the recommendation report has been submitted.

Schedule

This tasking notice requires three reports.

- The task 2 cost-benefit analysis report must be submitted to the FAA for review and acceptance no later than 6 months after publication of this notice in the **Federal Register**.
- The task 5 initial recommendation report must be submitted to the FAA for review and acceptance no later than 12 months after initiation of task 3 above.
- The task 6 addendum recommendation report must be submitted to the FAA for review and acceptance no later than 6 months after the initial recommendation report is submitted.

Working Group Activity

The Rotorcraft Occupant Protection Working Group must comply with the procedures adopted by the ARAC as follows:

1. Conduct a review and analysis of the assigned tasks and any other related materials or documents.

2. Draft and submit a work plan for completion of the task, including the rationale supporting such a plan, for consideration by the ARAC.

3. Provide a status report at each ARAC meeting.

4. Draft and submit the recommendation reports based on review and analysis of the assigned tasks.

5. Present the cost-benefit analysis report in task 2 at the ARAC meeting.

6. Present the initial recommendation report at the ARAC meeting.

7. Present the findings from the addendum recommendation report at the ARAC meeting.

Participation in the Working Group

The Rotorcraft Occupant Protection Working Group will be comprised of technical experts having an interest in the assigned task. A working group member need not be a member representative of the ARAC. The FAA would like a wide range of members (normal category rotorcraft manufacturers, transport category rotorcraft manufacturers, and rotorcraft operators from various segments of the industry such as oil and gas exploration, emergency medical services, and air tour operators) to ensure all aspects of the tasks are considered in development of the recommendations. The provisions of the August 13, 2014, Office of Management and Budget guidance, ''Revised Guidance on Appointment of Lobbyists to Federal Advisory Committees, Boards, and Commissions'' (79 FR 47482), continues the ban on registered lobbyists participating on Agency Boards and Commissions if participating in their ''individual capacity.'' The revised guidance now allows registered lobbyists to participate on Agency Boards and Commissions in a ''representative capacity'' for the ''express purpose of providing a committee with the views of a nongovernmental entity, a recognizable group of persons or nongovernmental entities (an industry, sector, labor unions, or environmental groups, etc.) or state or local government.'' (For further information see Lobbying Disclosure Act of 1995 as amended, 2 U.S.C 1603, 1604, and 1605.)

If you wish to become a member of the Rotorcraft Occupant Protection Working Group, write the person listed under the caption **FOR FURTHER INFORMATION CONTACT** expressing that desire. Describe your interest in the task and state the expertise you would bring to the working group. The FAA must receive all requests by December 7, 2015. The ARAC and the FAA will review the requests and advise you whether or not your request is approved.

If you are chosen for membership on the working group, you must actively participate in the working group, attend all meetings, and provide written comments when requested. You must devote the resources necessary to support the working group in meeting any assigned deadlines. You must keep your management and those you may represent advised of working group activities and decisions to ensure the proposed technical solutions do not conflict with the position of those you represent. Once the working group has begun deliberations, members will not be added or substituted without the approval of the ARAC Chair, the FAA, including the Designated Federal Officer, and the Working Group Chair.

The Secretary of Transportation determined the formation and use of the ARAC is necessary and in the public interest in connection with the performance of duties imposed on the FAA by law.

The ARAC meetings are open to the public. However, meetings of the

Rotorcraft Occupant Protection Working Group are not open to the public, except to the extent individuals with an interest and expertise are selected to participate. The FAA will make no public announcement of working group meetings.

Issued in Washington, DC, on October 30, 2015.

Lirio Liu,

Designated Federal Officer, Aviation Rulemaking Advisory Committee.

[FR Doc. 2015–28151 Filed 11–4–15; 8:45 am]

BILLING CODE 4910–13–P

DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

[Docket No. NHTSA–2015–0053; Notice 2]

BMW of North America, Inc., Grant of Petition for Decision of Inconsequential Noncompliance

AGENCY: National Highway Traffic Safety Administration (NHTSA), Department of Transportation (DOT).

ACTION: Grant of Petition.

SUMMARY: BMW of North America, Inc. (BMW) has determined that certain model year (MY) 2015 MINI Cooper, Cooper S hardtop 2 door, and Cooper S hardtop 4 door passenger cars do not fully comply with paragraph S4.2.3(a) of Federal Motor Vehicle Safety Standard (FMVSS) No. 226, *Ejection Mitigation.* BMW has filed an appropriate report dated May 20, 2015, pursuant to 49 CFR part 573, *Defect and Noncompliance Responsibility and Reports.*

ADDRESSES: For further information on this decision contact Karen Nuschler, Office of Vehicle Safety Compliance, the National Highway Traffic Safety Administration (NHTSA), telephone (202) 366–5829, facsimile (202) 366–3081.

SUPPLEMENTARY INFORMATION:

I. Overview: Pursuant to 49 U.S.C. 30118(d) and 30120(h) (see implementing rule at 49 CFR part 556), BMW submitted a petition for an exemption from the notification and remedy requirements of 49 U.S.C. Chapter 301 on the basis that this noncompliance is inconsequential to motor vehicle safety.

Notice of receipt of the petition was published, with a 30-day public comment period, on September 1, 2015 in the **Federal Register** (80 FR 52845). No comments were received. To view the petition, and all supporting documents log onto the Federal Docket Management System (FDMS) Web site at: *http://www.regulations.gov/.* Then follow the online search instructions to locate docket number ''NHTSA–2015–0053.''

II. Vehicles Involved: Affected are approximately 4,208 MY 2015 MINI Cooper, Cooper S hardtop 2 door, and Cooper S hardtop 4 door passenger cars manufactured from February 25, 2015 to April 24, 2015.

III. Noncompliance: BMW explains that written information describing the ejection mitigation countermeasure installed in the vehicles was not provided to the vehicle consumers as required by paragraph S4.2.3(a) of FMVSS No. 226.

IV. Rule Text: Paragraph S4.2.3 of FMVSS No. 226 requires in pertinent part:

S4.2.3 *Written information.*

(a) Vehicles with an ejection mitigation countermeasure that deploys in the event of a rollover must be described as such in the vehicle's owner manual or in other written information provided by the vehicle manufacturer to the consumer. . . .

V. Summary of BMW's Arguments: BMW stated its belief that the subject noncompliance in the affected vehicles is inconsequential to motor vehicle safety. A summary of its reasoning is provided as follows. Detailed explanations of its reasoning are included in its petition:

1. The vehicles are equipped with a countermeasure that meets the performance requirements of FMVSS No. 226.

2. The owner's manuals contain a description of the ejection mitigation countermeasure in the context of side impact.

3. The owner's manuals contain precautions related to the [ejection mitigation] system even though not required by FMVSS No. 226.

4. The [ejection mitigation] system uses the FMVSS No. 208 required readiness indicator, as allowed by FMVSS No. 226.

5. BMW has not received any customer complaints due to this issue.

6. BMW is not aware of any accidents or injuries due to this issue.

7. NHTSA may have granted similar manufacturer petitions re owner's manuals.

8. BMW has corrected the noncompliance so that all future production vehicles will comply with FMVSS No. 226.

In summation, BMW believes that the described noncompliance of the subject vehicles is inconsequential to motor vehicle safety, and that its petition, to exempt BMW from providing recall notification of noncompliance as required by 49 U.S.C. 30118 and remedying the recall noncompliance as required by 49 U.S.C. 30120 should be granted.

NHTSA's Decision

NHTSA's Analysis: NHTSA believes that while written information was not provided to vehicle owners describing the installed head air bags (side curtain) as vehicle occupant ejection mitigation countermeasures that deploy in the event of a rollover, the owner's manuals for the affected vehicles otherwise effectively describe, and illustrate the location of, the head air bags. NHTSA also believes that the status of the head air bags is monitored by the vehicle's air bag readiness indicator intended to show operational readiness of the entire airbag system. Therefore, drivers should be alerted to a malfunction of the head air bags that are intended to provide ejection countermeasures in the event of a rollover event, and occupant protection in the event of a significant side impact event.

BMW has also reported that they have not received any complaints from vehicle owners regarding the subject noncompliance and that vehicle production was corrected so that the noncompliance did not occur in subsequent vehicles. *NHTSA's Decision:* In consideration of the foregoing, NHTSA has decided that BMW has met its burden of persuasion that the subject FMVSS No. 226 noncompliance in the affected vehicles is inconsequential to motor vehicle safety. Accordingly, BMW's petition is hereby granted and BMW is exempted from the obligation of providing notification of, and a remedy for, that noncompliance under 49 U.S.C. 30118 and 30120.

NHTSA notes that the statutory provisions (49 U.S.C. 30118(d) and 30120(h)) that permit manufacturers to file petitions for a determination of inconsequentiality allow NHTSA to exempt manufacturers only from the duties found in sections 30118 and 30120, respectively, to notify owners, purchasers, and dealers of a defect or noncompliance and to remedy the defect or noncompliance. Therefore, this decision only applies to the subject vehicles that BMW no longer controlled at the time it determined that the noncompliance existed. However, the Granting of this petition does not relieve vehicle distributors and dealers of the prohibitions on the sale, offer for sale, or introduction or delivery for introduction into interstate commerce of the noncompliant vehicles under their control after BMW notified them that the subject noncompliance existed.

ROTORCRAFT OCCUPANT PROTECTION WORKING GROUP

TASKS 3 AND 4

CRASH RESISTANT FUEL SYSTEMS (CRFS) INTERIM ANALYSIS REPORT TO THE AVIATION RULEMAKING ADVISORY COMMITTEE (ARAC)

Submitted: May 11, 2017

EXECUTIVE SUMMARY

BACKGROUND

This report contains ROPWG preliminary recommendations for incorporating CRFS regulations into newly manufactured legacy rotorcraft. These are interim proposals, and some details may be modified or clarified in the final report due January 25, 2018.

METHODOLOGY

For the purposes of this report, the effectiveness of "partially-compliant" CRFS in crashes was first analyzed. "Partially-compliant" refers to currently produced, legacy helicopters that include some CRFS features in their fuel system designs while not fully complying with the requirements of Part 27/29.952. The effectiveness of these systems was then compared to that of the fully-compliant fuel systems analyzed in the Task 2 report, and legacy, non-CRFS fuel systems.

The crash data for the current study was extracted from the National Transportation Safety Board (NTSB) Microsoft Access Accident Database, current through December 2016. The initial filter criteria were as follows:

- Registration Number = All U.S. registered only
- Aircraft Category = Helicopters only, not experimental or restricted
- Event Type = Accidents only, not incidents
- Date of Accident = Between 1/1/1996 and 12/31/2016 (most recent 20-year data available)
- Homebuilt = *N* or is null (excludes homebuilt helicopters that were not type certificated and catches cases where NTSB inadvertently left the field unpopulated)

The database was then manually filtered to include only those helicopters equipped with what was considered partially-compliant CRFS at the time of the accident. The result was a database containing 274 accidents involving partially-compliant CRFS helicopters, consisting of a cumulative six models of helicopters from three different manufacturers.

Additionally, a similar but independent analysis was performed for helicopters that had standard fuel systems without significant CRFS features and were, therefore, considered non-compliant with respect to 27.952. This second database of non-CRFS compliant helicopters contained 558 accidents.

Note that all partially-compliant helicopters in this study were certificated to 14 CFR Part 27. While there were partially-compliant Part 29 aircraft in the NTSB Database, the number of crashes was too small to be statistically significant, and therefore these crashes were not included in this analysis.

RESULTS

Each of the partially-compliant and non-compliant accidents described above was individually reviewed to determine the following:

- Whether or not there was a post-crash fire (PCF), and if so, the cause of the fire
- The severity (survivability) of the accident
- The number of occupants that sustained thermal injuries after surviving the accident impact

The results of this analysis are summarized in the table below along with data on fully-compliant helicopters extracted from the Task 2 report. This permits a direct comparison of the effectiveness of fully-compliant, partially-compliant, and non-compliant CRFS in preventing post-crash fires and thermal injuries in survivable accidents.

Table 1. Comparison of Post-Crash Fire and Thermal Injury Rates for Fully-Compliant, Partially-compliant, and Non-Compliant CRFS Models

CRFS System	Post-Crash Fire Rate		Occupants That Received Thermal Injuries After Surviving Impact (all accidents)
	Accidents filtered by: • Post-crash fire of any source • Any accident severity	Accidents filtered by: • Post-crash fire due to fuel spillage • "Survivable" accidents only	
Fully-Compliant	13%	0%	0%
Partially-compliant	7%	0%-1%	0%
Non-Compliant	15%	11%	To Be Determined*

*Note: The ROPWG did not have adequate time to research this value before submitting this interim report. The ROPWG may attempt to determine this value for the final report if it is believed to be of sufficient value.

DISCUSSION AND CONCLUSIONS

Based upon the data presented in this report and summarized in Table 1, we conclude the following:

1. Compared to the fully-compliant CRFS models, the partially-compliant CRFS models are equally effective at preventing post-crash fires and thermal injuries in the current crash environment.
2. Compared to non-compliant CRFS helicopters, the partially-compliant CRFS helicopters reduced the post-crash fire rate by 90%-100% for fires due to fuel spillage in survivable accidents.
3. An analysis of the various makes and models of partially-compliant helicopters showed that, among designs that passed a 50-foot drop test (with or without structure) and had a puncture resistance of at least 250 lb, there were no trends of one model helicopter being more or less effective in preventing fuel-fed, post-crash fires and thermal injuries than another.
4. The absence of a roll-over vent valve on one of the partially-compliant fuel systems may have contributed to fuel spillage and subsequent post-crash fires after survivable accidents. However,

the resulting fires were small and slow-spreading and did not cause any thermal injuries nor hinder the egress of occupants.

RECOMMENDATIONS

The ROPWG recommendations for CRFS regulatory compliance with 27.952 for newly manufactured legacy aircraft are summarized below in Table 2, and discussed in detail in the Recommendations section in the body of this report. Since the CRFS features/components of the partially-compliant CRFS helicopters included in the study have been proven to be effective, ROPWG recommendations for newly manufactured, legacy helicopters are based upon an amalgamation of these CRFS systems.

Table 2. 27.952 Regulatory Recommendations for Newly Manufactured Legacy Helicopters		
Regulation	**Recommendation**	**Notes**
27.952(a)(1)(2)(3)(5)(6): Drop test requirements	Recommended	Regulation should also allow bladder-only drop test (i.e., no surrounding structure required).
27.952(a)(4) Drop test requirements	NOT recommended	
27.952(b): Fuel tank load factors	NOT recommended	N/A
27.952(c): Flexible fuel hoses and breakaway fittings	To be determined	Specific ROPWG guidance to be determined at a future meeting.
27.952(d): Frangible or deformable structural attachments	NOT recommended	27.952(f) and the associated AC guidance address these same items, but have a regulatory standard that is more appropriate for incorporation into a previously-approved legacy aircraft
27.952(e): Separation of fuel and ignition sources	NOT recommended	
27.952(f): Other basic mechanical design criteria	Recommended	The AC guidance for new production legacy rotorcraft should be drafted to additionally include elements of 27.963(g) (fuel tank puncture resistance) and 27.975(b) (rollover vent valves). Acceptable methods of compliance should ensure the legacy helicopters found to provide effective post-crash fire protection will be considered compliant.
27.952(g): Rigid or semi-rigid fuel tanks	To be determined	Specific ROPWG guidance to be determined at a future meeting.
Requirement for full compliance 10 years after approval of new CRFS rules	NOT recommended	Data for partially-compliant helicopters show that the recommendations in this report would be equally effective at preventing post-crash fires and thermal injuries, but with a substantially lower weight penalty and monetary cost.

DISCLAIMER

The FAA has the authority to protect deliberative, pre-decisional materials, such as advisory opinions, and recommendations presented by FAA staff while reaching a final determination or position on any particular matter under FAA consideration. The meetings of this Working Group are closed, and the information shared amongst the group during the deliberative and drafting stages may be of a proprietary nature to the participants. It is therefore the understanding and practice of the Working Group that such information and documents, to the extent they exist, are to be kept confidential within the Working Group and are only for use in achieving the task assigned to the Working Group by the FAA. To allow release of these documents would discourage the open and frank discussions between the Working Group members and agency employees, impede the governmental purpose of the Working Group, and potentially violate their proprietary nature.

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INTRODUCTION

The Federal Aviation Administration (FAA) amended regulations 14 CFR 27/29.561, .562, .785, and .952, to incorporate occupant protection rules, including those for emergency landing conditions and fuel system crash resistance, for new type designs in the 1980s and 1990s. These rule changes do not apply to newly manufactured rotorcraft with older type designs or to derivative type designs that keep the certification basis of the original type design. This approach has resulted in a low incorporation rate of occupant protection features into the rotorcraft fleet. At the end of 2014, 16% of the U.S. fleet had complied with the crash resistant fuel system requirements effective 20 years earlier, and 10% had complied with the emergency landing requirements effective 25 years earlier.[1] A recent FAA fatal accident study has shown that these measures would have been effective in saving lives if they had been incorporated into all newly manufactured helicopters.[2]

On November 5, 2015, the FAA tasked the Aviation Rulemaking Advisory Committee (ARAC) to provide recommendations regarding occupant protection rulemaking in normal and transport category rotorcraft for older-certification basis type designs that are still in production (legacy rotorcraft). The Rotorcraft Occupant Protection Working Group (ROPWG) was formed to study various issues related to bringing all newly-manufactured rotorcraft into compliance with current FAA occupant protection regulations, specifically 14 CFR Parts 27/29.561, .562, .785, and .952, and to provide recommendations on these issues to the ARAC.[3]

The ROPWG was given a number of sequential tasks to accomplish in meeting their obligations. Our first tasking (Tasks 1 and 2) was to provide a cost-benefit analysis of implementing current occupant protection regulations into all newly-manufactured rotorcraft. This report was submitted to ARAC in November 2016, unanimously accepted by ARAC in December 2016, and forwarded to the FAA. On January 25, 2017, FAA tasked ROPWG with the following:

> "...make recommendations on which Paragraphs of each Section for the existing occupant protection standards cited in the referenced FR Notice can be made effective for newly manufactured rotorcraft within 3 years after the effective date of a change to §§ 27.2 and 29.2. Additionally, the FAA tasks the ROPWG to make recommendations for full compliance to these occupant protection standards within 10 years (7 additional years) after the effective date of a change to §§ 27.2 and 29.2"

On January 27, 2017, ROPWG was additionally tasked with providing:

> "...an interim report to the ARAC containing initial recommendations on the findings and results related to 14CFR27/29.952 crash resistant fuel system standards by May 15, 2017. This report would be supportive of the FAA's response to the Congressional Requirements Section 2105 of the FAA Extension, Safety, and Security Act of 2016. The FAA is requesting interim proposals with

[1] Federal Register. FAA. Aviation Rulemaking Advisory Committee—New Task. Vol.80 (214), November 5, 2015, Notices.

[2] Roskop, L. Post-crash fires and blunt force fatal injuries in U.S. registered type certificated rotorcraft. Presented April 2015.

[3] Federal Register, op. cit., 2015.

respect to crash resistant fuel systems, and understands that a complete recommendation report is expected 12 months after initiation of Task 3, which would be January 25, 2018."

The current report is in response to the ARAC/FAA request to provide initial ROPWG recommendations on which of the CRFS standards (14CFR 27/29.952) should be adopted for newly manufactured, legacy rotorcraft over the near-term and long-term. These are interim proposals, and some details may be modified or clarified in the final report due January 25, 2018.

METHODS

DEVELOPMENT OF DATASET

National Transportation Safety Board (NTSB) accident data from crashes involving helicopters with fully-compliant Crash Resistant Fuel Systems (CRFS) were analyzed in the previous ROPWG Task 2 Report, and these CRFS were found to be highly effective in preventing post-crash, fuel-fed fires for most crashes. The next step in our analysis was to analyze the effectiveness of "partially-compliant" CRFS in crashes, and then compare their effectiveness to that of the fully-compliant fuel systems. These crashes were also compared to a subset of accidents of legacy helicopters with standard, non-CRFS fuel systems.

Three rotorcraft manufacturers were found to cumulatively manufacture six models of helicopters with "partially-compliant" fuel systems that have been involved in crashes recorded in the NTSB database. "Partially-compliant" refers to the inclusion of some CRFS features in their fuel system design while not fully complying with the requirements of Part 27/29.952, and spans aircraft models that are certified to nearly all 27.952 requirements to those that have only a few CRFS features. As an example, most of the partially-compliant helicopters have crash resistant fuel bladders, but they demonstrate a range of compliance with both the current drop test requirements and penetration requirements of 27/29.952, 27/29.963(g), and associated Advisory Circulars (AC).

Note that all partially-compliant helicopters in this study were certified to 14 CFR Part 27. While there were partially-compliant Part 29 aircraft in the NTSB Database, the number of crashes was too small to be statistically significant, and therefore these crashes weren't included in this analysis.

Details of the CRFS features incorporated into these models are described in the "Partially-Compliant CRFS Model Designs" section below. The manufacturer and model names have been redacted to protect proprietary manufacturer data. Note that one additional manufacturer has recently begun incorporating a partially-compliant fuel system in at least one of its legacy ("grandfathered") models, but no crashes of these helicopters had been reported in the NTSB Database as of December 31, 2016, the cut-off date for the current study.

The crash data for the current study was extracted from the NTSB's Microsoft Access Accident Database, current through December 2016. The initial filter criteria were as follows:

- Registration Number = All U.S. registered only
- Aircraft Category = Helicopters only
- Event Type = Accidents only, not incidents
- Date of Accident = Between 1/1/1996 and 12/31/2016 (most recent 20-year data available)
- Homebuilt = *N* or is null (excludes homebuilt helicopters that were not type certificated and catches cases where NTSB inadvertently left the field unpopulated)

The database was then manually filtered to include only those helicopters equipped with partially-compliant CRFS at the time of the accident, as identified to the ROPWG by OEM representatives. This included helicopters originally manufactured with CRFS features, as well as those that were originally manufactured without the CRFS features and then later retrofit with CRFS components. No other filters were applied. The end result was a database containing 274 accidents involving partially-compliant CRFS helicopters.

Additionally, a similar but independent analysis was performed for helicopters that had standard fuel systems without significant CRFS features and were, therefore, considered non-compliant with respect to 27.952. This second database of non-CRFS compliant helicopters contained 558 accidents.

PARTIALLY-COMPLIANT CRFS MODEL DESIGNS

The fuel systems of the partially-compliant CRFS helicopters included in the dataset are detailed in Table 3 below:

Table 3. Partially-Compliant CRFS Compliance Matrix

Regulation	Model				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
27.952(a): Drop Test	Bladder only[2]	Bladder only[2]	Certified	Certified	Incorporates fuel bladder, but drop test not performed
27.952(b): Fuel Tank Load Factors	(b)(1): No (b)(2): Meets (b)(3): Meets	(b)(1): No (b)(2): Meets (b)(3): Meets	(b)(1): No (b)(2): Certified (b)(3): Certified	Unlikely	(b)(1): N/A (b)(2): Unknown (b)(3): Likely
27.952(c): Flexible fuel hoses and breakaway fittings	Meets	Meets	Certified	Partial[5]	Meets
27.952(d): Frangible or deformable structural attachments	Meets	Meets	Certified	Partial[6]	Likely
27.952(e): Separation of fuel and ignition sources	Meets	Meets	Certified	Likely	Likely
27.952(f): Other basic mechanical design criteria	Meets	Meets	Certified	Likely	Likely
27.952(g): Rigid or semi-rigid fuel tank (tear resistance)	Meets	Meets	Certified	Meets	Meets
27.963(g): Fuel bladder puncture resistance	Partial[3]	Partial[3]	Certified[4]	Partial[7]	Likely[9]
27.975(b): Rollover vent valves	No	No	Certified	Partial[8]	No

Table Notes:

1. Definition of compliance terms:
    a. Certified: Test data and/or analysis demonstrating compliance was approved by the FAA.

   b. Meets: Proprietary tests and/or analysis show that the design meets or exceeds requirements of the regulation and advisory circular, but the tests/analysis were not submitted to the FAA.
   c. Likely: Proprietary tests and/or analysis indicate that compliance is likely, but test results/analysis have not been submitted to the FAA.
   d. Unlikely: Proprietary tests and/or analysis indicate that compliance is possible but unlikely without a design change.
   e. No: Proprietary tests and/or analysis indicate that compliance cannot be demonstrated without a design change.
   f. Partial: The general intent of the regulation (in whole or in part) is incorporated in the design, but compliance was not demonstrated to the full extent of the regulation and/or associated advisory circular.
   g. Unknown: The relevant tests and/or analysis have not been performed, so the level of compliance is undetermined.
2. Fuel cell/bladder alone (no structure) survived drop from 50 feet while 80% full of water.
3. Fuel bladder material meets 250 lb puncture test.
4. Early units were FAA certified and delivered with fuel bladders meeting 370 lb puncture resistance on bottom surface and the lower part of the sides, and 250 lb puncture elsewhere. Later units were/are delivered with a fuel bladder that meets 370 lb puncture requirement on all surfaces.
5. Most but not all fuel hoses are flexible. Slack is incorporated in fuel hoses in lieu of breakaway fittings, but due to geometry constraints, the available slack is less than that specified by the regulation and advisory circular.
6. The bladder connection to the airframe is frangible, but tests and/or analysis were not performed to determine compliance with the detailed requirements of the regulation and advisory circular.
7. Fuel bladder surfaces at a higher risk of puncture meet 370 lb puncture test requirement. Other surfaces meet 265 lb test.
8. Rollover vent valves are incorporated that were shown to be effective at preventing fuel leaks at angles between 90° and inverted. Valves are likely less effective at other (less likely) angles.
9. Installation utilizes a bladder inside rigid and semi-rigid structure. The FAA and the manufacturer have not discussed the possibility of issuing an Equivalent Level of Safety (ELOS) finding.

RESULTS

PARTIALLY-COMPLIANT CRFS PERFORMANCE

Each of the 274 accidents in the partially-compliant CRFS accident database was individually reviewed to determine the following:

- Whether or not there was a post-crash fire (PCF), and if so, whether the fire was due to:
  - A malfunction of the engine ("engine fire")
  - The ignition of ground foliage due to contact with the hot engine or exhaust component ("grass fire")
  - A post-crash rupture of a fuel line and/or fuel tank ("fuel spillage")
    - Note that only fuel spillage fires are addressed by the CRFS regulations under review; grass fires and engine fires are not affected by the regulatory changes under consideration
- The severity (survivability) of the accident
  - Rated on a scale of 1-4 as defined in Table 18 of the ROPWG Task 2 report, and reproduced below as Table 4
- The number of occupants that sustained thermal injuries
  - Occupants that received fatal blunt force trauma injuries during the accident were not included in the thermal injury tally

Table 4. Definition of Accident Severity Levels Utilized for the CRFS Review (reproduced from Task 2 report)

Severity	Description	Details/Example
0	Non-crash	Rotorcraft normal landing after damage to the rotorcraft.
1	Minor	Hard landing where the landing gear does not fully collapse and the rotorcraft remains upright. Most auto-rotations would fall in this category.
2	Moderate	Enough crash energy to fully collapse the landing gear and cause some fuselage crush, and/or any crash with a rollover or tipping on the side.
3	Severe	Significant impact energy and fuselage crush. Occupant living volume is maintained for at least one occupant.
4	Extreme	High energy impact where volume is compromised for all occupants. An example would be CFIT. This level of crash severity is often called "non-survivable."

To make the above determinations, the working group primarily reviewed information in the NTSB Database and publicly available news reports. However, since the NTSB reports rarely contain information on impact conditions and injury data is infrequently recorded for occupants other than pilots, the assistance of manufacturer accident investigators was required to establish accident severity and injury data for some accidents. This is the same procedure used for the ROPWG Task 2 report submitted on November 10, 2016, as well as the CT85-11 report "*Analysis of Rotorcraft Crash Dynamics for Development of Improved Crashworthiness Design Criteria*" completed in June 1985 that was used by the FAA in support of the original CRFS and CRSS (Crash Resistant Seat and Structure) rulemaking effort.

The results of this analysis are included below in Table 5 and Table 6:

Table 5. Post-Crash Fire and Thermal Injury Rates for Partially-Compliant Models				
Helicopter Model	**Total Accidents**	**Post-Crash Fire Rate**		**Occupants That Received Thermal Injuries After Surviving Impact (all accidents)**
		Accidents filtered by: • **Post-crash fire of any source** • **Any accident severity**	**Accidents filtered by:** • **Post-crash fire due to fuel spillage** • **"Survivable" accidents (severity level 1-3)**	
Model 1	59	5 (8%)	0-3* (0%-5%)	0 (0%)
Model 2	106	6 (6%)	0 (0%)	0 (0%)
Model 3	72	7 (10%)	0 (0%)	0 (0%)
Model 4	31	1 (3%)	0 (0%)	0 (0%)
Model 5	6	1 (17%)	0 (0%)	0 (0%)
Cumulative Total for All Partially-Compliant Models	**274**	**20 (7%)**	**0-3* (0%-1%)**	**0 (0%)**

*Note: For Model 1, for the 5 accidents with a post-crash fire, 2 of the fires were known to be engine fires. The other 3 fires are suspected to be engine fires, but there was insufficient data available to confirm the fire source.

Table 6. Breakdown of Partially-Compliant CRFS Accidents by Accident Severity							
Helicopter Model	**Total Accidents**	**Accident Severity**					
		Unknown	**0**	**1**	**2**	**3**	**4**
Model 1	59	1 (2%)	0 (0%)	13 (22%)	37 (63%)	6 (10%)	2 (3%)
Model 2	106	2 (2%)	3 (3%)	46 (43%)	41 (39%)	5 (5%)	9 (8%)
Model 3	72	0 (0%)	7 (10%)	26 (36%)	23 (32%)	3 (4%)	13 (18%)
Model 4	31	0 (0%)	4 (13%)	6 (19%)	19 (61%)	1 (3%)	1 (3%)
Model 5	6	0 (0%)	0 (0%)	3 (50%)	0 (0%)	2 (33%)	1 (17%)
Cumulative Total for All Partially-Compliant Models	**274**	**3 (1%)**	**14 (5%)**	**94 (34%)**	**120 (44%)**	**17 (6%)**	**26 (9%)**

NON-COMPLIANT CRFS PERFORMANCE

In order to provide context and perspective for the partially-compliant CRFS analysis described above (Table 5), an independent, yet similar, analysis was performed for helicopters that had standard fuel systems without significant CRFS features and were, therefore, considered non-compliant with respect to Part 27.952. This analysis looked at the post-crash fire rates over the same 1996 through 2016 time period for three representative non-CRFS, Part 27 aircraft. The results of this analysis are presented below in Table 7.

Table 7. Post-Crash Fire and Thermal Injury Rates for Non-CRFS Models

Total Accidents	Post-Crash Fire Rate		Occupants That Received Thermal Injuries After Surviving Impact (all accidents)
	Accidents filtered by: • **Post-crash fire of any source** • **Any accident severity**	**Accidents filtered by:** • **Post-crash fire due to fuel spillage** • **"Survivable" accidents (severity level 1-3)**	
558	81 (15%)	64 (11%)	To Be Determined*

*Note: The ROPWG did not have adequate time to research this value before submitting this interim report. The ROPWG may attempt to determine this value for the final report if the interested parties believe this to be of sufficient value.

Due to time constraints with this interim report, accident severity levels were only determined for the non-complaint CRFS accidents that experienced a post-crash fire. Accident severity levels may be determined for the remainder of the accidents (558) as part of the final report, if the interested parties believe this to be of sufficient value.

FULLY-COMPLIANT CRFS PERFORMANCE

The ROPWG Task 2 report submitted on November 10, 2016, analyzed the performance of fully-compliant CRFS. For convenience, the results of that study are reproduced below in Table 8 and Table 9, presented in a format consistent with the partially-compliant and non-CRFS data above.

Note that, as described in the ROPWG Task 2 Report, there are no helicopters certificated to Part 29 included in this analysis because there were very few crashes involving Part 29 helicopters in the database.

Table 8. Post-Crash Fire and Thermal Injury Rates for Fully-Compliant CRFS Models (Data from ROPWG Task 2 Report)

Total Accidents	Post-Crash Fire Rate		Occupants That Received Thermal Injuries After Surviving Impact (all accidents)
	Accidents filtered by: • Post-crash fire of any source • Any accident severity	Accidents filtered by: • Post-crash fire due to fuel spillage • "Survivable" accidents (severity level 1-3)	
53	7 (13%)	0 (0%)	0 (0%)

Table 9. Breakdown of Fully-Compliant CRFS Accidents by Accident Severity (Data from ROPWG Task 2 Report)

Helicopter Model	Total Accidents	Accident Severity					
		Unknown	0	1	2	3	4
Cumulative Data for Fully-compliant Models	53	0 (0%)	7 (13%)	15 (28%)	19 (36%)	3 (6%)	9 (17%)

COMBINED CRFS PERFORMANCE DATA

The post-crash fire and thermal injury data for fully-compliant, partially-compliant, and non-compliant CRFS Part 27 models is summarized in Table 10 and Table 11 below:

Table 10. Comparison of Post-Crash Fire and Thermal Injury Rates for Fully-Compliant, Partially-compliant, and Non-Compliant CRFS Models

CRFS System	Post-Crash Fire Rate		Occupants That Received Thermal Injuries After Surviving Impact (all accidents)
	Accidents filtered by: • Post-crash fire of any source • Any accident severity	Accidents filtered by: • Post-crash fire due to fuel spillage • "Survivable" accidents only (severity level 1-3)	
Fully-Compliant	13%	0%	0%
Partially-compliant	7%	0%-1%	0%
Non-Compliant	15%	11%	To Be Determined*

*Note: The ROPWG did not have adequate time to research this value before submitting this interim report. The ROPWG may attempt to determine this value for the final report if it is believed to be of sufficient value.

Table 11. Comparison of Accidents by Accident Severity for Fully-Compliant, Partially-Complaint, and Non-Compliant CRFS Models							
Helicopter Model	**Total Accidents**	**Accident Severity**					
		Unknown	**0**	**1**	**2**	**3**	**4**
Cumulative Total for Fully-Compliant Models	53	0 (0%)	7 (13%)	15 (28%)	19 (36%)	3 (6%)	9 (17%)
Cumulative Total for All Partially-compliant Models	274	3 (1%)	14 (5%)	94 (34%)	120 (44%)	17 (6%)	26 (9%)
Cumulative Total for Non-Compliant Models	558	To Be Determined*					

*Note: Due to time constraints with this interim report, accident severity levels were only determined for the non-complaint CRFS accidents that experienced a post-crash fire. Accident severity levels may be determined for the remainder of the accidents as part of the final report, if the interested parties believe this to be of sufficient value. Statistical analysis of these data will be provided in the Final Report.

DISCUSSION

The data presented in Table 5, Table 7 and Table 8 and summarized in Table 10 demonstrate that the crash performance of the partially-compliant Part 27.952 helicopters, with regard to the prevention of post-crash fires, is essentially identical to the performance of fully-compliant helicopters. Both groups had no significant post-crash fires or thermal injuries for survivable crashes (Severity 1-3). This is in contrast to non-compliant helicopters that had an 11% rate of post-crash fire due to fuel spillage following survivable crashes. Additionally, the crash data suggested that rollover vent valves were effective in preventing fuel spillage from vent lines although there were no significant fires resulting from this mechanism in partially-compliant models that did not incorporate rollover vent valves.

An analysis of the various makes and models of partially-compliant helicopters showed that, among designs that passed a 50-foot drop test (with or without structure) and had a puncture resistance of at least 250 lb, there were no trends of one model helicopter being more or less effective than another in preventing fuel-fed, post-crash fires and thermal injuries. One partially-compliant model (#5) did not meet these criteria, but due to the small number of accidents in the database for this model, it is not possible to make a determination as to the effectiveness of its fuel system CRFS features.

As discussed in the ROPWG Task 2 Report, requiring full compliance with the current occupant protection regulations in newly manufactured, legacy helicopters would be extremely disruptive to Original Equipment Manufacturers (OEMs) and Operators since full compliance would reduce performance, increase costs and, in some cases, be completely impractical, resulting in the discontinuation of certain helicopter models. Based partially on the Task 2 report, the FAA requested that the ROPWG determine which portions of the current occupant protection regulations could be shown to be effective in legacy helicopters.

This study has demonstrated that currently manufactured, partially-compliant CRFS helicopters perform equivalently to fully-compliant CRFS models. Consequently, ROPWG recommends that the FAA not pursue a requirement that all newly manufactured helicopters meet the full requirements of 27.952 and associated ACs since current partially-compliant models are achieving equivalent crash performance. Furthermore, requiring partial compliance will be far less costly to the industry since many models are now being manufactured with an effective CRFS and, for those that are not equipped with CRFS, achieving partial compliance at a level similar to current partially-compliant models will be less costly and far less disruptive than meeting full compliance. Recommendations for the definition of an adequate, partially-compliant CRFS are detailed below.

Finally, there were very few helicopters certified to Part 29 involved in crashes, and as a result, it is impossible for ROPWG to take an empirical approach toward the issue of determining an appropriate fuel system for newly manufactured, legacy Part 29 helicopters. For this reason, ROPWG cautiously recommends that, unless further analysis for the final version of this report suggests otherwise, similar rules for Part 29 helicopters be adopted as for Part 27 helicopters. This approach is consistent with current regulations (27/29.952) which do not provide separate criteria for Part 27 and 29 helicopters.

CONCLUSIONS

Based upon the data presented in Table 5 through Table 10, we conclude the following:

1. Compared to the fully-compliant CRFS models, the partially-compliant CRFS models are equally effective at preventing post-crash fires and thermal injuries in the current crash environment.
2. Compared to non-compliant CRFS helicopters, the partially-compliant CRFS helicopters reduced the post-crash fire rate by 90%-100% for fires due to fuel spillage in survivable accidents.
3. An analysis of the various makes and models of partially-compliant helicopters showed that, among designs that passed a 50-foot drop test (with or without structure) and had a puncture resistance of at least 250 lb, there were no trends of one model helicopter being more or less effective than another in preventing fuel-fed, post-crash fires and thermal injuries.
4. The absence of a roll-over vent valve on one of the partially-compliant fuel systems may (or may not) have contributed to fuel spillage and subsequent post-crash fires after survivable accidents. However, the resulting fires were small and slow-spreading and did not cause any thermal injuries nor hinder the egress of occupants.

Note that these are interim conclusions, and may be somewhat modified or clarified in the final report due January 25, 2018.

RECOMMENDATIONS

27.952 RECOMMENDATIONS

The ROPWG recommendations for CRFS regulatory compliance with 27.952 for newly manufactured legacy aircraft are summarized below in Table 12, and discussed in detail following the table. Since the CRFS features/components of the partially-compliant CRFS helicopters included in the study (Table 5) have been proven to be effective, ROPWG recommendations for newly manufactured legacy helicopters are based upon an amalgamation of these CRFS systems.

Note that while the FAA asked for a recommendation on "which Paragraphs of each Section for the existing occupant protection standards cited in the referenced FR Notice can be made effective for newly manufactured rotorcraft", the ROPWG members believe that the inclusion of elements of 27/29.963(g) (Fuel tank puncture resistance) and 27/29.975(b) (Rollover vent valves), in addition to the recommendations for 27.952, is required in order to produce effective CRFS regulations for newly manufactured legacy helicopters. The ROPWG recommends that these requirements be specified in Advisory Circular guidance for newly manufactured, legacy helicopters, as summarized in Table 12 and discussed in detail following the table.

Also note that the ROPWG is recommending these regulatory requirements and modifications in the context of newly manufactured, legacy helicopters only. While the data in this report could conceivably be used in consideration of modifications to the regulations as they apply to new type designs, such recommendations are beyond the scope of the ROPWG tasking. This report should not be interpreted as making any recommendations for or against the amendment of current CRFS regulations.

Table 12. 27.952 Regulatory Recommendations for Newly Manufactured Legacy Helicopters		
Regulation	**Recommendation**	**Notes**
27.952(a)(1)(2)(3)(5)(6): Drop test requirements	Recommended	Regulation should also allow bladder-only drop test (i.e., no surrounding structure required).
27.952(a)(4) Drop test requirements	NOT recommended	
27.952(b): Fuel tank load factors	NOT recommended	N/A
27.952(c): Flexible fuel hoses and breakaway fittings	To be determined	Specific ROPWG guidance to be determined at a future meeting.
27.952(d): Frangible or deformable structural attachments	NOT recommended	27.952(f) and the associated AC guidance address these same items, but have a regulatory standard that is more appropriate for incorporation into a previously-approved legacy helicopter.
27.952(e): Separation of fuel and ignition sources	NOT recommended	
27.952(f): Other basic mechanical design criteria	Recommended	AC guidance for new production legacy rotorcraft should be drafted to additionally include elements of 27.963(g) (fuel tank puncture resistance) and 27.975(b) (rollover vent valves). Acceptable methods of compliance should ensure that legacy helicopters found to provide effective post-crash fire protection will be considered compliant.
27.952(g): Rigid or semi-rigid fuel tanks	To be determined	Specific ROPWG guidance to be determined at a future meeting.
Requirement for full compliance 10 years after approval of new CRFS rules	NOT recommended	Data for partially-compliant helicopters show that the recommendations in this report are equally effective at preventing post-crash fires and thermal injuries, but with a substantially lower weight penalty and monetary cost.

DISCUSSION OF RECOMMENDATIONS

27.952(a): Drop Test Requirements

Recommended with qualification that bladder-only drop tests are permitted.

Dropping the bladder alone is generally considered more severe with respect to pressure loads on the bladder, while dropping with surrounding structure is more critical with respect to puncture and other hazards associated with attachment to structure. Therefore, either approach to drop testing may be critical for a specific bladder installation.

As noted in Table 3 and the associated notes, as part of the non-required development testing for the CRFS in Models 1 & 2, the CRFS fuel bladders were subjected to a 50-foot drop test per the requirements of 27.952(a), except that the test was performed for the bladders alone (i.e., the surrounding structure was not included in the drop). It is clear from the post-crash fire data for these models that these fuel systems are extremely effective at preventing post-crash fires and thermal injuries following survivable accidents.

Therefore, while the surrounding structure may indeed create a puncture hazard, including bladder material puncture resistance and other material properties identified in AC 27-1b as part of guidance is an equally effective but less arduous and less expensive means of ensuring puncture resistance compared to dropping the bladder inside the structure.

Note that mandating 27.952(a) Paragraphs 1, 2, 3, 5, and 6, and making paragraph 4 optional, would allow for tests with or without the surrounding structure.

27.952(b): Fuel Tank Load Factors

NOT recommended

The data in Table 3 and Table 10 show that CRFS systems with fuel tank load factors certified to lower levels (i.e., those required for the original certification basis) in current partially-compliant helicopters are equally effective at preventing post-crash fires and thermal injuries as CRFS systems in fully-compliant helicopters. For many helicopter models, increasing the structural retention strength of the fuel tanks would require a significant increase in fuselage strength, with associated weight penalties, research and development costs, and manufacturing costs. This is particularly true for small, legacy rotorcraft that were designed around lower load factors. These penalties and costs, combined with data showing the lack of a measurable benefit, lead to the recommendation that this regulation not be required for newly manufactured legacy rotorcraft, and therefore the load factors required for a particular model during its original certification remain in effect.

27.952(c): Fuel Line Self-sealing Breakaway Couplings

To be determined

27.952(c) and 27.952(f) and their associated AC guidance, both address crash resistant fuel hoses and a means of preventing over tensioning of those lines in a survivable crash. While these regulations and guidance address very similar topics, the regulatory requirements of 27.952(c) include prescriptive details that are impractical for some previously-approved, legacy aircraft that have

demonstrated adequate post-crash fire protection. The requirements of 27.952(f) are generally much more appropriate for a previously-designed airframe.

Note that the Model 4 data from Table 3 and Table 5 shows that this design, while partially-compliant with 27.952(c) but likely compliant with 27.952(f), was extremely effective at preventing post-crash fires following survivable accidents.

Although ROPWG members agree that some elements of 27.952(c) and its associated guidance should be incorporated into the CRFS requirements for newly manufactured, legacy rotorcraft, some felt that certain components of this paragraph were unnecessary and cost prohibitive for some models of legacy rotorcraft and that those elements should not be required. Others did not agree. Since ROPWG was unable to resolve precisely which requirements of 27.952(c) should be required and since resolution of these issues will require further study and discussion by the ROPWG, we elected to defer our recommendation on 27.952(c) until the final report.

27.952(d): Frangible or deformable structural attachments

NOT recommended

27.952(d) and 27.952(f) (recommended; see below), and their associated AC guidance, both address crash resistant attachments of the fuel system components. While these regulations and guidance address very similar topics, the regulatory requirements of 27.952(d) include prescriptive details that are impractical for some previously-approved, legacy aircraft showing adequate post-crash fire protection, while the requirements of 27.952(f) are much more appropriate for a previously-designed airframe. Therefore, it is recommended that compliance with 27.952(f) be required, but compliance with 27.952(d) is NOT required.

Note that the Model 4 data from Table 3 and Table 5 shows that this design, while partially-compliant with 27.952(d) but likely compliant with 27.952(f), was extremely effective at preventing post-crash fires following survivable accidents.

27.952(e): Separation of fuel and ignition sources

NOT recommended

27.952(e) and 27.952(f) (recommended; see below), and their associated Advisory Circular guidance, both address the separation of fuel and ignition sources. While these regulations and guidance address very similar topics, the regulatory requirements of 27.952(e) include prescriptive details that are impractical for some previously-approved, legacy aircraft showing adequate post-crash fire protection, while the requirements of 27.952(f) are much more appropriate for a previously-designed airframe. Therefore, it is recommended that compliance with 27.952(f) be required, but compliance with 27.952(e) is NOT required.

Note that the data in Table 3 and Table 10 show that CRFS systems with typical separation of fuel and ignition sources are equally effective at preventing post-crash fires and thermal injuries as newer models certified to 27.952(e).

27.952(f): Other basic mechanical design criteria

Recommended

27.952(f) addresses, in part, the requirements of 27.952(c), (d), and (e), but imposes a regulatory burden ("as far as practicable") that is more appropriate for a previously-designed, legacy airframes. Detailed advisory material can be proposed to describe the intent and methods of compliance that would be required to meet these criteria in Advisory Circulars.

Additionally, while the FAA asked for a recommendation on "which Paragraphs of each Section for the existing occupant protection standards cited in the referenced FR Notice can be made effective for newly manufactured rotorcraft", the ROPWG members believe that the inclusion of elements of 27/29.963(g) (Fuel tank puncture resistance) and 27/29.975(b) (Rollover vent valves), in addition to the recommendations for 27.952, is required in order to produce the most rational and cost/weight effective CRFS regulations for newly manufactured, legacy helicopters. The ROPWG recommends that these requirements be defined as part of Advisory Circular guidance to the proposed retroactive requirements for newly manufactured rotorcraft. However, the ROPWG has not completed its study on the specific performance design elements of these regulations it will recommend at this time. Specific performance design recommendations are planned for inclusion in the final report based upon an analysis of the actual crash performance of the existing CRFS elements in partially-compliant helicopters as noted above.

27.952(g): Rigid or semi-rigid fuel tanks

To be determined

This paragraph and its associated Advisory Circular guidance (AC27-1B) address test standards for fuel cell penetration and tear resistance. Compliance with 27.952(g) helps ensure that fuel bladders will not be torn or punctured during an accident, which could result in catastrophic fuel leakage. The partially-compliant helicopter models analyzed in Table 3 meet or likely meet certain aspects of this requirement, particularly puncture resistance. However, most were not designed to meet nor tested to the reduced Mil-T-27422B tear resistance standards specified in AC27-1B. ROPWG members were divided on whether to recommend a tear resistance standard for newly manufactured, legacy rotorcraft. Considering the time constraints in producing this Interim Report, ROPWG elected to defer a decision on this paragraph pending further data and discussions on this topic. The ROPWG will provide its recommendations on this paragraph in its final report due in January, 2018.

Requirement for full compliance 10 years after approval of new CRFS rules

The ROPWG recommends that the FAA **does not** require full compliance with 27.952 after a 10-year period for legacy, newly manufactured helicopters, for the following reasons:

- The data in this report shows that there would be little or no benefit to mandating full compliance instead of the partial compliance solution recommended in Table 12. The full compliance requirement would be very costly and disruptive to the OEM's and operators alike. Additionally, this requirement would result in the discontinuation of certain helicopter models due to the infeasibility of making the required changes in these models.
- The Task 2 report showed that achieving full compliance with 27.952 was very costly for legacy helicopters, both financially and in terms of weight. While this interim report does not calculate the costs of partial compliance, these costs will clearly be lower compared to full compliance, particularly since many currently-produced partially-compliant helicopters either

meet or mostly meet these requirements already. Delaying full compliance by 7-10 years will not change that fact, nor result in lower costs and performance deficits.

APPENDIX A

ROPWG MEMBERSHIP

NAME	COMPANY/ REPRESENTING	Position
Dennis F. Shanahan	Injury Analysis, LLC	Chair
Robert J. Rendzio	Safety Research Corporation of America (SRCA)	Voting Member
Harold (Hal) L. Summers	Helicopter Association International	Voting Member
Jonathan Archer	General Aviation Manufacturers Association (GAMA)	Voting Member
Daniel B. Schwarzbach, SPO	Airborne Law Enforcement Association's (ALEA)	Voting Member
Krista Haugen	Survivors Network for Air & Surface Medical Transport	Voting Member
Joan Gregoire	MD Helicopters, Inc.	Voting Member
John Wittmaak	Bell Helicopter Textron, Inc.	Voting Member
Matthew Pallatto	Sikorsky	Voting Member
William Taylor	Enstrom Helicopter Corporation	Voting Member
Pierre Prudhomme-Lacroix	Airbus Helicopters	Voting Member
David Shear	Robinson Helicopter Company	Voting Member
Chris Meinhardt	Air Methods	Voting Member
John Heffernan	Air Evac Lifeteam	Voting Member
John Becker	Papillon Airways Inc	Voting Member
Christopher Hall	PHI Air Medical, LLC	Voting Member
Bill York	Robertson Fuel Systems	Voting Member
Randall D. Fotinakes	Meggitt Polymers & Composites	Voting Member
Marv Richards	BAE Systems	Voting Member
Laurent Pinsard	EASA Structures Engineer	Non-Voting Member
Rémi Deletain	EASA Powerplant & Fuel Engineer	Non-Voting Member
Martin R. Crane	FAA Structures Engineer	Non-Voting Member